The **International Journal of Innovative Research in Engineering & Multidisciplinary Physical Sciences** (**IJIRMPS**) is a **multidisciplinary, bi-monthly, online, peer reviewed, widely indexed, openly accessible international journal** and helping researches to share their research information **since 2013**.

Our aim is to explore advances in research pertaining to applied, theoretical and experimental technological studies. The goal is to promote scientific information interchange between researchers, developers, engineers, students and practitioners working all around the world. We provide an opportunity for practitioners and educators of all fields to exchange research evidence, models of best practice and innovative ideas.

Research Areas

As a multidisciplinary journal, we are accepting Research work from all branches of **Engineering**, all branches of **Ph.D.**, all fields of **Medical & Pharmacy**, all branches of **Business Administration (MBA)**, all disciplines of **Physical Sciences** and all streams of **Computer Applications (MCA)**.

Here is the wider list of all the disciplines:

- Engineering
- Medical / Pharmacy
- Business Administration
- Physical Science
- Computer Applications
- Arts
  - Drawing
  - Fashion
  - Movies / Music / TV
- Biology
  - Agriculture / Botany
  - Bio + Chemistry
  - Genetics / Molecular
  - Geology
  - Medical / Physiology
  - Zoology
- Chemistry
  - Petroleum
  - Pharmacy
- Computer
  - Artificial Intelligence / Simulation / Virtual Reality
  - Automation / Robotics
  - Data / Information
  - Design
  - Electronics
  - Logic
  - Network / Security
- Mathematics
  - Economy / Commerce
  - Logic
  - Maths + Physics
  - Statistics
- Sociology
  - Administration / Law / Management
  - Archaeology / History
  - Banking / Finance
  - Data / Information / Statistics
  - Economics
  - Education
  - Geology
  - Health
  - Home Science
  - Intelligence / Security
  - Journalism / Media
  - Linguistic / Literature
  - Philosophy / Psychology / Religion
  - Politics
  - Sports
  - Tourism / Transport
- Physics
  - Astronomy
  - Civil Engineering
  - Electric
  - Energy
  - Mechanical Engineering
  - Nano Technology / Nuclear

INDEX

Algae growth stabilization and prediction model matrix of soil sludge

[1]S. Siregar, [2]M.N.M. Pauzi, [3]C.M.M. Kasim, [4]S.H.M. Yusof, [5]K. Arumugam, [6]N. S. Yaacob, [7]M. Arifin

[1]Senior Lecturer, [2]Lecturer, [3]Lecturer, [4]Lecturer, [5]Student, [6]Senior Lecturer, [7]Assoc. Prof
Faculty of Engineering and Biotechnology,
Universiti Selangor, Bestari Jaya, Selangor, Malaysia

Abstract: **The pattern growth of the three algae species – PRK1-E01, C. Vulgaris and Nephrochlamys Subsolitaria which are found in the sludge within the Sabak Bernam region is not stable. The unstable distribution matrix of the algae growth is derived to determine a stable growth by modeling a transition matrix and stable distribution probability using Marcov Chain methodology. Thus, a stable algae growth can be predicted.**

Keywords: **Algae growth; Marcov Chain; Sludge extraction; Distribution matrix; stable probability**

I. INTRODUCTION

Sludge is a residuum that contains adsorbed and insoluble impurities which is being produced during a wastewater treatment. It is also defined as nutrient-rich organic materials. Those biosolids is recycled through soil application into an healthy benefits has been an exceedingly esteemed regular practice in numerous nation in the world by [1]. As an alternative, the recycling process in this study uses 25% to 89% of the biosolids as suggested by [2] and [3].

Other than that, mass-culturing of high-value microalgae species is utilized from the aquaculture sludge. [4], [5], [6] have demonstrated that microalgae growth in aquaculture wastewater is possible. Moreover, it can be used in the production of valuable products such as nutraceuticals, cosmeceuticals, pharmaceuticals, aquaculture feeds and biofuels.

Microalgae is a group of eukaryotic organisms that are commonly found in seawater and freshwater waters. This type of algae is able to withstand temperatures due to sunlight, control the level of water salinity, wide pH value, light intensity either in water reservoirs or in the desert. Some important elements such as phosphorus, nitrogen, silica and iron as well as inorganic nutrients needed by microalgae. Micronutrients are also important for the reproduction of algae. Microalgae have carbon-rich compounds needed in biofuels, pharmaceuticals, cosmetics, supplements, animal foods and many more uses (see [7] and [8]). [9] state that they have also produced a wide range of bioproducts such as antioxidants, polysaccharides, bioactive compounds, proteins, vitamins, pigments and lipids.

Previously, cell culture flasks are widely used to test the growth of microalgae which is expensive and time consuming (see [10]). However, at present, newly establish system is employed to culture selected microalgae which is called as microplate-incubation technique by [11]. Microplates are an obvious choice for high-throughput studies as it is reliable, fast, cost effective and not requiring intensive labor (see [12]). Besides that, it is mostly used in clinical microbiology and not been extensively used in environmental field. [13] noted that to find the bioaccumulation of metals by different species of algae, microtechnique is developed and it is proven that microplates can be used for algae growth and also for toxicity tests. According to [14], microplates is an ideal platform for microalgae culture for medium to high throughput screening purposes. Previously, those studies show that border wells in the microplates are not used during experiment as it is exposed to strong currents of air although microalgae growing in the border wells which have greater access to light and CO_2 [15-17].

In order to analyze and predict the future behavior, the Markov chain model is being utilized by many researchers in different application. The following references signify the applicability of Markov chain model in this context. Few of the examples, [18] utilizes Markov chain model to predict the possible states by illustrating the performance of the top two banks which are Guarantee Trust bank of Nigeria and First bank of Nigeria. They used six years data from 2005 to 2010. [19] implements a Markov chain model in forecasting the stock market trend in China. [20] introduce Markov chain model to forecast stock market trend of Safaricom share in Nairobi Securities Exchange in Kenya. Mettle, [21] uses Markov chain model with finite states to analyze the share price changes for five different randomly selected equities on the Ghana Stock Exchange and [22] consider forecasting model based on non-homogenous index sequence. But, none of them have utilized Marcov Chain methodology for the application of algae growth prediction and stability.

II. METHODOLOGY

Preparing of Sludge

Sludge was collected from aquaculture site in Sabak Bernam shrimp pond. One (1) kg of sample is collected from the site.

Course particles in the sludge is removed and oven dries at 60°C until moisture is removed. After the drying process, dried sludge is grinded and sieved for omogenization.

Sludge Extraction

Aqueous extraction method is carried out on the sludge samples at an ambient temperature of 105°C. Extraction method carried out to the sludge sample was 105°C. Sludge sample, 20 g of dried sludge was added with 200 ml of ultra-pure water (1 part of sludge to 10 parts of ultra-pure water) in Schott bottles. For high temperature of aqueous extraction, sample was autoclaved for one hour at 105°C. Then, sample was centrifuged using Beckmen Allegra X-30R centrifuge machine at 2500 rpm for 15 minutes. Supernatant was filtered using Whatman Glass Microfiber Filter (GF/F) 0.7µm and filtrates were kept in freezer for further analysis.

Preparation of Microalgae

Three microalgae species were used in this study such as *Chlorella vulgaris* (TRG 6), *Nephroclamys subsolitaria* (KDH 3 - C05) and unknown species (PRK 1 – E01). Microalgae sp. were collected from Peninsular Malaysia and, the genus and species of the microalgae were identified by University Malaysia Terengganu (UMT). *C. vulgaris* was a marine microalga while *N. subsolitaria* and PRK 1 – E01 were freshwater microalgae.

Subculture of microalgae sp.

Stock culture was prepared for all microalgae sp. at University Selangor (UNISEL). *C. vulgaris* uses Conway media and the other two microalgae use BBM as artificial growth medium. Three 50 ml conical flasks were autoclaved. 50 ml of Conway media or BBM was poured into the conical flasks and 1000 µl of microalgae was then added to the media. The sample was shake well and incubated at 25°C for further uses. After one or two weeks of incubation, the strains were used to test on sludge extracts. Subculture of all microalgae were conducted to avoid any cross-contamination in pure culture.

Microplate Incubation Technique

Microplate contains 96 wells which can be filled up to 200µl of solution as shown in **Fig. 1**. 175 µl of suitable media, 5 µl of extracted sludge and 20 µl of algae were added in each well to record the exponential phase of microalgae. Control wells were also included in every test.
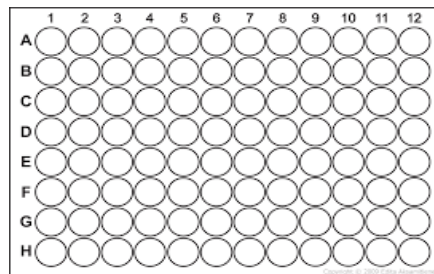
Figure 1. Microplate with 96 wells**.**

The ambient temperature at 25°C, source of light at 2,500 lux within 12-hour cycle period and 12-hour dark are few of the parameters. The microalgae growth is being monitored 24 hours to determine the optical density (OD) at 680 nm with the used of microplate reader Infinite M200 PRO (Tecan, Austria). The microalgae development is governed by evaluating the OD, by [23] as described it in the absorption of visible radiation in which the chlorophyll adsorption peak is approximately at the value of 680 nm. Each of the wells containing controls and samples are mixed using 8' multi-channel Ependorf pipettor prior to the OD measurement. The OD of all the 96-wells are calculated for every 24 hours.

Discrete-Time Marcov Chains

Considers a system as one of a countable or finite state space where, $S \subseteq \{0,1,2,\ldots\}$.

Definition 2.1. By [24] *A discrete-time of stochastic process* $\{X_n : n \geq 0\}$ *with a state space* $S \subseteq \{0,1,2,\ldots\}$ *is called a discrete-time Markov chain (Mc) if and only if it has a Markov property (Mp),*

$$P\left(X_{n+1} = j \mid X_n = i, X_{n-1} = i_{n-1}, \ldots, X_0 = i_0\right) = P\left(X_{n+1} = j \mid X_n = i\right). \tag{1}$$

for all $n \geq 0$, $i, j, i_0, i_1, \ldots, i_{n-1} \in S$ (the probability of the next state given the current state and the entire past depends only on the current state). The Mp as shown in Equation 1 is a constraint on the memory of the process: knowing the immediate past means the earlier outcomes are no longer relevant.

Transition Matrix

[25] states that if a Mc has k possible states, which labels as 1, 2, …, k, then the probability of the system is in the state i at any observation after it is in the state j at the preceding observation as denoted by p_{ij} and is called the transition probability from state j to state i. The matrix $P = [p_{ij}]$ is called the transition matrix of the Mc. For example, in a three-state Mc, the transition matrix has the form of a new state as shown in the Equation 2,

$$\begin{array}{ccc} 1 & 2 & 3 \end{array}$$
$$\begin{bmatrix} p_{11} & p_{12} & p_{13} \\ p_{21} & p_{22} & p_{23} \\ p_{21} & p_{32} & p_{33} \end{bmatrix} \begin{array}{c} 1 \\ 2 \\ 3 \end{array} \tag{2}$$

Matrix p_{32} is the probability in which the system will change from state 2 to 3, p_{11} is the probability that the system will still be in state 1 if it is previously in state 1, and so forth. The transition matrices of the Mc have the property that the entries in any column sum to 1. If $P = [p_{ij}]$ is the transition matrix of any Mc with k states, then for each j must be written as,

$$p_{1j} + p_{2j} + \ldots + p_{kj} = 1 \tag{3}$$

in which, if the system is in state j at one observation, it is certain to be in one of the k possible states at the next observation for the probability models of the three (3) algae species - PRK1-E01, C. vulgaris (TRG 6) and Nephrochlamys subsolitaria.

Algae growth data

The daily Alga Growth Data of PRK1-E01, C. vulgaris (TRG 6) and Nephrochlamys subsolitaria during Day 2, Day 3 and Day 4 are gathered in Table 1 and Fig. 2.

Table 1. The Alga growth data of three species from Sabak Bernam   Sludge within 3-day period.

ALGAE SPECIES	DAY 2	DAY 3	DAY 4
PRK1-E01	0.07	0.09	0.11
C. vulgaris (TRG 6)	0.06	0.12	0.17
Nephrochlamys subsolitaria	0.05	0.10	0.18
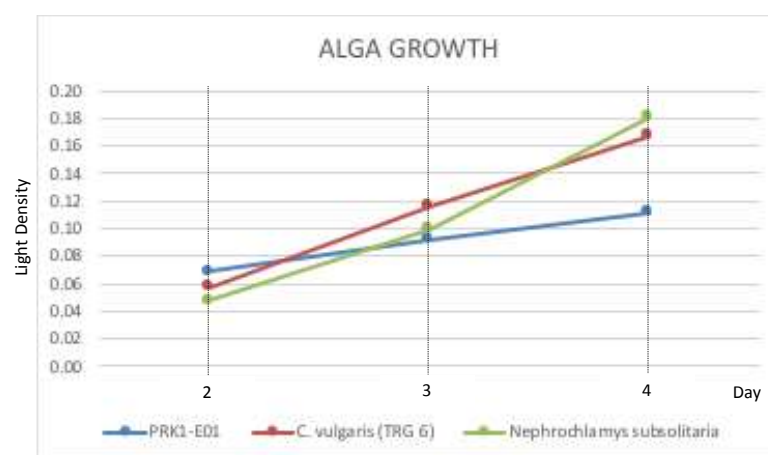
Figure 2. The algae growth data for 4-day period.

Algae growth

The algae growth data is selected at the highest value of each day with the three different species at different day '
growth trends of PRK1-E01, *C. Vulgaris* (TRG 6) and Neophrochlamys Subsolitaria during day 2,3 and 4 in (10^{-2})

Algae Species	DAY 2	DAY 3	DAY 4	Total
PRK1-E01	7	9	11	27
C. vulgaris (TRG 6)	6	12	17	35
Nephrochlamys subsolitaria	5	10	18	33
Total	**18**	**31**	**46**	**95**

III. RESULTS AND DISCUSSION

Unstable Distribution Growth

The algae growth is distributed equally which is being produced randomly means that each type of algae has equal access information. The probabilities of the Mp are estimated through technical analysis in which PRK1-EO1 is growth at 26% followed by the next day in which C. Vulgaris (TRG 6) at 15% and Nephrochlamys subsolitaria at 55% and so on.

The probability of each algae growth can be determined by the ratio as stated in Equation 4 and the results are captured in Table 3 in which the transition schematic diagram is demonstrated in Figure 3.

$$P(Algae) = \frac{Algae\ growth}{Total\ Algae\ growth} \qquad (4)$$

Table 3. The probability growth from day 2,3 and 4

From \ To	Day 2 PRK1-E01	Day 3 C. vulgaris (TRG 6)	Day 4 Nephrochlamys subsolitaria
PRK1-E01	0.26	0.33	0.41
C. vulgaris (TRG 6)	0.17	0.34	0.49
Nephrochlamys subsolitaria	0.15	0.30	0.55
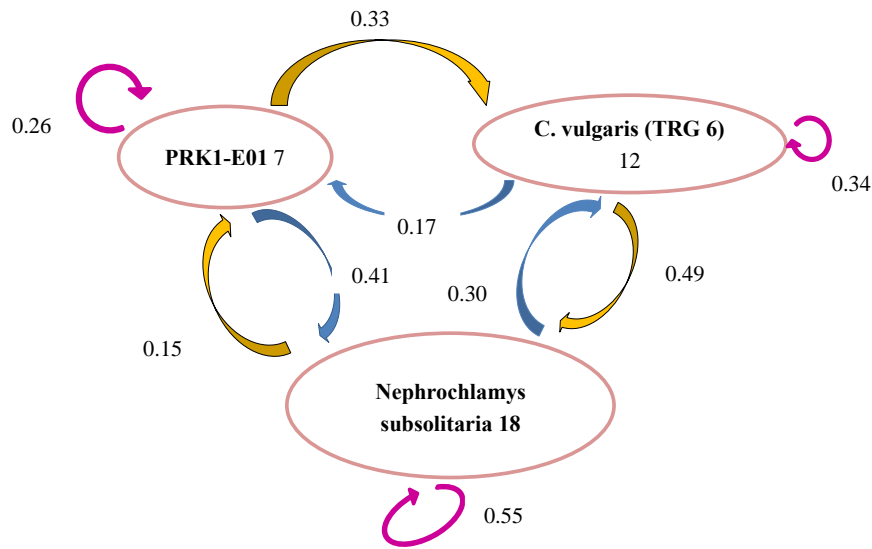
Figure 3. Transition diagram

Computation Growth

The computation process to predict the algae growth trends for unstable distribution within day 2 to 4 is captured in Table 4.

Table 4. Probability Table of Markov Chains

Algae Species	Day 2	Day 3	Day 4	Total
PRK1-E01	0.26	0.33	0.41	1.0
C. vulgaris (TRG 6)	0.17	0.34	0.49	1.0
Nephrochlamys subsolitaria	0.15	0.30	0.55	1.0
Total	0.58	0.97	1.45	
	$\neq 1$	$\neq 1$	$\neq 1$	

Derivation from unstable to stable distribution − **Table 4** shows that the total probability of the day 2, 3 and 4 are not equal to 1, then the distribution is unstable. Therefore, to derive the unstable into a stable distribution, the algae growth probability has to be derived first as follows,

Lets,

Tot = Total number of PRK1-E01, C. vulgaris (TRG 6) and Nephrochlamys subsolitaria in Table 2 (yellow highlight), resulting a total of 37.

a_{11} = PRK1-E01

a_{22} = C. vulgaris (TRG 6)

a_{33} = Nephrochlamys subsolitaria

Equation (4) can be derived into Equation (5) as follows,

$$P(a_{nn}) = \frac{Algae \ growth}{\sum_{n=1}^{3} a_{nn}} \tag{5}$$

From the above equation, thus the unstable distribution probability for PRK1-E01 is 0.19; unstable distribution probability for C. vulgaris (TRG 6) is 0.32; and the unstable distribution probability for Nephrochlamys Subsolitaria is 0.49.

Lets X_0 represents the row matrix of the unstable algae growth probability with the three species which is represented by a vector with Algae growth Space as S= {PRK1-E01, C. vulgaris (TRG 6), Nephrochlamys subsolitaria}.

Thus,

$$X_0 = (P(a_{11}) \quad P(a_{22}) \quad P(a_{33})) \tag{6}$$

or, $X_0 = (0.19 \quad 0.32 \quad 0.49)$

Then, the probability of Table 4 can be transformed into the transition matrix as shown in Equation (7),

$$\text{To}$$

$$A = \begin{bmatrix} 0.26 & 0.33 & 0.41 \\ 0.17 & 0.34 & 0.49 \\ 0.15 & 0.30 & 0.55 \end{bmatrix} \text{From} \tag{7}$$

The probability matrix has the ability to predict what is going to happen in the future based apart from what is happening currently and how things going to be changed.

Determination of future algae growth

The future algae growth is the matrix of the current algae growth transition probabilities [26]. Thus,

$$X_{n+1} = X_n A, \quad n = 0,1,2,... \tag{8}$$

where, X_{n+1} = Next Algae Growth,

A = Probability Matrix

X_n = Initial Algae Growth

Lets. $X_n = (PRK1\text{-}E01, C.vulgaris (TRG 6), Nephrochlamys subsolitaria)$,
when $n = 0 \rightarrow$ One day after Day 2 : Day 3
Thus,

$$X_1 = X_0 A \tag{9}$$

or,

$$X_1 = (0.19 \quad 0.32 \quad 0.49) \begin{pmatrix} 0.26 & 0.33 & 0.41 \\ 0.17 & 0.34 & 0.49 \\ 0.15 & 0.30 & 0.55 \end{pmatrix}$$

or,

$$X_1 = \begin{pmatrix} \underset{PRK\ X_2}{0.1773} & \underset{Vulgaris\ X_2}{0.3185} & \underset{Neph\ X_2}{0.5042} \end{pmatrix}$$

Therefore, the total up of the probabilities above is equal to 1.

Determination of algae growth distribution

The algae growth is determined by multiplying each algae probability with the total number of the three algae PRK1-E01, C.Vulgaris (TRG 6) and Nephrochlamys subsolitaria.

Therefore, each algae growth for PRK1-E01, C. Vulgaris (TRG 6) and Nephrochlamys subsolitaria are determined as 6.5601, 11.784 and 18.655 respectively.

So, the matrix of algae growth is denoted by, $X_1 = (6.5601 \quad 11.7845 \quad 18.6554)$

When $n = 1 \rightarrow$ Two days after day 2 : day 4

$$X_2 = X_1 A$$

$$= \begin{pmatrix} 0.1773 & 0.3185 & 0.5042 \end{pmatrix} \begin{pmatrix} 0.26 & 0.33 & 0.41 \\ 0.17 & 0.34 & 0.49 \\ 0.15 & 0.30 & 0.55 \end{pmatrix}$$

$$X_2 = \begin{pmatrix} 0.175873 & 0.318059 & 0.506068 \end{pmatrix}$$

$$= \begin{pmatrix} \underset{\text{PRK } X_2}{0.175873} & \underset{\text{Vulgaris } X_2}{0.318059} & \underset{\text{Neph } X_2}{0.506068} \end{pmatrix}$$

Thus, the total up of the probabilities of the above is equal to 1.

Then again, the distribution of the algae growth is determined for the second attempt by multiplying the above first round probability by the total number of the three algae PRK1-E01, C. Vulgaris (TRG 6) and Nephrochlamys subsolitaria,

Therefore, each algae growth for PRK1-E01, C. Vulgaris (TRG 6) and Nephrochlamys subsolitaria are determined in the second attempt as 6.507301, 11.768183 and 18.724516 respectively.

So, the matrix of Algae Growth is denoted by,

$$X_2 = \begin{pmatrix} 6.507301 & 11.768183 & 18.724516 \end{pmatrix}$$

So, the diagonalize process determines the second attempt for the algae growth matrix is as follows,

$$Let\ A = \begin{pmatrix} 0.26 & 0.33 & 0.41 \\ 0.17 & 0.34 & 0.49 \\ 0.15 & 0.30 & 0.55 \end{pmatrix}$$

Thus, the eigenvalues of A are $\lambda_1 = 1$, $\lambda_2 = 0.1177$, and $\lambda_3 = 0.0323$.

To determine the eigenvectors corresponding to the eigenvalue $\lambda = 1$, compute the null space of $A - 1.000I$.

Therefore $E_1 = \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$, $E_{0.1177} = \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 0.9448 \\ -0.0002 \\ -0.3277 \end{pmatrix}$ and $E_{0.0323} = \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 0.6270 \\ -0.7390 \\ 0.2466 \end{pmatrix}$

So, the corresponding eigenvectors are

$$v_1 = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix} \quad v_2 = \begin{pmatrix} 0.9448 \\ -0.0002 \\ -0.3277 \end{pmatrix} \quad \text{and} \quad v_3 = \begin{pmatrix} 0.6270 \\ -0.7390 \\ 0.2466 \end{pmatrix}$$

Next to verify that $D = P^{-1}AP$, where

$$P = \begin{pmatrix} 1 & 0.9448 & 0.6270 \\ 1 & -0.0002 & -0.7390 \\ 1 & -0.3277 & 0.2466 \end{pmatrix} \quad \text{and} \quad P^{-1} = \begin{pmatrix} 0.1757 & 0.7148 & 0.2375 \\ 0.3180 & 0.2759 & -0.9229 \\ 0.5063 & -0.9907 & 0.6854 \end{pmatrix}$$

So that $D = P^{-1}AP = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0.1177 & 0 \\ 0 & 0 & 0.0323 \end{pmatrix}$

or, $D^n = \begin{pmatrix} 1^n & 0 & 0 \\ 0 & 0.1177^n & 0 \\ 0 & 0 & 0.0323^n \end{pmatrix}$

While $A^n = PD^nP^{-1}$

$$= \begin{pmatrix} 1 & 0.9448 & 0.6270 \\ 1 & -0.0002 & -0.7390 \\ 1 & -0.3277 & 0.2466 \end{pmatrix} \begin{pmatrix} 1^n & 0 & 0 \\ 0 & 0.1177^n & 0 \\ 0 & 0 & 0.0323^n \end{pmatrix} \begin{pmatrix} 0.1757 & 0.7148 & 0.2375 \\ 0.3180 & 0.2759 & -0.9229 \\ 0.5063 & -0.9907 & 0.6854 \end{pmatrix}$$

$$= \begin{pmatrix} 1^n & 0.94480(0.1177^n) & 0.6270(0.0323^n) \\ 1^n & -0.0002(0.1177^n) & -0.7390(0.0323^n) \\ 1^n & -0.3277(0.1177^n) & 0.2466(0.0323^n) \end{pmatrix} \begin{pmatrix} 0.1757 & 0.7148 & 0.2375 \\ 0.3180 & 0.2759 & -0.9229 \\ 0.5063 & -0.9907 & 0.6854 \end{pmatrix}$$

$$= \begin{pmatrix} 0.1757+0.3(0.1177^n)+0.32(0.0323^n) & 0.7148+0.26(0.1177^n)-0.62(0.0323^n) & 0.2375+0.3(0.1177^n)+0.32(0.0323^n) \\ 0.1757-0.64(0.1177^n)-0.37(0.0323^n) & 0.7148-0.00006(0.1177^n)+0.73(0.0323^n) & 0.2375+0.0002(0.1177^n)-0.51(0.0323^n) \\ 0.1757-0.10(0.1177^n)+0.12(0.0323^n) & 0.7148-0.09(0.1177^n)-0.24(0.0323^n) & 0.2375+0.3(0.1177^n)+0.17(0.0323^n) \end{pmatrix} \quad (10)$$

Since $X_{n+1} = A X_n$ in Equation (10).

Then,

$$X_n = X_0 A^n \qquad (11)$$

where $n = 0,1,2,...$ and A^n is denoted by Equation (11).

If the future growth is becoming the same with the initial growth, then the chain shall be stopped means that the distribution becomes stable.

Then, the values of X_n where $(n = 0,1,2,...7)$ can be summarized in the table form as shown in Table 5 as follows,

Table 5 demonstrates that the distribution is stabled at seventh (7th) attempt by multiplying the probability and algae growth value of $n = 7$. The distribution value for the next state is the same as before. Then, the algae growth matrix begins to be converged. Therefore, the solution is concluded that the probabilities are converged to a steady state algae growth, thus n → 7 means that the values of 6.500351527 for PRK1-E01, 11.76563604 for C. vulgaris (TRG 6) and 18.73401243 for Nephrochlamys subsolitaria are finalized.

This solution concludes that the probabilities is converged to a steady algae growth, thus, n → 7 means that the values of 6.500351527 for PRK1-E01, 11.76563604 for C. vulgaris (TRG 6) and 18.73401243 for Nephrochlamys subsolitaria are finalized.

If the same result is obtained with the unstable by the row unstable (transpose method), then the future growth is becoming the same with the initial growth, so the Mc should be on hold. This means that the distribution is stable.

Table 4. The summary of the distribution probability values for X_n

N	X_n	(PRK1-E01; C.Vulgaris(TRG6);Nephrochlamys S)	Corresponding Eigenvectors
0	X_0	(0.19; 0.32; 0.49)	0
1	X_1	(0.1773; 0.3185; 0.5042)	E_1=(0.01267; 0.0015; -0.0142)
2	X_2	(0.175873; 0.318059; 0.506068)	E_2=(1.427(10_{-3}); 4.41(10^{-4}); -0.001868)
3	X_3	(0.17570721; 0.31799855; 0.50629424)	E_3=(1.6579(10^{-4}); 6.045(10^{-5}); -2.2624(10^{-4}))
4	X_4	(0.175685477641; 0.3179911583; 0.5063210776)	E_4=(1.94459(10^{-5}); 7.3917(10^{-6}); -2.68376(10^{-4}))
5	X_5	(0.175685477217; 0.317990279255; 0.506324243528)	E_5=(4.24(10^{-8}); 8.79(10^{-6}); -3.166(10^{-6}))
6	X_6	(0.175685208078970; 0.317990175486710; 0.506324616434320)	E_6=(2.69(10^{-7}); 1.037(10^{-7}); -3.73(10^{-7}))
7	X_7	(0.175685176398421; 0.317990163261837; 0.506324660339742)	$E_7 \rightarrow 0$ the system stable
8	X_8	(0.175685172669063, 0.317990161822426; 0.506324665508511)	$E_8 \rightarrow 0$ the system stable

Figure 4 shows the new transition diagram in which it is designed after the distribution is stable. Then, the probability matrix and initial algae growth is utilized to calculate the next algae growth. If the attemption goes on the next algae growth continuously, then the algae growth is kept changing very quickly and the changes can be seen either lower or higher. Then, it drives the algae growth matrix begins to converge to certain particular values.
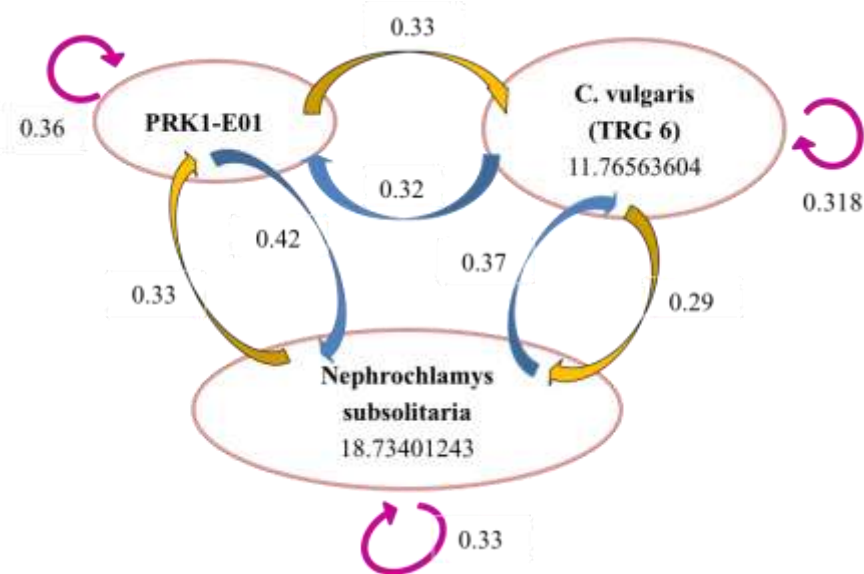
Figure 4. The Result for New Stability Transition Growth Diagram

The nth value depends on the situation of getting the stability of the distribution matrix. The stable distribution matrix demonstrates that a new algae growth value shall be obtained on the following day. In the analysis above that the distribution is stabled at the 8th attempt by multiplying the probability with the algae growth value of $n = 7$. Then, the distribution will be valued for the next attempted state as exactly the same as the earlier attemption one step behind . Now, the algae growth matrix begins to be converged.

IV. CONCLUSION AND RECOMMENDATION

This attemption steps or systems methodology can be used as an example before any new products are introduced into the market. As example a new product which are not yet available in the market. In order for a new product to be penetrated into the marketplace, a marketing and commercial study shall be done at all optimum levels of those study and evaluation.

An attempted curiosity attitude from customers is a norm at the initial state to purchase any new products in the marketplace as compared to their favorite products in which they are used to purchase. If the new product is good or matched the customer's needs, the they will switch to the new brand for the second attempt. If it is bad product, the customer will not continue to purchase it rather maintaining the previous brand. Therefore, the probability matrix using Markov Chains method is very useful to predict on how a new product shall be able to penetrate into the current marketplace competing with any established brands.

V. ACKNOWLEDGMENT

VI. CONFLICT OF INTEREST

All authors declare no conflicts of interest in this paper.

REFERENCES

[1] S. T. Madariaga and S. L. Marín, Sanitary and environmental conditions of aquaculture sludge. *Aquaculture research,* **48(4)** (2017), 1744-1750. https://doi.org/10.1111/are.13011

[2] M. Escudey, M. Förster, J.E. Becerra, J.P. et. al.. Disposal of domestic sludge and sludge ash on volcanic soils. *Journal of hazardous materials,* **139(3)** (2007), 550-555. https://doi.org/10.1016/j.jhazmat.2006.02.062

[3] C. Bonnin, Organic pollutants and sludge – the French experience in: Research the Sludge Directive, A conference on Sewage Sludge, Brussels, (2001), Retrieved 30 Oct 2018, from htpp://europe.eu.int/comm/environments/ sludge/ conference.htm.

[4] N. M. Nasir, N. S. A. Bakar, F. Lananan, et. al., Treatment of African catfish, *Clarias gariepinus* wastewater utilizing phytoremediation of microalgae, *Chlorella sp.* with *Aspergillus niger* bio-harvesting. *Bioresource technology,* **190** (2015), 492-498. https://doi.org/10.1016/j.biortech.2015.03.023

[5] Z. Guo, Y. Liu, H. Guo, et. al. Microalgae cultivation using an aquaculture wastewater as growth medium for biomass and biofuel production. *J. Environmental Sciences,* **25 (**2013), S85-S88. https://doi.org/10.1016/S1001-0742(14)60632-X

[6] M. H. Michels, M. Vaskoska and M.H. Vermuë, et. al., Growth of Tetraselmis suecica in a tubular photobioreactor on wastewater from a fish farm. *Water research,* **65** (2014), 290-296. https://doi.org/10.1016/j.watres.2014.07.017

[7] P. Das, S. S. Aziz and J. P. Obbard, Two phase microalgae growth in the open system for enhanced lipid productivity. *Renewable Energy,* **36(9)** (2011), 2524-2528. https://doi.org/10.1016/j.renene.2011.02.002

[8] L. Barsanti, P. Coltelli, V. Evangelista, A.M. Frassanito, V. Passarelli, N. Vesentini and P. Gualtieri, Oddities and curiosities in the algal world. In: *Algae toxins: nature, occurrence, effect and detection*. Dordrecht: Springer, (2008), 353–391.

[9] L. Brennan and P. Owende, Biofuels from microalgae a review of technologies for production, processing and extractions of biofuels and co-products. *Renewable and sustainable energy reviews,* **14(2)** (2010), 557-577. https://doi.org/10.1016/j.rser.2009.10.009

[10] M. Huesemann, B. Crowe and P. Waller, et. al.. A validated model to predict microalgae growth in outdoor pond cultures subjected to fluctuating light intensities and water temperatures. *Algal Research,* **13** (2016), 195-206. https://doi.org/10.1016/j.algal.2015.11.008

[11] Q. Zhao, A. N. Chen, S.X. Hu, et. al., Microalgal Microscale Model for Microalgal Growth Inhibition Evaluation of Marine Natural Products. *Scientific reports, 8*(1), (2018), 10541. https://doi.org/10.1038/s41598-018-28980-z

[12] J. Van Wagenen, S. L. Holdt and D. De Francisci, et. al., Microplate-based method for high-throughput screening of microalgae growth potential. *Bioresource technology,* **169** (2014), 566-572. https://doi.org/10.1016/j.biortech.2014.06.096

[13] C. Blaise, Legault, R., Bermingham, N., Van Coillie, R., & Vasseur, U. P. (1986). A simple microplate algal assay technique for aquatic toxicity assessment. *Toxicity Assessment*, *1***(3),** 261-281.

[14] A. Pacheco, I. Hernández☐Mireles and C. García☐Martínez, et. al., Microplates as a microreactor platform for microalgae research, *Biotechnology progress, 29*(3) (2013), 638-644, https://doi.org/10.1002/btpr.1721.

[15] C. Blaise and J. F. Férard. (2005), Overview of contemporary toxicity testing. In Small-Scale Freshwater, *Toxicity Investigations,* (2013), 1-68, Springer, Dordrecht, https://doi.org/10.1007/1-4020-3120-3.

[16] D. St☐Laurent, C. Blaise and P. MacQuarrie, et. al., Comparative assessment of herbicide phytotoxicity to *Selenastrum capricornutum* using microplate and flask bioassay procedures. *Environmental Toxicology and Water Quality, 7*(1) (1992), 35-48. https://doi.org/10.1002/tox.2530070104

[17] R. Rojíčková, D. Dvořáková and B. Maršálek, The use of miniaturized algal bioassays in comparison to the standard flask assay. *Environmental Toxicology and Water Quality: An International Journal, 13*(3) (1998), 235-241. https://doi.org/10.1002/(SICI)1098-2256(1998)13:3%3C235::AID-TOX5%3E3.0.CO;2-8

[18] D. N. Choji, S. N. Eduno & G. T. Kassem, Markov Chain Model Application on Share Price Movement in Stock Market: *Journal of Computer Engineering and Intelligent Systems. www. iiste.org, 4*(10) (2013), 84-95.

[19] D. Zhang, X. Zhang, Study on Forecasting the Stock Market Trend Based on Stochastic Analysis Method: *International Journal of Business and Management. 4*(6) (2009), 163-170.

[20] S. Otieno, E. O. Otumba and R. N. Nyabwanga, Application of Markov Chain to Model and Forecast Stock Market Trend: A Study of Safaricom Shares in Nairobi Securities Exchange, Kenya: *International Journal of Current Research,* (2015), 14712-14721.

[21] F. O. Mettle, Quaye ENii Boi and R. A. Laryea, A Methodology for Stochastic Analysis of Share Price of Markov Chains with Finite States, *SpringerPlus, 3*(1) (2014), 657, doi: 10.1186/2193-1801-3-657

[22] N. M. Xie, S. F. Liu, Y. J. Yang and C. Q. Yuan, On Novel Grey Forecasting Model Based on Non-Homogenous index Sequence. *Applied Mathematical Modelling,* 37, (2013), 5059-5068. https://dx.doi.org/10.1016/j.apm.2012.10.037

[23] K. Dziosa and M. Makowska, Monitoring of Chlorella sp. growth based on the optical density measurement. *Problemy Eksploatacji*. (2016)

[24] Damjan Škulj, Discrete time Markov chains with interval probabilities. *International Journal of Approximate Reasoning*, **50**(2009), 1314–1329.

[25] H. Anton and C. Rorres, *Elementary Linear Algebra,* (8th ed.). Canada: Techsetters, Inc, 2000.

[26] D. Poole, *Linear Algebra: A Modern Introduction,* United States of America: Robert W. Pirtle, 2011.

MOBILITY MANAGEMENT AND PERFORMANCE STATISTICS IN CELLULAR COMMUNICATION

[1]C Ufuah, [2]K O Tanno

Delta State Polytechnic Otefe-Oghara, Nigeria

Abstract: **This study presents and examines a management model of cellular mobility protocols and the performance of some of its parameters for optimal spectral efficiency of the mobile communication system. Mobility management enables the networks to track the location of mobile nodes. Location management encompasses location registration and call delivery or paging. With the convergence of the internet and wireless mobile communications and with the rapid growth in the number of mobile subscribers, mobility management emerges as one of the most important and challenging problems for wireless mobile communication over the internet. This work is presented on the platform of an analytical framework that can enhance considerably the mobility mechanism in wireless network. Some advance schemes namely, guard channels, and handover queuing are discussed. All these prioritizations schemes have a common characteristic reducing the call dropping probability at the expense of increased call blocking probability. The mobility management scheme addressed latency in the service delivery enhancing the guaranteed quality of service (Qos) and an efficient and robust channel capacity.**

INTRODUCTION

Mobility management is extremely important in cellular network because of the cellular architecture employed to maximize spectrum utilization. Mobility is the procedure that transfers an ongoing call from one cell to another as the user's moves through the coverage area of cellular system. One way to improve the cellular network performance is to use efficient handover prioritization schemes when user is switching between the cells. Efficient prioritization scheme accommodates a number of new calls while guarantees the quality of service (QoS) of handover call.Over the past years, a number of IP mobility management protocols have been proposed. Different mobility management frameworks can be broadly distinguished into two categories – device mobility management protocol localized or micro-mobility and protocol for inter-domains or macro mobility. The movement of a mobile node (MN) between two subnets within the domain is referred to as micro-mobility.

Mobility management enables the serving networks to locate a mobile subscriber's point or attachment for delivering data packets (ie location management), and maintain a mobile subscriber's connection as it to change its point of attachment.

Domains: A domain represents an administrative body which may include different access network such as WLAN, second – generation (2G) and third generation (3G) networks. Next – generation all – IP wireless network will induce various heterogenic networks, each of them using possibly different access technologies.

A handover is a process in telecommunications and mobile communications in which a connected cellular call or data session is transferred from one cell site (base station) to another without disconnecting the session. Cellular services are based on mobility and handover, allowing the user to be moved from one cell site range to another to be switched to the nearest cell site for better performance   Ekici (2012).

The progressive trend of urbanization involving changes in the activities of a city has created several problems. Addressing these problems requires reliable and detailed information regarding the urban structure and its dynamics. In order to avoid abrupt termination of ongoing call handover request should be given priority to new call this is called as mobility prioritization.

There are two techniques for this.

1)   Guard Channel Concept: In this technique, a fraction of the total available channel in a cell is reserved exclusively for handover request from ongoing calls which may be handed off into the cell.

2)   Queuing: Queuing of handoffs is possible because there is a finite time interval between the time the received signal level drops below handoff threshold and the time the call is terminated due to insufficient signal level. The delay size is determined from the traffic pattern of a particular service area Misra, Das and McAuley (2010).

This is the process by which a mobile mode keeps its connection active when it moves from one access point to another. There are stages in the mobility process. First, the initiation of handover is triggered by either the mobile device or a network agent or the changing network conditions. The second stage is for a new connection generation when the network must find new resources for the handover connection and perform and additional routing operations. Depending on the movement of the mobile device, it may undergo various type of handover. In a broad sense, handover may be intra-system (horizontal handover) which occurs in homogenous networks. The type occurs when the signal strength or the serving BS goes below a certain threshold value. Handover

on the other hand may also be inter-system (vertical handover) which takes place in heterogeneous networks when a user moves out or the serving network and enters and overlying network or to underlying network for service requirement.

In essence, the design or mobility management techniques in all wireless networks must address the following issues: (1) signaling overhead and power requirement for processing handover messages should be minimized. (ii) Qos guarantees must be made (iii) network resources should be efficiently used and (iv) the mobility mechanism should be scalable viable and robust.

With the convergence of the internet and wireless mobile communications and with the rapid growth in the number of mobile subscribers, mobility management emerges as one of the most important and challenging problems for wireless mobile communication over the internet. Mobility management enables the serving networks to locate a mobile subscriber's point or attachment for delivering data packets (ie location management) and maintain a mobile subscriber's connection as it to change its point of attachment.

Location management enables the networks to track the location of mobile nodes. Location management has two major sub-tasks (i) location registration on (ii) call delivery or paging. In location registration procedure, the mobilizers node periodically sends specific signals the inform the network of its current location so that the location database it kept update.

The call delivery proceeds in involved after the completion or the location registration. Based on the information that has been registered in the network during the location registration.

The overall aim of this study is to enhance the concept of cellular mobility protocols and investigate some critical parameters to validate the concept.

In order to achieve the aim of this study, the following objectives are set out as outlined below.

(a)   Ascertain call set up time to enhance efficiency and effectiveness of calls made by a mobile station.

(b)   Optimize the quality of service (QoS) as a critical performance indicator of the network for efficient service delivery.

Technology Developments

The radio spectrum is a precious and scarce resource. Therefore, novel technologies for efficient spectrum utilization to enhance the capacity of 3G and beyond systems are keenly anticipated. Factors that could have a significant impact on the deployment of mobile telecommunications technologies in this timeframe include radio access techniques enabling greater intelligence and flexibility to be built into transmitters and receivers. Some technology topics that appear relevant to some lesser or greater degree to the future development are: advanced radio resource management (RRM) algorithms; flexible frequency sharing methods; smart antennas; diversity techniques; coding techniques; space-time coding; efficient multiple access schemes or adaptive modulation.

3G mobile communications systems arose as a response to the challenge of developing systems that increased the capacity of the existing 2G systems. Simultaneously, they would provide a platform that allowed a seamless and ubiquitous access to the user of a wide range of new services, both circuit and packet switched, with higher requirements in terms of bit rate than those for which 2G systems were conceived. The development of 3G systems started in 1995, coordinated by the ITU-T (International Telecommunications Union – Telecommunications sector) under the generic terminology of IMT-2000 and so far different radio access technologies have been considered leading to the development of several standards. Within this framework, the Universal Mobile Telecommunications System (UMTS) is the European proposal given by ETSI (European Telecommunications Standards Institute) to the 3G challenge. As a matter of fact, it is the dominant standard, resulting from the standardization work done by the 3GPP (3rd Generation Partnership Project), an organization formed by different regional standardization bodies that include the presence of both manufacturers and operators from all around the world.

UMTS has been developed as the migration of the ETSI 2G/2.5G systems GSM/GPRS. The aim is to facilitate as much as possible the extension of the existing networks of these worldwide systems as well as the interoperability of the new UMTS system with the previous networks, thus allowing a progressive migration of the technology. As a result of this requirement, the most important changes introduced in the initial release of UMTS consist of a new radio access network based on a different radio access technology, while keeping the core network similar to that existing in GSM/GPRS systems.

The general UMTS network architecture from the physical point of view is presented here and it consists of an abstract model, applicable to any UMTS network, with independency of the specific release . It is organised in domains, and each domain represents the highest level group of physical entities. Reference points are defined between the different domains. The basic split considers the User Equipment (UE) domain, used by the user to access the UMTS services, and the Infrastructure domain, UMTS 7 composed of the physical nodes, belonging to the network operator, that support the service requirements and the interconnection with the entity at the other end (e.g. another UE from the same or another network) with whom the end-to-end service has to be established.

The infrastructure domain in the UMTS architecture contains the physical nodes that terminate the radio interface allowing the provision of the end-to-end service to the UE. In order to separate the UMTS Subscriber Identity Module (USIM) domain.

UMTS 11 supporting one or both of the two modes, as well as the ability to interoperate between them. Notice that, from the radio resource management point of view, the concept of radio resource is different for each mode. As a result, the RRM strategies in both cases lead to different types of algorithms. In the context of this book, only the RRM strategies for the UTRAN FDD mode are considered.

UTRAN. Quality requirements expressed by, for example, delay and reliability attributes, only apply to incoming traffic up to the guaranteed bit rate. It is worth noting that the guaranteed bit rate at the RAB level may be different from that on the UMTS bearer level, for example due to header compression.

- Delivery order. This indicates whether the UMTS bearer shall provide in-sequence SDU (Service Data Unit) delivery or not and specifies if out-of-sequence SDUs are acceptable or not.
- Maximum SDU size used for admission control and policing. This corresponds to the maximum packet size that can be delivered at the top of the radio interface.
- SDU format information. This is the list of possible exact sizes of SDUs.
- SDU error ratio. This indicates the fraction of SDUs lost or detected as erroneous. This attribute is used to configure the protocols, algorithms and error detection schemes, primarily within UTRAN.
- Residual bit error ratio. This indicates the undetected bit error ratio in the delivered SDUs. It is used to configure radio interface protocols, algorithms and error detection coding.
- Delivery of erroneous SDUs. This indicates whether SDUs detected as erroneous will be delivered or discarded.

Cellular Mobility Prioritization Schemes

Different ideas and approaches are proposed to reduce the handover dropping probability. One approach is to reduce the handover failure rate is to prioritize handover call over new calls. Handover prioritization schemes have a significant impact on the call dropping probability and call blocking probability. Such scheme permits high utilization of bandwidth while guaranteeing the quality of service of handover calls**.**

The guard channel scheme was introduced in 80s for mobile cellular systems. However the guard channel scheme are still used in telecommunications with the name of Cut-off Priority Schemes. GC scheme improving the probability of successful handover by simply reserving a number of channels exclusively for handover in each cell. The GC scheme is feasible because new calls are less sensitive to delay than the handover calls.

According to GC Therefore according to the cell occupancy by Markov chain it is straight forward to derive the steady state probability P n that n channels are busy.

The call admission control scheme refers to the task of deciding whether new call requests are admitted into the network or not. In the CAC the arrival of new call are estimated continuously and if they are higher than the predefined threshold level then some calls are restricted (blocked) irrespective of whether a channel is available or not to decrease the probability of handover calls. In the CAC both the new and handover calls have to access to all channels. If a new call that is generated in cell cannot find an idle channel the call is discarded immediately.

In order to improve the mobility call prioritization scheme it is advisable to equalize the traffic load over the cells. Traffic reason and directed retry handover make use of this principal. First the new call to be served and if the receiver is able hear a neighbouring cell and are not considered in this situation. Traffic reason handover International Journal of Advance Research in Science and Engineering can be used to transfer traffic from one cell to another neighbouring when they are closed to the congestion. The traffic reason handover idea is based on the neighbouring cell having an overlapping service area. The overlapping service area arises naturally in GSM cellular system especially in small-cell high capacity micro cellular configurations. The small-cells are capture by subdividing a congested cell each with his own base station. The call arising in the common area (overlapping) of cells have access to channels more than one base station. By appropriate control strategy a cell may select the base station to establish a connation and contribute to efficient spectrum management.
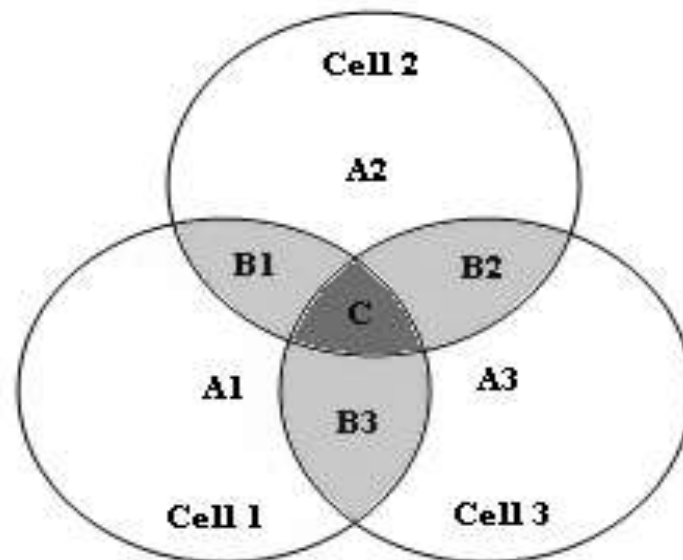
Fig 3: Areas A, B and C of three Cells

QoS and QoE

This section defines and explains the differences between QoS and QoE. This will help us to understand the requirements of the operator and of the end-user:

- QoS is defined as the ability of the network to provide a service at an assured service level. QoS encompasses all functions, mechanisms and procedures in the cellular network and terminal that ensure the provision of the negotiated service quality between the user equipment (UE) and the core network (CN).
- QoE is how a user perceives the usability of a service when in use – how satisfied he or she is with a service in terms of, for example, usability, accessibility, retainability and integrity of the service. Service integrity concerns throughput, delay, delay variation (or jitter) and data loss during user data transmission; service accessibility relates to unavailability, security (authentication, authorization and accounting), activation, access, coverage, blocking, and setup time of the related bearer service; service retainability, in general, characterizes connection losses.

QoS provisioning is a process that deploys QoS in networks and mobile terminals. The process translates planning results into mechanisms and parameters understandable by network elements and mobile terminals and it further configures them on equipment or devices.

QoS provisioning can be classified in three categories: radio, core and transport QoS provisioning that configures the QoS mechanisms inside the network; service QoS provisioning that maps services into QoS profiles and terminal QoS provisioning that provides service application specific QoS information to terminals.

With the growth of mobile services, it has become very important for an operator to measure the QoS and QoE of its network accurately and improve it further in the most effective and cost-efficient way to achieve customer loyalty and maintain competitive edge.

Cellular network optimization can be seen as a process to improve the overall network quality as experienced by the mobile subscribers and to ensure that the network resources are efficiently utilized. This includes performance measurements, analysis of measurement results and updates of the network configuration and parameters. The optimization process can be initiated because of several reasons, the most typical are:

- New technologies, elements or features of particular network elements are taken into use.
- External edge conditions have changed.
- Detection of decreased QoS performance in a particular network area.

Roaming

Roaming is derived from Real-time Optimally Adapting Mesh (ROAM).

Roaming refers to a wireless network service extension in an area that differs from the registered home network location. Roaming enable a mobile device to access the internet and other mobile services when out of its normal coverage are. It also givers a mobile device the ability to move from one access point to another.

Roaming services are usually provided by cellular service providers as well as internet service providers (ISP) via a cooperative agreement. Traditional cellular roaming service are provided by both the global system for mobile communication (GSM) and Code Division Multiple Access (CDMA) operators. Services are either free or billed according to local area rates. Wireless telecommunication roaming series are usually included in mobile/cell phone subscriber services packages for use outside local networking zone. GSM/WLAN roaming services can be supplied in two different seniors. One in SIM – based roaming and the second in user-name/password base roaming.

Wireless local area network (WLAN) roaming servicers are segmented as follow.

Internal roaming: implemented when a mobile station is transferee with a strong signal between access points, preventing network blockage or interruption from weak signals.

External roaming: implemented when a mobile station shifts to a wireless land or other foreign wireless internet service provider (WISP) to a access services. WISP allows users to maintain an internet connection while mixing within a local coverage area.

Paging

The paging system was invented by Al Gross as an adaptation of his two - way radio, the walkie talkie. After some early market resistance from doctors who were afraid that the system would upset their patients and disturb their golf games, Gross sold the first system in 1950 to New York ' s Jewish Hospital. That first system provided a means by which a centralized antenna could broadcast alerts to small, inexpensive pagers, or beepers. A page simply transmitted an identification number, which was recognized only by the pager being addressed. If that pager were in range, it beeped, hence the term beeper. Response to the page was in the form of a telephone call to the paging company to retrieve a message.

The downstream data to the pager originate in several ways. The most common approach involves the paging party dialing a telephone number which often is toll free. That number either may be dedicated to that one pager or may be one of many associated with the service provider.

Pagers can be classified as tone only, numeric, alphanumeric, and voice enabled. Tone - only pagers cause the device to emit an audible tone and/or to vibrate or blink so it is not disruptive. Numeric pagers permit the receipt of numbers only on a display. The vast majority of contemporary pagers are alphanumeric, capable of receiving and displaying both alphabetic and numeric characters. Contemporary pagers contain enough memory to support as many as 30,000 characters. But relatively few pagers currently can support the storage of voice messages, which are extremely memory intensive. This voice capability is accomplished through the downloading of compressed voice mail from a centralized voice processor to the pager over a packet network.   **Location management protocols**

For next-generation heterogeneous wireless networks, the inter-working and inter-operating function is suggested to accommodate roaming between dissimilar networks. For existing practical systems, several solutions are proposed for some specific pairs of inter-working systems. In these schemes, the inter-operating function is implemented in either some additional inter-working unit with the help of dual-mode handsets.

In a location management mechanism has been proposed for heterogeneous network environment. It involves a mechanism for inter-system location updates and paging. Inter-system location update is implemented by using the concept of a *boundary location area* (BLA) existing at the boundary between two systems and off management is performed.

Mobility Management Protocols

 A heterogeneous handover process in mobility management occurs when an MN either moves between networks with different access technologies, or between different domains. As the diversity of available networks increases, it is important that mobility technologies become agnostic to link layer technologies, and can operate in an optimized and secure fashion without incurring unreasonable delay and complexity. Supporting handovers across heterogeneous access networks, such as IEEE 802.11 (Wi-Fi), global system for mobile communications (GSM), code-division multiple access (CDMA), and worldwide interoperability for microwave access (WiMAX) is a challenge, as each has different quality of service (QoS), security, and bandwidth characteristics. Similarly, movement between different administrative domains poses a challenge since MNs need to perform access authentication and authorization in the new domain. Thus, it is desirable to devise a mobility optimization technique that can reduce these delays and is not tightly coupled to a specific mobility protocol. In this section, we describe different types of handovers and investigate the components that contribute to a handover delay. Some inter-technology and media-independent handover frameworks are then described.

Mobile services

Sophisticated 4G service discovery mechanisms will combine the location/situation information and context-awareness in order to deliver users' services in a best possible manner. Additionally, future mobile services will require more complex personal and session mobility management to provision personalized services through different personalized operating environments to a single user terminal address. Whether SIP should be the core 4G protocol, and whether the service delivering framework be the network layer-based or application layer-based is still an open question Pandya et al (2010).

Data Collection and Analysis

In this study, various call quality parameters were evaluated for two cellular mobile operators, i.e operators P, operator Q, with existing infrastructure within Semi-Urban Township Location in Nigeria. Two parameters were evaluated. These parameters are call setup time and performance statistics (QoS indicator). In this study, data collection was obtained from the network management centre (NMC) and all inclusive in mobile switching centres.

Data were obtained for the two cellular services operators, P and Q. Reports were initially collected and collated on hourly basis for which an average hourly figure was computed for a day. This progressively translated to an average of seven days taken for a week. Finally data were then computed on a weekly basis for a period of 24 weeks.

The following table shows the data obtained from each of the parameters.

Table 1. Call set up time

S/N	NETWORKS OPERATOR	NETWORKS OPERATOR	CALL SETUP TIME (h, m, s, ns)
1.	P	P	00.00.07.20
2.	P	Q	00.00.10.02
3.	Q	Q	00.00.08.07
4.	Q	P	00.00.08.22

Table 2: Performance statistics (QoS indicator)

S/N	QoS INDICATOR	P (%)	Q (%)
1.	TCH congestion (without handover) rate	4.15	0.87
2.	TCH congestion (without handover) rate	20.00	5.10
3.	Call set-up success rate	81.27	94.52
4.	Drop call rate	1.41	1.62
5.	SDDH congestion rate	4.15	2.34

Results

Call Set Up Time

From table 9 we observed that it takes P to P the shortest call set up time, this is followed by Q to P; Q to Q and finally it takes P to Q relatively the longest call set up time.

Call set up time was observed to be enhanced due to less congestion in the radio interface, effective radio resources allocation and access network transmission availability.

Performance Statistics (QoS Indicator)

It is observed from table 2 that the channel congestion rate without handover management is higher respectively for P and Q. But with effective handover management the channel congestion becomes lower. Also the causes of success rate for P and Q are relatively high and efficient. Finally, while P recorded lower drop call rate, P however is higher than Q channel congestion rate.

Quality of service played significant roles in attaining network interconnectivity and operation reliability.

Discussion

 In today's competitive telecommunication environment, mobility management is the most important feature of a wireless cellular communication system.

In cellular communication today, emphasis has shifted to delivery of exceptional services while maintaining low cost and operation reliability. The telecommunication service providers are saddled with the challenge to deliver high quality service, innovative at a time of rapid change and cost pressure. Improved network availability, reliability and effective handover management can play significant roles in attaining the goal of sustained interconnectivity and maintainability.

Mobility management is a resource for the information needed to manage the networks in a proactive way so the service problem can be addressed before it affects the customer. Much of raw data about various network elements is not useful until it is translated into real information as observed between this study and related earlier studies.

Conclusion

The mobility management within any cellular system is of great importance. It is a critical process and if performed incorrectly handover can result in the loss of the call.

In this study a great deal of emphasis on mobility in GSM network was given .Very important too is the fact that handover in GSM network are very important to maintain the quality of a call. Mobility prioritization schemes were also analyzed in order to enhance the quality of service (QoS) of GSM wireless network. Extensive survey and analysis of the handover prioritization schemes that is guard channels, call admission control and handover queuing has been provided. This research work contributed the following to telecommunication body of knowledge and the larger society   among others:

Presentation of an cellular mobility framework to enhance efficient service delivery in wireless network and exploration of some of the most time proven cellular communication protocols to meet the competitive demands of data rates and spectral capacity.

Recommendations

The following are hereby recommended for greater achievement in further research;

(1)   To predict the upcoming traffic evolution and network expansions as per increasing number of mobile users.
(2)   To benchmark network with another competitor's network to attract more users at the cost of better quality on a national and global platform.

REFERENCES

Akyildiz, I.F.; Altunbasak, Y. and Sivakumar, R. (2012). AdaptNet: an adaptive protocol suite for the next generation wireless internet. *IEEE Communications Journal* 42: 128 – 136.

Buddhikot, M.; Chandranmenon, G.; Han, S. and Lee, Y.W. (2011). Integration of 802.11 and Third-Generation Wireless Data Networks. *IEEE INFOCOM Journal* 1: 503 - 512.

Campbell, A.T.; Gomez, J. and Kim, S. (2011). Design, implementation and evaluation of cellular IP. *IEEE Personal Communications Journal* 7: 42 – 49.

Dutta, A.; Famolari, D.; Das, S. and Ohba, Y. (2012). Media-independent pre-authentication supporting secure inter domain handover utilization. *IEEE Wireless Communication Journal* 15: 55 – 64.

Eastwood, L.; Migaldi, S.; Xie, Q. and Gupta, V. (2010). Mobility using IEEE 802.21 in a heterogeneous IEEE 802.16/802.11-based IMT-advanced (4G) network. *IEEE Wireless Communication Journal* 15: 26 – 34.

Ekici, E. (2012). Optimal Two-Tier Cellular Network Design. *IEEE Wireless Communication Journal* 10: 24 – 32.

Ghaderi, M. and Boutaba (2010). Call Admission Control in Mobile Cellular Networks: A Comprehensive Survey. *Wireless Communications and Mobile Computing Journal* 6: 69 - 93.

Hsieh, R.; Zhou, Z.G. and Seneviratne, A. (2011). A seamless handoff architecture for Mobile IP. *IEEE INFOCOM Journal* 3: 174 – 184.

Kim, K.; Kim, C. and Kim, T. (2012). A seamless handover mechanism for IEEE 802.16e broadband access. *International Journal on Computational Science* 3515: 527 534.

Misra, A.; Das, S. and McAuley, A. (2010). IDMP – based fast handoffs and paging in IP-based 4G mobile networks. *IEEE Communication Journal* 4: 138 – 145.

Misra, A.; Das, S.; Dutta, A.; McAuley, A. and Das, S.K. (2002). IDMP-based fast handoffs and paging in IP-based 4G mobile networks. *IEEE Communications Magazine* 4: 138-145.

Mohanty, S. (2011). A new architecture for 3G and WLAN integration and inter-system handover management. *Wireless Networks Journal* 12: 733 – 745.

Pandya, R.; Grillo, D. and Lycksell, E. (2010). IMT – 20000 standards: networks aspects. *IEEE Personal Communication Journal* 4: 20 -29.

Salsano, S.; Polidoro, A.; Mingardi, C.; Niccolini, S. and Veltri, L. (2008). SIP-based mobility management in next-generation networks. *IEEE Wireless Communications* 15: 92-99.

Soliman, H.; Castelluccia, C.; ElMalki, K. and Bellier, L. (2008). Hierarchical Mobile IPv6 mobility management (HMIPv6). *IEEE Wireless Communications Journals* 15: 81 - 84

Yokota, H.; Idoue, A.; Hasegawa, T. and Kato, T. (2002). Link layer assisted Mobile IP fast handoff method over wireless LAN networks. *Proceedings of ACM MOBICOM* 11: 131-139.

Zhang, Y. (2008). Vertical handoff between 802.11 and 802.16 wireless access networks. *IEEE Communications Journal* 15: 91 – 94.

Zhang, Q.; Guo, C.; Guo, Z. and Zhu, W. (2003). Efficient mobility management for vertical handoff between WWAN and WLAN. *IEEE Communications Journal* 11: 102-108.

Performance analysis of deep learning and statistical models on enhancing stock market portfolio

Satyajit Reddy[1], Sarthak Rao[2], Divyanshu Sharma[3]

Research Scholars
Department of Information Technology,
Dwarkadas J. Sanghvi College of Engineering, Mumbai - 400056

Abstract: **Time series data is considered very useful in the domains of business, finance and economics. Stock market data specifically is generated at high volumes and excessively used for forecasting purposes for gaining wealth. The problem is challenging due to the dynamic nature of stock market fluctuations. Conventional techniques for prediction of next lag of time series data have been successful to an extent with statistical algorithms such as Exponential Smoothing and Autoregressive Integrated Moving Average (ARIMA). With the advent of deep learning architectures and advanced computational processors, we analyze the performance of such techniques for stock market forecasting. The paper presents performance comparison of Exponential Smoothing, ARIMA, Vanilla LSTMs and Stacked LSTM models. The empirical analysis concludes the superior performance of deep learning techniques with RMSE score as low as 3.208 on daily closing price stock data for a period of ten years. Furthermore, we also propose a portfolio optimization method to calculate returns and maintain profits while trading in stock market.**

Keywords: **forecasting, stock market, LSTM, ARIMA, Exponential Smoothing, portfolio optimization**

Introduction:

Between expert analysts and investors, the developments in stock price estimation have acquired considerable significance. Owing to unavoidable noisy conditions and high uncertainty in response to global trends, the stock market outlook for interpreting trends is difficult. Any variables including annual or quarterly earnings, company announcements, and varying shifting habits respond to the dynamics of stock markets. Investors depend on different technical metrics based on stocks that are gathered on a regular basis. While these metrics are used to analyze stock returns, predicting regular market trends [1] is challenging. In the changing modern environment, the detailed prediction of stock patterns is fascinating and a difficult task. Non-economic and economic influences are some of the parameters that affect the actions of stock trends and are taken into account.

The dimensions of technical investigation were clustered into sentiment, flow-of-funds, raw data, trend, momentum, volume, period, and instability [2]. The actions of different market players are reflected by sentiment. Flow-of-funds is a form of metric used to analyze the financial condition of different buyers to pre-evaluate their intensity of purchasing and selling securities, so suitable tactics, such as short squeeze, may be implemented. Pattern and movement are instances of market-based metrics, pattern is used to chart stock market volatility, while movement is used to measure the pace of price action and decide if a stock price trend turnaround is about to take place. Volume is a metric that represents both buyers and sellers' appetite for investment, and it is also a foundation for forecasting trends in stock prices. The process is grounded on the idea that in the context of a long phase of more than 10 years comprising brief periods of a few days or weeks, inventory values differ regularly. Lastly, instability is also used to analyze the magnitude of stock market variations and to measure vulnerability and to define the amount of provision and confrontation. Opinions could trigger short-term market volatility that in turn create disconnections amongst the valuation and actual value of the shares of a firm, but over long stretches of time, the measuring system kicks in when the dynamics of a company inevitably cause its shares to agree on the value and market price. A notable example arises from Nobel Laureate Robert Shiller, who found that stock markets are highly unpredictable over the short term, but their price-to-earnings over long stretches are somewhat stable [3]. In analyzing the economic situation, Diamond [4] clarified what returns to imagine from capital markets and indicated that returns might be considerably smaller in the future. Shiller et al. [5] also indicated that markets were overvalued, and at some moment the bubble would break.

Statistical methods, often assuming linearity, stationarity, and normality, offered a way to estimate and forecast stocks before the introduction of machine learning techniques. A systematic array of figures like daily revenue amounts and stock values is the time series of financial sector research [6]. The Auto-Regressive Moving Average (ARMA), the Auto-Regressive Integrated Moving Average (ARIMA), the Generalized Autoregressive Conditional Heteroskedastic (GARCH) volatility, and the Smooth Transition Autoregressive (ARIMA) are among category of quantitative methods that fell into the classification of univariate research owing to the usage of time series as input variables, according to [7].

The ARIMA model is a commonly used stock price valuation methodology [8]. ARMA integrates Auto-Regressive (AR) frameworks that aim to understand the movement and mean reversion patterns commonly found in markets and Moving Average (MA) methods that seek to catch the time series disturbances. The ARMA model's major drawback is that volatility clustering, a key scientific phenomenon in several time series analysis, is not considered. ARIMA is a logical addition of the ARMA deterministic model, and a non-stationary series can be reduced to a stationary series. In order to predict future stages, the ARIMA [9] is adapted to time series results. Furthermore, Zhong and Enke define another category of statistical methods, including Linear

Discriminant Analysis (LDA), Quadratic Discriminant Analysis (QDA), and regression algorithms, which typically use multiple input variables.

In forecasting capital markets, deep learning has been widely analyzed for its promise [10]. Tasks for deep learning are commonly divided into supervised and unsupervised learning. A collection of annotated input data for training the program and obtained output data are required in supervised learning. However, only the unlabeled or detected performance data is usable in unsupervised learning. The objective of supervised learning is to create a training model to transform data automatically to the output data given. The computer must have trained to see an input data point as conditioned and to estimate the predicted performance. The goal of unsupervised learning is to train an algorithm to find in the given dataset a pattern, association, or cluster. It may also serve as a precursor for supervised activities in learning [11]. In stock price path estimation, several algorithms have been used.

Effective algorithms such as Random Forest, logistic regression, and neural networks have substituted simpler methods such as the single decision tree, discriminant analysis, and Naïve Bayes [12]. Multivariate analysis by the use of Artificial Neural Networks (ANNs) has become a powerful and common analysis method in financial sector analysis with nonlinear, data-driven, and easy-to-generalize features. In time series prediction, deep nonlinear neural network topologies have recently begun to draw interest [13]. Another method which has recently been used for stock market analysis is sentiment analysis [14]. Via automated processing of text corpuses such as news feeds or tweets related to financial markets and public corporations, it is the method of forecasting stock patterns. The techniques of emotion classification are primarily divided into a data mining technique and a lexicon-based methodology, additionally separated through dictionary or corpus-based techniques. The ability of using sentiment indicators from an unstructured text to increase the efficacy of models for forecasting volatility patterns in the stock market was shown by [15].

In this paper, we target and categorize the performance of two domains of research as mention above i.e. statistical techniques and deep learning techniques which have rose to prominence drastically in the last decade. We take into account multiple stocks with variable dataset characteristics to check the error in each technique over a generalized set of trends.

Related Work:

Latest developments in market analysis and forecasting fall into four categories: statistical, pattern recognition, deep learning (ML), and analysis of sentiments. Most of these categories fall into the wider technical analysis framework, although there are several artificial learning methods that often merge broader technical analysis concepts with quantitative evaluation techniques to stock market forecasting. A taxonomy of common stock prediction techniques is shown in Fig. 1. These methods have gained traction and have in the recent past demonstrated positive results in the field of stock analysis.

In much of the stock analysis literature, Devi et al. [16] attempted to resolve certain problems not actually discussed, like the dimensionality and expectation of an immature trader. The authors effectively use the past data for the training of the ARIMA model of four Indian midcap firms. To estimate the accuracy of the model, the Akaike Information Criterion Bayesian Information Criterion (AICBIC) test was introduced.
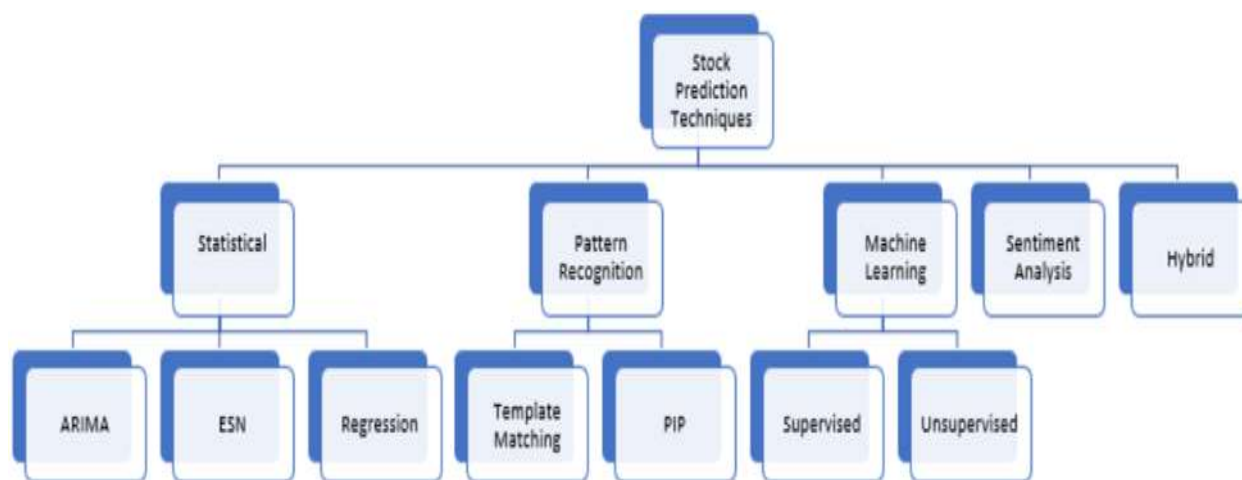
Fig. 1. Stock market prediction techniques

Checking the formula on growth stocks and the Nifty 50 Index revealed how, due to low failure and variability, the Nifty Index is the path to go for novice traders. The detailed method of constructing ARIMA models is discussed by Ariyo et al. [17]. The authors chose parameters such as the standard regression error, modified R-square, and Bayesian knowledge criteria to define the optimal model from all the ARIMA models produced. Based on the above parameters, the best ARIMA model did a competent job of forecasting Nokia and Zenith Bank's stock prices. In addition, he made a good argument not to compromise ARIMA models' forces in terms of stock assessment as it can perform relatively well for short-term prediction against the new forecasting methods available currently. In order to forecast the stock price of Tata Consulting Services stock based on five characteristics, i.e. free, large, low, near price and value, Bhuriya et al. [18] introduced regression model variants. The article describes the efficiency of the regression

models of the linear, polynomial, and radial basis function (RBF) based on the confidence values of the outcomes expected. Furthermore, he also stated that the model of linear regression surpassed the other strategies and obtained a 0.97 confidence score.

For stock price prediction, several deep learning strategies have been explored. Two commonly used machine learning algorithms are ANN and Support Vector Regression (SVR) to forecast stock value and stock market index values [19]. In order to forecast long-term stock price trend, the authors used five times double cross-validation and Area Under the Curve (AUC) as an output metric and reported Random Forest as the top algorithm. Milosevic [20] suggested a long-term stock market price forecast strategy through a classification task where a stock is 'good' if the stock price rises by 10 percent in a year, otherwise it is 'bad'. In addition, he conducted a manual selection of functions, picked 11 appropriate fundamental ratios, and applied multiple algorithms for machine learning to market prediction. It follows that the best F-Score of 0.751 towards techniques such as SVM and Naïve Bayes was obtained by Random Forest. The eXtreme Gradient Boosting is another method that has drawn the interest of data scientists (XGBoost). The trajectory of stocks based on the XGBoost algorithm was forecast by Dey et al. [21] using technical indicators as characteristics. The findings reveal that XGBoost beats the other efficiency approaches for long-term estimation of Apple and Yahoo inventories, reaching a precision of 87-99 percent.

A sentiment analysis model based on Twitter data was introduced by Pagolu et al. [22]. To evaluate the polarity of opinions behind the tweets, the authors used N-gram and Word2vec (2-layer NN). They reached a precision of around 70 percent and noted that 71.82 percent was the association between price and opinion. The researchers indicated that the model's accuracy would improve with more details. The research by Xu and Cohen [23] introducing StockNet, a neural network architecture for forecasting stock market movement from tweets and historical stock prices, involves other methods using natural language and social media data. The model reveals a state-of-the-art efficiency and adds repeated, continuing latent variables for improved stochasticity management.

Methodology:

The methods proposed in this paper takes into account some of the traditional statistical techniques such as Holt-Winter's Exponential Smoothing and Auto Regressive Integrated Moving Average (ARIMA) to model the prediction on the closing prices on selected stocks from the NIFTY 50 dataset. We take into consideration four stocks based on the volatility, trend from different industries: DRREDDY, TCS, HINDUNILVR, GAIL. The data is extracted from the Yahoo Finance website for the period of years 2008-2018 on a daily frequency. Additionally, emphasis has been given to deep learning techniques for forecasting stock market behavior. Recurrent Neural Network architectures are taken into consideration, namely vanilla LSTMs and Stacked LSTM. The section gives an overview towards the specifications of techniques implemented below:

I.   Exponential Smoothing

Exponential smoothing is a digital forecasting model that exponentially weighted historical data in order to have larger scales in the moving average of the most current data. In too many prediction cases, the exponential smoothing approach has been used as a very useful method for many years. Methods of prediction are a mathematical method to evaluate what is likely to happen in the future, relying on applicable historical evidence. In order to provide a structured, pragmatic way of thought, workmanship and strategies to provide more trust, this technique is very helpful in carrying out an empirical approach to the actions or trends of past results. Holt Winter Additive is the forecasting mechanism used in this prediction. The method of Holt Winters forecasting is a mixture of the method of Holt and the method of Winters, used for forecasting if the data has a seasonal and pattern portion. Three smoothing equations, namely the overall smoothing equation, the refinement of patterns and the seasonal smoothing equations, are the basis of the Holt Winters process. We implemented the additive method with the help of following equations:

Smoothing Level:

$$S_t = \alpha X_t - I_{t-L+1} - \alpha S_{t-1} + b_{t-1} \qquad (1)$$

Smoothing Trend:

$$b_t = \beta S_t - S_{t-L+1} - \alpha S_{t-1} + \beta b_{t-1} \qquad (2)$$

Smoothing Seasonal:

$$I_t = \gamma X_t - S_{t+1} - \gamma I_{t-L} \qquad (3)$$

Forecast:

$$F_{t+m} = S_t - b_t m + I_{t-L+m} \qquad (4)$$

II.   ARIMA Model

The conventional ARIMA method becomes unfeasible, and when periodic modification order is high or its diagnostics fail to specify that time sequences are static after seasonal amendment, it is in many examples difficult to conclude a model. In such cases, the static parameters of the classical ARIMA model are measured to be the main constraint of high seasonal variable demand forecasting. Another constraint of the classical ARIMA approach is that the best fit model for a data series requires a large number

of observations to be determined. An ARIMA model is labelled as an ARIMA model (p, d, q), in which the number of autoregressive terms is p, the number of differences is d and the number of moving averages is q.

Autoregressive process:
Autoregressive models assume that Y_t is a linear function of the preceding values and is given by equation:

$$Y_t = \alpha_1 Y_{t-1} + \varepsilon_t \qquad (5)$$

Each observation consists of a random component (random shock, ε) and a linear combination of the previous observations. α_1 in this equation is the self-regression coefficient.

Integrated process:
The behavior of the time series may be affected by the cumulative effect of some processes.

$$Y_t = Y_{t-1} + \varepsilon_t \qquad (6)$$

where the random perturbation ε_t is a white noise.

Moving average process:
The current value of a moving averaging process is a linear grouping of the current disruption with one or more previous perturbations. The moving average order indicates the number of previous periods embedded in the current value. Thus, a moving average is defined by equation:

$$Y_t = \varepsilon_t + \theta_1 \varepsilon_{t-1} \qquad (7)$$

III.   Long short-term memory

Recurring neural networks, which have a disappearing gradient problem, are an improvement over the general recurrent neural networks. As stated by Hochreiter et al. [24], by incorporating gating functions into their state dynamics, LSTM RNNs address the vanishing gradient issue commonly found in ordinary recurrent neural networks. An LSTM maintains a hidden vector h and a memory vector m for controlling state updates and outputs at each time stage. More concretely, Graves et al. [25] define the computation at time step t as follows:

$$g^u = \sigma(W^u h_{t-1} + I^u x_t) \qquad (8)$$
$$g^f = \sigma(W^f h_{t-1} + I^f x_t) \qquad (9)$$
$$g^o = \sigma(W^o h_{t-1} + I^o x_t) \qquad (10)$$
$$g^c = tanh(W^c h_{t-1} + I^c x_t) \qquad (11)$$
$$m_t = g^f \odot m_{t-1} + g^u \odot g^c \qquad (12)$$
$$h_t = \tanh(g^o \odot m_t) \qquad (13)$$

where σ is the logistic sigmoid function, $\odot$ represents elementwise multiplication, W^u , W^f, W^o , W^c are recurrent weight matrices and I^u, I^f, I^o, I^c are projection matrices. Although LSTMs have the ability to learn sequence temporal dependencies, in long sequences the have difficulty with long term dependencies.

IV.   Stacked LSTMs

With the growing advancement of computer processors and a range of deep neural networks being implemented, learning algorithms have demonstrated their strong self-learning capabilities. For a deep LSTM-based neural network, stacking many LSTM layers is indeed important. The key principle of the deep neural network is that several nonlinear levels of mapping among endpoints are used for learning features numerically. The performance of the hidden layer is not only generated forward over time, as seen in Figure 2, but also used as one of the inputs of the next hidden layer of LSTM.
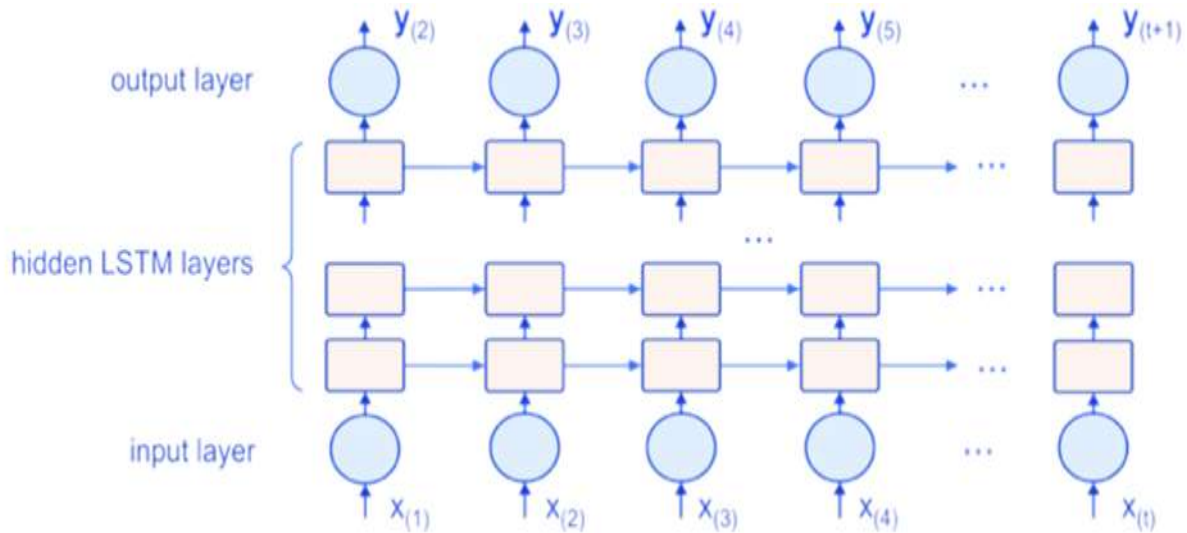
Fig. 2. Stacked LSTM architecture with multiple hidden LSTM layers

The advantages of stacked LSTM over vanilla LSTM architecture are due to:

(1) Stacking LSTM layers helps the data to predict raw temporal signal characteristics from various aspects at each point of time

(2) Model parameters are spread through expanding memory capacity over the entire space of the model, allowing the model to enhance convergence and optimise dynamical raw data processes.

(3) The LSTM neural network has a time stage structure to recall memories. As for 1-D data analysis, a restricted signal can be converted into a matrix of input-dimensional rows and time-stage columns. It is apparent that LSTM emulates the memory process as humans do which ensures that it can instantly memorize a signal item by item and collect substantial raw temporal signal inherent in it. A deep neural LSTM network can thus help improve the entire mechanism.

V.   Performance metrics:

To evaluate the performance of the proposed nonlinear combination model, mean absolute error (MAE), root mean square error (RMSE) and mean absolute percentage error (MAPE) are used defined as follows:

$$MAE = \frac{1}{N} \sum_{I=1}^{N} |y_t - \hat{y}_t| \tag{14}$$

$$MAPE = \frac{1}{N} \sum_{I=1}^{N} |\frac{y_t - \hat{y}_t}{y_t}| \times 100\% \tag{15}$$

$$RMSE = \sqrt{\frac{1}{N} \sum_{I=1}^{N} (y_t - \hat{y}_t)^2} \tag{16}$$

Results:

The results computed from the models mentioned above are observed in this section and the performance is analyzed with the help of common evaluation metrics. The data for the period of December 2007 to Jan 2018 for the aforementioned stocks can be seen in Fig. 3.
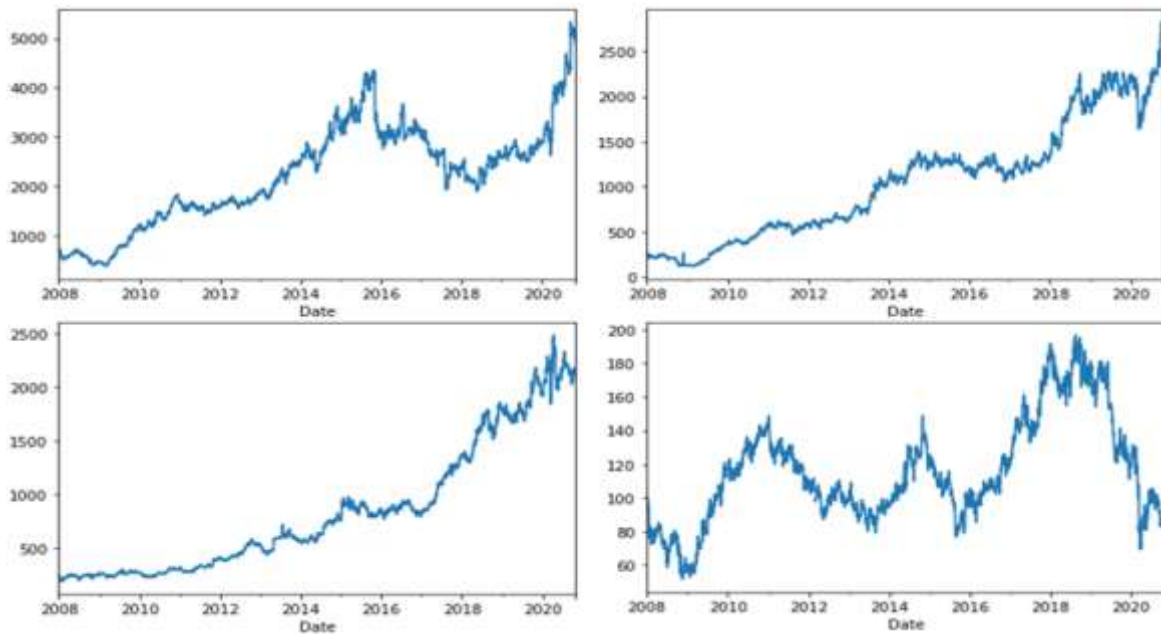
Fig. 3. NIFTY50 stock data from December 2007-Jan 2018

We start with the Holt-Winter's exponential smoothing method which has been applied first on the four stocks data with seasonal periods as 365 (daily frequency closing prices). With 4687 values, the training data set contains 4219 values and the test data contains 468 values. As shown in Fig. 4. Validation on test data follows the slope.
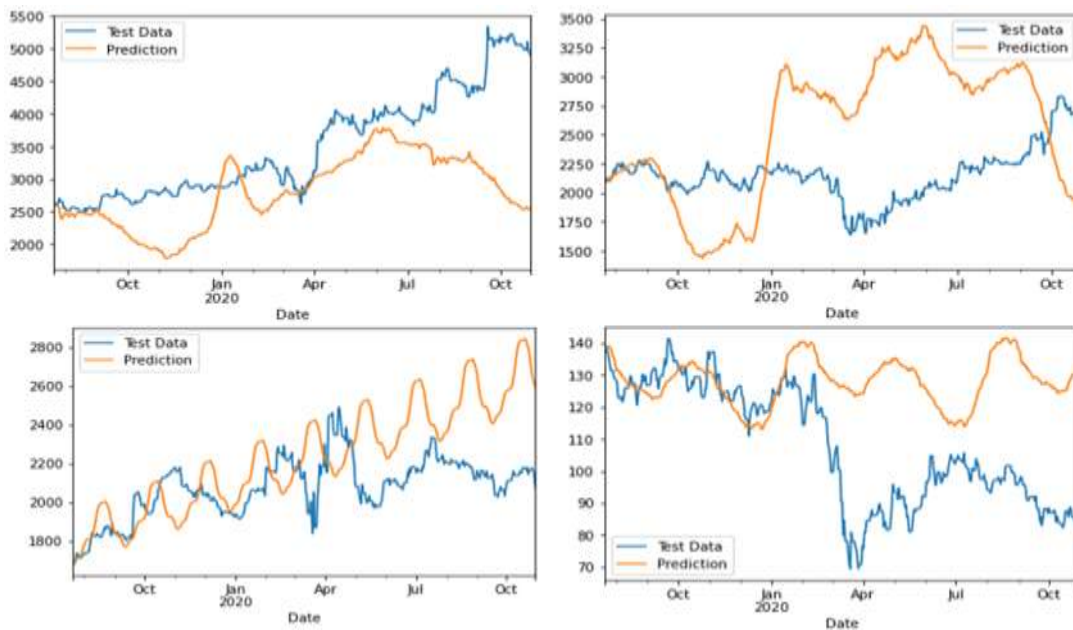
Fig. 4. Exponential Smoothing model forecasting results: DRREDDY, TCS, GAIL, HUL (Clockwise)

The ARIMA model gives significantly improved results as compared to the exponential smoothing. The stock data are initially checked for stationarity using the Augmented Dickey Fuller test which present null hypothesis for all four stocks. This leads to using first difference on the data for applying ARIMA model. The values for p, d and q are generated using Auto ARIMA to compute multiple combinations leading to best AIC and BIC scores for implementation. As show in Fig. 5, the predicted values are validated on the test data leading to an RMSE score of 84.69, 152.1, 6.052, and 212.2 respectively as presented in Table. I below.
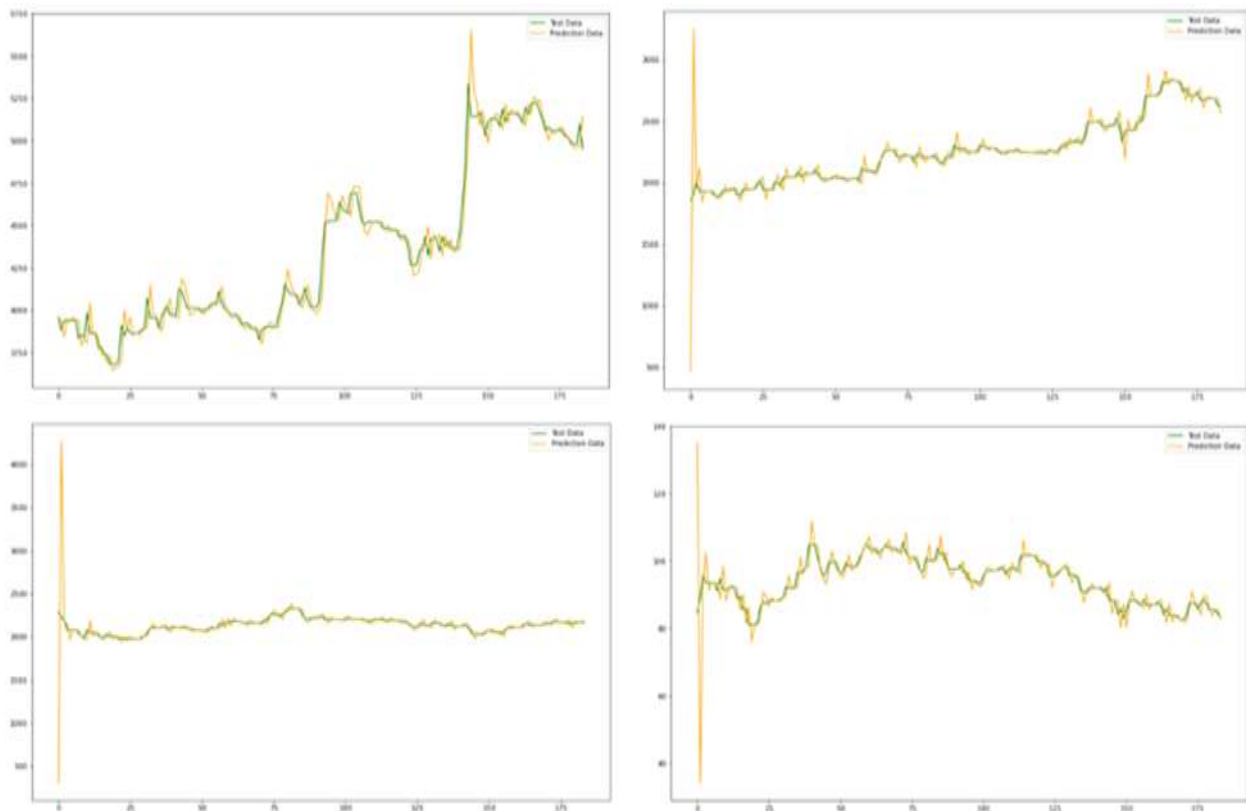
Fig. 5. ARIMA model forecasting results: DRREDDY, TCS, GAIL, HUL (Clockwise)

Although ARIMA gives very high performance, the model is generally useful for small datasets and as the data points are increased, the performance starts decreasing. Due to this drawback, we implement deep learning techniques with memory elements that are specifically advantageous for forecasting with long run relationships. These kinds of techniques are extremely useful in high frequency trading circuits.

We take into account two recurrent neural networks architectures, i.e... Vanilla LSTMs and Stacked or Deep LSTMs with performance optimization. Stacked LSTM networks have a deeper learning model and are made up of several hidden layers of LSTMs. Such different hidden layer's act as a Deep Recurrent Neural Network (DRNN). In this analysis, for prediction, a stacked LSTM model is implemented with four layers having 50 neurons and a dense layer that is run for 600 epochs with a batch size of 32. The iterative updating of weights using the training data is an important part of training an LSTM network. For stochastic gradient descent [26], the Adaptive Movement Estimation (Adam) algorithm is used and the loss function is loss mean squared error.

Fig. 6. Stacked LSTM model forecasting results: DRREDDY, TCS, GAIL, HUL (Clockwise)
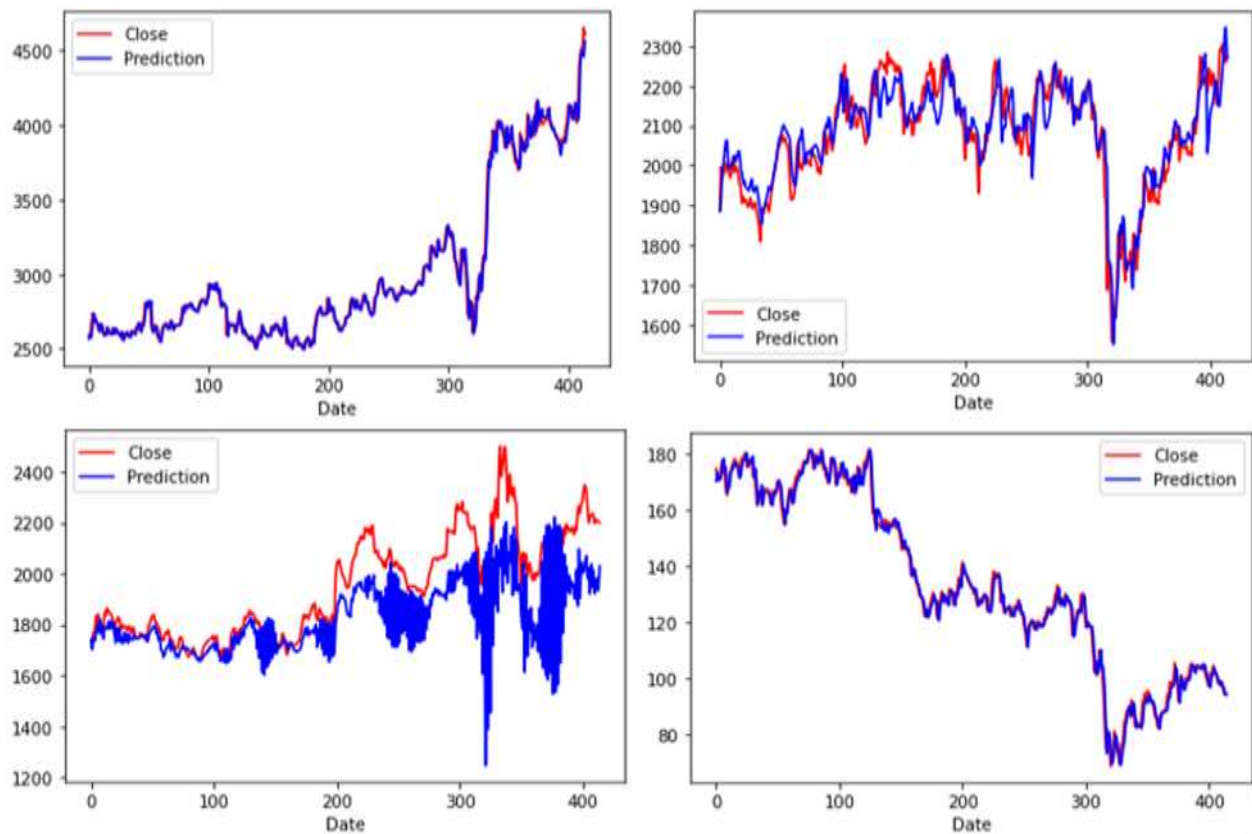
As it is difficult to analyze the performance of ARIMA and Stacked LSTM architecture, we look into the RMSE, MAE and MAPE scores as shown in Table. I for all the techniques which helps in inferring the success of each forecasting model. As shown below, although ARIMA provides excellent forecasting results, the stacked LSTM model gives a lesser RMSE score. Further taking into consideration, the interdependence of stock market data on past data points, LSTM architectures provide an edge over the statistical techniques.

Table I. Evaluation metrics for model performance

	Exponential Smoothing			ARIMA			Vanilla LSTM			Stacked LSTM		
	RMSE	MAE	MAPE	RMSE	MAE	MAPE	RMSE	MAE	MAPE	RMSE	MAE	MAPE
TCS	775.3			152.1			96.49			54.38		
GAIL	37.17			6.052			12.49			3.208		
HINUNILVR	281.5			212.2			192.1			180.8		
DRREDDY	952.8			84.69			70.12			59.76		

Discussion & Conclusion:

When the nature of the economy based on rising and declining asset values has been foreseen and recognized by an investor. In the trading plan, the next issue is how much of its share it should allocate for various stocks in its portfolio [27]. A very important factor to consider is the adjustment of the ratio of capital in stock market to achieve benefit. The optimization of Markowitz's portfolio [28] is solely based on a statistical basis and provides a very satisfying outcome in the distribution of one's market share [29]. As shown in equation 17, return can be calculated as:

$$r = (adjClose(i) - adjClose(i-1))/adjClose(i) \qquad (17)$$

The variance of return, the covariance matrix of return, weights and sum should be 1. We then adjust the weight to gain profit and select the portfolio which has max Sharpe ratio and in volatility given by equation 18-20. By performing Markowitz Portfolio Optimization technique, we can understand how much we must invest our money in a market.

$$expected\ return = transpose\ of\ weigh \times return \qquad (18)$$

$$volatility = (transpose\ of\ weights\ \times covariance\ of\ return\ \times weights)^{\frac{1}{2}} \qquad (19)$$

$$Sharpe\ ratio = \frac{expected\ return}{volatility} \qquad (20)$$

The development process should go through relevant data selection, data preprocessing to eliminate noise and missing values to create the prediction model. Study of the right algorithm, accompanied by model assessment. The study presented in this paper uses the LSTM to forecast the stock market exchange activity. The findings indicate that advanced versions of LSTM appear to provide more detailed results than standard algorithms. It can be shown that this paradigm is efficient for both private traders and corporate investors. They will obtain the potential actions of the movement of consumer rates and take the correct decision to make a profit. Different characteristics and facets of the industry should be addressed in future work to make forecasts more reliable. We also plan to use consumer feedback on the product to forecast the market shift.

References:

[1]   J.L. Ticknor, A Bayesian regularized artificial neural network for stock market forecasting, Expert Syst. Appl. 40 (14) (2013) 5501–5506.

[2]   Hu, Yong, Kang Liu, Xiangzhou Zhang, Lijun Su, E. W. T. Ngai, and Mei Liu. 2015. Application of evolutionary computation for rule discovery in stock algorithmic trading: A literature review. Applied Soft Computing 36: 534–51.

[3]   Shiller, Robert J. 1980. Do Stock Prices Move Too Much to Be Justified by Subsequent Changes in Dividends? Cambridge: National Bureau of Economic Research.

[4]   Diamond, Peter A. 2000. What Stock Market Returns to Expect for the Future. Social Security Bulletin 63: 38.

[5]   Shiller, Robert C. 2000. Irrational Exuberance. Philosophy & Public Policy Quarterly 20: 18–23.

[6]   Fu, Tak-chung, Fu-lai Chung, Robert Luk, and Chak-man Ng. 2005. Preventing Meaningless Stock Time Series Pattern Discovery by Changing Perceptually Important Point Detection. Paper presented at the International Conference on Fuzzy Systems and Knowledge Discovery, Changsha, China, August 27–29

[7]   Zhong, Xiao, and David Enke. 2017. Forecasting daily stock market return using dimensionality reduction. Expert Systems with Applications 67: 126–39.

[8]   Hiransha, M., E. A. Gopalakrishnan, Vijay Krishna Menon, and Soman Kp. 2018. NSE stock market prediction using deep-learning models. Procedia Computer Science 132: 1351–62.

[9]   Box, George E. P., Gwilym M. Jenkins, Gregory C. Reinsel, and Greta M. Ljung. 2015. Time Series Analysis: Forecasting and Control. Hoboken: John Wiley & Sons.

[10]   Shen, Shunrong, Haomiao Jiang, and Tongda Zhang. 2012. Stock Market Forecasting Using Machine Learning Algorithms. Stanford: Department of Electrical Engineering, Stanford University, pp. 1–5.

[11]   Bhardwaj, Aditya, Yogendra Narayan, and Maitreyee Dutta. 2015. Sentiment analysis for Indian stock market prediction using Sensex and nifty. Procedia Computer Science 70: 85–91.

[12]   Ballings, Michel, Dirk Van den Poel, Nathalie Hespeels, and Ruben Gryp. 2015. Evaluating multiple classifiers for stock price direction prediction. Expert Systems with Applications 42: 7046–56.

[13]   Bao, Wei, Jun Yue, and Yulei Rao. 2017. A deep learning framework for financial time series using stacked autoencoders and long-short term memory. PLoS ONE 12: e0180944.

[14]   Bollen, Johan, Huina Mao, and Xiaojun Zeng. 2011. Twitter Mood Predicts the Stock Market. Journal of Computational Science 2: 1–8.

[15]   Seng, Jia-Lang, and Hsiao-Fang Yang. 2017. The association between stock price volatility and financial news—A sentiment analysis approach. Kybernetes 46: 1341–65.

[16]   Devi, B. Uma, D. Sundar, and P. Alli. 2013. An Effective Time Series Analysis for Stock Trend Prediction Using Arima Model for Nifty Midcap-50. International Journal of Data Mining & Knowledge Management Process 3: 65

[17]   Ariyo, Adebiyi A., Adewumi O. Adewumi, and Charles K. Ayo. 2014. Stock Price Prediction Using the Arima Model. Paper presented at the 2014 UKSim-AMSS 16th International Conference on Computer Modelling and Simulation (UKSim), Cambridge, UK, March 26–28.

[18]   Bhuriya, Dinesh, Girish Kausha, Ashish Sharma, and Upendra Singh. 2017. Stock Market Prediction Using a Linear Regression. Paper presented at the 2017 International Conference of Electronics, Communication and Aerospace Technology (ICECA), Coimbatore, India, April 20–22; vol. 2.

[19]   Patel, Jigar, Sahil Shah, Priyank Thakkar, and K. Kotecha. 2015. Predicting stock market index using fusion of machine learning techniques. Expert Systems with Applications 42: 2162–72.

[20]   Milosevic, Nikola. 2016. Equity Forecast: Predicting Long Term Stock Price Movement Using Machine Learning. arXiv.

[21]   Dey, Shubharthi, Yash Kumar, Snehanshu Saha, and Suryoday Basak. 2016. Forecasting to Classification: Predicting the Direction of Stock Market Price Using Xtreme Gradient Boosting.

[22]   Pagolu, Venkata Sasank, Kamal Nayan Reddy, Ganapati Panda, and Babita Majhi. 2016. Sentiment Analysis of Twitter Data for Predicting Stock Market Movements. Paper presented at the 2016 International Conference on Signal Processing, Communication, Power and Embedded System (SCOPES), Paralakhemundi, India, October 3–5.

[23]   Xu, Yumo, and Shay B. Cohen. 2018. Stock movement prediction from tweets and historical prices. Paper Presented at the 56th Annual Meeting of the Association for Computational Linguistics, Melbourne, Australia, July 15–20.

[24]   S. Hochreiter and J. Schmidhuber, "Long Short-Term Memory," Neural computation, vol. 9, no. 8, pp. 1735–1780, 1997.

[25]   A. Graves et al., Supervised Sequence Labelling with Recurrent Neural Networks. Springer, 2012, vol. 385.

[26]   D. P. Kingma and J. Ba, "Adam: A method for stochastic optimization," arXiv preprint arXiv:1412.6980, 2014.

[27]   Mrcela, L., Mercep, A., Begusic, S., & Kostanjcar, Z. (2017) Portfolio optimization using preference relation based on statistical arbitrage. In Smart Systems and Technologies (SST), 2017 International Conference on (pp. 161–165). IEEE.

[28]   Fang, J., & Xiaoyun, M. (2017) Dynamic Multi-Mode Portfolio Optimization Strategy for Markovian Arrival Process. In Robots & Intelligent System (ICRIS), 2017 International Conference on (pp. 139–142). IEEE.

[29]   Das, S., & Goyal, M. (2012) Rebalancing a two-asset Markowitz portfolio: A fundamental analysis. In Computational Intelligence for Financial Engineering & Economics (CIFE), 2012 IEEE Conference on (pp. 1–8). IEEE.

A New Technique to eliminate excessive copies of Cloud Data through Secure Key Hierarchy

Dr. Nileshkumar Gupta

A.K. Garg Engineering College
Ghaziabad

Abstract: **Attribute-based Encryption has been ordinarily utilized in circulated computation wherever an information supplier re-appropriates his/her mixed data to a cloud professional association and may grant the information to customers having unequivocal capabilities (or properties). Regardless, the quality ABE structure does not backing secure elimination of excessive data, and that is vital for removal of duplicate copies of undefined knowledge, thus saving extra space and framework data transmission. During this paper, we tend to gift an attribute-based mostly limit system with secure elimination of excessive data during an ewer cloud setting, wherever a non-public cloud is in charge of duplicate acknowledgment associated an open cloud manages the limit. Differentiated and, therefore, the previous knowledge elimination of excessive data systems, our structure has two central focuses. Directly off the bat, it'd be wont to subtly bestow knowledge to customers by demonstrating access approaches instead of sharing unscrambling keys. Moreover, it brings home the portions of bacon the quality plan of linguistics security for knowledge protection. Whereas existing structures merely achieve it by representational process and additional delicate security thought. Besides, we tend to set forward a framework to vary a code text over one access approach into figure writings of the proportionate plaintext nonetheless below varied access game plans while not revealing the first plaintext.**

Keywords: **security, safe perusing, key confirmation, diminish deduplication.**

I. INTRODUCTION

Distributed computing considerably encourages data suppliers World Health Organization have to be compelled to spread their data to the cloud while not revealing their subtle data to outsiders and may wish purchasers with precise authorizations to own the choice to urge to the data. This assumes data to be positioned away in jumbled way with getting to regulate methods to such associate scope that no-one apart from purchasers with properties (or certifications) of express assemblies will be able to decipher the encoded data. An associate coding strategy that come across this requirement is termed attribute-based coding, wherever a client's non-public key's associated with a property set, a letter is disorganized below associate appearance approach over tons of possessions, and a shopper will decipher a cipher text with its non-public key if its planning of traits satisfies the doorway strategy connected with this cipher text. Still, the quality ABE framework disregards to achieve secure deletion of excessive data, which may be a procedure to spare further space and system transfer speed by confiscating excess replacements of the disorganized data place away within the cloud. Then one more time, as way as we tend to may presumably grasp, existing developments for secure deduplication aren't supported property based mostly coding. Since Attribute-based Encryption and secure deletion of excessive data are generally applied on the distributed computing, it is tempting to structure a scattered storing background with the two possessions.

We take into account the concomitant scenario within structure of a character based mostly warehousing framework supporting securely deletion of excessive data of disorganized data within the cloud, within which, the darkness will not store any file over once although the element that it would get mixed reproductions of an identical record encoded below varied admittance methods. Associate data worker, Bob, means that to transfer a document M to cloud and offer M through purchasers having sure accreditations. Thus on do in and of itself, Bob encodes M below associate entrance strategy associate over tons of abilities and transfers the relating cipher text to the cloud, with the tip goal that lone purchasers whose provisions of properties satisfying the doorway strategy will decipher the cipher text. Subsequently, a different data supplier, Alice, handovers a cipher text for equivalent elementary document M nonetheless attributable to associate alternative admittance approach A0. Since the report is assigned during a disorganized structure, the cloud cannot understand that plain text regarding cipher text of Alice is adored that examination to Bob's, and also can hoard M double. Such a traced warehousing spends further space and correspondence transmission capability.

II. RELATED WORK

ABE (Attribute-Based Encryption):
Sahai & Waters, given the thought of it and later on, Goyal et al. elaborate the key organization ABE (KP-ABE) & cipher text strategy ABE (CP-ABE) as the two complementary kinds of ABE.

Bettencourt, Sahai, & Waters projected prime CP-ABE. Nevertheless, it is safe underneath the traditional assembly model. A CP-ABE structure underneath additional established access arrangements is projected by Goyal et al. supported the amount of

hypothetic suspicion. Thus, on beating the constraint that the attribute house scale is poly on the face of it restricted within the security boundary and therefore the attributes square measure mounted ahead, Rouselakis and Waters designed an outsized universe CP-ABE system underneath the prime-request gathering. During this research paper, the Rouselakis Waters framework is occupied because of hidden arrange for stable development.

Securely Deletion of excessive data: With the target of additional economic area for distributed storage administrations, Douceur et al. projected the principal declare adjusting privacy and proficiency in playacting deduplication referred to as united coding, wherever a message is encoded underneath a message-decided key with the objective that unclear plaintexts square measure disorganized to the equivalent cipher texts. For this case, if two clients transfer a similar document, the cloud employee will watch the comparable cipher texts and store only one duplicate. Executions and variations of synchronous coding were deployed. Thus on formalizing the accurate safety description for joined coding, Bellare gave a crypto logic crude named letter fastened coding and purpose by purpose several explanations to catch completely diverse safety requests. Abadi et al. excellence concluded the security classification by seeing the plain text conveyances relying upon the open boundaries of plans. This prototype was later reached out by Bellare by giving security to communications that square measure each connected and dependent on the open framework boundaries. Since message-bolted coding cannot avoid savaging power assaults wherever records falling into an accomplished set are recuperated, a style that provides secure deletion of excessive data reposition opposing beast power assaults was advanced Keelveedhi, Bellare and Ristenpart and acknowledged in a powerful framework referred to as server-helped coding for deletion of excessive data capability. During this research paper, a parallel strategy to it has been used to complete secure deletion of excessive data with relevancy the personal cloud within the stable development.

III. PRELIMINARIES

In following segment, we will audit important cryptographic thoughts and classifications that are to be utilized in later stage.

3.1 Bilinear Couplings and Complexity Conventions

Assume that Group on may be a probabilistic polynomial time calculation that inputs a security boundary λ, and yields a triplet (P, g, p) wherever P maybe a gathering of request g that's created from p, and g may be a prime. We tend to characterize ˆ a : P × P → P1 to be an additive guide the off probability that it's the attendant properties.

• Bilinear: for all p ∈ P, and c, d ∈ Z∗ g, we've got ˆ a(pc,gd) = ˆ a(p,p)cd.

• Non-degenerate: ˆ a(p,p) 6= 1.

We state that P may be an additive gathering if the gathering activity in P is profitably computable Associate in Nursing d there exists a gathering P1 and an effectively process able additive guide ˆ a: P×P → P1 as higher than.

given$\rightarrow^{-}$ y =

$$p, p^{\mu},$$

$$p^{a^i}, p^{b^i}, p^{s.b_j}, p^{a^i b_j}, p^{a^i/b_j^2} \quad \forall (i,j) \in [f,f],$$

$$p^{a^i/b_j} \qquad\qquad \forall (i,j) \in [2f,f], i \neq f+1,$$

$$p^{a^i b_j/b_{j'}^2} \qquad\qquad \forall (i,j,j') \in [2f,f,f], j \neq j',$$

$$p^{\mu a^i b_j/b_{j'}}, p^{\mu a^i b_j/b_{j'}^2} \qquad\qquad \forall (i,j,j') \in [f,f,f], j \neq j',$$

It is onerous to acknowledge ($\rightarrow^{-}$ y, ˆ a(p,p)cf+1μ) from ($\rightarrow^{-}$ y, Z), wherever p ∈ P, Z ∈ P1, c, μ, d1, ..., bf ∈ Z∗ g picked autonomously and systematically at impulsive.

3.2 Symmetric Encryption

Symmetric encryption schemes have keyspace KS and MS is made of the two algorithms: an encryption calculation SE. Ec(KS, ms) produces a cipher text C on input a key KS ∈ KS and a message ms ∈MS, and a decoding calculation SE. Dc(KS, C), which yields a communication ms or the disappointment image ⊥ on input a key KS ∈ KS and any cipher text C.

3.3 Assurance Structure

An assurance structure CME is made out of the accompanying 3 calculations boundary age calculation CPG which is taking a security boundary λ as information and yields the open boundaries cpars, committal calculation Com which is taking the open boundaries cpars & information x as information and yields a dedication com to x alongside a de-committal key dec, and a confirmation calculation that it acknowledges or 0 to demonstrate that it rejects. A responsibility plan ought to be both restricting, which implies that the decommit stage can effectively open to just one worth, and concealing, which implies that the submit stage doesn't uncover any data about x. For X ∈ {Hiding, Binding}.

3.4 Access Arrangements & Linear Secret Allocation Arrangements

Definition 1: (Access Arrangements)

Let $\{A1,...,An\}$ be a set of parties. An assortment $B \subseteq 2\{A1,...,An\}$ is monotone in the event that $\forall C,D$: in the event that $C \in An$ and $C \subseteq D$, at that point $D \subseteq B$. B (monotone) get to structure is a (monotone) assortment An of non-void subsets of $\{A1, ..., An\}$, i.e., $B \subseteq 2\{A1,...,An\}\backslash\{\emptyset\}$. The sets are known as the approved sets, and the sets not in An are known as the unapproved sets.

Definition 2: (**Linear Secret Allocation Arrangements**)

Leave A alone a lot of gatherings. Let G be a grid of size $l\times n$. Let $\rho:\{1,...,l\} \rightarrow R$ be a capacity that plots a line to a group for naming. Leave r alone any prime digit. A mystery distribution plan Π terminated a lot of gatherings R is a direct mystery sharing plan (LSSS) over Zr if

  1) The offers for each gathering structure a vector over Zr.
  2) There is a grid G with one-lines and n sections called the offer creating lattice for Π.

IV. SYSTEM ARCHITECTURE AND SECURITY MODEL

In this area, we portray the framework design and the proper meaning of ciphertext-strategy trait based capacity framework supporting secure deduplication.

4.1 System Architecture

The engineering of our quality primarily based reposition framework with secure deduplication has appeared in Figure during which four components area unit included: data suppliers, appropriate authority (CA), cloud, and purchasers. An associate degree data provider has to re-appropriate her/his data to the cloud and supply it with purchasers having sure accreditations. The CA provides every consumer associate degree unscrambling key connected with its arrangement of qualities. The cloud contains associate degree open cloud that is answerable for data reposition and a personal cloud that plays out a sure calculation, as an example, tag checking. Once causing a record to reposition demand, each data provider at the start marks label T and mark L connected with statistics, and associate degreed later struggles the data below an entry arrangement over heaps of characteristics. Besides, all data supplier creates a symptom pf on the connection of the label T, the mark L and also the encoded message ct3

Figure: System design of characteristic centered storage with secure deletion of excessive data
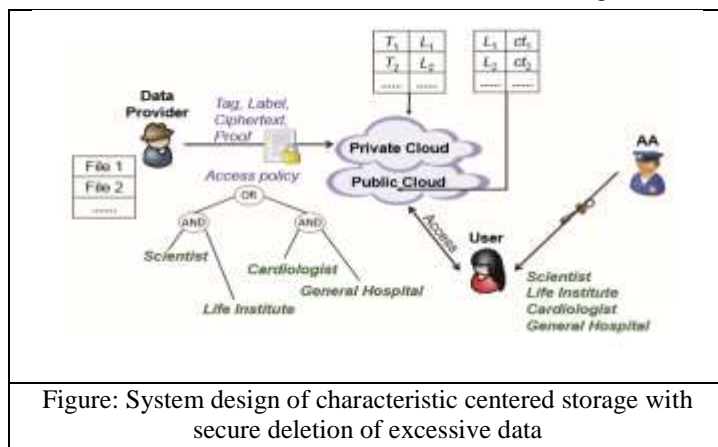
V. ATTRIBUTE-BASED STORAGE WITH SECURE DEDUPLICATION

In this segment, we depict a stable development of a trait-based capacity framework supporting secure deduplication, examine its security, and show its exhibition from theoretical and trial investigation.

5.1 Construction

• Decrypt. This calculation takes the open boundary standards, a ciphertext (M, ρ), E, B, C, $\{Ci, Di, Ei\}i\in[1,l]$ with the relating name K and a private key sA for a property set An as the info. Assume that a particular set A fulfills the entrance structure (M, ρ). Characterize I as I = $\{i : \rho(i) \in A\}$. Indicate by $\{wi \in Zp\}i\in I$ a lot of constants with the end goal that if $\{vi\}$ are legitimate portions of any mystery μ as per (M, ρ), then $Pi\in I\ wivi = \mu$. It figures the message M as $\hat{}\ a(B,s0\ 1)\ Qi\in I(\hat{}\ a(Ci,s0\ 2)\hat{}\ a(Di,s(i)\ 1\ )\hat{}\ e(Ei,s(i)\ 2\ ))wi = \hat{}\ a(f,f)\alpha\mu\hat{}\ a(f,w)\mu r\ Qi\in I\ \hat{}\ a(f,w)rviwi = \hat{}\ a(f,f)\alpha\mu$, and counteracts $\hat{}\ e(g,g)\alpha\mu$ from C to acquire β. At that point, it processes $M = SE.Dc(G(\beta), E)$. On the off chance that $fg1(M)hg0(\beta) = L$, it yields M. Else, it yields a disappointment symbol$\perp$.

5.2 Security

Next, we demonstrate that the proposed stockpiling framework safeguards the security of the encoded information as far as open Cloud and private Cloud, separately.

Theorem

Expecting that $(q - 1)$ supposition clamps in F, SE is a protected single key encryption plan, and L is created succeeding a safe duty conspire, at that point, the proposed characteristic based hoarding background with secure deletion of excessing data is specifically

unclear in regards to the perspective on the open Cloud. Confirmation. The Rouselakis Waters plot is identified to be pointedly ambiguous accepting that $(q - 1)$ presumption grips in F. Our verification for Theorem 1 generally surveys that in excluding that in test stage, E∗ and L∗ = fg1(M∗ b)hg0(β) will be added to the first test ciphertext. Note that E∗ won't unveil any data about M∗ b because of safety of the fundamental SE scheme, L∗ won't enlighten any data concerning M∗ b because of the safety of the basic responsibility plot.

5.3 Implementation
My project implements using with modules.
- i)   Data Provider
- ii)   Cloud
- iii)   Deletion of
- iv)   Attribute Authority

5.3.1 Data Provider
Information supplier transferring document to cloud with tag, name and security key, the proposed plot ensures information uprightness against any label irregularity assault. Accordingly, security is improved in the proposed plot.

5.3.2 Cloud
Secure Deduplication to spare storing universe for distributed storing administrations, Douceur et al. The main answer for adjusting classification and productivity in deletion of excessive data called joined encryption, where a communication is scrambled under a message contingent key, so indistinguishable plain texts are encoded to the equivalent ciphertexts. For this situation, if two clients transfer a similar record, the cloud worker can perceive the equivalent ciphertexts and store just one duplicate of them. Which may disregard the protection of the information if the cloud worker can't be completely trusted. This is a customer who possesses information and wishes to transfer it into the distributed storage to spare expenses. An information proprietor scrambles the data and re-appropriates it to the distributed storage with its file data, that is, a tag.

5.3.3 Deduplication
Information deduplication is a particular information pressure method for dispensing with copy duplicates of rehashing information. Related and to some degree, equal terms are canny (information) pressure and single-occurrence (information) stockpiling. This procedure is utilized to improve capacity use and can likewise be applied to organize information moves to lessen the number of bytes that must be sent. In the deduplication procedure, one of a kind pieces of information, or byte designs, are distinguished and put away during a process of examination. Deduplication strategies exploit information similitude to distinguish similar information and decrease the extra room. Conversely, encryption calculations randomize the encoded documents to make ciphertext undefined from hypothetically irregular information.

5.3.4 Attribute Authority
The AA gives each client an unscrambling key associated with client set of qualities At the client-side, every client can download a thing, and decode the ciphertext with the property based private key created by the AA if this present client's characteristic set fulfills the entrance structure.

VI.   EXPECTED RESULTS DISCUSSION

In this segment, we give further elaboration on the two principle methods we presented in this paper.

6.1 Adjustable Characteristic Centered Encryption
Lai et al. introduced crypto logical crude referred to as multipurpose CP-ABE, wherever a semi-believed intercessor is carried into the locale of CP-ABE. The intercessor, given a background full hidden entry key, will modify any code text beneath one admittance approach into cipher texts of the equivalent plain text beneath another access method while not learning any knowledge regarding the plaintext throughout the modification procedure. However, this strategy for utilizing a single secret entry key for all cipher texts is remarkably insecure, since if the only key's undermined.

The safety for the background is going to be thoroughly damaged. An associate ill-disposed consumer utilizing the undermined secret entrance key will recover a cipher text into associate entry arrangement that his/her characteristics fulfill. During this manner, it will get the plain text not planned for him/her. Moreover, the hidden entrance key is formed by the AA UN agency as of currently controls the decipherment keys within the framework. Therefore it's enticing to decrease its capability in dominant cryptography. Not the least bit like that in our procedure is coordinated with the tip goal that every hidden entrance key should be used to alter its relating ciphertext. On these lines, even sooner or later, a secret entrance key's contained, the hurt is strained to 1 message. At a significant level, our strategy carries an associate with another approach to fabricate versatile CP-ABE frameworks from an alternate perspective.

6.2 Deduplication in Hybrid Cloud
Take care of this issue, a more vulnerable safety idea called defense under picked dissemination assaults [8] was advanced under the supposition that the information message is adequately erratic. Not quite the same as the current technique for characterizing a more vulnerable security idea for the distributed storage framework with secure deduplication, half and half cloud design, comprising of a couple of open and private mists, is presented in our capacity framework to such an extent that the semantic security gets attainable for the open cloud. This structure of twin mists has been generally received practically speaking, where the security

of the open cloud for the most part goes up against a bigger number of difficulties than that of the private cloud, and consequently it is alluring to have more grounded information secrecy insurance at the open cloud side. We accept that the cross breed cloud engineering is a promising way to deal with capacity frameworks with deletion of excessive data, in which the scrambled information is re-appropriated to the open cloud while deletion of excessive data checking is taken care of by the private cloud.

VII. CONCLUSION

Attribute-Based Encryption is being extensively useful in disseminated processing where data suppliers redistribute their mixed data to cloud and they can confer the data to customers having shown qualifications. Then again, deletion of excessive data is a huge technique to save the additional area and framework move speed, which discards duplicate copies of indistinct data. In any case, the standard ABE structures don't provision safe deletion of excessive data, which marks them overpriced to be connected in some business amassing organizations. In this research paper, we showed a novel method to manage comprehend a quality based limit system supporting safe deletion of excessive data. Our capability arrangement has operated under a creamer cloud building, in which a private cloud controls the sum and open cloud manages limit. Resulting to getting a limit request, the private cloud first draughts the legitimacy of the moved thing with the associated proof. If the proof is real, the private cloud turns a mark establishing approximation to see if comparative data covered up cipher text has been taken care of. Accepting this is the situation, at whatever point it is significant, it recuperates cipher text to a cipher text of comparable plain text over a passageway approach which is the affiliation set of both access systems. The proposed amassing system acknowledges two imperative focal points. Directly off the bat, it might be used to subtly give data to various customers by deciding a passageway approach as conflicting to sharing the unscrambling key. Moreover, it achieves the standard thought of semantic safety while obtainable deletion of excessive data contrives simply achieve it under a more delicate safety thought.

6.3 Results

(a) KeyGen

(b) Encrypt

(c) Re-encrypt

(d) Decrypt
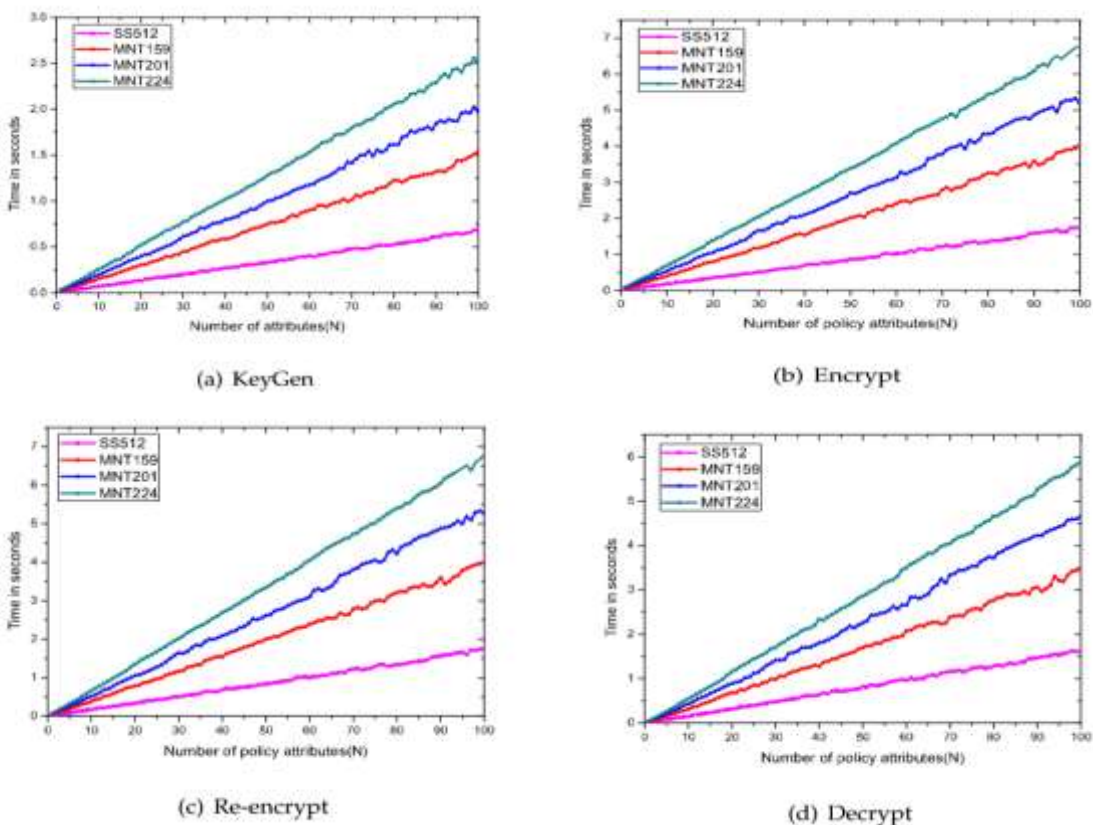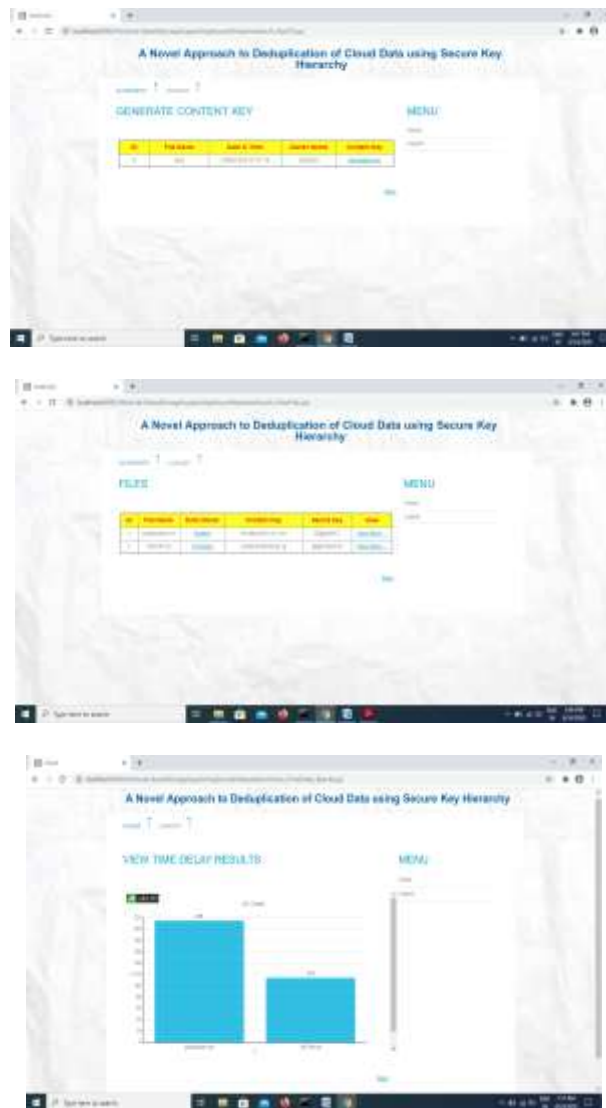
REFERENCES

[1] D. Quick and K. R. Choo, "Google drive: Forensic analysis of data remnants," J. Network and Computer Applications, vol. 40, pp. 179– 193, 2014.

[2] Hendrik Graupner, Kennedy A Torkura, Muhammad Sukmana, Christoph Meinel, "Secure Deduplication on Public Cloud Storage", ICBDC 2019: Proceedings of the 2019 4th International Conference on Big Data and Computing, May 2019 Pages 34–41, https://doi.org/10.1145/3335484.3335502"

[3] Liu Zhenhua, Kang Yaqian, Li Chen, Fan Yaqing, Hybrid cloud approach for block-level deduplication and searchable encryption in large universe, The Journal of China Universities of Posts and Telecommunications, Volume 24, Issue 5, 2017, Pages 23-34, ISSN 1005-8885, https://doi.org/10.1016/S1005-8885(17)60230-9

[4] S. Annie Joice, M. A. Maluk Mohamed, Cloud Storage: A Review on Secure Deduplication and Issues, Journal of Internet Technology Volume 20 (2019) No.3, DOI: 10.3966/160792642019052003019

[5] Sara Abdel Razek, Dr.Heba El-Fiqi, Prof. Dr. Ibrahim Mahmoud "Cloud Storage Forensics: Survey", International Journal of Engineering Trends and Technology (IJETT), V52(1),22-35 October 2017. ISSN:2231-5381. www.ijettjournal.org. published by seventh sense research group

[6] M. Bellare, S. Keelveedhi, and T. Ristenpart, "Message-locked encryption and secure deduplication," in Advances in Cryptology - EUROCRYPT 2013, 32nd Annual International Conference on the Theory and Applications of Cryptographic Techniques, Athens, Greece, May 26-30, 2013. Proceedings, ser. Lecture Notes in Computer Science, vol. 7881. Springer, 2013, pp. 296–312.

[7] K. R. Choo, M. Herman, M. Iorga, and B. Martini, "Cloud forensics: State-of-the-art and future directions," Digital Investigation, vol. 18, pp. 77–78, 2016.

[8] Chinmay Patil, Shubham Kasabe, Ronik Mahajan, Ajay Indani, Prof. V.V. Waykule, "Attribute based Storage to avoid duplicate files on cloud", International Journal of Advance Research in Engineering, Science & Technology, Volume 5, Issue 4, April-2018

[9] 1. M. Jiang, Y. Hu, H. Lei, B. Wang, Q. Lai, "Lattice-based certificateless encryption scheme", Frontiers of Computer Science, Vol. 8, p. 828, 2014, DOI: https://doi.org/10.1007/s11704-014-3187-6

Integrated Framework to Mitigate Risks during Strategy Implementation

[1]Abdelgadir M. Mahmoud, [2]Omer M. Osman

[1]Senior Lecturer, [2]PhD Candidate
Razak Faculty of Technology and Informatics
Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia

Abstract: In today's competitive business environment, business entities are faced with greater uncertainties (threats and opportunities) as they strive to create value. In the quake of the current global economic crisis, businesses in a bid to stay competitive have taken several crucial measures. However, for companies to keep track of their strategies, achieve their strategic objectives and reduce the impact of uncertainties, appropriate decisions should be made with a solution that reduces the impact of risks. Technical reports from companies showed that there is deviation from their original strategic plan tracks, and they are unable to achieve their strategic objectives. A preliminary study was conducted to identify the factors that lead to inefficiencies during strategic plan implementation. The result of the preliminary study showed that there is lack of risk management, especially information and incentive alignment risks. This research aims to propose a framework that mitigates risks during strategy implementation, through how the key choices made in strategy will either increase or reduce two characteristic types of risk (information and incentive alignment risks). These two types of risk (which are not mentioned in depth in other or past types of risk management categories) are the key inefficiency creators in the strategic planning and decision making that arise because of decision patterns. The proposed framework considers how to question the key decisions and how to turn inefficiencies into opportunities and points of power to create value. The proposed framework also presents essential fundamental concepts and enablers for achieving sustainable performance such as developing organizational capability, creative thinking, innovation, agility, succeeding through people and sustained outstanding results. The framework presents a mechanism to identify and assess the information and incentive alignment risks in the key decisions. The developed framework helps to reinvent desired strategic performance which lies in changing how decisions are made.

1. INTRODUCTION

The roots of the term risk can be traced back as far as the late middle ages, the modern concept of risk appeared only gradually, with the transition from traditional to modern society. The modern understanding of risk presupposes subjects or institutions, accountable for their actions that make decisions under conditions of apparent uncertainty. Some apparent uncertainties, however, can be measured or quantified probabilistically and are, therefore, more precisely called risks (1). Risk management is a continuous process that is accomplished throughout the life cycle of a system. It is an organized methodology for continuously identifying and measuring the unknowns; developing mitigation options; selecting, planning, and implementing appropriate risk mitigations; and tracking the implementation to ensure successful risk reduction. Effective risk management depends on risk management planning; early identification and analyses of risks; early implementation of corrective actions; continuous monitoring and reassessment; communication, documentation, and coordination (2). Strategy risk relates to risk at the corporate level, and it affects the development and implementation of an organization's strategy (3). Strategy risk is a function of the compatibility of an organization's strategic goals, the business strategies developed by management to achieve those goals, the resources deployed against these goals, and the quality of the implementation (4).

2. LITERATURE REVIEW

Enterprise Risk Management (ERM) supports agencies' ability to articulate risks, align and allocate resources, and proactively discuss management and mitigation strategies and activities to better equip agencies to deliver on their goals and objectives and potentially improve stakeholder confidence and trust. Moreover, ERM should operate with the purpose of supporting the mission and vision, integrating existing risk management practices across functional silos and improving strategic planning and decision-making (5).

The environment in which an organization operates has become more complex, more rapidly changing, and more demanding (6). As stated by Drucker (7), we are living in "an age of discontinuity". It is therefore vital that an organization be aware of the internal and external forces that may shape its future (8). The monitoring, evaluating and disseminating of information from the external environment to key personnel within an organization is known as environmental scanning (9). Hambrick (10) states that environmental scanning refers to the managerial activity of learning about events and trends in the organization's environment. Environmental scanning can yield a number of benefits for decision-makers within the organization, for example, it will help in detecting environmental signals. However, this is only part of the scanning process as assessing its strategic implications requires a forecast of the expected rate of change, or a forecast of the impact of the change (11). In addition, scanning provides managers with information about events and trends in their relevant environments, which facilitates opportunity recognition (12). Also Barringer and Bluedorn (12) state that scanning is a method to reduce uncertainty. Scanning can help managers cope with uncertainty, but only

if they realize that uncertainty can only be reduced, not eliminated. To assess the organizational environment as one of the main steps in the strategic planning formation process, strategic tools are used. According to Clark (13), strategy tools are concepts, analytical frameworks, techniques and methodologies that assist strategic managers in making informed decisions.

Today, information can no longer be treated as a source of competitive advantage, but a competitive necessity. It penetrates in all aspects of an organization, crosses data processing and information systems department. The information potential can be realized by the means of appropriate management and knowledge of the organizational and cultural aspects (14). Information risk is always present to some extent in every business. Reducing it is most urgent where the inefficiencies it causes are most intense. Getting an assessment of the extent of information inefficiency involves understanding three key properties of the decision that is made with insufficient information. These three key properties of the decision are the consequent of the decision, The degree of reversibility or finality of the decision and the measure of the know unknowns associated with the decisions (14).

Incentive alignment risk arise when the incentive imposed by a business model lead to actions that clash with the boarder interest of a value chain. For most businesses, achieving alignment is a continuous process. While alignment is a state, its definitional opposite – misalignment – is an infinite number of states in a multidimensional space. Thus, a discussion of the alignment process requires both identifying the state of alignment and monitoring the dynamics of misalignment (15). If the decisions made crucial to the strategic direction of the corporate or a business unit with misaligned incentives, the consequent incentive inefficiency is likely to be more harmful and a worthy adversary to take on (16).

3. METHODOLOGY

The adopted approach includes qualitative, quantitative and Mixed-method techniques. The instruments used to collect the data in this study are the literature review, the semi- structured interviews, and questionnaires. The outcomes of the literature review and the preliminary study were used as input to identify the factors that lead to inefficiencies in the decision making during strategy implementation, through studying the performance of strategy successful factors in selected business units.

The data collected via semi-structured interviews was used in the preliminary study to evaluate the implementation of the strategy successful factors in selected business units. Questionnaires were used to validate that some business units are suffering from information and incentive alignment risks and evaluate the negative effect of these two types of risk in the decisions making. The reliability coefficient (Cronbach's Alpha) was found to be positive, with the reliability rate based on the Cronbach-Alpha scale (0.88 and 0.84) for the information and incentive alignment risks data.

In this study, data was analyzed using descriptive and inferential statistics. Descriptive statistics included percentages, frequencies, means, and standard deviations while inferential statistics included regression and correlation analysis. Data processing was undertaken through coding the completed questionnaires, entry into SPSS and then checked for accuracy of data input.

4. RESULTS AND ANALYSIS

The results of the preliminary study at selected Business Units revealed that:
1.   There were deviations periodically from the strategy plans tracks.
2.   There are no risk management procedures during strategy execution.
3.   There are no procedures to manage the information and incentive alignment risks.
4.   There is no mechanism to manage risks during decision making process.

Questionnaires were used to validate that some business units are suffering from information and incentive alignment risks and evaluate the negative effect of these two types of risk in decisions making. The output of the questionnaires can be summarized in the following main points:
1.   Respondents emphasized that the selected business units are affected and suffering of Information and Incentive Alignment Risks.
2.   Respondents agreed with the symptoms as factors that lead to inefficiencies in the decision making.

4.1 PROPOSED FRAMEWORK COMPONENTS

The proposed framework was formed to promote sustainable success and to provide guidance to keep the strategy plan in its track through managing risks in the decisions. This is realized through a set of three integrated components which comprise the framework. The firs component is the Fundamental Concepts, to underlying principles which are the essential foundation of achieving sustainable and strategy alignment (sustainability). The second component is the Risk Mitigation process, which helps organization to manage risks in decisions, and reinvent decisions aligned with strategy track by converting the fundamental concepts and strategic performance management into practice through innovative decision path. The third component strategic performance management. A dynamic assessment process and powerful management tools to support organizations. It's a multistep process that guides the leadership in designing and revising the strategic performance.

The proposed framework (see Fig. 1) based on continues improvement concept. It is using three integrated components (Fundamental Concepts, Strategy Performance management and Decision risk management process). The framework helps organizations to

question themselves to invent or keep track of strategy with the attributes to achieve sustainability, drive innovation and improve results.

The proposed framework studying the identification of risks (information and incentive alignment risks symptoms) in the key decisions, then the framework open the path to reinventing desired strategic performance which lies in changing how decisions are made. The proposed framework mainly considers how to question the key decisions and how to identify value destroying points and turn these inefficiencies into opportunities and points of power to unlock new value.
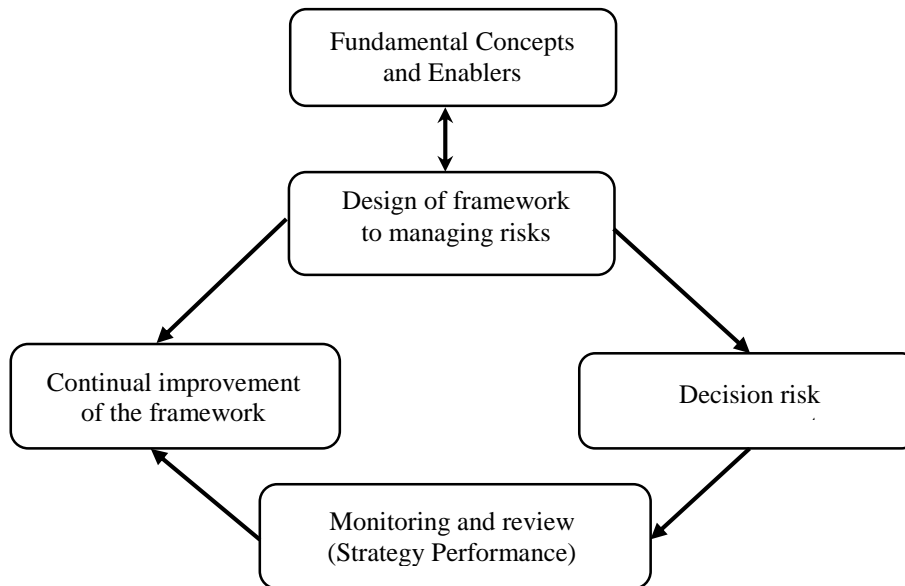
Figure 1 the proposed Framework Components

The strategic performance management provides a structured approach to question the performance of the organization. It combines strategic planning with performance management by creating an organizational structure based on strategies and functions, aligning resources with the structure, addressing human capital and productivity, and establishing performance measures (17).

4.2 THE FUNDAMENTAL CONCEPTS AND ENABLERS
These Fundamental Concepts and enablers Contribute in risk mitigation, that it outlines the essential foundation for achieving sustainable performance for the organization. They can be used as the basis to describe the attributes of the framework for the organizational culture. They also serve as a common language for top management and decision makers, these concepts can be summarizing in five enablers (18), which are:
1. Developing Organizational Capability
2. Harnessing Creativity & Innovation
3. Managing with Agility
4. Succeeding through the People
5. Sustaining Outstanding Results

4.3 STRATEGIC PERFORMANCE MANAGEMENT
Strategic Performance Management is a multistep process (Fig. 2) that guides the leadership in designing and revising a system of strategic performance management. It combines strategic planning with performance management by creating an organizational structure based on strategies and functions, aligning resources with the structure, addressing human capital and productivity, and establishing performance measures (19).

4.4 MANAGING INFORMATION AND INCENTIVE ALIGNMENT RISKS
The proposed framework considers how to question the key decisions and how to identify value destroying points and turn these inefficiencies into opportunities and points of power to unlock new value during strategy implementation (16). The framework is about mitigating risks through questioning how the key choices made and how will either increase or reduce the two characteristic types of risk (information risk and incentive alignment risk). Mitigating risks is managed through three steps in the proposed framework, which involves:
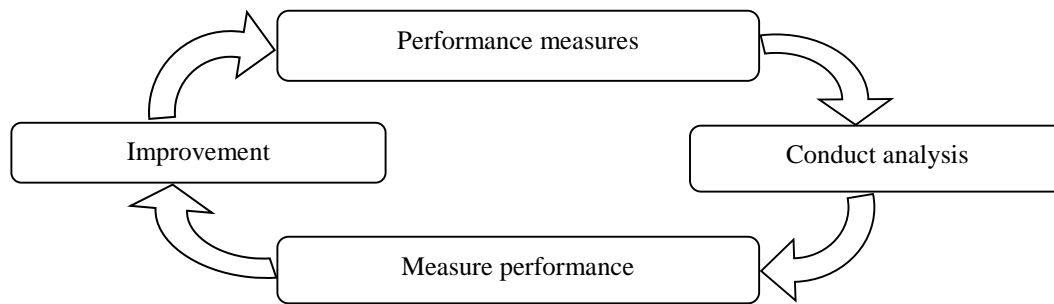
Figure 2 Strategic performance management

4.4.1 RISK IDENTIFICATION
Identify and assess inefficiencies in decisions by searching the appearance of signs or symptoms of information and incentive alignment risks, which can help the organization honestly identify value-destroying points and pointed their root-cause inefficiencies.

4.4.2 RISK ASSESSMENT
Estimating the consequences of identified risks (16) (information and incentive alignment risks), which are shown in the following points:
1.   Incentive alignment risks assessment
2.   Information risk assessment

4.4.3 REINVENT DECISIONS
The path to reinventing desired strategic performance lies in changing how decisions are made, so decisions are the main factor for inventing and reinventing new strategic decision path. To make this decision formulation the proposed framework chooses four basic types of interventions: changing what decisions strategy involves; when a decision is made; who should make the decision; and why the decision maker makes the decision the way he does.

4.5 CHANGING WHAT DECISIONS STRATEGY INVOLVES
Determining what decision to select in designing corporate strategy is usually the dominant driver of their risks and inefficiencies nonetheless; organizations often take these foundational decisions for granted. A few simple rules apply when reinventing the strategy by modifying what it defines as important (16):
1.   Balance focus with flexibility: The so-called Pareto principle applied here: 20 percent of products or services account for 80 percent of risks. Eliminate just a   few, and the organization will improve excessively.
2.   Reduce the number of decisions: It's possible to reduce the number of decisions without reducing products or services offering.
3.   Hedge decision against one another: Business risks arising from different decisions seldom rise and fall synchronously. We can complementary decisions to build a portfolio of risks that hold each other in check, balance demand fluctuations and optimize capacity. It can also hedge by pooling resources with other companies.

4.6 WHEN A DECISION IS MADE
Determining when to make key business decisions and the order in which they are arranged, relative to one another, is very important to the business and strategic performance and to the value it create. So if the decision pattern modified to change the absolute timing of key decisions and /or the way they interrelate, we can produce powerful business output (16). A few simple rules can help by changing the when of key business decisions:
1.   Delay decision as long as possible. If the opportune moment for obtaining information is fixed in time, we can attempt to delay decisions as long as possible to bring them closer to that moment.
2.   Change the sequence of decisions. This can be a way to incorporate more information into the process. Some companies have reduced their R&D risks in this way and others reduced inefficiencies in the way they produce products and services.
3.   Split a key decision into phases so as to obtain early information, before the decision is completed. Even when decision sequence can't be changed it may still be able to gather highly useful preliminary information before committing to key decision.

As organizations continue growing in complexity and global reach, decisions in them spread out, creating situations in which the historical decision maker may no longer be best suited to the role. In order to design innovative business models, changing who makes the decision can be an effective-even breaking through strategy (16). Three principles guide this approach:
1.   Transfer decision rights to the best-informed decision maker, that will lead to decision
2.   Decisions that impose fewer information and incentive-alignment inefficiencies.
3.   Transfer decision making to the party best able to tolerate the decision's consequences, that can create value.
4.   Move the consequences (costs) of the decision to the party that benefits the most

4.7 WHO SHOULD MAKE THE DECISION

As organizations continue growing in complexity and global reach, decisions in them spread out, creating situations in which the historical decision maker may no longer be best suited to the role. In order to design innovative business models, changing who makes the decision can be an effective-even breaking through strategy (16). Three principles guide this approach:

1.   Transfer decision rights to the best-informed decision maker, that will lead to decisions that impose fewer information and incentive-alignment inefficiencies.

2.   Transfer decision making to the party best able to tolerate the decision's consequences, that can create value.

3.   Move the consequences (costs) of the decision to the party that benefits the most.

4.8 WHY THE DECISION MAKER MAKES THE DECISION THE WAY HE DOES

The design of an organization imposes certain goals and incentives on decision makers. Because decision makers are generally rational actors, these factors can powerfully influence the decisions they make. For instance, an organization that cares mainly about near-term profits will make decisions very different from those of an organization that cares most about long-term sustainability. When differently motivated decision makers must collaborate to create value, incentives have to be adjusted so that the parties can pursue their objectives without damaging the value chain. Understanding the respective parties' incentives helps induce decisions that best create value (16).

4.9 COMMUNICATION AND CONSULTATION

Communication and consultation with external and internal stakeholders should take place during all stages of the risk management process. Therefore, plans for communication and consultation should be developed at an early stage. These should address issues relating to the risk in decision itself, its causes, its consequences (if known), and the measures being taken to treat it. Effective external and internal communication and consultation should take place to ensure that those accountable for implementing the risk management process and stakeholders understand the basis on which decisions are made, and the reasons why particular actions are required.

4.10 MONITORING AND REVIEW

The organization's monitoring and review processes should encompass all aspects of the risk management process for the purposes of:

1.   Ensuring that controls are effective and efficient in both design and operation;

2.   Obtaining further information to improve risk assessment;

3.   Analyzing and learning lessons from events (including near-misses), changes, trends, successes and failures;

4.   Detecting changes in the external and internal context, including changes to risk criteria and the risk itself which can require revision of risk treatments and priorities; and

5.   Identifying emerging risks.

Progress in implementing risk treatment plans provides a performance measure. The results can be incorporated into the organization's overall performance management, measurement and external and internal reporting activities. The results of monitoring and review should be recorded and externally and internally reported as appropriate, and should also be used as an input to the review of the information and incentive alignment risks management framework. The risk management process is shown in Fig. 3.

5. CONCLUSION

Based on the study findings, the study concluded that Information Risk and Incentive Alignment Risk are factors (risks) that affecting business units strategy plan implementation. To reduce the impact of inefficiencies in decision making that arising from information and incentive alignment risk during strategy implementation, the output of the previous studies from objective one and objective two were used as input that used innovation, creative thinking and agility as organizational fundamental concepts to be applied in the business units and also used as enablers to reinvent strategic decisions. Then, for monitoring the strategic performance and the efficiency of the framework and continuous improvement, strategic performance management tools are integrated with the framework components. The developed framework provides guidance to keep the strategy plan in its track through managing risks in decisions. This is realized through a set of three integrated components which make the framework: The Fundamental Concepts and Enablers, The Risk Mitigation Framework and Strategic Performance Management. Using these three integrated components help organizations to question themselves to invent or keep track of strategy with the attributes to achieve sustainability, drive innovation and improve results.
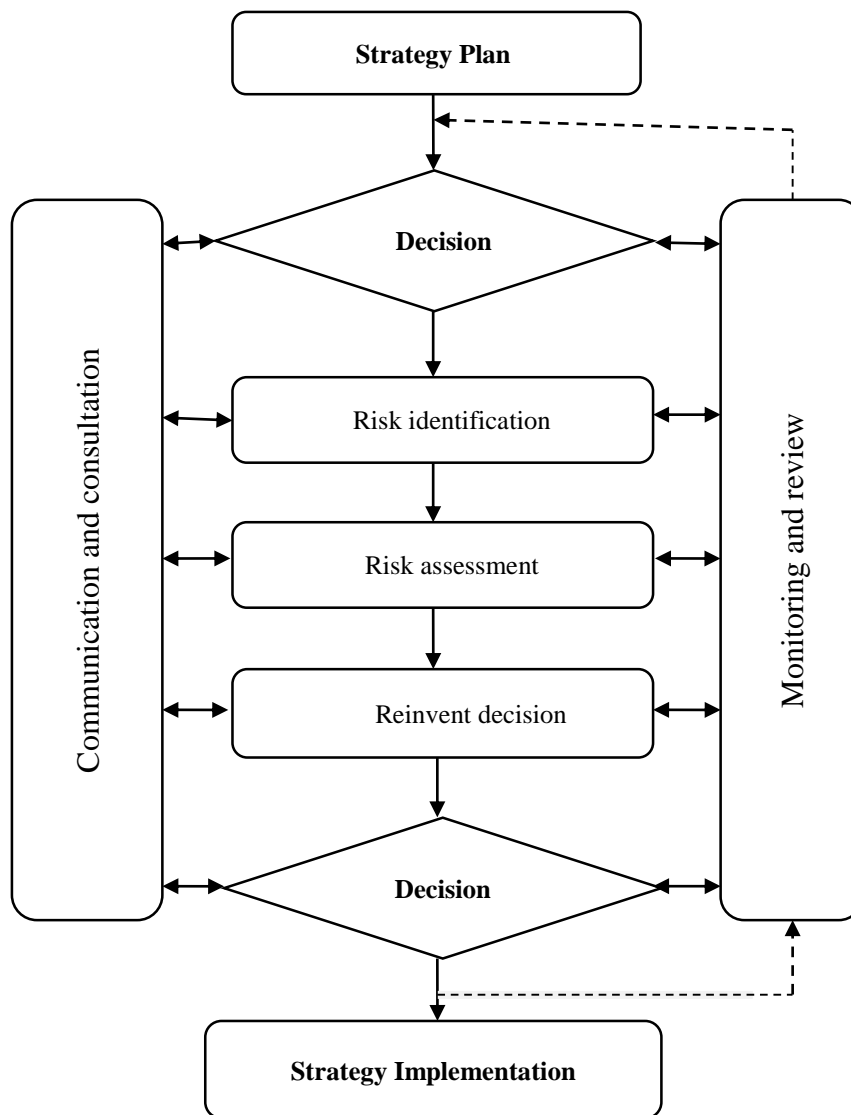
Figure 3 The risk management process

REFERENCES

[1] Karin Zach Mann. History of Technology. Munich Center for Technology in Society. Technische University, München, Deutsches Museum. 80306 Munich, Germany, 2014.

[2] C. Crouhy. The essentials of risk management. Second edition. US, 2014.

[3] Alexander Roberts. Dr William Wallace. Mr Neil McClure. Strategic Risk Management- Edinburgh Business School Heriot. Watt University Edinburgh. EH14 4AS. United Kingdom. 2012.

[4] Joanne Curtis Taylor. Concepts of strategic risk and managing strategic risk. Janury 2012.

[5] Playbook: Enterprise Risk Management for the U.S. Federal Government, 2016.

[6] Ghosh. Strategic Planning: A Contingency Approach, vol. 16, no. 4, pp. 93–103, AYC, 2.13.

[7] Drucker. The Practice of Management. H& R, New York, P 2001.

[8] Galloway. Strategic management in public sector research organizations: a critical review, International Journal of Public Sector Management, vol. 3, no. 1, pp. 5–24, ID 2000.

[9] Wheelen and Hunger. Strategic Management. Addison-Wesley. Reading, Mass. JD 2015.

[10] Hambrick. Environmental Scanning and Organizational Strategy, Strategic Management Journal, vol. 3, no. 2, pp. 159–174, 2011.

[11] Barringer and Bluedorn, The Relationship Between Corporate Entrepreneurship and Strategic Management, Strategic Management Journal, vol. 20, pp. 421–444, 1999.

[12] Bluedorn. The interface and convergence of the strategic management and organizational environment domains, Journal of Management, vol. 20, pp. 201–262, 2012.

[13] Clark, Strategic management tools usage: a comparative study Strategic Change, vol. 6, pp. 417–427. 2007.

[14] Maria Stoyanova Todorova. Management Information Systems: Information As A Strategic Resource Impact On Company's Strategy. 3 Nov 2017.

[15] Christopher M. Scherpereel, Alignment: the duality of decision problems, Northern Arizona University, College of Business Administration, Flagstaff, Arizona, USA,2006.

[16] Karan Girottra And Serguel Netessine. The Risk Driven. Harvard Business Review Press. Boston. 2014.

[17] Suzanne McGilloway. Introduction of a performance management and development system, National College of Ireland. July 2005.

[18] The EFQM Excellence Model 2013, EFQM. Organization. Brussels, Belgium; 2013.

[19] Sam Redding and Allison Layland. Strategic Performance Management, Building State Capacity and Productivity Center. 2015.

Factors Affecting Systems Engineering Complexity during Developmental Phase: Systems Practitioners, Developers, and Researchers' Perspectives - Systematic Review

[1]Mahir H. Moh. Ibrahim, [2]Abdelgadir Mahmoud, [3]Roslizar Bin Mat Ali

[1]Ph.D. Candidate, [2]Senior Lecturer, [3]Associate Professor
[1]Engineering and Technology,
[1]Razak Faculty of Technology and informatics, University Technology Malaysia, Kuala Lumpur, Malaysia

Abstract: **The Systems Engineering design process is challenged to deliver successful complex systems in multidisciplinary and heterogeneous components. Growing human needs and evolving society bring ever greater challenges in the formation of a complex and large engineered system. System complexity is related to lots of parts and large size of the system when there is difficulty in understanding how the system works or in predicting the consequences of any change that may affect the process and systems develop itself. The leadership is performing an important role to manage a complex system. Leaders should be able to set back from immediate focus and look at the desired big picture. In practice, many factors contribute to Systems Engineering complexity in this review. This study intends to explore and analyze the complexities and the factors that contribute to the complexity of the Systems Engineering design approach. The data in this study were collected systematically from several electronic scholarly databases, including the ISI Web of Science, Scopus, Wiley Online Library. This study quantified the challenges and causes of the Systems Engineer complexity. Then, the challenges were categorized into two groups, managerial and technical causes. Ultimately, seven Systems Engineering complexity factors were identified, and their impact on the Systems Engineering processes was ranked using the Pareto principle. Among the factors, rapidly emerging technology was the most significant factor contributing to Systems Engineering complexity.**

Index Terms: **Systems Engineering, complexity factors, rapidly emerging technology, design process, development phase insert.**
_____

I. INTRODUCTION

The need to satisfy human development and grow the prosperity of society create systems requirements at a fast pace. Responding to those requirements may lead to large and complex engineered systems, but at the same time, it should add value to society. Complexity often occurs from a considerable number of components and their connectivity [1]. Further, the system's complexity is the result of coupling interconnectivity and interdependence characteristics that address stakeholder desires. Both these properties will guide the future design of systems regardless of application domains (INCOSE, 2014). Later, Cloutier [2] introduced two more features that could influence the future of the systems design: simplicity and adaptability. However, the last two characteristics are critiqued because they do not generate a reasonable complexity for the systems, as they could indirectly be contained in both interconnectivity and independence characteristics of the system's elements. As Kossiakoff, Sweet [3], Systems Engineering is an essential design approach to realize such advanced technological complex systems.

Engineers use the Systems Engineering approach to cope with systems complexity. However, it is still a challenge for the Systems Engineer to deliver complex systems that meet the requirements and the current trends in technology growth. There are a few Systems Engineering complexity factors that are the main challenges to deliver successful systems. The factors that have high impact on the Systems Engineering design approach were identified, analyzed, and discussed in this study.

Studies over the past five years provided important literature on the challenges encountered in Systems Engineering. Pennock and Wade [4] defined ten assumptions and illusions of Systems Engineering. Their study also highlighted that traditional Systems Engineering practices depended on many of these assumptions, rather than on sound scientific knowledge. Then, Madni and Sievers [5] introduced concurrent Systems Engineering, that is, the Model-Based Systems Engineering (MBSE) that overcomes the defined ten assumptions and illusions of the Pennock and Wade [4].

This review used exploratory and interpretive methodology to investigate the following research objectives:

1. Identify the factors that contribute to Systems Engineering process complexity during the developmental phase in Systems Engineering life-cycle.
2. Analyze the factors that contribute to the complexity of the design during the developmental phase in the Systems Engineering life-cycle.

II. METHODOLOGY

This study aims to explore the phenomena of the complexity in the Systems Engineering design approach. Accordingly, the exploratory sequential design by Creswell and Guetterman (2018) was used throughout the research objectives. Firstly, the data was qualitatively collected through a systematic review of the studies that related to the problem. The factors of the system engineering complexities were then identified for analysis. The researcher has combined and adopt procedures for planning and

conducting the systematic literature review from the concept of Xiao and Watson [6] and the perspective of Carrión, González [7]. As a result, appropriate, practical, and useful procedures have been introduced throughout the study in the following sections.

DATA COLLECTION

The primary data in this study were mainly collected from several electronic scholarly databases, including the ISI Web of Science, Scopus, Wiley Online Library, IEEE, and International Council on Systems Engineering (INCOSE The author confined research to articles five years old or newer as of the beginning of 2020. Articles had to be published in indexed journals and written in the English language. Keywords like Systems Engineering, Challenges, Complexity, and Factors were used for preliminary search in the databases for journals focused on Systems Engineering practitioners and developers. Fig. 1 represents the structural diagram of terms variation and synonyms, followed by inclusion and exclusion criteria for refining.
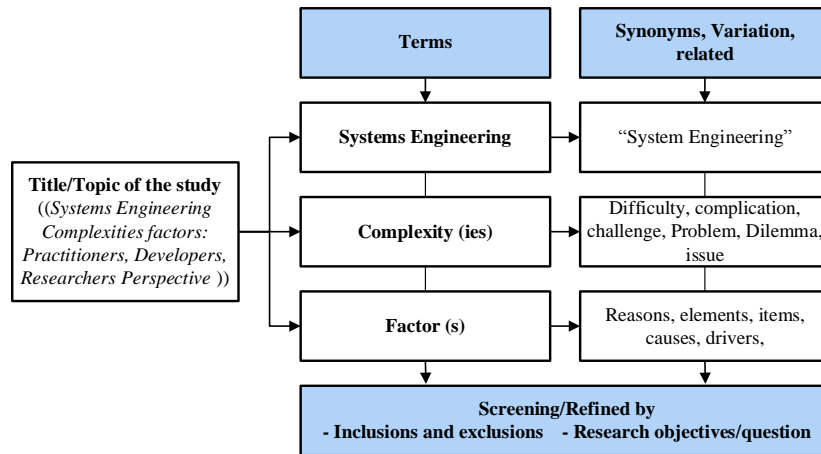
Figure 1 Structure diagram terms variation of searching

Table 1 represents the initial search script and results of the literature review studies in the field of Systems Engineering Complexities in each database.

Table 1 Search script used for each data base

Data Base source	Syntax	Results/Valid
Web of Science (WOS)	(TI=("System* Engineering") AND TI=(complex* OR difficult* OR complic* OR challenge* OR problem* OR dilemma* OR opportunit* OR issue*)) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article OR Editorial Material)	Results = 90 = 23 after removing (book chapter magazine + conferences+ review) or include only Articles and Editorials = 22 include English Languages only
Scopus	TITLE ("system* engineering") AND TITLE (compex* OR difficult* OR compli* OR challenge* OR problem* OR dilemma* OR oppprtunit*) AND PUBYEAR > 2014 AND (LIMIT-TO (DOCTYPE , "ar"))	SCOPUS Results = 55 = 15 after excluding (book chapter magazine + conferences+ review) = 15 include English Languages only
IEEE	("Document Title":"system* engineering") AND ("Document Title":complex* OR difficult* OR compli* OR challenge* OR problem OR dilemma OR opportunit*) + issue*	IEEE Results = 194 = 28 after removing (book chapter magazine + conferences+ review) = 28 include English Languages only
Wiley Online Library	"system*+engineering" in Title and "complex* OR difficult* OR compli* OR challenge* OR problem* OR dilemma* OR opportunit*" in Title	Wiley Results =198 = 139 after removing (book chapter magazine + conferences+ review = 139 include English Languages only

SCREENING – INCLUSION AND EXCLUSION CRITERIA

The population includes published articles on the Systems Engineering approach, which could be technology-based or management-based, including related journal articles, technical publications, standards, and special papers.

The Endnote references management tool has been used to manage all compiled lists of references. Fig. 2 demonstrates the flow diagram of identification, screening, eligibility, and included studies. 362 documents from the complied list at identification level were filtered to exclude theses, conference papers, book chapters, and magazines. 25 references were excluded due to duplications. Finally, one reference was removed because it was not in English. About 31% of results (178 titles and abstracts) reached the eligibility level. A systematic review quality was made to exclude non-relevant topics.
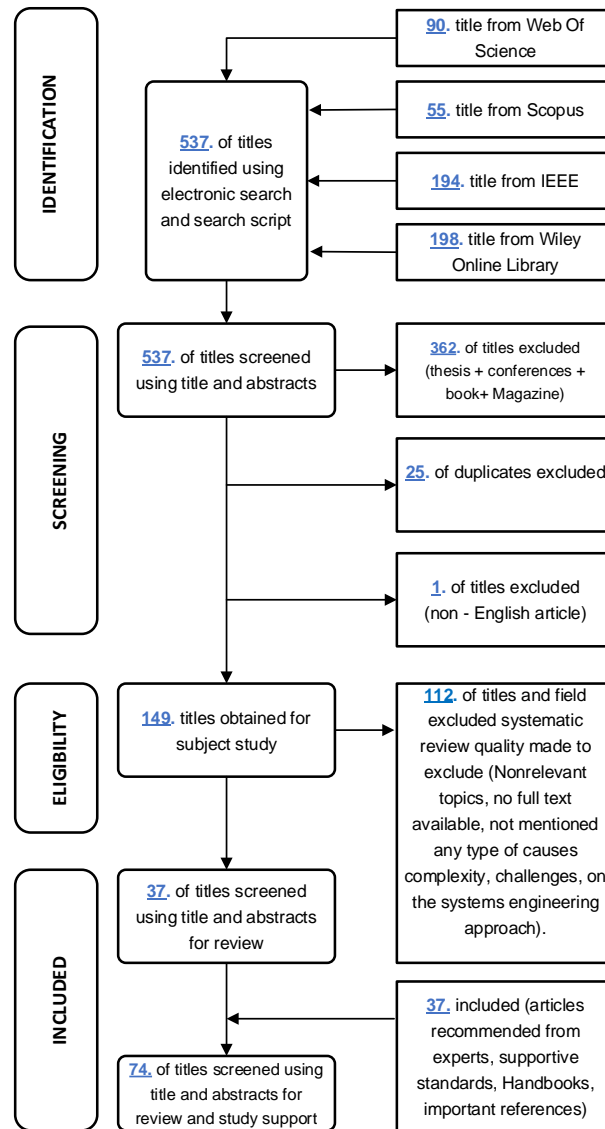

Figure 2 Flow diagram of the literature reviewed

III. COMPLEXITY AND SYSTEMS ENGINEERING

This section highlights the definition of the term complexity and determines the factors that influence the system engineering process based on the data extracted from the systematic review. Fig**.** 3 shows the flowcharts used to achieve the research objectives.
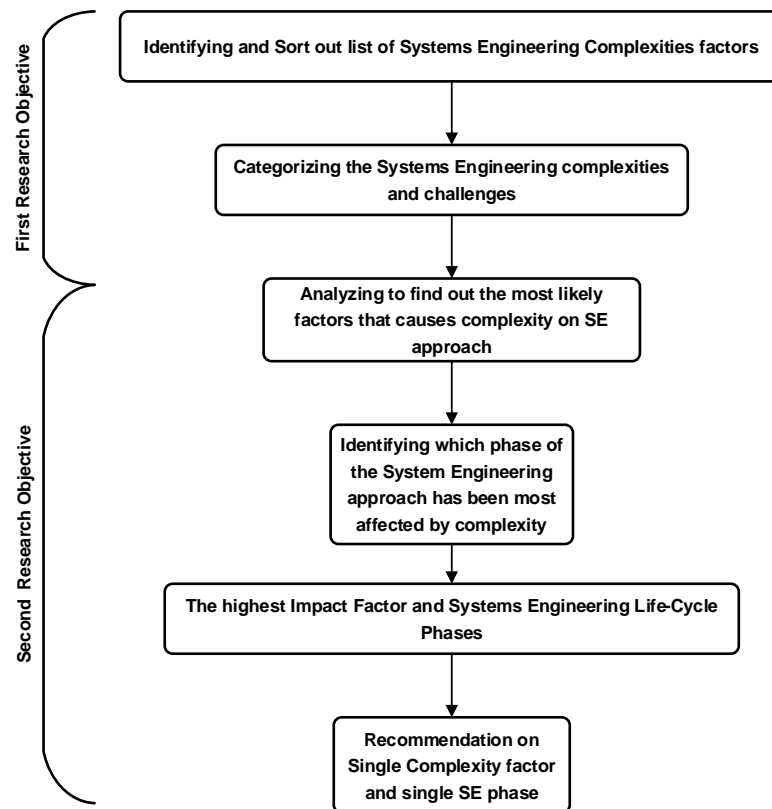

Figure 3 Flowchart of the study steps to achieve the research objectives

COMPLEXITY

Wildly divergent definitions of "complexity" have emerged; it has no singular meaning [8, 9]. Applying such a broad topic as complexity to the equally common topic of Systems Engineering is extremely difficult [10]. However, this study introduces an operational definition of complexity1,2 regarding Systems Engineering and its life-cycle. Hall [11] stated that Systems Engineering originated to deal with complexity. Nevertheless, new and emerging complications have arisen due to fast change in requirement.

Snowden and Boone [12] showed that the system could be Simple, Complication, Complex, and Chaotic. The complex systems are always taking the characteristic of Unknown Unknows in advance, such as in Systems Engineering process in Systems Engineering process a major change in the system requirement, unpredictable emerging technology used in the main system, a shift in management. At the complex system, the Cause-and-Effect relationships are so intertwined they are only evident in the late stages [12]. This feedback brings no right answer, with many competing ideas. The domain of complex systems needs creative, innovative methods [12]. Besides, leadership is performing an essential role in managing a complex system by creating environments that allow patterns to emerge and increasing levels of interaction and communication. Also, leaders should be able to set back from immediate focus and look at the desired big picture and applying holism principle [13].

[1.] Sheard and Mostashari [8] stated "*Complexity is associated with difficulty of understanding, difficulty of teasing apart the problem (or system) without destroying the emergent functionality, and difficulty of prediction and control. Complexity is also associated with large size, lots of parts, things that are densely interconnected, things that have many different types of parts.*"

[2.] Cloutier [2] defined complexity is " *a measure of how difficult it is to understand how a system will behave or to predict the consequences of changing it. It occurs when there is no simple relationship between what an individual element does and what the system as a whole will do, and when the system includes some element of adaptation or problem solving to achieve its goals in different situations.*"

White [14] introduced well processes of leadership on complex adaptive systems, while Snowden and Boone [12] said the leaders have to act differently from the previous solution during managing complex systems due to deferent variables and want to apply complexity science. Also, he introduced the leadership's framework for decision making, which could be easier to follow in the complex adaptive systems.

However, Systems Engineering principles and theories could help to deal with big picture view which is required to cater with complex systems, such as, Principle of Holism "*A system has holistic properties not manifested by any of its parts. The parts have properties not manifested by the system as a whole*"[15], and also Hitchins [16] stated, "*systems engineering addresses the whole problem, and creates the whole solution.*"

SYSTEMS ENGINEERING COMPLEXITIES AND CHALLENGES – REVIEW OF EXISTING PERSPECTIVES OF PRACTITIONERS AND DEVELOPERS.

Based on the reviewed literature, the terms 'complexities,' 'challenges,' and other synonyms have the same sense. The researcher has developed descriptions and typologies to discuss the complexities and challenges of Systems Engineering. Systems Engineering challenges were appropriately categorized as external and internal challenges (Table 2). External challenges include changing global policies, regulations, or even technical patterns. Internal challenges are difficulties within the Systems Engineering processes such as bad requirement definition, lack of training, or holistic view deficiency in managing the SE process. These external and internal challenges were further classified into technical-based and management-based challenges for more specificity. The technical-based typology was used by Young, Farr [17] in Systems Engineering integration. Similarly, Sheard [18] used the same typology to further study the classification of Systems Engineering challenges. Management-based challenges were cited by Young Young, Farr [17] and INCOSE [19] as social-political complexity challenges.

Category	Type challenges	Existing challenges/Complexities	Cited authors
External	**Technology based**. Also this typology used by Young, Farr [17] as shown on (system integration base). Similarly, was used by Sheard [18].	• Rapid evolving new technologies, and big data. • Greater utilization of commercial off-the-shelf.	• D'Souza, Kossmann [20] • Roberts, Mazzuchi [21] • Farnell, Saddington [22]. • Ben Levitt MITSDM Streamed live on Apr 10, (2018). • Blanchard and Blyler [23]. • Hirshorn, Voss [24]. • Cloutier [2].
	Management based. Similar to Social-Political complexity of Young, Farr [17] and Socio-Economic of INCOSE [19].	• International competition (organizations, suppliers, subcontractor). • Resources globalization (efficient resource utilization). • Political and economic interdependence. • sharing the knowledge and technology (security issue). • Progressive Human and society needs.	• Crossley, Luan [25] • Clark [26]. • Blanchard and Blyler [23]. • University [27]. • Blanchard and Blyler [23]. • INCOSE [19]. • Young, Farr [17]. • Cloutier [2]
Internal	**Technology based**. Also this typology similar to Young, Farr [17] as shown on (system integration base). Similarly, was used by Sheard [18].	• Integration of COTS in development and production phases • Integration of Rapid Emergent Technology Items (RETIs) • Difficulty of Prediction the behavior of the system [25, 28] • Leadership	• Hoehne [29] • Crossley, Luan [25] • Curran, Allaire [28] • Farnell, Saddington [30] • Hoehne [29] • University [27] • Cloutier [2] • White [14]
	Management based. Similar to Social-Technical complexity of Young, Farr [17] and Socio-Economic of INCOSE [19].	• Poor coupling between technical and programmatic sides. • Bad holistic view. Need emphasis on all life cycle systems (whole view) • Bad definition of the system requirements. • Higher overall life-cycle costs. • last-minute changes in design • The tightness of time schedule/systems life cycle • Failure to recognize and deal with risk (example of Challenger and Columbia accident - independent technical authority)	• Hoehne [29] • Farnell, Saddington [22] • Clark [26]. • Blanchard and Blyler [23]. • Young, Farr [17]. • University [27] • Cloutier [2]

Table 2 Existing challenges for Systems Engineering

ANALYSIS OF CHALLENGES AND COMPLEXITIES RELATIONSHIPS

Fig. 4 illustrates the seven most-cited complexity factors that have direct effects on the system's life-cycle. The primary features of the information in Fig. 4 provide the context of problem background. It further shows how the problem evolved and how it reached the current status of complexities in the Systems Engineering approach.
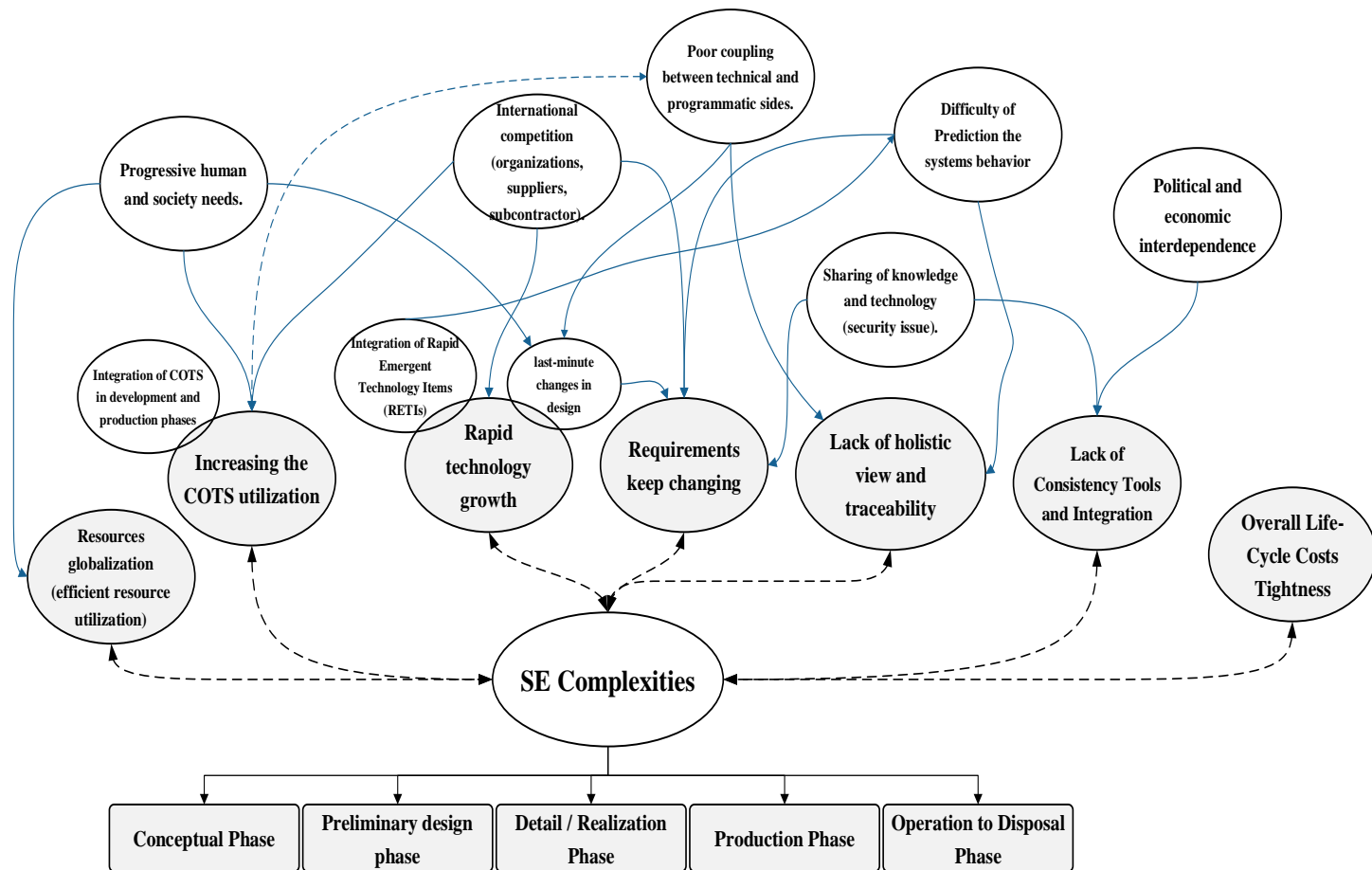

Figure 4 Relationship between existing challenges and Systems Engineering complexities

The seven complexities that have a stronger correlation with the Systems Engineering phases include:

1. Resource globalization. It is affected by human needs and last-minute change requests by stakeholders. Human always seek comfort with emerging new designs if they think that makes their lives better; nevertheless, that puts pressure on system engineers to meet these requirements while designing a system. The last-minute change is usually the consequence of a customer request or technical feasibility. Furthermore, it has facilitated the use of faster and more efficient transportation /communication means for expediting procurement and related processes [23, 31, 32].

2. Increasing the utilization of Commercial Off The-Shelf (COTS). It may be derived from the competition of the items' suppliers and the growing needs of humans and society. In addition, the international competition of parts suppliers creates a variety of options from products. If COTS is built in the system, the complications arising from integration besides alignment of specifications [23, 33].

3. Rapidly Emerging Technology. This is influenced by COTS and progressive human needs. Correspondingly, it causes difficulties in the prediction of systems performance and in integration while developing a system [3, 34-37]

4. The change in requirements. This factor influences more than four motivates, as shown in Fig. 4, all are related to change requests. In the industrial sector, inconsistent requirements and different performance objectives usually make the decision-making process more complex [38]. New requirements are a challenge to delivering efficient system [39].

5. Lack of holistic view and requirement traceability. The main concern stems from a poor coupling between the technical and management sides of the systems builders, due to a large number of subsystems and change [2, 40, 41].

6. Lack of consistency tool and integration. The inconsistency originates from the variation of a multidiscipline system of design and a large number of subsystems within traditional Systems Engineering (document-centric). Complex

systems are called interdependence systems if there is no shared management between their components/subsystems, and if they are still developing. This often results in emerging behaviour [42]. However, Systems Engineering is challenged to deliver the lowest possible interdependence in the system [2].

7. The tightness of budget for the overall system life-cycle. Basically, considerable attention has been paid to reducing the costs associated with the acquisition and procurement of systems, and little attention has been paid to the costs of system operation and support. When designing systems, it is important to observe all decisions in the context of total costs [23].

The literature listed in Table 3 provides relevant observational evidence for Systems Engineering complexity. It also shows the seven complexity factors most related to Systems Engineering design process, corresponding to the individual author's opinion and findings on each factor. More than half of the cited authors stated that the fast pace of technology growth creates complexities in the integration process of Systems Engineering. Furthermore, three factors- lack of consistency tools and integration, resources globalization, and lack of holistic view and traceability of the requirements- were cited more than ten times by different authors. Two factors- bad requirements definition and overall life-cycle- have shown the lowest impact on the Systems Engineering process as they were stated less than ten times. Nevertheless, several works of literature have dealt with the concept requirements definition criteria as an essential question on Systems Engineering in other areas out of this study's scope.

Table 3 Factors that contribute to the Systems Engineering complexity by different authors

No.	Authors	Effect of Systems Complexity Faced by Systems Practitioner, Developer, Researchers						
		Rapidly Emerging Technology (21)	Globalization Market Place (13)	COTS Using (10)	Lack of Holistic View and Traceability On SE (12)	Bad Definition of the Requirement (07)	Overall Life-Cycle Costs Tightness (02)	Lack of Consistency Tools and Integration (16)
1	Curran, Allaire [28]	■	■			■		■
2	Winzer [31]		■					
3	Sheard [43]			■				
4	MacKenzie, Bryden [44]			■				
5	Wu, Gouyon [33]			■				
6	Roberts, Mazzuchi [21]	■	■					
7	Shortell [34]	■	■					
8	Hoehne [29]				■			■
9	Crossley, Luan [25]							■
10	University Lecture Notes [27].	■	■	■	■			■
11	Madni and Sievers [5].	■			■	■		■
		Technology Growth (21)	Globalization Market Place (13)	COTS Using (10)	Lack of Holistic View and Traceability On SE (12)	Bad Definition of the Requirement (07)	Overall Life-Cycle Costs Tightness (02)	Lack of Consistency Tools and Integration (16)
12	Farnell, Saddington [22].	■			■			
13	D'Souza, Kossmann [20]	■	■			■		
14	NDIA [45].	■		■	■			■
15	Blanchard and Blyler [23].	■	■	■	■		■	■
16	Eisner [46].	■	-	■	■			■
17	Haskins, Forsberg [47].	■			■	■		■
18	INCOSE [19].	■	■					
19	Ashby, Blessner [48].	■	■				■	

No.	Authors	Effect of Systems Complexity Faced by Systems Practitioner, Developer, Researchers						
20	Sheard [18].		■					
21	Hirshorn, Voss [24].	■		■				
22	Reichwein and Paredis [49].			■				
23	Horváth, Tepjit [50].				■			
24	Ben Levitt MITSDM Streamed live on Apr 10, (2018).	■				■		
25	Blackburn, Verma [51].		■					■
26	Cloutier [2].	■	■	■	■	■		■
27	Ward, Rossi [52].	■						
28	Sales and Becker [53]							■
29	Lankhorst [32].	■	■					
30	Mordecai, Dori [54].					■		
31	Liebel, Marko [55].							■
32	Zdravković and Panetto [56].	■						
33	Walworth, Yearworth [57].				■			
34	Wheaton and Madni [58].							■
35	Pennock and Wade [4].				■			■
36	George Mathew, Liscouet-Hanke [59].	■						■
37	Kenett, Zonnenshain [60]	■						

The Pareto principle, or more accurately, the rule of "80/20," which explains cause and effect, was used in this study. It is a statistical analysis tool used to select a limited number (20%) of overall variables for decision-making to achieve a meaningful overall effect (80%) [61, 62].

The Pareto principle was used to determine the factor that has the highest impact on Systems Engineering life-cycle during the developmental phase. The frequency and accumulative percentage of the factors that have an impact on the SE complexity are shown in Fig. 5.
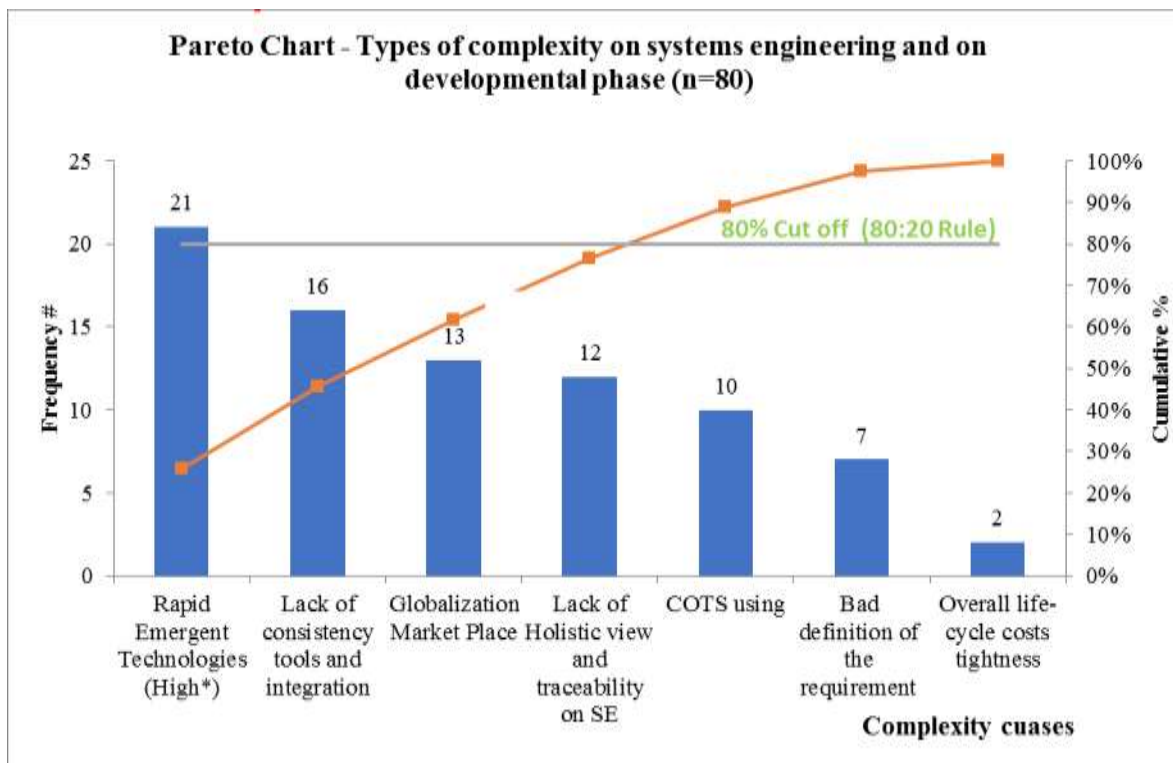
Figure 5 Pareto Chart – Factors contributing to System Engineering Complexity (N=80)

The results showed that technology growth (*Rapidly Emerging Technology Items*) was the most significant factor (Fig. 5). Moreover, the Rapidly Emerging Technology Items lay above the line of the percentage of citation accumulations, which indicates that if a researcher reduces the impact of this factor, they are likely to solve 80 percent of Systems Engineering complexities problems.

Table 4 shows the Systems Engineering phases beside short descriptions of their tasks and levels of the system. It also reflects the associated complexity factors for the design phases of Systems engineering that were obtained from the preliminary analysis of Fig. 5.

Table 4 Systems Engineering phases and challenges throughout life cycle

	Conceptual design	Preliminary design	Detail design and development	Production/ construction	Operational use and system support
Activities description [24, 63, 64]	Need identification; functional constraints; R&D needs analysis; maintenance and support concept; selection of technological approach; evaluation of feasible technology applications; system functional definition; system/program planning.	Functional analysis; trade-off studies; allocation of requirements; synthesis; preliminary design; testing and evaluation of design concepts (early prototyping); contracting; acquisition plans; implementation of programs; major suppliers.	Subsystem/component design; trade-off studies and of alternatives evaluation; development of engineering and prototype models; verification of manufacturing and manufacturing processes; developmental testing and evaluation; supplier activities; production planning.	Production or construction of system components; production activities of suppliers; acceptance testing; distribution and operation of systems; testing and evaluation development / operational; system assessment.	System operation in the user environment; maintenance and logistic support; operational testing; system improvement modifications; contractor support; system assessment (field data collection and analysis).
Level of the system	**Primary System Level**	**Subsystem Level**	**Detailed level/Components level**	**Items/Parts**	
	Example: aircraft and/or related systems.	Major aircraft subsystems, including hydraulic, electrical, avionic, power plant, fuel, air conditioning, structure, seats.	Components that include wing, fuselage, tail, landing.	Parts that include fittings, fasteners, blades, propellers, screws, nuts, ribs, spars, frames, stiffeners, skin, shafts, wires.	Feedback and modification for improvement or optimization

Associated complexities:
- Overall lifecycle tightness of cost
- Bad definition of the requirement
- COTS utilization
- lack of holistic and consistency
- Globalization market place and competitions
- Lack of Consistency Tools and Integration
- Rapidly Emerging Technology Items
- Complexities Density

All the factors contributing to the SE complexities extend to more than one stage. Three factors- "the overall cost of the life-cycle," "lack of a holistic view," and "poor definition of requirements-" influence all phases of the System Engineering design approach. Rapidly emerging technologies and wrong definition of requirements weighted highest among all other factors.

Finally, any changes to the requirements, items concepts, or technologies upgrade will lead to a redesign of some subsystems, which in turn, will increase the cost of iterations periods.

The factors contributing to the SE complexity, agreed on by the authors, practitioners, and designers, will be discussed in the following sections.

1. Rapidly Emerging Technology

There is no single definition of the central concept of Emerging Technology [65]. In this study, *Rapidly Emerging Technology* refers to the advancement of the items or components used during the development phase of the systems. The rapid technological advancement discussed by Blanchard and Blyler [23] shows that technology is growing faster than our ability to control and manage it through a traditional Systems Engineering approach. Systems designers should consider existing and potential future improvements in technologies to the system while designing it. Otherwise, there is a significant possibility that the main system will be out of trend.

The International Council On Systems Engineering INCOSE [19]) has named the following technologies as ones that will create challenges to Systems Engineering:

- sensor technologies:
- material science
- miniaturization
- human-computer interaction technologies
- computational power

Additionally, it is very useful to consider electrification and hybridization technologies as a fast-growing technologies. This adds a level of challenges to current systems under development and the Systems Engineering design approach as these technologies are under development and making very real progress (Brelje & Martins, 2019; Schäfer et al., 2019).

One of the problems of ongoing technologies is technology insertion in the man system. The insertion scenario of new technologies while designing using the Systems Engineering approach has not been mentioned [66]. Moreover, some of the technology insertion processes are still struggling and may cause significant reworking: for example, the lithium-ion batteries in the Boeing 787 Dreamliner model [67].

2. Lack of Consistent Tools

Madni and Sievers [5] indicated that traditional Systems Engineering models such as Waterfall, V-model, and Incremental were facing inconsistency in addressing the heterogeneity of subsystems. As the systems continued to scale and increase in application complexity, they were unable to maintain consistency and assure traceability during systems development at the same level.

Based on the data that was extracted from the literature listed in Table 3, the causes of inconsistency in systems integration could be summarized as follow:

- a large number of systems levels,
- multidiscipline in systems,
- sequential of traditional Systems Engineering. Even though concurrent Systems Engineering has overcome such deficiencies, it still lacks full functionality, and

A study by Madni and Sievers [5] presented Model-Based Systems Engineering (MBSE) as a methodology equipped with suitable tools like repository (single source of truth) for data and information exchange between systems team builders. This model may overcome most of the traditional Systems Engineering deficiencies.

3. Globalization and marketplace competitions

Globalization means there are interdependencies in the world [23]. In depth, many systems are currently being developed by several departments at different places, by multiple suppliers, and through multiple organizations [68]. It is facilitated by rapid and improved communications practices [18]. Globalization affects the Systems Engineering phases that involve multisource components and items. Due to the increasing global competition caused by globalization, systems developers have better access to global resources to fulfil systems requirements. A strong correlation has been observed between globalization and the utilization of Commercial Off The-Shelf (COTS), which further improves the accessibility of the required resources in Systems Engineering [31]. However, multiple studies identified globalization as the complexity factor to multi-resource management in the Systems Engineering life cycle [27]. In the development phase of the Systems Engineering life cycle, the designer needs to perform preliminary prototyping and contracting according to major Systems Engineering standard frameworks from the Department of Defence (DoD) or the National Aeronautics and Space Administration (NASA) [24]. Otherwise, the traditional Systems Engineering approach might experience downstream failure on verification and validation, or even in the production phase.

4. Lack of holistic view

Systems Engineering is defined as a holistic and integrative discipline (Hirshorn, Voss [24]. Nevertheless, Cloutier [2] from the INCOSE global community noted that one of the factors that made Systems Engineering more challenging was the lack of a holistic view by practitioners and system developers. The development phase is one of the important phases of the systems life-cycle, where most of the engineering developments happen. A holistic view is an essential personal skill for practitioners and systems developers in planning, organizing, and realizing the system-of-interest. This will remain a challenge if enterprises wish to be competitive in the current technology trend.

A holistic approach helps to reduce risks and difficulties in managing tasks in the development phase and improve the communication between the systems levels. Furthermore, Cloutier [2] stated that use of Holism principle is essential in Systems Engineering to reduce individualization risk. Currently, the Systems Praxis Framework, which was developed by INCOSE and International Society for the Systems Sciences (ISSS), is the potential solution for Lack of holistic to today's complex systems [2].

Possible explanations of the consequences of the "lack of holistic view" in Systems Engineering is unable to explain the behavior of the overall systems by individual parts [50].

5. Commercial Off The Shelf (COTS) utilization

Increasing numbers of systems have adopted COTS to lower the initial procurement costs and shorten the acquisition cycle (Blanchard and Blyler, 2016; Eisner, 2008). This is because COTS usually makes use of the latest commercial technology, which will be replaced by new technology innovation in a short period of time, and are taken as consumables [69].

To its advantage, COTS could be selected and implemented for technical (shortening the developmental phase), organizational (reducing the overall cost of the developmental phase), or strategic reasons (access to technology not available internally) [33]. Recently, professional COTS often comes with supporting documentation such as proof of verification, validation conformance, and manufacture specifications or fact sheet. It is always recommended to review the specifications to ensure the COTS fit the requester's requirements [24].

On the other hand, the advantages of COTS challenged by integration concerns such as performance (what is supposed to do), compatibility (no standards), product assessment (uncertainty of meeting the required needs), or supplier behavior (agreements promises false) [33]. Additionally, MacKenzie, Bryden [44] observed that many companies struggle with COTS integration into the Systems Engineering processes, the possible reason the employee is unfamiliar with that COTS.

Moreover, stakeholders occasionally order COTS, which indicates that they have decided to apply a readily available solution to their system without first validating that solution [54].

Furthermore, risks associated with the use of COTS during system life-cycle include the obsolescence of models and of improvements in system interfaces. The competition of COTS providers makes individual components obsolete within two years [34]. The incompatibility between two or more systems requirements in COTS specifications may cause further complications to systems engineers. It is a nontrivial task to tackle this type of complexity, as it depends on the experience and design expertise of hardware and software engineers [46].

According to the literature listed in Table 3, COTS usage was an unavoidable situation in many cases. Multisource of COTS generates complexity to integration in Systems Engineering processes during the development phase due to deferent standards used. It will be difficult to integrate new COTS during the development process, as this may lead to the re-integration and re-assessment and re-validation of the system under construction.

6. Bad Definition of the Stakeholder Requirement

Mordecai, Dori [54] defined the Stakeholder requirements as ideas, expectations, requests, a set of needs, goals, assumptions, guidelines, preferences, objectives, constraints, intentions, or desires. Requirements are the needs or demands of the stakeholder collected as statements to constrain and identify a system or process. The ideal requirements are clear, unambiguous, consistent, unique, traceable, verifiable, and "SMART" (Specific, Measurable, Attainable, Realizable, Time-bounded) [70]. However, the inadequate definition of the requirement for stakeholders indicates that the requirement is improperly collected or elicited, which leads to developmental phase difficulties, extra cost for a delayed change request, functional analysis, or issues in integration and systems evaluation.

Practically, requirements are the input to the design process at the beginning of systems formulation, while specifications are the output of the development phase. In other words, the development phase is begun with well-defined requirements [23, 24]. Yet, some inexperienced developers are unable to differentiate a requirement from a specification.

Continuous monitoring of the requirements during the Systems Engineering life-cycle results in internal complexity as it requires controlled traceability, and hence adds more tasks to systems developers. de Weck [71] and Hirshorn, Voss [24] proposed some tools that could assist the requirement monitoring process, including Excel spreadsheets, professional commercial tools like DOORS for large complex systems, and metadata.

While traditional sequential Systems Engineering is unable to address the complexity from continuous requirements monitoring that involves rapid and dynamic changes of input, a holistic view and MBSE can reasonably overcome this issue [5].

Standard definitions to reduce the risk of bad Stakeholder requirement definition are as follows:
- ISO / IEC 15288 (IEEE STD 15288 – 2008)

- System Engineering Handbook, Version 3.1 Working Group requirements (http:/www.incose.org/ChaptersGroups/WorkingGroups/processes)
- System life cycle process (6.4.1 Stakeholder Requirements Definition Process)
- NASA Systems Engineering Handbook

7. Overall Life-Cycle Cost – Tight Budget

Briefly, a Systems Engineering life-cycle cost is the expenses from all the systems phases [2].

Usually, a tight project budget has a positive impact on the project/system owners, the sponsor, and other stakeholders. In this case, however, systems engineers and developers are challenged to deliver the system within that limited cost range. As a result, the cost tightness combined with a poor definition of the requirements and a dynamically changing environment makes task management complicated.

When calculating the overall life-cycle cost, the systems engineer needs to understand that any of the above-mentioned processes might need to be repeated until the desired specification is achieved. Moreover, rapid and frequent change in technology and requirements will affect the life-cycle cost analysis of the systems of interest as well, even though it may lead to better performance.

Concisely, overall life-cycle cost is causing complexity in Systems Engineering in the following ways:
- requirement of minimum life-cycle cost,
- dependency of the lifecycle cost in decision making and design reviews output, and
- dependency of life-cycle cost in making the decision that relates to the change of technology in the systems-of-interest.

IV. CONCLUSION

A Systems Engineering complexity is defined by different sources as a measure of the difficulty in understanding the behavior of a system or in predicting the consequences of a change. This study identified and analyzed factors that lead to the complexity of Systems Engineering throughout the phases of the life-cycle of Systems Engineering.

Complexity factors were found to be linked to each other and intertwined with the Systems Engineering stages or processes. This creative synthesis is essential to produce an integrated system that can meet the end-user requirements.

Although other factors are crucial, rapid emergent technology has the highest impact on Systems Engineering complexity, particularly during the developmental phase in complex systems like Aviation industry, because any changes accrue during design process lead to verification and revalidation and reintegration as well. MBSE can be used to resolve some of the SE complexity issues. Still, some of the factors remain as challenges to the traditional Systems Engineering.

In order to integrate cutting edge technology into the Systems Engineering processes, a system engineer or developer needs to follow the technology development closely. The rapid change in emergent technologies happens during systems development will lead to repetition in requirements verification, specifications validation, subsystems or components design, trade-off studies, alternatives evaluation, engineering and prototype models development, production planning, and tests and evaluation development. The available Systems Engineering frameworks or guidelines lack means to accommodate and address the issue of rapidly emerging technologies.

Some questions remain unanswered, especially in interconnectivity improvement. Improving system interconnectivity eliminates the erratic behavior of complex multidiscipline components and helps to produce a better systems design, especially a smart and dynamic systems solution. However, in order to improve system interconnectivity, external technical-based challenges such as globalization and COTS need to be tackled first.

MBSE has the advantage of a holistic view and traceability over traditional document-centric Systems Engineering. However, the majority of the companies do not use MBSE due to a lack of training and experience in their employees.

REFERENCES

[1] Sheard, S.A. and A. Mostashari, 7.3.1 A Complexity Typology for Systems Engineering. INCOSE International Symposium, 2010. 20(1): p. 933-945.

[2] Cloutier, R.J., Guide to the Systems Engineering Body of Knowledge (SEBoK). 1.91. 2018, The Trustees of the Stevens Institute of Technolog.

[3] Kossiakoff, A., et al., Systems engineering principles and practice. Vol. 83. 2011: John Wiley & Sons.

[4] Pennock, M.J. and J.P. Wade, The top 10 illusions of systems engineering: A research agenda. Procedia Computer Science, 2015. 44: p. 147-154.

[5] Madni, A.M. and M. Sievers, Model based systems engineering: Motivation, current status, and research opportunities. Systems Engineering, 2018. 21(3): p. 172-190.

[6] Xiao, Y. and M. Watson, Guidance on Conducting a Systematic Literature Review. Journal of Planning Education and Research, 2017. 39(1): p. 93-112.

[7] Carrión, P.V.T., et al. Methodology for systematic literature review applied to engineering and education. in 2018 IEEE Global Engineering Education Conference (EDUCON). 2018. IEEE.

[8]   Sheard, S.A. and A. Mostashari, 6.2.1 Complexity Types: From Science to Systems Engineering. INCOSE International Symposium, 2011. 21(1): p. 673-682.

[9]   Gilbert, D. and M. Yearworth, Complexity in a Systems Engineering Organization: An Empirical Case Study. Systems Engineering, 2016. 19(5): p. 422-435.

[10] Saikou Diallo, S.M., Andreas Tolk, RESEARCH AGENDA FOR NEXT-GENERATION COMPLEX SYSTEMS ENGINEERING, in Emergent Behavior in Complex Systems Engineering. 2018. p. 370-389.

[11] Hall, A.D., A methodology for systems engineering. 1962: Van Nostrand.

[12] Snowden, D.J. and M.E. Boone, A leader's framework for decision making. Harvard business review, 2007. 85(11): p. 68.

[13] White, B.E. and B.G. McCarter, Emergence of SoS, sociocognitive aspects, in System of systems engineering—Principles and applications. 2009, Taylor & Francis Group: Boca Raton.

[14] White, B.E., On leadership in the complex adaptive systems engineering of enterprise transformation. Journal of Enterprise Transformation, 2015. 5(3): p. 192-217.

[15] Adams, K.M. and J. Mun. The application of systems thinking and systems theory to systems engineering. in Proceedings of the 26th National ASEM Conference: Organizational Transformation: Opportunities and Challenges. 2005. American Society for Engineering Management Rolla, MO.

[16] Hitchins, D., What Are the General Principles Applicable to Systems? INSIGHT, 2009. 12(4): p. 59-63.

[17] Young, L.Z., et al., The role of complexities in systems engineering cost estimating processes. 2010.

[18] Sheard, S.A. 5.2. 1 systems engineering complexity in context. in INCOSE International Symposium. 2013. Wiley Online Library.

[19] INCOSE, A., A world in motion: systems engineering vision 2025, in International Council on Systems Engineering. 2014.

[20] D'Souza, A., M. Kossmann, and S. Watts, The enabling role of Configuration Management for the Systems Engineering of tomorrow's complex Systems and Systems of Systems. INCOSE International Symposium, 2016. 26(1): p. 2180-2194.

[21] Roberts, B., T. Mazzuchi, and S. Sarkani, Engineered Resilience for Complex Systems as a Predictor for Cost Overruns. Systems Engineering, 2016. 19(2): p. 111-132.

[22] Farnell, G., A. Saddington, and L. Lacey, A new systems engineering structured assurance methodology for complex systems. Reliability Engineering & System Safety, 2019. 183: p. 298-310.

[23] Blanchard, B.S. and J.E. Blyler, System Engineering Management. 2016: John Wiley & Sons, Inc.

[24] Hirshorn, S.R., L.D. Voss, and L.K. Bromley, Nasa systems engineering handbook. 2017.

[25] Crossley, W.A., et al., Optimization problem formulation framework with application to engineering systems. Systems Engineering, 2017. 20(6): p. 512-528.

[26] Clark, J.O. System of systems engineering and family of systems engineering from a standards, V-model, and dual-V model perspective. in 2009 3rd Annual IEEE Systems Conference. 2009. IEEE.

[27] University, T.O. Systems engineering: challenging complexity. 2019 17/05/2019 [cited 2019 12/10/2019]; Available from: https://www.open.edu/openlearn/science-maths-technology/computing-ict/systems-engineering-challenging-complexity/content-section-0?active-tab=description-tab.

[28] Curran, Q.C., D. Allaire, and K.E. Willcox, Sensitivity analysis methods for mitigating uncertainty in engineering system design. Systems Engineering, 2018. 21(3): p. 191-209.

[29] Hoehne, O., The SoS-VEE Model: Mastering the Socio-Technical Aspects and Complexity of Systems of Systems Engineering (SoSE). INCOSE International Symposium, 2016. 26(1): p. 1494-1508.

[30] Farnell, G.P., A.J. Saddington, and L.J. Lacey, A new systems engineering structured assurance methodology for complex systems. Reliability Engineering & System Safety, 2019. 183: p. 298-310.

[31] Winzer, P., Generic System Description and Problem Solving in Systems Engineering. IEEE Systems Journal, 2017. 11(4): p. 2052-2061.

[32] Lankhorst, M., Enterprise architecture at work. Vol. 352. 2017, Springer, Berlin, Heidelberg: Springer.

[33] Wu, Q., et al., Use of Patterns for Know-How Reuse in a Model-Based Systems Engineering Framework. IEEE Systems Journal, 2020: p. 1-12.

[34] Shortell, T.M., INCOSE Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities. 2015: John Wiley & Sons.

[35] Sousa-Poza, A., C. Keating, and S. Kovacic, Systems engineering: evolution and challenges. International Journal of System of Systems Engineering, 2015. 5(4): p. 379-399.

[36] Saravi, S., et al., A Systems Engineering Hackathon – A Methodology Involving Multiple Stakeholders to Progress Conceptual Design of a Complex Engineered Product. IEEE Access, 2018. 6: p. 38399-38410.

[37] Wheaton, M.J. and A.M. Madni, Model-Based Approach for Resilience and Affordability Tradeoff Analysis, in AIAA Scitech 2019 Forum. 2018, INCOSE.

[38] 38.   Buzuku, S., et al., A Case Study of Complex Policy Design: The Systems Engineering Approach. Complexity, 2019. 2019.

[39] de Graaf, R., et al., Value Engineering as a Specialty for Systems Engineering: Exploring Opportunities. INSIGHT, 2019. 22(1): p. 41-44.

[40] Sitton, M. and Y. Reich, Enterprise Systems Engineering for Better Operational Interoperability. Systems Engineering, 2015. 18(6): p. 625-638.

[41] Chai, H.F. and Q. Sun, Research on the Giant and Complex Financial Information System Engineering Management from the Perspective of Meta-synthesis Methodology-with the Bank Card Information Exchange System Engineering as a Sample. Frontiers of Engineering Management, 2016. 3(4): p. 404-413.

[42] Tolk, A., S. Diallo, and S. Mittal, COMPLEX SYSTEMS ENGINEERING AND THE CHALLENGE OF EMERGENCE, in Emergent Behavior in Complex Systems Engineering. 2018, John Wiley & Sons, Inc. p. 78-97.

[43] Sheard, S.A., Evolution of systems engineering scholarship from 2000 to 2015, with particular emphasis on software. Systems Engineering, 2018. 21(3): p. 152-171.

[44] MacKenzie, C.A., K.A. Bryden, and A.A. Prisacari, Integrating narratives into decision making for complex systems engineering design issues. Systems Engineering, 2020. 23(1): p. 65-81.

[45] NDIA, S.E.D., Top five systems engineering issues in defense industry, in Vers 9, 1/23/03. 2003, National Defense Industrial Association: USA.

[46] Eisner, H., Essentials of project and systems engineering management. 2008: John Wiley & Sons.

[47] Haskins, C., et al. Systems engineering handbook. in INCOSE. 2007.

[48] Ashby, D., P. Blessner, and B. Olson, An investigation into the impact of applying systems engineering life-cycle processes during new product development and the economic growth of the diversified industrial sector. Journal of Enterprise Transformation, 2019: p. 1-23.

[49] Reichwein, A. and C.J.J. Paredis. OVERVIEW OF ARCHITECTURE FRAMEWORKS AND MODELING LANGUAGES FOR MODEL-BASED SYSTEMS ENGINEERING. in Proceedings of the ASME 2011 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference. 2012.

[50] Horváth, I., S. Tepjit, and Z. Rusák. Compositional engineering frameworks for development of smart cyber-physical systems: A critical survey of the current state of progression. in ASME 2018 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. 2018. American Society of Mechanical Engineers.

[51] Blackburn, M., et al., Transforming systems engineering through model centric engineering. 2018, Stevens Institute of Technology Hoboken United States: Stevens Institute of Technology Hoboken United States.

[52] Ward, D., et al. The Metamorphosis of Systems Engineering through the evolution of today's standards. in 2018 IEEE International Systems Engineering Symposium (ISSE). 2018. IEEE.

[53] Sales, D.C. and L.B. Becker. Systematic literature review of system engineering design methods. in Brazilian Symposium on Computing System Engineering, SBESC. 2019.

[54] Mordecai, Y., D. Dori, and Ieee, Model-Based Requirements Engineering: Architecting for System Requirements with Stakeholders in Mind. 2017 Ieee International Symposium on Systems Engineering. 2017, New York: Ieee. 143-150.

[55] Liebel, G., et al., Model-based engineering in the embedded systems domain: an industrial survey on the state-of-practice. Software & Systems Modeling, 2018. 17(1): p. 91-113.

[56] Zdravković, M. and H. Panetto, The challenges of model-based systems engineering for the next generation enterprise information systems. Information Systems and e-Business Management, 2017. 15(2): p. 225-227.

[57] Walworth, T., et al., Estimating project performance through a system dynamics learning model. Systems Engineering, 2016. 19(4): p. 334-350.

[58] Wheaton, M.J. and A.M. Madni, Model-Based Approach for Resilience and Affordability Tradeoff Analysis, in AIAA Scitech 2019 Forum. 2019.

[59] George Mathew, P., S. Liscouet-Hanke, and Y. Le Masson, Model-Based Systems Engineering Methodology for Implementing Networked Aircraft Control System on Integrated Modular Avionics – Environmental Control System Case Study. 2018, SAE International.

[60] Kenett, R.S., A. Zonnenshain, and R.S. Swarz, Systems Engineering, Data Analytics, and Systems Thinking: Moving Ahead to New and More Complex Challenges. INCOSE International Symposium, 2018. 28(1): p. 1608-1625.

[61] Kiremire, A.R., The application of the pareto principle in software engineering. Consulted January, 2011. 13: p. 2016.

[62] Ng, J.J., The 80/20 Principle Thinking as a tool for Project Management. IEEE Engineering Management Review, 2019: p. 1-1.

[63] Enrico, Z., et al., Application of reliability technologies in civil aviation: Lessons learnt and perspectives. Chinese Journal of Aeronautics, 2019. 32(1): p. 143-158.

[64] Sadraey, M.H., Aircraft design: a systems engineering approach. 2013.

[65] Rotolo, D., D. Hicks, and B.R. Martin, What is an emerging technology? Research Policy, 2015. 44(10): p. 1827-1843.

[66] Saravi, S., et al., A Systems Engineering Hackathon - A Methodology Involving Multiple Stakeholders to Progress Conceptual Design of a Complex Engineered Product. Ieee Access, 2018. 6: p. 38399-38410.

[67] Oyeniya, A., Certification challenges for emerging technologies in aviation. 2018.

[68] Albarello, N. and H. Kim. Application of an MBSE Approach for the Integration of Multidisciplinary Design Processes. in Complex Systems Design & Management. 2014. Cham: Springer International Publishing.

[69] Hitchins, D.K., Systems engineering: a 21st century systems methodology. 2008: John Wiley & Sons.

[70] Szejka, A.L., et al., A Method for Formalizing Requirements Interoperation in Complex Systems Engineering. Insight, 2015. 18(4): p. 28-30.

[71] de Weck, O.L., Fundamentals of systems engineering. 2009.

Traditional Arts and Socio-Cultural Changes: The Case of Bags in the Bamenda Grassfields of Cameroon

Exodus TIKERE MOFFOR

The University of Yaoundé 1, Cameroon

Abstract: **The bag like any other aspect of art is an important cultural heritage of every society. As Frank Boas puts it arts and man are inseparable, and that no society can exist without arts. In the Bamenda Grassfields, bag production is done by a few cultures and such activity performed absolutely by the men has been handed down from one generation to another with very little modification. In the pre-colonial days, traditional bags were produced with three major raw materials namely animal skin, fibre and a special fabric called *ndop*. But today, with the challenges of modernity, the traditional bags of the Bamenda Grassfieds is undergoing gradual modifications both in materials used in production and function. Despite these changes noticed in the manufacture as well as use of the traditional bag, this receptacle still fulfils its functions some of which are to store and carry objects. They are also used to provide healing to patients. Bags can also be used to portray the socio-political organisation of the Bamenda Grassfielders. They are elements of social stratification and cultural identity; they therefore have roles in politics, social, religion, economics and healing.**
Data for this research was carried using the qualitative as well as the quantitative methods and the information was analysed soon after the data collection was over.

Keywords: **Tradition, arts, change, bag, cultural heritage, socio-culture**

Introduction

A bag is a receptacle, a flexible container made of cloth, paper, plastic and fibre. The bag is a very useful instrument in every community. The traditional bags which are discussed in the research paper are those made of raffia fibre, animal skin and the *ndop* fabric. According to Venice and Alastair Lamb (1981: 139),

> *Raffia weaving occurs all over Africa where the raffia palm is found. It is important in Madagascar. In Angola, Zaire, Congo and Gabon, it is by far the most significant form of indigenous textile production. In Cameroon, the use of raffia is more or less confined in the Grasslands where Bamessing or the Ndop Plain and the Meta region around Mbengwi are the major centres.*

Bags can be used for storage, packaging of food and other items. The bag can also be used to store traditional medicine. There are bags of different sizes, shapes and colours. In the Grassfields of Cameroon, bags go beyond mere carrying of food and storage of medicine; it is used as an element to spot evil persons in the society and also an element of social stratification. Some bags are embroidered with emblematic motifs and such bags are used only by the royalty and the ruling class. In the Bamenda Grassfields, bags are fabricated with a variety of materials ranging from fibre, animal skin to fabric. Bags are hardly produced from nylon materials. In this area, bags are produced predominantly in the Meta area in Momo Division and in Bamessing in Ngoketunjia Division. Bags production is an activity which is predominantly male. Women can only assist in the collection of fibre which is the most used raw material for bags fabrication. Bags accomplish different functions some of which are political, religious, social and healing.

In the Bamenda Grassfields of Cameroon, the traditional bag is very visible in cultural ceremonies, men, women, commoners and notables carry bags which match their social ranks. The Bamenda Grassfields is a region that corresponds to the Anglophone North West Region of the Republic of Cameroon. The part of Grassfields that was under English Administration known as the 'Bamenda Grassfields'[1] (Warnier, 1975: 43).

The natural vegetation of this region consists of short and tall grasses with raffia and oil palms growing along the courses of the rivers and streams and banana trees surrounding the compounds. The oil and raffia palms serve as raw materials to weavers who use them for the production of baskets, bags, caps, mats, chairs, tables, cupboards and thatches.

All the peoples of the Grassfields are organised in *fondoms* of different sizes. Most of them are independent (Warnier, 1975: 42). Almost everywhere, *chiefdomship* is hereditary and the *fon* is a sacred figure. The distribution of power between *fons*, regulatory societies, lineage and ward heads varied from chiefdom to chiefdom as well as the degree of concentration of power, the less centralised being probably the Meta is among stateless societies (Warnier, 1975: 32-3). The political structure of most, if not all,

---

[1] 'Bamenda Grassfields' after World War 1, Cameroon a former German colony was divided into two: one part (the greater part) was put under French administration under the League of Nations Mandate, while the Western remaining part was mandated to the British who administered it as part of Nigeria. The part of the Grassfields that was under English rule was called 'Bamenda Grassfield.'

Bamenda Grassfields fondoms are, basically similar. The *fon* has very great executive authority next to the village regulatory society known as *kwifon*. Chiefs, notables and quarter heads also form part of the political structure. Most Bamenda Grassfields fondoms are patrilineal (apart from the Kom and the Aghem societies are matrilineal) and highly ranked societies. The political system is based on hereditary traditional authority and access to power is highly determined by direct descent. On the political strata of these chiefdoms therefore, the *kwifon* comes first followed by the *fon*, notables and quarter-heads. And only the *fon* and a few notables have the privilege to used specially decorated woven bags.

Methodology

This piece of work is an attempt to demonstrate the dynamics of the traditional bags and the need for its revival. To collect data for this paper, the qualitative and quantitative methods were used. Underlying these moethods, the following research techniques were emplyed: direct observation, indepth-interview and questionnaire. The writers of this paper visited many fondoms of the Bamenda Grassfields where he saw the fabrication of different traditional bags. He also took part in the production of bags by collecting fibre.He also visited many cultural ceremonies where these bagsare being used. He interviewed the notables on several occasions to know when they use these bags, and who uses what type of bag. With the women, he was out to find out the type of bag used in storing their cups and other items. He also interviewed young people and traditional medical doctors to understand in what ways they use the traditional bags. Questionnaires were equally used and among some of the information that were provided by the questionnaire was the livelihood of the people especially the king makers and other notables, bags production, acquisition of bags, marketing of the object, and societal perception of the bagsin the Bamenda Grassfields societies.

Data management analysis

Data analysis of the study began soon after our field work. Information recorded during observation and interview sessions were transcribed and arranged according to the different categories of people interviewed.

Findings

Findings disclose that bags are an aspect of art which cuts across all the facets of the culture. Their production is reserved absolutely for the men folks; Venice and Alastair Lamb (1981: 139) note that in Cameroon as elsewhere in Africa, raffia weaving is a male craft. All stages from the preparation of the raffia fibre through the weaving to the sewing up of the finished articles, bags and costumes, is carried out by men, most of whom belong to families which have been engaged in this occupation for many generations. But today, the women are engaged in the collection of raffia fibre which is used by the men for production. The functions of these bags rang from political, religious, social, healing to economic are produced from materials got from the immediate environment

Political functions of Bags

In the majority of Grassfields chiefdoms, some bags are used only by the ruling class (the *fon*, chiefs and notables).This is to distinguish them and their functions from the commoners. They use bags during special ceremonies such as death celebrations, funerals and twins' celebrations. The *fon* for example uses special bags with specific motifs like the bag below which bears the lizard symbol. This bag is used to store traditional elements that he needs for the service of the chiefdom.

Plate 1: A bag adorned with the lizard motif. Photo Tikere (16/10/2017)

On an officer outing to a death celebration or a funeral ceremony, the fon's bag which contains camwood and other items are carried by one of his chinda's. The camwood in this bag is used to anoint the deceased in the case of a funeral. This product from the camwood tree which has the colour of blood permits the deceased to be ushered in the realm of the living death. It is also a means of wishing him farewell and upon the anointing of the camwood, incantations are being done in words like

> *Nju (calls the name of the deceased) as you travel to meet our fathers and fore fathers (ancestors) who have gone ahead of you, may you go well, have peace where you are going, explain to them how we are faring. We bite you farewell but that as you go you continue to watch over us (Tah Nambeh, 12/01/2010)*

This is done because the people of the Bamenda Grassfields like majority of Africans believe that there is life after death and those who have gone beyond watch, guide and guard the living.

This is conducted by the *fon* himself if the deceased is a notable or king maker but in other cases, this is performed by the *fon's* representative who could be a prince or the chief priest. At the level of the clan, the clan head conducts the rites.

In most Bamenda Grassfileds cultures, the palace has a bag which contains some potent potion used to spot out evil doers. If someone steals for instance and does not want to own up as the culprit, the *fon* will use this bag which he will ask all the villagers to take turns to touch and the individual whose hand gets stock on it is the criminal. The same bag is used to banish evil doers from the society. Evil doers are people who perform acts that are detrimental both to individuals and the society. Some evil doers are witches, wizards or murderers. When the culprit is escorted at the limits of the village, some of the potion which is in the bag is brought out and blown behind him/her thereby signifying that as he/she is leaving the village, he/she should never return else he/she will die without entering the land. This bag therefore acts as a form of social control, discouraging stealing and other ills in the society.

There are other bags that are reserved only for the royal family and some of these bags have symbolic motifs such as the leopard skin, the traditional wear of the Grassfields commonly called *ndop* and cowry shells. A bag made of leopard skin is used only by the *fon* because he is regarded as a leopard.

Plate 2: A bag decorated with the leopard skin. Photo Tikere (10/09/2015)

Cowry shells decorated bags are carried by princess during very important cultural ceremonies like the enthronement of a fon, chief and the annual dance. This bag together with the traditional attire is used to identify children from the royal family.

Plate 3: A princess of the Bafut chiefdom carrying a bag made with the *ndop* fabric decorated with cowry shells. Photo Tikere (17/12/2012)

As we can see in the picture above, the lady is a princess in the Bafut chiefdom, this is recognisable in her traditional dressing of the *ndop* fabric, necklaces and she carries a horse tail and a titled bag. Her dresses and the objects she carries are symbolic marks of honour, honour which she acquires by birth.

Bags are used as a title objects. In most Bamenda Grassfields chiefdoms, people are usually identified because of the contributions they make in the development of the society. One such identification marks is the award of titles to distinguish those who have contributed to the growth of the society and a form of encouragement of hard work. During the annual dance (*abinemfor*or*leleh,*)of

the Bafut chiefdom for example, there is usually the award of traditional titles to distinguish personalities, people who have carried out very important contributions in the chiefdom. These titles among which are traditional bags, cups, the red feather and the pine of the porcupine are handed by the *fon* of Bafut himself to the beneficiaries. The bags are produced with are of different materials bearing diverse colours. As can be seen in the plates below, there are two of such bags, the first made of red fabric and the next of fibre.

Plate 4: Title bags. Photo Tikere (17/12/2012)

The red bag is given to both male and female. This bag is embroidered, embellished with some golden bells attached on it. It is worn on the neck of the initiate by the *fon*. This is the first class title which Bafut people called *barmegum*.

Plates 5 and 6: The *fon* awarding a title bag to some Bafut elites. Photo Tikere (17/12/2012)

This same title is given to women but the difference is in the size of the bag awarded to women. The bag given to women is smaller than that handed to men. Women are awarded only the bag but some men are also given the royal sword known as *anguieh*. There are very few women who are honoured with such a title.

Plate 7: A title bag awarded to a woman. Photo Tikere (17/12/2012)

The red bag is handed to people who have either carried out projects such as a building project, water project and so on. As the *fon* hands these titles to the recipients, he uses these words

The people of Bafut (including the ancestors) have seen what you have done and want to encourage you to continue to do more. Building a place does not necessarily mean that you come from there. Developers will strive to have an impact wherever they fine themselves. We say thank you, the gods appreciate you and may you have a long life (fon Abumbi II of Bafut). 25/03/2015).

The next type of bag is made of fibre is awarded to women alongside the title cup, a small round calabash (mo'oh) with a small hole bored on it. This calabash might be used by these title women in the place of the *mo'oh* tong. The calabash is handed to the initiate who holds it in the left hand and the woven bag is put on the right hand. This title is given to teachers, medical doctors to name these few. The contribution of the above mentioned persons is immense in the culture of Bafut. This is the third class title which is the equivalent of the red feather for the men.

Plates 8 and 9: The award of fibre bags to a distinguished Bafut woman. Photo Tikere (17/12/2012)

The bag here plays a dual role; it serves as a sign of tribute and a container in which the title cup is put. These title symbols (the bag and the cup) are carried to cultural ceremonies and who aver meets someone with this title, gives her the respect which she deserves.

In the Bambui cultural sphere, notables like the one which is in the plate below (Ta Mekezang) keeps his title bags at home. Such bags are hung on the wall with their contains prepared to solve specific problems or each bag has a specific occasion in which the notable has to use. These bags even when its owner is absence, no one can look into or touch it for fear that the potent potion in it can harm or affect him or her.

Plate 10: The bags of a notable hanging on the wall. Photo Tikere (10/09/2015)

When a 'big' notable or a 'big' title holder dies, his 'bag' is handed down to his successor. This bag which is transferred from one successor to another, from one generation to the next, serves as the heart bit of the entire family. Such a bag is handled and handed either by the *fon* or by a king maker because it does not warrant everyone in the society to touch or see into it. This bag is handed only to a male successor. This means that in the cultural sphere of the Bamenda Grassfields, if a man dies without having a male child, his successor can come among his girl children but this female successor will not use the bag, stool, title cup or any other status symbol that she inherits. These objects are handed to her male child who will succeed her father. The female successor is therefore a sort care taker because the position cannot be vacant. It is important to note that only the bags of hereditary notables are transmitted from one generation to another. The powers that the bags of other notables possess die at the death of their owners.

Bags are used as an element of social stratification. Themajority of Bamenda Grassfields chiefdoms are highly stratified, people occupy different social positions and such positions are empowered with some social stratification symbols and the traditional bag

is one of such. The *fon* occupies the highest social rank followed by the chiefs, the king makers, notables, and traditional medical doctors. The commoners are at the tail of the social strata.

The *fon* embodied the society, and to Nkwi and Warnier (1982: 62), he is hyper-social and hyper-cultural. Whereas the encroachment of nature on the cultural universe of the chiefdom is seen as polluting, the influence of the hyper-cultural *fon* is seen as a blessing and as constantly regenerating the society. The *fon* is hyper-social and hyper-cultural because he embodies what human society is all about; the alliance between in-laws (the *fon* had many wives and married off his many daughters), the alliance between clans, lineages and quarters in the societies of the chiefdom, the social rules and norms, and the contact with the ancestors who warranted the social order and the prosperity of the society. This is why the *fon*, in olden days, was never involved in repression. Repression and social control must deal with polluting actions, and the *fon* belonged to the opposite pole of human society, the cultural pole, which is free from pollution and danger. He was therefore, kept away from any polluting contact and was never involved in social control and repression except as a moderator. The *fon* who is at the top, uses bags with the *ndop* fabric and the lizard motifs among others. Him and the position he occupies are regarded as the biggest in the entire society. The *fon* is not bigger than all the other persons in his society but the powers vested on him by the ancestors and his people determine his grandeur.

The chiefs, king makers, notables and traditional healers all can use bags embellished with cowry shells. The above mentioned personalities apart from the traditional healers are part of the ruling class and have the distinguish authority and functions which permit them to possess and use objects with an emblematic symbol like the cowries. The *tiloh* or sub chief comes immediately after the *fon* on the political strata of Bamenda Grassfields. The *tiloh* is usually referred to as the hereditary rulers, council of elders or clan heads. Most of them are migrants who came to Kedjom with their own *kwifon* societies but surrendered them since two *kwifons* cannot govern the same chiefdom. Being very instrumental in their various chiefdoms, they work hand in hand with the *fon* in the management of the village. They are the *fon's* advisers; they appoint and crown a successor when a *fon* is 'missing' and they are equally the core of the *kwifon* society.

Becheh or king makers are equally very important notables in the Bamenda Grassfields. These are old princes who are members of *kwifon*. It is important to note that when a *fon* is *ya'ah* or crowned, princes in his generation cannot be members of the *kwifon* else all of them will be equal (to the *fon*). This therefore, means that *becheh* are princes, three to four generations to that of the *fon*. They can become members of the *kwifon* because of their seniority in the palace. Being components of the ruling class, they together with *betiloh* administer the affairs of the chiefdom, advising the *fon* on very important issues and also taking part in the 'catching' or appointing and crowning of a new *fon*.

Plate 11: A title bag. Photo Tikere (07/04/2015)

A bag like the one above, reserved for big notables. This bag as can be seen has the pine of the porcupine on it. The object is the highest title among the Bamenda Grassfields, thus anyone who has it either on his cap or bag is either a fon, chief, and king maker. Just as this animal uses the pine to protect itself against predators, these personalities use this title symbol to demonstrate their role one of which is to protect as well as work for the interest of the society?

Plate 12: The pine of the porcupine. Photo Tikere (07/04/2015)

Traditional medical doctors on their part have the immense role of providing medical care in the entire society: by healing the sick, sending away evil spirits from people and safeguarding the entire society. Below is the picture of a traditional healer who uses his bags adorned with cowry shells in restoring the health of his patients.

Plate 13: Animal skin bags used to store powdered medicine. Photo Tikere (16/10/2017)

Commoners, who occupy the last position on the social ladder, use 'common' bags, bags which do not have any significant designs wand as a result do not have any cultural consequence in the society. The bags possessed and used by this category have only one function, to store and carry their common cups to cultural celebrations: traditional marriages, death celebrations, funerals and succession ceremonies. If a commoner works hard and impacts the development of his society as discussed above, he or she can climb horizontally to a more honourable position where he or she can have the prerogative to use title objects like the bag.

Plate 14: A bag reserved for a commoner. Photo Tikere (13/12/2018)

Religious functions of bags

Religion plays a very important part in the lives of the Grassfielders in general and the Bamenda Grassfields in particular. The majority of Grassfields people believe that spiritual forces reside in objects such as bags, stones, trees and others. During very important celebrations among these people, the traditional bag is used to store or carry medicine or camwood which is used in the ceremony. In a death celebration for example, masquerades carry bags which contain the powers of this group, this bag in the Bambui language is called *boor*and then the name of the juju or masquerade is mentioned. *Boorkechu*for instance is the bag of *kechu*. *Kechu* is the name of a masquerade or juju in the Bambui *fondom*. It is important to note that each dance group or masquerade or juju in the Bamenda Grassfieldshas its 'bag' in which its powers resided. The bag is also referred to as the spirit of the juju. Such a bag is handled and used to wade away other forces which may interrupt in its activities or make it not to perform and function well. Occasions in which masquerades have to perform is an opportunity for them to test the strength of their bags. The strength of a masquerade is measured in the strength of its bag.

Plates 15 and 16: Bags used in cultural celebrations. Photo Tikere (17/12/2012)

Some of such bags contain the camwood as has been mentioned above. The camwood is a very important element in the cultures of the Bamenda Grassfields people. It is used in many traditional rites such as rites of passage, traditional marriages, enthronement of the *fon* , burials, initiation rites, twins' celebrations, in succession rites to name only these. The camwood is sometimes applied

dry and sometimes it is mixed with palm oil. During burial, it is used to rub the corpse before it is lowered into the grave. This is to say fare well to the deceased. In traditional marriages, mixed camwood with palm oil is anointed on the bride and the groom. It is believed that this will render the couple to be very humble if at all they or one of them was cruel or brutal. This is thus a panacea for cruel behaviour.

Among the Kom people, there is a special rite of passage where young women pass to motherhood. In this rite, the woman is accompanied round the compound with other dancers who are all women, who are members of this group. The initiate dances bear body with her body anointed with camwood from her head to her toes. She is decorated with a series of beaded chains and she dances with a long symbolic anthropomorphic walking stick. The woman dancing in front or leading the dance carries a woven bag. This bag usually serves as a container in which the initiate stores her drinking cup and other items which she may need in any cultural event.

Plate 17: Rite of passage in Kom. Photo Tikere (10/02/1980)

Through this ceremony therefore, particular women move from one category to another. This superior category, permits them to attend certain meetings and enter certain houses in Kom. She has the right to associate with some important women in the Kom society.

This type of bag is handed to a widow among the Bamileke after widowhood rites. She carries the bag to every ceremony that holds in the society.

The traditional bag is also very valuable to priests and pastors of the Catholic and Presbyterian churches. These servants of God use the bags to carry their Bibles and other small objects which they need to serve mass. The very first missionaries and priests and pastors who came to Africa and Cameroon in particular discouraged the natives from using their traditional art among which where bags with the pretext that they do not glorify God. Today, they have started using the bags in for the service of the Lord because they have found out that it is part of the cultural heritage of this people.

Bags and Healing

In the Bamenda Grassfields like in the majority of African cultures, traditional medicine is part and parcel of the people culture. They go for this because they believe in it and it is as old as the culture itself. Some traditional medicines are stored in bags and bags used by traditional doctors are made of two principal materials: fibre and animal skin. Fibre bags are usually used to store harvested herbs. Harvesting of herbs is usually done very early in the morning when the leaves still have all the medicinal properties in them.

Plates 18 and 19: A traditional doctor going to harvest herbs. Photo Tikere (16/10/2017)

Traditional doctors store most of their powder medicine in bags made of animal skin. Such medicines are pounded in the mortar meanwhile others are ground on the stone. The colours of the medicines vary from black, white, yellow to brown. Each bag will contain specific medicine destined to cure a particular ailment.

When most patients who suffer from frontal headache and chest ache consult a traditional healer, a bag containing some potion is place on the affected part. The medicine is expected to send out the spirit or heal the portion of the body which is malfunctioned.

Plate 20: A bag containing potion. Photo Tikere (16/10/2017)

Some of such bags are often seen hanging on the wall in the healer's healing room. Many of them are above five decades old but their contains are renewed every year to maintain their effectiveness. Some of these bags are handed down from father to son upon succession. Children succeed their parents and when they do, they continue with their parents' activities and responsibilities.

Plates 21 and 22: Pictures showing bags hung on the wall of a healer's room. Photo Tikere (16/10/2017)

Traditional medicine men sometimes produce a small bag that they give to their clients or patients to tie on the waist. Some of the bags have protective powers meanwhile others are powerful charms which are aimed at bringing good luck to its user. One of the most important conditions of such bags usually produced with animal skin is that, it is forbidden for water to touch them. If water touches them, they either loss their powers or have an adverse effect on the user.

Social Functions of Bags

Bags have a great social role, some are used as gifts, and others are used to store as well as carry other objects such as the cup. Many Bamenda Grassfields people usually carry the bags and the cups to different ceremonies. Greetings from Cameroon, you are welcome etc, are some of the inscriptions that we can find on bags which are given out as gifts. Sometimes such bags will carry the colours of the flag (green, red and yellow) as portrayed in the plate below.

Plate 23: A bag meant to be offered as a gift. Photo Tikere (10/09/2015)

Gifts play a very important role in the lives of Bamenda Grassfields people in particular in Africans in general. These objects often portray the relationship that exists between individuals and nationals. When visited, the host usually offers a symbolic gifts which as acts as a souvenir to his or her visitor. This is a bond that ties the two persons or societies together.

During the annual dance in most Bamenda Grassfields chiefdoms, women and men alike dance the colourful fon's dance with the traditional bags hanging on their hands for the women and on the shoulder for the men. The bag here adds more beauty and honour to the owner's personality. They can identify themselves with their traditional and culture.

Plate 24: Women dancing in the fon's dance. Photo Tikere (17/12/2012)

At some point of the celebration, the participants sit and are entertained with food and palm wine provided by the palace. The palace does not provide the cups with which this drink has to be served because it is the culture of the people that a real 'man' of the Bamenda Grassfields culture always goes to a ceremony with his bags in which is usually found the cup, cola nut and other cultural elements.

Plate 25: A woman at a cultural ceremony. Photo Tikere (17/12/2012)

Some people especially the men will often carry their traditional medicine which is either meant to guide or protect them in case of danger in their bags. And when they carry their bags and meet a woman in a stream doing some laundry, a kind man will ask her to come out before he crosses the bridge, this in order that the medicine in his bag should not affect the woman. Due to the fact that it

is already the way of life of these people, when a woman who is doing laundry sees a man either young or old coming, she first of all observes very well, if he is carrying a bag, she will hastily leave the stream for him to cross first before she returns to the stream and continue with her work.

If a man, especially an elderly man meets a number of people conversing, if he is carrying a bag, they will move in one direction to allow the old man to pass. It is believed that if the old man passes in their midst, they are going to be affected by the contain of his bag.

Economical functions of bags

The functions of traditional bags may be obtained through use. For those involve in their production, they are in the first place commodities; products which can be traded, bought or sold mainly to acquire income. But before pre-colonial times, these bags were not manufactured for economic purpose – they were mainly to serve the chiefdom in varied domains, with most of them having political and magico-religious functions. This explains why many of the palaces in the Grassfields of Cameroon had to hold their producers in high esteem because they produce objects in the tribal style, articles which conformed to the tribal tradition of designs, motifs and symbols. Furthermore, in the pre-colonial era, the *fons*, nobles and secret societies served as the major market for these objects for they were made mainly for them. With colonisation, traditional bags were highly priced by tourists and art collectors and this made these cultural artifacts to become highly in demand that many weavers and chiefdoms started using them as commodities.

The economic importance of trade in traditional bags is therefore a very recent development per say, and this could largely be due to the fact that Grassfields woven objects including those of Bamenda Grassfields are famous for their aesthetic qualities. Bags were easily adaptable for men of different socio-political ranks and prestige. Bamenda Grassfields bags were and are still highly commanded and sought after throughout the region, both for their superb craftsmanship as well as their special metaphysical power they were believed to possess.

More so, elaborately woven bags made for both daily and ceremonial use, were and are objects of frequent exchange among the various chiefdoms of the Grassfields. The commercialisation of these items is done by both the male and female folk although its production is restricted only to the male. The female do not take part in its manufacture because of the taboo that surrounds the production.

The marketing of bags is done at the local as well as external level. The weekly markets are not the only outlet for local weavers, who are usually capable to commercialise their objects directly from their compounds, to art shops, handicraft centres, museum owners and to tourists. Although most weavers are not full time workers, majority of them, notwithstanding their ages, are able to contribute substantially to the household income - medical expenses of family and relations (children, wives, grandparents, grandchildren, aunts, uncles among others), schools fees and pay for the apprenticeship of their children and other relations who are not engaged in weaving.

The costs of traditional bags vary from one producer to another. The cost of a bag is determined by the material used in its production and its quality. A bag made of animal skin can costs forty thousand (40.000) francs meanwhile a fibre bag costs thirty thousand (30.000) francs. The costs of a bag intended for a gift depends mainly on the inscriptions that appear on it. To many weavers therefore, a good bag demands much time and good quality material. Some of the weavers note that the prices of traditional bag have dropped. Despite this drop in the prices, there are still a handful of master weavers maintain the tribal style and tradition in the production of good and quality objects. Such artists put the blames on young untalented artisans who have flooded the market with 'just any kind' of products, articles of low quality, because they are struggling for survival.

Museum owners are equally potential consumers of bags. They come from all over the country, buy things that have already been produced and place commands on others. Tourists, missionaries and important personalities in the North West Region also purchase bags. Art collectors, art lovers and tourists pay less on an object than the authors wanted. This has pushed most weavers to hack their products in the streets of major towns in Cameroon.

Symbols represented on traditional bags and their Significance

The motifs represented on the Bamenda Grassfields traditional bags are anthropomorphic, zoomorphic as well as geometric. Some of the symbols usually found on bags are the leopard, cowry shells, the lizard, the *ndop*. Geometric figure designed on bags are the circle, the triangle to mention these few.

Motif	language	Bafut	Kedjom	Oku	Kom	Bambui
Animal	Leopard	*Nkanse*	*Manh*	*Bah*	*Nyam abo*	*Kalong*
	Lizard	*Nkongse*	*Kebas*	*Nkesakenyam*	*Abas*	*Afuh*
Inanimate	Cowry	*Agheh*	*Kueh*	*Wekelel*	*Igwo*	*Agheh*
Geometric figures	Cycle	*Nkangse ikarese*	*Nkale*	*Eykal*	*Nkal*	*Nkankka'a*

Such motifs have cultural meanings that can be read or interpreted only by those who are rooted in the culture of this region. Each emblematic symbol is associated with a specific personality.

The Leopard

The leopard (*Pantherapardus*), is a member of the *Felidae* family and the smallest of the four "big cats" in the genus Panthera, the other three being the tiger, lion and jaguar. Leopards live mainly in grasslands, woodlands and riverside forests. While they are usually associated with the savanna and rainforest, leopards are exceptionally adaptable. The leopard is solitary and, aside from mating, interactions between individuals appear to be infrequent.

Leopards are generally considered to be nocturnal, agile and stealthy predators. Although smaller than the other members of the *Panthera* genus, the leopard is still able to take large prey given its massive skull that well utilizes powerful jaw muscles. Antelopes and deers provide a majority of the leopard's prey.

The leopard is known for its ability in climbing, and it has been observed resting on tree branches during the day, dragging its kills up trees and hanging them there. They are capable of carrying animals up to three times their own weight this way. The leopard is the only big cat known to carry its prey up into a tree. It is a powerful swimmer, although not as strong as some other big cats, such as the tiger. Leopards are versatile, opportunistic hunters. In the open savannah, they are most successful when hunting between sunset and sunrise, though they may hunt during the day.

Leopards have been known to humans since pre-history and have featured in the art, mythology and folklore of many countries where they have historically occurred, such as ancient Greece, Persia and Rome, as well as somewhere they have not existed for several millennia, such as England. The modern use of the leopard as an emblem for sport or a coat of arms is much more restricted to Africa, and through numerous products (http://en.wikipedia.og/wiki/Leopard).

According to Notué and Triaca (2000: 68) the leopard is a large elegant and powerful feline, with elongated forms. Thanks to its cunning attitude, power and ferocity, it is one of the most feared animals and, as such, one of the most respected in the African jungle. Knopfli (1999: 34) defines the leopard as a large feline, powerful, fast-running and flesh-eating animal, active particularly at night and very unpredictable. Its preys are mainly big field animals such as antelopes, cows and goats.

Mankon beliefs give this creature many powers. It is the perfect symbol of royalty and is associated with political and judicial authority as well as symbolising strength, the power of the *fon*, prestige and the greatness of royalty. Besides, the *fon* is indeed called "leopard" and his children "those" of this animal (Notué and Triaca, 2000: 68).

Bamenda Grassfields people give a lot of respect and honour to the *manh*– the leopard and this could be seen in the fact that a hunter who kills this animal is awarded a traditional title – a red feather as a mark of bravery and courage. In those days, such a hunter was to be given a raffia bush and one of the *fon's* daughters as a wife, for he had the power and wit to overcome such an animal which itself had power over some animals in the forest. Strength and wit therefore were two criteria that the *fon* used to select husbands for his daughters. A powerful man will always protect and fend for his family. In addition, getting married to a princess in the Bamenda Grassfields was an honour and this encouraged many young men to work hard to have the privilege to marry the daughter of the palace.

To demonstrate its importance in the Bamenda Grassfields, it is represented as a motif on bags. Such an emblematic object is reserved for the highest ranking personality of the chiefdom – the *fon*.

Just as the *fon* uses the skin of the tiger, he uses that of the leopard to rest his feet on its coat, to absorb the leopard's power. It is believed that when this is done, the *fon* can transform into a leopard when need arises. When there is a problem in the palace to escape, he changes into a leopard. He can equally do so when he wants to go to somewhere either in or out of the chiefdom without anyone's knowledge. The leopard therefore is a symbol of honour, protection and courage.

The Cowry

Cowryis the common name for a group of small to large marine gastropods in the family *Cypraeidae*. The word cowry is also often used to refer to the shells of these snails. Many people find the very rounded, shiny, porcelain-like shells of cowries pleasing to look at and to handle. Shells of certain species have historically being used, in the past and present, very extensively in jewellery, and for other decorative and ceremonial purposes.

Plate 26: /Kueh/ Cowries. Photo: Tikere (10/01/11)

The shells of cowries are almost always smooth and shiny and more or less egg-shaped, with a long, narrow, slit-like opening (aperture). The shells of cowries were used for centuries as a currency in Africa. Huge amounts of cowries were introduced into Africa by western nations during the period of slave trade. The Ghanaian unit of currency known as the Ghanaian cedi was named after cowry shells. Starting over three thousand years ago, cowry shells, or copies of the shells, were used as Chinese currency. They were also used as means of exchange in India. (http://en.wikipedia.og/wiki/cowry)

On the Bamenda Plateau, as Nkwi and Warnier (1982:92) note that cowries were known as *aghié*, whereas elsewhere, they were called *mbefu*, which means "white money" or "white grains". According to Nkwi and Warnier (1982:92) and Knopfli (1999: 65) cowry shells are valuable because in pre-colonial times they were used as money in many parts of Cameroon. Knopfli (1999: 65) continues by saying that anything could be bought with cowries, even women, for they were one of the goods to be bought with money.

Cowry shells were replaced by copper rods and the former's function changed in most Grassfields chiefdoms. Cowries were used as an ornament and a status symbol by the *fons* and chiefs. Chiefly wives wore and still wear strings of them as necklaces, armlets or anklets. *Fon's* wives are marked out by wearing cowry shells as they are traditionally respected in these chiefdoms for being of greater social position than other women.

The cowry is also used as decorative and identification marks on art objects like bags, bowls, walking sticks, embroidered costumes, stools, houseposts, doorframes as well as title drinking vessels. These objects are set aside for the *fon*, members of the royal family and notables. The sign symbolises dignity and thus it is an insignia of dignitaries.

Plate 27: The bag of a traditional healer. Photo: Tikere (16/10/2017)

Cowry shells are equally used by diviners for divination. A diviner will use them together with other objects, and throws them on the ground. By shaking and throwing them on the ground, he looks at the symbol which comes on top. From this symbol, he could discern what hopes and fears are in the minds of the patient or person he is carrying out his divination. He becomes a sort of psychoanalyst at an encounter group of the whole chiefdom. These cowries can be used for individual consultation but their main function is to inform the diviner what is in the mind of an individual by encouraging that individual to reveal himself or herself to the diviner. This object gives the diviner channels of communication with the society's gods and they help him to preserve the features of a particular individual soul.

Plates 28 and 29: A diviner communicating with the gods. Photo: Tikere (16/10/2017)

The Lizard
Lizards are small to average sized reptiles belonging to the family Gekkonidae, found in warm climates throughout the world. All lizards have no eyelids and instead have a transparent membrane which they lick to clean. Many species will, in defence, expel a

foul-smelling material and faeces onto their aggressors. There are also many species that will drop their tails in defence, a process called autotomy.

Many species are well known for their specialized toe pads that enable them to climb smooth and vertical surfaces, and even cross indoor ceilings with ease. The toes of the creature have a special adaptation that allows them to adhere to most surfaces without the use of liquids or surface tension. They feed on insects, including mosquitoes http://en.wikipedia.og/wiki/Lizard.

Different kinds of lizards are common in Bamenda Grassfields, ranging from the small insectivorous and peaceful gecko or house lizard, to the giant lizard living in the bush. The people describe various characteristics of lizards. All types of lizards have long bodies and long tails, and their skin is covered with scales almost like fish. A lizard can lost its tail without being cut and grow a new one. The lizard is the fastest climber not only on trees but even on smooth surfaces, as if it had sticky fingers and toes.

The rainbow lizard is used by witch doctors to send and direct lightning. For instance, in cases of theft, adultery, land stealing and the like, the offended person consults a *ngambeman* – a diviner asking him to kill the wrongdoer by causing lightning to strike his compound. The *ngambeman* will catch this lizard, put medicine into its mouth and gunpowder on its back. He then asks the plaintiff to strike a match and burn the gunpowder on the lizard. The gunpowder puffs and the lizard runs away to the wrongdoer's compound and hides there. Before long lightning will strike that compound and burn it down, possibly at the same time striking and killing the man (Knopfli, 1999: 57).

The lizard as a symbol is represented on stools, bags, thrones, houseposts, doorframes and walking sticks. Bamenda Grassfields people believe that this lizard is the rainbow lizard. This animal which has a reddish-dark skin is very poisonous and dreadful. It is known in Kedjom as *kebas*. If it bites someone, it is believed it cannot be cured, thus the people always watch out for it and would not let it escape if seen. Items that carry the lizard symbol are used by the fons, chiefs and king makers. Due to their poisonous nature, it is believed that the notables who constitute part of the ruling body having acquired the poisonous characteristics of the lizard, will use it to guard against enemies from within and out of Bamenda Grassfields. The lizard in this case stands for protection.

Although the lizard is poisonous, if killed, the head is cut and combined with other products to produce traditional medicine – *fefehkeloh* in Kedjom commonly called "black medicine" in Pidgin English. Black medicine can be used to cure stomach-ache or disorder, and snake bites. This medicine is produced by a category of people in Kedjom known as *ngang*. They are sub chiefs and king makers. Because of its ability to serve as medicine that heals sick people makes it an omen- and a symbol of abundant life.

The *Ndop* Fabric

This is one of the most important insignias of royalty in the Bamenda Grassfields of Cameroon. If seen in use anywhere in the entire chiefdom, it represents the power and might of the fon. This fabric is used to produce a variety of art objects ranging from clothes to bags. Objects which are made with this fabric are used in ceremonies like the fon's dance, enthronement of a fon, and succession of a big notable. During such occasion, the area where the fon sits is decorated with the *ndop* fabric to demonstrate his majesty. This material is usually blue and white in colour having some geometric motifs like the circle and triangles.

Plate 30: A traditional bag made with the ndop fabric. Photo: Tikere (10/01/11)

The Circle

The circle is the most emblematic of all geometric designs used on Bamenda Grassfields arts in general and on bags in particular. This motif is represented on varied art forms. In sculpture, it is found on stools and bangles and on embroidered costumes.[2] Such an object on which a circle is adorned is used exclusively by the *fon*. A bag with circle emblem usually carries a single circle as could be seen in the plate above. The circle makes the item very beautiful just by looking at it. But the circle go beyond mere decoration. It is regarded as the symbol of the moon. Their prominence in the sky and their regular cycle of phases have since ancient times made the moon an important cultural influence on language, calendars, art and mythology (http://.wikipedia.org/wiki/Moon).

The *fon* is the symbol of the moon and like one, he is expected to protect everyone even criminals who find their way to the palace. As an embodiment of peace, the *fon* or *ntoh* is there to ensure peace in the entire chiefdom. The *fon* is the father of all and unifies the village around himself. He is therefore not supposed to be engaged in repression and as already discussed, repression and social control must deal with polluting actions, and the *fon* must belong to the opposite pole of human society, the cultural pole, which is free from pollution and danger. He could only take part in social control and repression as a moderator.

Some people believe that this motif stands for the moon because of its circular nature.[3] The moon is Earth's only natural satellite and the fifth largest satellite in the solar system. It is the brightest object in the sky after the sun. The motif portrayed here is that of a full moon, the moon which comes out at night. The night is regarded as a dangerous period of day when many funny things happen. The moon therefore provides light to all irrespective of the sex, age or social status. Everyone even the dangerous of all thieves also benefits from this gift of nature. The *fon* who uses art object with such a symbol (the symbol) is regarded as a model, he is expected to set an example for others to follow and this explains why he is looked upon to provide the symbolic light that shines indiscriminately to every village folk. The *fon* must not look and treat certain villagers as superior to others, he has a duty to protect, love, welcome everyone in the same manner like the moon. The moon therefore stands for peace, clarity, purity and unity.

There is yet another interpretation of the circle. It is considered to signify the sun. The sun is the star at the centre of the solar system. It is the star that the earth spins around. It is almost perfectly spherical and provides heat and sunlight, it is the Earth's primary source of energy. Solar energy can be harnessed by a variety of natural and synthetic process – photosynthesis by plants captures the energy of sunlight and converts it to chemical form oxygen, and reduced conversion by solar cells are used by solar power equipment to generate electricity or to do other useful work, sometimes employing concentrating solar power. In many pre-historic and ancient cultures, the sun was thought to be a solar deity or other supernatural phenomenon. Worship of the sun was central to civilisations such as the Inca of South America and the Aztecs of what is now Mexico. Many ancient monuments were constructed with solar phenomena in mind (http://en.wikipedia.org/wiki/sun).

The *fon* in most Bamenda Grassfields chiefdoms is referred to as the sun and this may be because like the sun which is at the centre of the solar system that the Earth revolves around, he is at the centre of a very singular cultural manifestation in the chiefdom. Like the sun, the *fon* unites his people around him, people to whom he has to from time to time provide palm oil and salt. This demonstrates a strong sense of social organisation of these chiefdoms that have brought up grandiose arts among which is the traditional bag. As a functional sign, the sun in these societies is regarded as a liturgical motif represented on such objects as bags, stools and embroidered costumes which are used by the *fon* for specific rites or during any other celebration which signifies the way of life of the people. The *fon* here is the symbol of unity.

The *fon* is considered as a special light of the sun that shines in the lives of the people, light which shines for all irrespective of age and size. This symbolism of the sun associating it with the *fon* may be due to the fact that it provides light which does not only serve humans, but is also very invaluable for plants that use it to manufacture food through a process known as photosynthesis. The value of plants in the life of a people cannot be over emphasised. It serves as food, as medicine, as home of spirits, as one of the main raw materials of the bag.

The Dynamics of Traditional Bags

Considering the fact that there is no aspect of culture which is static, the traditional bags of the Bamenda Grassfields have witnessed some changes in recent years especially in the domain of production and use. As mentioned above, traditional Bamenda Grassfields bags were manufactured out of three major raw materials: animal skin, fibre and the *ndop* fabric. Today, bags especially those reserved for commoners are produced from nylon. Such bags are believed to be resistant because of the material which has been used in its production. To the local people therefore nylon bags can last for many years and they can be easily washed when dirty. Below is an example of a nylon bag made in Mankon Bamenda.

---

[2] The embroidered robe the *fon* uses bears only a single moon on the back part of the dress. This moon is believed to provide a symbolic light to the people who are all under the *fon's* leadership.

[3] The moon is the object, similar to a planet, which moves in the sky around the Earth once every 28 days and which can often be seen clearly at night when it shines with the light coming from the sun.

Plate 31: A machine woven bag. Photo: Tikere (10/01/2019)

Nylon bags are woven using machines and not the hand as it is commonly done with the traditional bags. These bags like most modern art objects do not really fulfil the functions the traditional bags would because they are too colourful and do not reflect the tradition of it producers. The producer of this bag does not take into consideration the tribal style, the object does not conformed to the tribal tradition of designs, motifs and symbols.

Today, bags are carried just on any side of the body on like before when bags were carried only on the left side. In the days of old, bags be they those hung on the hand or on the shoulder, this was supposed to be on the left side of the body. The left side of the body is looked upon as the weaker side of the body equated to the 'woman side of the body' so the power of the bag therefore reinforces this part of the body.

Plate 32: A young man carrying a traditional bag. Photo: Tikere (10/01/2019)

The plate above portrays a young man who hangs his bag on the right side of the body. This only helps to remind us that as time changes, the daily life of the people too change and as Knopfli (1999: 8) states that nowadays young people are brought up in an environment made of plastic and concrete. They drink from glasses, eat from enamel plates; store their belongings in suitcases or cartons. They do not manufacture what they use on a daily bases.

Most weavers in the field remarked that the palace or the *fon* and his notables were the major consumers of traditional bags. At first this category provided a major market for crafts since most of the products were for them. But today, because the palaces generally do not buy crafts well, some craftsmen do not see the need to produce such crafts used by traditional leaders. They say that even when the palace gives a command for a bag to be produced, the palace does not pay an amount that is encouraging, an amount that a museum owner or a tourist could have paid. Meaning that what the palace offers is only compensation which is a sign of encouragement. At times they can give to the palace free of charge because they will first of all have a name at the village level and the product can also help to sell or expose them in and out of society.

Conclusion

The traditional bag of the Bamenda Grassfieldsis a very important part of the people's cultural heritage. These bags are produced by the male folk who use a variety of natural resources got from the immediate environment. This art object played a fundamental role in the lives of the individuals in particular and the culture in general. This explains why many of the palaces had to hold their producers in very high esteem because they produce objects in the tribal style, articles which conformed to the tribal tradition of designs, motifs and symbols. But the traditional bag of the Bamenda Grassfields has witnessed some changes ever since this part of the country came into contact with the external world.

References

- Boas, Franz,
1927. Primitive Art Oslo

- Knopfli, Hans,
1997. *Crafts and Technologies: Some Traditional Craftsmen of the Western Grassland of Cameroon*. (British Museum Occasional
          Paper N^0. 107). Lonaon: Trustees of the British Museum.
1999. *Sculpture and Symbolism. Crafts and Techniques: Some Traditional Craftsmen of the Western Grassfield Woodcarvers and
          blacksmiths* (part 2). Basel: Basel Mission.
2001. *Crafts and Technologies: Some Traditional Craftsmen and Women in the Western Grasslands of Cameroon*(Part 3). Basel:
          Basel Mission.

- Moffor, Exodus Tikere,
2005. *Culture Portrayed in Handicrafts. A Case Study of Bambui Society in the Grassfield of Cameroon*. Masters Dissertation,
Department of Sociology and Anthropology: The University of Yaounde 1.
2008. *Symbolism on Handicrafts in the Bambui Fondom (Western Grassfield – Cameroon)*.
          Higher Diploma Dissertation, Department of Anthropology: The University of Yaounde 1.

- Nkwi, Paul,
1987, *Traditional Diplomacy: A Study of Inter-Chiefdom Relations in the Western Grassfieds, North West Province of
Cameroon*. Yaoundé.

- Nkwi and Warnier,
1982, *Elements for the History of the Western Grassfields*. Yaoundé: Department of Sociology University of Yaoundé.

- Notué, Jean-Pual and Triaca Bianca,
2000. *The Treasure of the Mankon Kindom: Cultural Objects of the Royal Palace*. Yaoundé

- Northern, Tamara,
1975, *The Signs of the Leopard Beaded Art of Cameroon.* New York. The William Benton Museum of Art.

- Warnier, Jean-Pierre,
1975. *Pre-colonial Mankon: The Development of a Cameroon Chiefdom in its Regional Setting.* Ph.D Thesis; Philadelphia:
University of Pennsylvania.
1985. *Echanges, développement et hiérarchies dans le Bamenda Précolonial.* Wiesbaden and   Stuttgart, Steiner Verlag.

- Venice and Alastair Lamb,
1981. *Au Cameroon, Weaving – Tissage.* Hertingfordbany, Hertfordshire, Roxford Books

- http://en.wikipedia.og/wiki/cowry
- http://en.wikipedia.og/wiki/Lizard
- http://.wikipedia.org/wiki/Moon
- http://en.wikipedia.org/wiki/sun

Novel approach for network intrusion detection using machine learning

Prof. Sachin Pandey

Assistant Professor
Information Technology Department
Pune Institute of Computer Technology, Pune

Abstract: **Advancement in the technologies has led to increment in the massive amount of data that massive amount of generated data has to be secured in such way that third party should not be able to take control over them The online platforms such as face book which has large number of users are the main sources of generating large amount of data ,each users activity on the internet is being captured in one or the other ways, security of network has become a great challenge in this modern era. Hence it has become very important to build an effective intrusion detection system. We have implemented a compressive survey of some of the major machine learning techniques based on Naïve Bays Classifier, K Nearest Neighbors Classifier, Decision Tree Classifier and the Logistic Regression in this paper.**

Index Terms: IDS, artificial neural network, NSL-KDD dataset, Feature selection.

Introduction

An Intrusion detection system is used to detect the malicious activity over the network to make the network, server lines secure and free from any intrusions. We can use intrusion detection system to detect the malicious activity related to some specific devices (host intrusion detection system) or to detect the malicious activity occurred in the entire network (network intrusion detection system) which is the common type used. The two main challenges in building the efficient intrusion detection system is first, the feature selection from the dataset is very difficult as it will tell us how important a feature can be. The feature selection changes with the change in attack type. Secondly, there does not exist a labeled traffic real-time networking. Intrusions in the network are mainly caused by unauthorized users trying to access the system and the authorized users who attempt to gain additional privileges given to them.

Machine learning is the field of study that allows the computer to learn automatically without being explicitly programmed therefore machine learning mainly focuses on the development of programmers that are able to learn themselves and perform the task, the information gained by different machine learning techniques is different for each set of input . It has become difficult for traditional network protection techniques to distinguish the normal traffic and the network traffic since the new emerging attacks are having similar behavior and characteristics to that of normal traffic. In this paper following machine learning techniques are implemented Naïve Bayer Classifier, Neighbors Classifier, Decision Tree Classifier and the Logistic Regression Model then later comparison is done based on their 5 major parameters accuracy, precision, recall, f1-score.

LITERATURE SURVEY

The system proposed by **Wei-Chao Lin, et al.** [18] uses the k-NN classifier to predict the state of each network packet, whether to be from a normal or attack traffic. This system is trained and evaluated using the KDD CUP'99 dataset, where the evaluation measures show a good prediction accuracy of 99.89% accurate predictions. However, as the k-NN classifier is a lazy classifier, the knowledge is extracted each time a prediction is required, i.e., the training dataset is scanned every time a new packet enters the network, which is a very resource-consuming process. **Neha G Relan and Dharmaraj R Patil [19] ,** which perform an intrusion detection system with the use of the decision tree classifier. The performance of the proposed system has scored a highest of 95.09%, using the KDDCUP'99 dataset for both training and testing stage. **Malek Al-Zewairi, et al.** [20] suggest an intrusion detection system depend on deep learning that include of five hidden layers with ten neurons in each layer. The deeper the neural network, the more complex attribute can be discover based on the input data, while raising the number of neurons in a layer rising the number of attributes that the layer can detect. The accuracy of the deep learning model is compared to other classifiers, such as logistic regression, decision tree, Naïve Bays 9+and neural network, where the experimental results show that the deep learning model has scored the highest with 98.99% accuracy when tested with the UNSW-NB15 dataset.

Proposed system

There are so many techniques and algorithms are available to improve the monitoring of network intrusion detection system in recent years. In this paper, we have presented a complete survey of some main methods of machine learning applied on intrusion Detection. In this paper following machine learning techniques are implemented by us: Naïve Bayer Classifier, Neighbors Classifier, Decision Tree Classifier and the Logistic Regression Model then later comparison is done based on their 5 major parameters.

Here implementation is done on two level of approach firstly here we implemented the machine learning algorithms and at next level we have taken the level 1 results to train the next level where in 5 major parameters   accuracy, precision, recall, f-score are compared

3. Modules
1. Train dataset and test data set

Collecting data for training the system is one of the main challenges in developing a network-based intrusion detection system. Although the KDD 1999 data set is widely being used but these data sets are unreliable for building a system in reality, accuracy on NSL-KDD dataset is significantly higher than KDDCup99 dataset. Hence in this paper NSL KDD dataset rather than KDDCup99 dataset, accuracy on NSL-KDD dataset is significantly higher than KDDCup99 dataset.

2. **Feature selection:** Here we are removing the number of input variables while developing the predictive model reducing the input variables reduces the computational cost and as well as improve the performance. Once this is done we fit the data frame of testing and training dataset

Since 41 features are there in NSL KDD hence it impossible to take all those features and plot the feature selection graph hence we take decision of dropping the last 9 where there are no variations in the value some of the columns such as su_attempted, srv_error rate have only 0 as their values

3. Build the model: We build two models on the basis of two classifiers, a K Nearest Neighbors Classifier and a logistic regression classifier. Both of the above mentioned models are present in the Scikit-learn module.

4. Prediction and Assessment (Authentication): With the use of the test data to make predictions of the model. Multiple scores are considered here like accuracy score, then recall, the f-measure, confusion matrix. Perform a 10-fold cross-validation.

EXPERIMENTAL RESULT
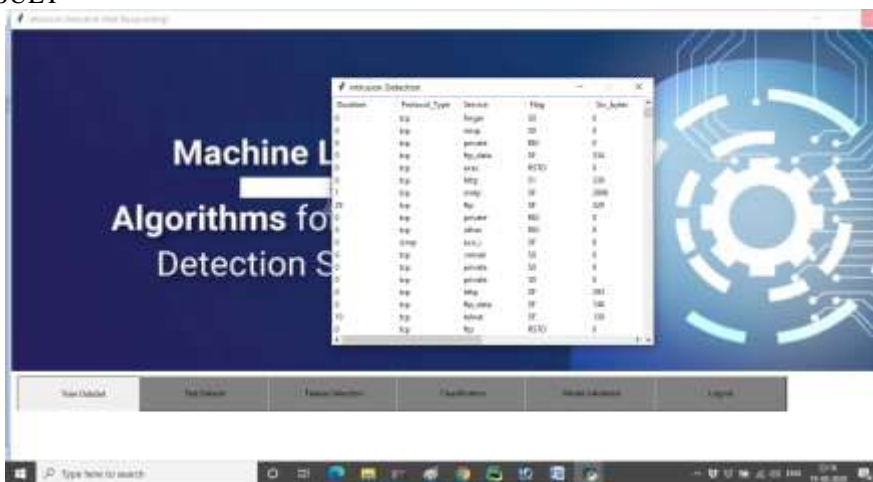
Fig 1: Loading Dataset
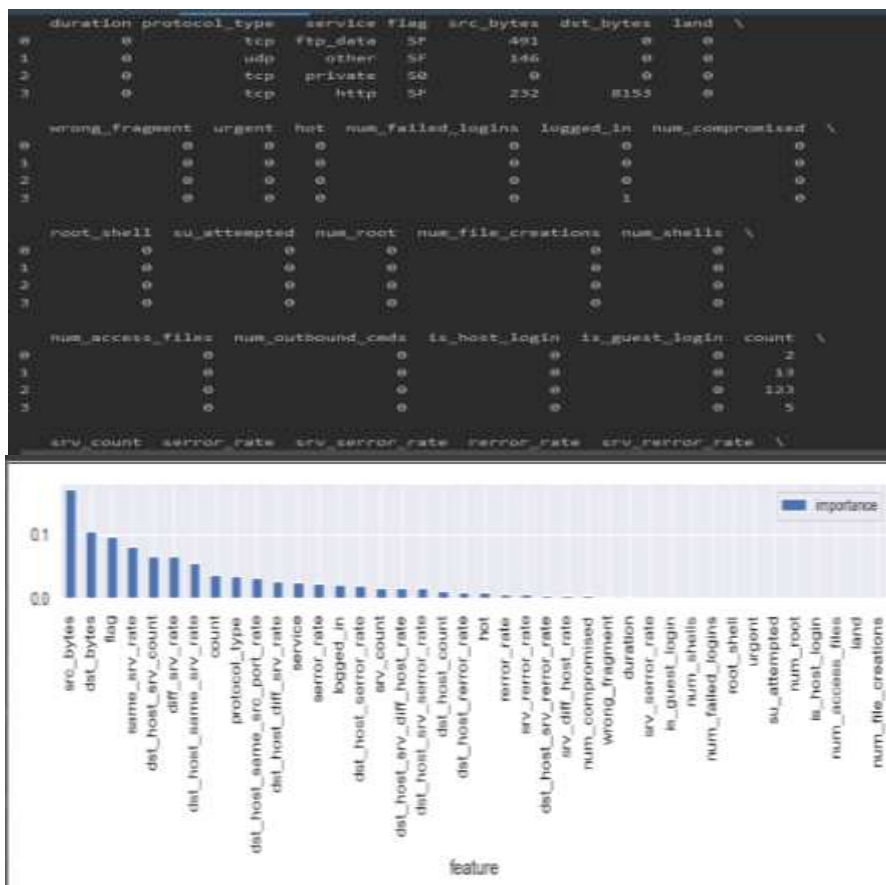
Fig 2: Feature selection graph
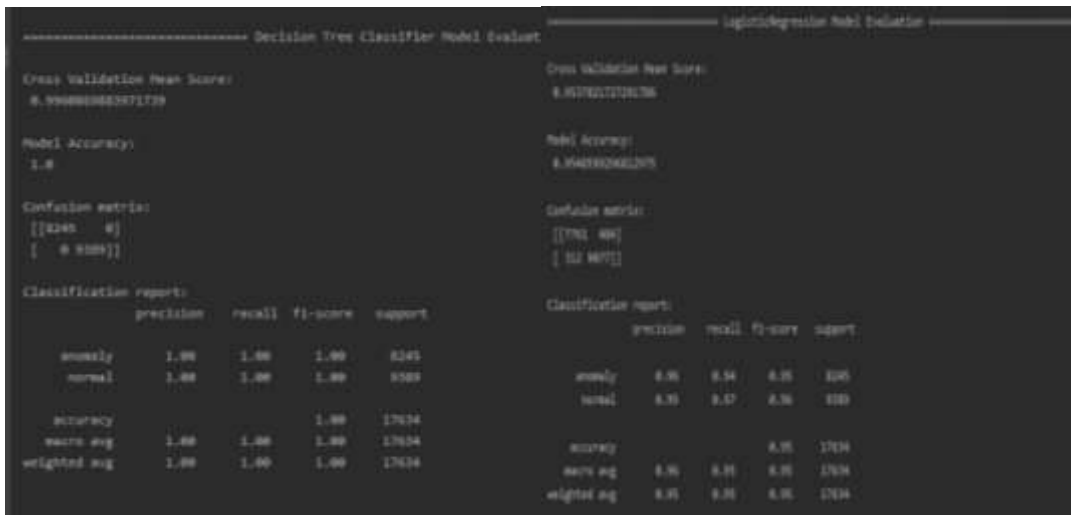
Fig: 3 Model Validation process
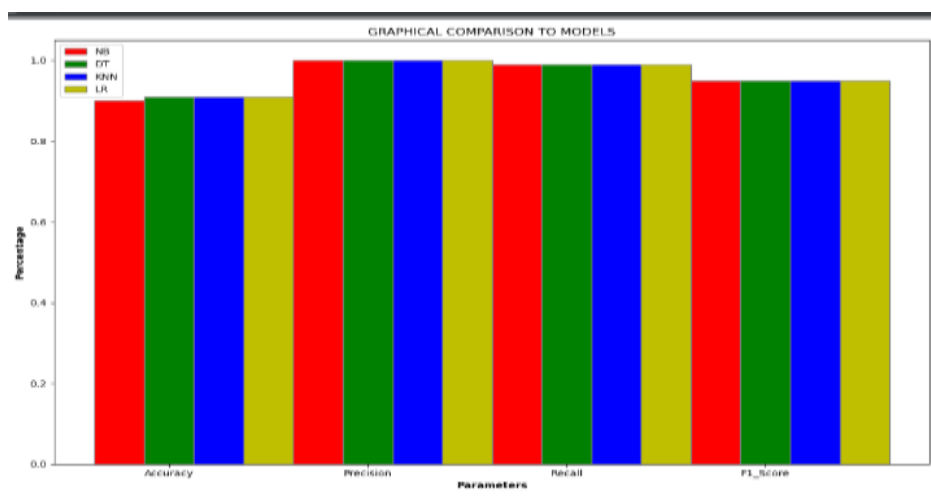
Fig: 4 Graphical Comparisons to Models

CONCLUSION

In the domain of network security, Network Intrusion Detection System is the most important and useful defense technology. So many of the available techniques have been implemented for the intrusion detection system in recent years. A detailed survey of major techniques implemented on intrusion Detection is presented in this research paper. Techniques based on classification algorithms such as Naive Bayes algorithm, Decision Tree algorithm, KNN, Linear Regression. We do a comparison of experimental values a system where we try to increase the efficiency of the parameters in the intrusion detection system compare the parameters such Accuracy, Precision, Recall, F-score.

REFERENCES

1. Zeeshan Ahmad, Adnan Shahid Khan, Cheah Wai Shiang, Johari Abdullah, Farhan Ahmad, "Network intrusion detection system: A systematic study of machine learning and deep learning approaches",wiley.com, https://doi.org/10.1002/ett.4150
2. Javed Asharf, Nour Moustafa, Hasnat Khurshid, Essam Debie, Waqas Haider, Abdul Wahab, "A Review of Intrusion Detection Systems Using Machine and Deep Learning in Internet of Things: Challenges, Solutions and Future Directions", mdpi.com, https://doi.org/10.3390/electronics9071177
3. K. A. I. PENG, V. C. M. LEUNG, and Q. HUANG, "Clustering Approach Based on Mini Batch K means for Intrusion Detection System Over Big Data," SPECIAL SECTION ON CYBERPHYSICAL- SOCIAL COMPUTING AND NETWORKING, 2018.[Online]. Available: 0.1109/ACCESS.2018.2810267
4. AHMAD, M. BASHERI, M. J. IQBAL, and A. RAHIM, "Performance Comparison of Support Vector Machine, Random Forest, and Extreme Learning Machine for Intrusion Detection."[Online]. Available: 0.1109/ACCESS.2018.2841987
5. Q. Niyaz, M. Alam, W. Sun, and A. Y. Javaid, "A Deep Learning Approach for Network Intrusion Detection System," in Conference Paper in Security and Safety, 2015.

Equations of Flying-Airboat Control Response Determination Movement Due to the Ground Effect

[1]H. Y. Akuma, [2]M. Arifin

Faculty of Engineering and Life Sciences
Universiti Selangor, Bestari Jaya, Selangor, Malaysia

***Abstract*: A flying-airboat is a concept of a wing-in-ground (WIG) craft that seeks to take advantage of desirable characteristics within the ground effect, to provide versatile solutions to sea transportation needs in the Southeast Asia region. Previous research has shown that bodies traveling within the ground effect experience an improved lift-to-drag ratio, which translates to significantly better performance. The FAB is a concept that seeks to take advantage of these benefits through a design that facilitates motion entirely within the ground effect. By applying the relevant equations of motion and incorporating various physical design parameters of the concept, a non-linear model can be implemented on the MATLAB/Simulink platform. A simulation of the model shows relative improvements in the performance, response, and stability of the FAB concept subjected to the ground effect as compared to its motion within a free airstream.**

I. INTRODUCTION

A flying-airboat (FAB) is a new concept that incorporates the favorable attributes of motion within the ground effect into its design. The achievement of the concept includes a compound wing design as well as a tubular-skirt profile, similar to those in air-cushion vehicles (ACVs) or hovercrafts. The wing design is idealized for the creation of lift with airflow over the airfoil section creating a dynamic air cushion [1]. On the other hand, the tubular skirt, in conjunction with moving air pumped from a set of fans, facilitates dynamic pressure that can potentially create an area of pressure differentiation underneath the body. An addition of a variable duct system that can vector the air within the skirt downwards has the potential to create lift along the Z-direction.

Determining the advantages of movement over ground effects and how physical design concepts respond to various control inputs are among the key factors in this study. Analysis of the framework of control over movement behavior in different situations can be made by developing a mathematical model of movement and applying it to the MATLAB platform. These results can further be used as a basis for changing and perfecting the design of the FAB. Therefore, the calculation of motion equations is applied to the design, which is first compiled by Mohd Zaid [2].

Previous studies in the marine and aviation fields have shown that a design combining the speed and efficiency of aircrafts with the practical implications of a marine-based craft provide a combined benefit of versatility. The design and development of the FAB concept thus seeks to provide a platform that can be used for fast and efficient sea-based missions involving search and rescue operations. To do so, Newtonian-Euler equations are modeled based on the physical parameters of the design and then tested on the MATLAB platform.

There are two forms of ground effect under consideration encompassing span-dominated ground effect (SDGE) and chord-dominated ground effect (CDGE) [3]. Research conducted previously by Wetmore and Turner revealed that SDGE significantly reduces induced drag, whereas CDGE enhances a body's lift-producing capabilities [4]. The proposed design of the FAB concept seeks to utilize both these elements of the ground effect by encompassing a compound-wing design as well as a skirt facilitating dynamic pressure. However, this investigation focuses on the improvement of aerodynamic capabilities as a consequence of the compound wing design. To this effect, the motion of the FAB in a steady-state within the ground effect is tested against a model in unbounded free stream. The results of motion within the ground effect are then compared against motion of the FAB concept in the free airstream and conclusions deduced on the design implementation of the FAB concept. Renders of the tentative design are illustrated in **Fig. 1**.
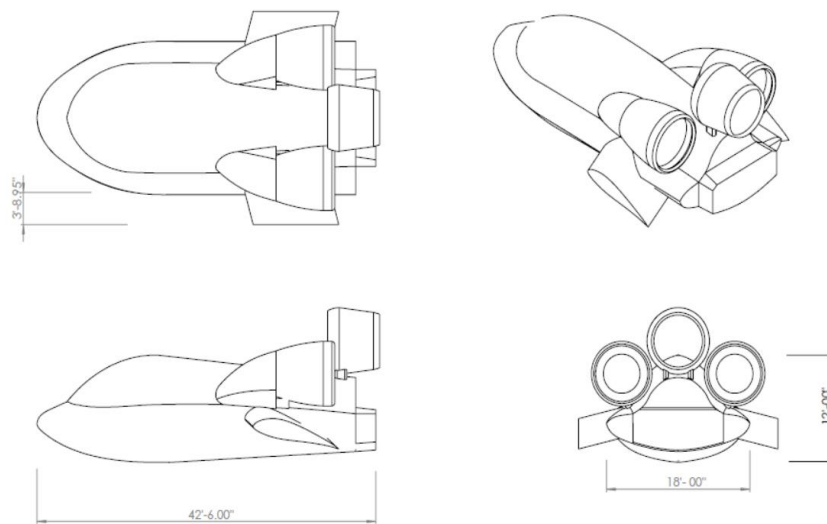
Fig. 1: Tentative design of the FAB Concept

II. METHODOLOGY

The methodology applied encompasses a series of steps which apply various relevant theories including aerodynamic theory, ground effect theory and control theory to deduce a numeric model that can be idealized on MATLAB. These steps are grounded in a non-linearized simulation framework encompassing the FAB's aerodynamics which is underpinned by twelve ordinary differential equations (ODEs) that define its state [5]. The model also incorporates external factors such as gravitational forces and wind disturbance. **Fig. 2** below depicts the resultant dynamics and the form of their implementation on MATLAB.

The block diagram comprises of various components which can be defined as follows.
  I.   Aerodynamics – this block comprises of the relevant forces and moments affecting the FAB model as a result of aerodynamic capabilities. Parameters such wing span, the location of the center of gravity, angle of downwash and lift and drag coefficients thus play a determinate role within this block. It also affected by inputs that are pertinent to the control surface deflections .i.e. rudder, aileron and elevators.
 II.   Propulsion – this block comprises the forces and moments that are generated by the engine and contributing towards the overall motion of the body. Its inputs are thus synonymous with the throttle settings.
III.   Gravity – The external independent forces acting on the body as a result of gravity are defined in this block.
IV.   Wind corrections – This block represents the forces that act on the body due to atmospheric disturbances.
 V.   Atmosphere – Variables pertaining to air data that are obtained from onboard sensors are defined within this block. They include the Mach number, the Airspeed, Reynolds number and so on [5].

U denotes inputs which constitute the control vector $\bar{\mathbf{u}}$, whereas the states are defined by $\bar{\mathbf{X}}$. The definitions for the control and state vectors are also summarized in **Tables 1** and **2**.

Table 1: Control Input Definitions

	Alphanumeric	Symbol	Name	Unit
	u(1)	δ_A	Longitudinal deflection	rad
	u(2)	δ_E	Lateral deflection	rad
	u(3)	δ_R	Directional deflection	rad
$\bar{\mathbf{U}} =$	u(4)	δ_{TH1}	Throttle position 1	-
	u(5)	δ_{TH2}	Throttle position 2	-
	u(6)	W_{xE}	Longitudinal wind	m/s
	u(7)	W_{yE}	Lateral wind	m/s
	u(8)	W_{zE}	Vertical wind	m/s

Table 2: State definitions

	Alphanumeric	Symbol	Name	Unit
	x(1)	u	Velocity in x-axis	m/s
	x(2)	v	Velocity in y-axis	m/s
	x(3)	w	Velocity in z-axis	n/s
	x(4)	p	Rate of roll	rad/s
	x(5)	q	Rate of pitch	rad/s
$\bar{\mathbf{X}} =$	x(6)	r	Rate of yaw	rad/s

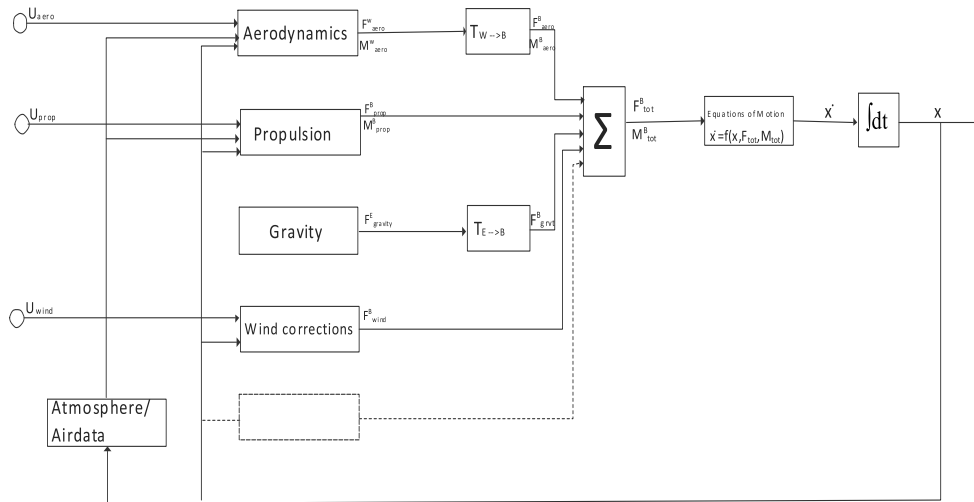| x(7)	φ	Roll angle	rad
x(8)	θ	Pitch angle	rad
x((9)	ψ	Yaw/heading angle	rad
x(10)	x	x position of CoG	m
x(11)	y	y position of CoG	m
x(12)	z	Z position of CoG	m

Fig. 2: Body dynamics block diagram [3]

The above definitions comprise the relevant design function and are applied within the MATLAB framework in the form of differential equations to give an overall. This deduction is shown in **Fig. 3** below.
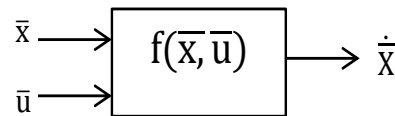

Fig. 3: Function combining the control inputs and the states

Consequently, the implementation of the model on the MATLAB entails a number of steps which are depicted in the following sections.

Control Input Saturation

A definition of the limits for the control inputs is established as the first step. This definition encompasses values beyond which the control inputs will have no effect on the physical motion of the model and are summarized in Eq. (1).

$$\bar{u} = \begin{bmatrix} \delta_{aileron} \\ \delta_{tail} \\ \delta_{rudder} \\ \delta_{Thrust1} \\ \delta_{Thrust2} \\ W_{xE} \\ W_{yE} \\ W_{zE} \end{bmatrix} = \begin{bmatrix} u1 \\ u2 \\ u3 \\ u4 \\ u5 \\ u6 \\ u7 \\ u8 \end{bmatrix} \in \begin{bmatrix} [-20°, 20°] \\ [-15°, 5°] \\ [-25°, 25°] \\ [0.2,10] \\ [0.2,10] \\ [constant] \\ [constant] \\ [constant] \end{bmatrix} * \frac{\pi}{180} = \begin{bmatrix} [-0.349,0.349] \\ [-0.262,0.087] \\ [-0.436,0.436] \\ [0,0.175] \\ [0,0.175] \\ [-inf,inf] \\ [-inf,inf] \\ [-inf,inf] \end{bmatrix} \quad (1)$$

Intermediate Variables

Intermediate variables provide a relationship between the control inputs and the non-differential equations to determine the state vector. They include various predetermined variables that affect motion such as the airspeed, the angle of attack, the sideslip angle and the dynamic pressure. The intermediate variables applied in this investigation are as shown in **Table 4**.

Table 3: Intermediate variables and application

APPLICATION	VARIABLES
Airspeed	$V_A = \sqrt{U^2 + V^2 + W^2} \rightarrow \sqrt{x_1^2 + x_2^2 + x_3^2}$
Attack angle	$\alpha = \tan^{-1}\dfrac{w}{u} \rightarrow \tan^{-1}\dfrac{x_3}{x_1}$
Sideslip angle	$\beta = \sin^{-1}\dfrac{V}{V_A} \rightarrow \sin^{-1}\dfrac{x_2}{V_A}$
Dynamic pressure	$Q = \dfrac{1}{2}\rho V_A^2$
Translational velocity	$\bar{V}_b = \begin{bmatrix} u \\ v \\ w \end{bmatrix} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$
Angular velocity vector	$\bar{\omega}_b = \begin{bmatrix} p \\ q \\ r \end{bmatrix} = \begin{bmatrix} x_4 \\ x_5 \\ x_6 \end{bmatrix}$

The Lift Coefficient

Determining the lift coefficient encompasses an examination of the compound wing in the conceptual design and its lift properties, as well as the tail section if any. The wing used in this investigation is the Eppler E857 whose lift curve is illustrated in the **Fig. 4**. The lift curve presented shows a critical angle of approximately 17 degrees and presents -5 degrees as the angle of attack where the lift produced is zero. Equations for the coefficient of lift of the wing body can thus be defined by Eq. 2 [6].

$$C_{lwb} = \begin{cases} n(\alpha - \alpha_{l=0}) \text{ if } \alpha \le \dfrac{17\pi}{180} \text{ otherwise} \\ a_3\alpha^3 + a_2\alpha^2 + a_1\alpha + a_0 \end{cases} \qquad (2)$$

Whereby: $\alpha_{l=0}$ is the angle of attack where lift is 0

n = 5.5 is the slope of the lift curve
a_3 = -768.5
a_2 = 609.2
a_1 = -155.2
a_0 = 15.212
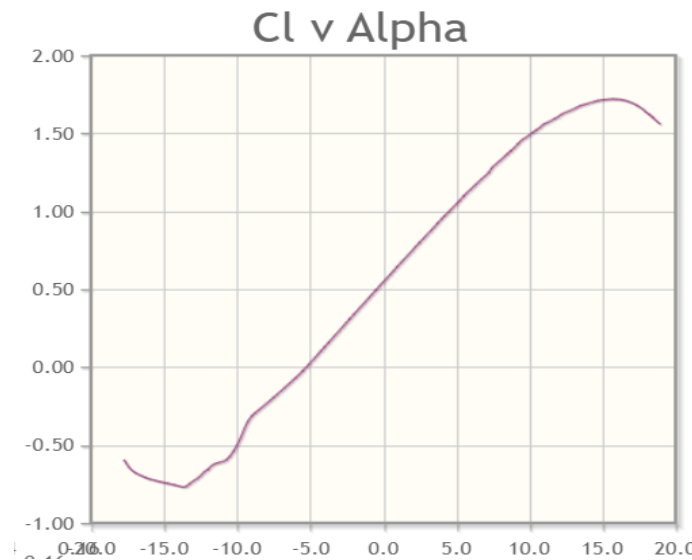
Figure 4. Lift Curve for Eppler E857 [7]

After initial tests, a small tail section was added to the model to increase its stability. The lift produced by this section is based on the angle of attack of the tail section which is defined by Eq. 3 [6].

$$\alpha_t = \alpha - \varepsilon + u_2 + 1.3x_5 \frac{l_t}{V_A} \qquad (3)$$

Where: ε (downwash) $= \frac{\partial \varepsilon}{\partial \alpha}(\alpha - \alpha_{l=0})$

u_2 = tail angle

$1.3x_5 \frac{l_t}{V_A}$ = dynamic pitch response

l_t is the distance between the wing & tail

Based on the angle of attack deduced above, the coefficient of lift of the tail section is given below [6].

$$C_{lt} = 3.1 \frac{S_t}{S} \alpha_t \qquad (4)$$

Where: S_t is the tail plan form area

S is the wing plan form area

A combination of the wing body and tail coefficients gives the overall coefficient of lift as shown by Eq. 5.

$$C_L = C_{lwb} + C_{lt} \qquad (5)$$

The ground effect however, has an influence on the coefficient of lift and therefore, in the model simulated within the ground effect, an influence parameter is incorporated as follows.

$$C_L' = \frac{C_L}{(1 - \sigma_{ge})} \qquad (6)$$

Whereby: C_L' is the coefficient of lift within the ground effect

C_L is the total coefficient of lift

σ_{ge} is the ground effect influence parameter given by:

$$\sigma_{ge} = e^{-2.48(\frac{2h}{b})^{0.768}}$$

Whereby: h is the height and,

b is the wing span

The Coefficient of Drag

The drag coefficient is based upon Computer Fluid Dynamics (CFD) simulations done in previous research conducted by Mohd Zaid [2]. A predetermined value is thus employed.

Sideforce Coefficent

Forces acting along the y axis also contribute to the control response for the model and are based on predetermined constants. Because, the sideslip angle and rudder control input are assumed to be zero for the purpose of this research however, this force is assumed to be negligible. Nevertheless, the applicable equation is presented by Eq.7 as follows.

$$C_Y = -1.6\beta + 0.24u_3 \qquad (7)$$

Whereby: β is the sideslip angle

u_3 is the directional control (rudder) angle

Stability Frame

The resultant coefficients and forces are in the stability frame and presented by Eq. 8 and 9 as follows.

$$\overline{C}_F^{Stblty} = \begin{bmatrix} Force\ along\ x\ axis \\ Force\ along\ y\ axis \\ Force\ along\ z\ axis \end{bmatrix} = \begin{bmatrix} -C_D \\ C_Y \\ -C_L \end{bmatrix} \tag{8}$$

$$\bar{F}_A^{\ S} = \begin{bmatrix} -D \\ Y \\ -L \end{bmatrix}^S = \begin{bmatrix} -C_D \cdot Q \cdot S \\ C_Y \cdot Q \cdot S \\ -C_L \cdot Q \cdot S \end{bmatrix}^S \tag{9}$$

The above forces in the stability frame are transformed to the body frame of reference as follows.

$$\bar{F}_A^{\ B} = \ C_{b/s}(\alpha) * \bar{F}_A^{\ S} \tag{10}$$

Whereby: $C_{b/s}(\alpha)$ is the transformation matrix about the angle of attack denoted as follows:

$$C_{b/s}(\alpha) = \begin{bmatrix} \cos\alpha & 0 & -\sin\alpha \\ 0 & 1 & 0 \\ \sin\alpha & 0 & \cos\alpha \end{bmatrix} \tag{11}$$

Coefficients of Moment

Moments of coefficients for the model are given about both the aerodynamic center of the body, and its center of gravity. These moments are based upon Newtonian laws of motion. Derivation for moment about the aerodynamic center is presented as follows [6].

$$\bar{C}_{M.ac} = \begin{bmatrix} C_{l.ac} \\ C_{m.ac} \\ C_{n.ac} \end{bmatrix} = \ \bar{n} + \ \frac{\partial C_m}{\partial x} \cdot \bar{\omega}_b + \frac{\partial C_m}{\partial u} \cdot \begin{bmatrix} u_1 \\ u_2 \\ u_3 \end{bmatrix} \tag{12}$$

Whereby: n̄ is a moment effect defining the static behavior and can be broken down as follows:

$$\bar{n} = \begin{bmatrix} -1.4\beta \\ -0.59 - 3.1\dfrac{S_t l_t}{S\bar{c}}(\alpha - \varepsilon) \\ (1 - \alpha\dfrac{180}{\pi})\beta \end{bmatrix} \tag{13}$$

In the above equation:
$\bar{c}$ is the mean aerodynamic chord length
l_t is the distance between the aerodynamic center of the tail and the CoG

$$\frac{\partial C_m}{\partial x} = \begin{bmatrix} -11 & 0 & 5 \\ 0 & -4.03\dfrac{S_t l_t^{\ 2}}{S\bar{c}} & 0 \\ 1.7 & 0 & -11.5 \end{bmatrix} * \frac{\bar{c}}{V_A} \tag{14}$$

$$\frac{\partial C_m}{\partial u} = \begin{bmatrix} -0.6 & 0 & 0.22 \\ 0 & -3.1\dfrac{S_t l_t}{S\bar{c}} & 0 \\ 0 & 0 & -0.63 \end{bmatrix} \tag{15}$$

The terms $\frac{\partial C_m}{\partial x}$ and $\frac{\partial C_m}{\partial u}$ are used to define the effectiveness of the controls
The moment about eh aerodynamic center is therefore as follows.

$$\bar{M}_{A.ac} = \ \bar{C}_{M.ac} \cdot Q \cdot S \cdot \bar{c} \tag{16}$$

On the other hand, the moment coefficient bout the center of gravity can be defined as follows.

$$\bar{M}_{A.cg} = \ \bar{M}_{A.ac} + \bar{F}_A^{\ B} \cdot (\bar{r}_{cg} - \bar{r}_{ac}) \tag{17}$$

Whereby:

$$\bar{r}_{cg} = \begin{bmatrix} X_{cg} \\ Y_{cg} \\ Z_{cg} \end{bmatrix} = \begin{bmatrix} x\ position\ of\ CoG \\ y\ position\ of\ CoG \\ z\ position\ of\ CoG \end{bmatrix} = \begin{bmatrix} 0.25\bar{c} \\ 0 \\ -0.30\bar{c} \end{bmatrix} \tag{18}$$

and

$$\bar{r}_{ac} = \begin{bmatrix} X_{ac} \\ Y_{ac} \\ Z_{ac} \end{bmatrix} = \begin{bmatrix} x\ position\ of\ aero\ center \\ y\ position\ of\ aero\ center \\ z\ position\ of\ aero\ center \end{bmatrix} = \begin{bmatrix} 0.21\bar{c} \\ 0 \\ 0 \end{bmatrix} \tag{19}$$

Propulsion Effects

The forces and moments as a result of the engine thrust are also derived to come up with the dynamic model. Thrust is produced by a dual-fan setup and can be modeled as follows.

$$F_i = \delta_{th.i} \cdot m \cdot g \tag{20}$$

Whereby: F_i represents the thrust force produced by the ith engine(fan)
$\delta_{th.i}$ is the control input for the ith fan
m is the mass of the Airboat
g is the gravitational force

The representation above can be related to the control inputs for thrust and be denoted as follows.

$$u_4, u_5 \leq \frac{10\pi}{180} \begin{cases} F_1 = U_4 \cdot m \cdot g \\ F_2 = U_5 \cdot m \cdot g \end{cases} \tag{21}$$

In the body frame, the above forces as a result of propulsion are as follows.

$$\bar{F}_{Ei}{}^b = \begin{bmatrix} F_i \\ 0 \\ 0 \end{bmatrix}^b \tag{22}$$

$$\bar{F}_E{}^b = \bar{F}_{E1}{}^b + \bar{F}_{E2}{}^b \tag{23}$$

The above principle was also used to simulate propulsion as a result of the thrust force being vectored vertically, and parallel to but opposite the force of gravity. This was as a means to simulate the resultant forces produced by a tubing mechanism that is expected to be incorporated into the FAB's design, so as to facilitate VTOL. The resultant forces produced as a result of the nozzles underneath the FAB were modeled as follows.

$$\begin{aligned} F_3 &= F_1 \\ F_4 &= F_2 \end{aligned} \tag{24}$$

Where F_3 and F_4 are the vertical forces vectored to the right and left nozzle systems underneath the FAB

As representation of this forces in the body frame was subsequently determined as follows.

$$\bar{F}_{Ei}{}^b = \begin{bmatrix} 0 \\ 0 \\ F_i \end{bmatrix}^b \tag{25}$$

$$\bar{F}_E{}^b = \bar{F}_{E3}{}^b + \bar{F}_{E4}{}^b \tag{26}$$

The vertical mode of the FAB is activated once the control inputs u4 and u5 are at a setting of 60% or above. This translates to about 0.12 radians out of a maximum setting of 0.17 (10 degrees). Since the two throttle inputs are operated simultaneously, these translates to a value of 0.24, which is represented with the following MATLAB syntax.

```
if (u4+u5>0.24)
    FE_b = FE_bv;
elseif (u4+u5<0.24)
    FE_b = FE_bh;
        end
```
(27)

Where; FE_bv is the vertical force in the body frame,
FE_bh is the horizontal force in the body frame and
FE_b is the Total Engine Force.

The above syntax dictates that a throttle input above 0.12 radians for each engine will activate the vertical force prompting a velocity along the z-axis. On the other hand, a throttle input below 0.12 radians for each engine maintains horizontal thrust and velocity along the x-axis.

The moments produced as a result of the propulsion effects are also of relevance. The determination of these forces is based on the application points of the thrust in relation to the center of gravity, given in the primary axes. This derivation is as follows.

$$M_{Ecg.i}{}^b = \bar{\mu}_i{}^b \cdot \bar{F}_{Ei}{}^b \tag{28}$$

Whereby: $\bar{\mu}_i{}^b$ is the moment arm and can be expressed as follows

$$\bar{\mu}_i{}^b = \begin{bmatrix} X_{cg} - X_{APT.i} \\ Y_{ApT.i} - Y_{cg} \\ Z_{cg} - Z_{APT.i} \end{bmatrix} \tag{29}$$

The overall propulsion moment about the center of gravity along the x-axis is therefore determined as follows.

$$M_{Ecg}{}^b = M_{Ecg.1}{}^b + M_{Ecg.2}{}^b \tag{30}$$

On the other hand, the concept has the potential to have a propulsion moment about the center of gravity but along the z-axis. This is represented as follows.

$$M_{Ecg}{}^b = M_{Ecg.3}{}^b + M_{Ecg.4}{}^b \tag{31}$$

In the above equation the equated components represent resultant engine moments as a result of the nozzles found in the skirt. Similar to the forces, these moments are activated by a throttle setting above 0.12 radians.

Gravity Effect

Forces acting on the body as a result of gravity are also defined as part of the equations of motion. This is done as follows.

$$\bar{F}_g = m \cdot \bar{g} \qquad\qquad \bar{F}_g{}^e = \begin{bmatrix} 0 \\ 0 \\ g \end{bmatrix} \cdot m \tag{32}$$

The forces are transformed from the earth frame to the body frame as follows [6].

$$\bar{F}_g{}^b = C_{b/e}(\varphi, \theta, \psi)\bar{F}_g{}^e \tag{33}$$

The result of the above transformation is as follows.

$$\tag{34}$$

$$\bar{F}_g{}^b = \begin{bmatrix} -g \sin x8 \\ g \cos x8 \sin x7 \\ g \cos x8 \cos x7 \end{bmatrix} \cdot m$$

Consequently, the derived forces and moments are implemented on the MATLAB platform using tools such as m-text and a model with the interpreted MATLAB function on Simulink. The results are presented in the following section.

III. RESULTS

Implementation of the equations derived above is done in conjunction with various constant values, which define desirable control inputs and initial states. The results based on simulations run through MATLAB computational software are presented in the following sections.

Control Inputs

For the purpose of this investigation, the control input values chosen include elevator deflection set at –0.087 rad (≈ 5°) and a throttle setting of 0.14 rad ((≈ 8°). All the other control inputs are assumed to have a constant value of zero. These inputs are simulated as constants for a period of 180 seconds and their results plotted in **Fig. 5.**

State Simulation

On the other hand, inputs chosen for the initial state include a longitudinal speed (along x-axis) of 50 m/s (≈ 58 knots)and a height of 1.5 meters. The pitch angle also corresponds to the elevator deflection at 0.087 rads. These inputs are demonstrated as follows.

$$x0 = [50; 0; 0; 0; 0; 0; 0; 0.087; 0; 0; 0; -1.5]; \tag{35}$$

The control inputs above are simulated on the MATLAB platform for a period of 180 seconds and are plotted for both a model within ground effect and one where the ground effect parameter is not considered. **Fig. 6** represents a model with the ground effect parameter whereas **Fig. 7** is for a model lacking ground effect influence.

Angle of Attack

To demonstrate the effect of the angle of attack has on the stability of the model, simulations are also done at optimal 30 m/s longitudinal velocity and at various angles of attack including at 5, 17 and 30 degrees. It should be noted that the critical angle of attack is 17 degrees and that the input of the states is in form of radians. The corresponding pitch angles are thus 0.087 rad, 0.297 rad and 0.525 rad. The results are presented in **Fig. 8**, **Fig. 9** and **Fig. 10**.

Vertical Force

A vertical mode was also simulated to depict how vectored thrust forces from the engines to nozzles underneath the Airboat model would affect its dynamic capabilities. The vertical mode was programmed to be initiated with a throttle setting of above 66% on each engine translating to a setting above 0.12 rads for control inputs U4 and U5. **Fig. 11** shows the plotted results when the model was in horizontal mode (0.11 rads for u_4, u_5), whereas **Fig. 12** shows a simulation of the vertical mode at a throttle setting of 0.13 rads.
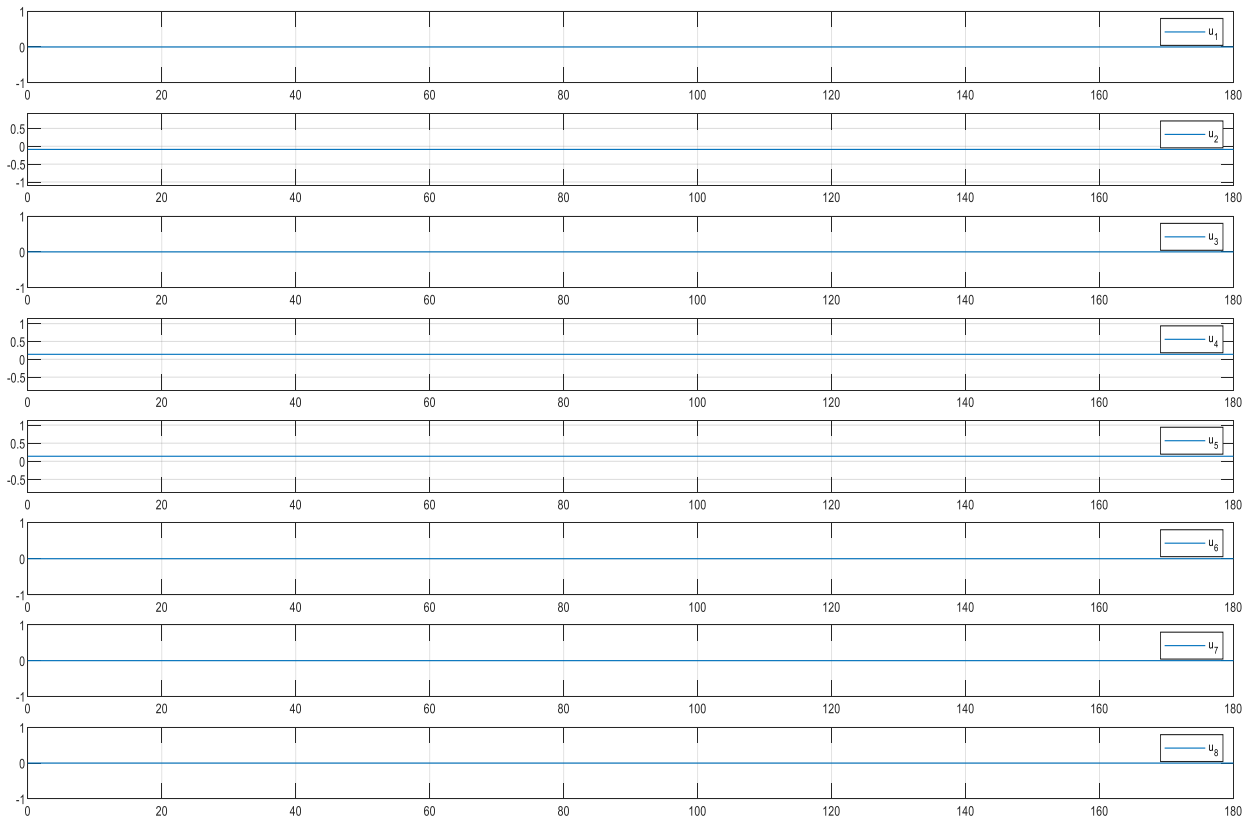
Fig. 5: Graph showing Control Input Plots over a period of 180 seconds
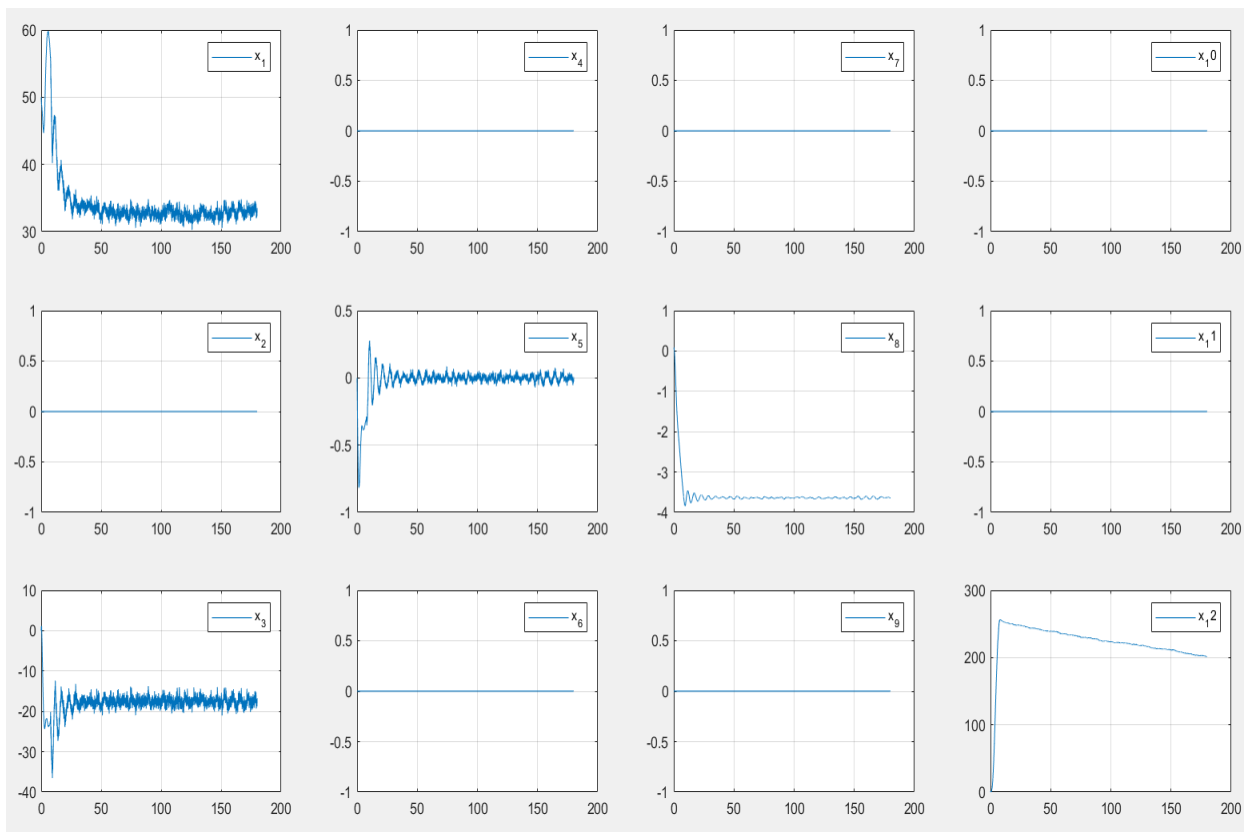
Fig. 6: Output of the States with the Ground Effect Influence
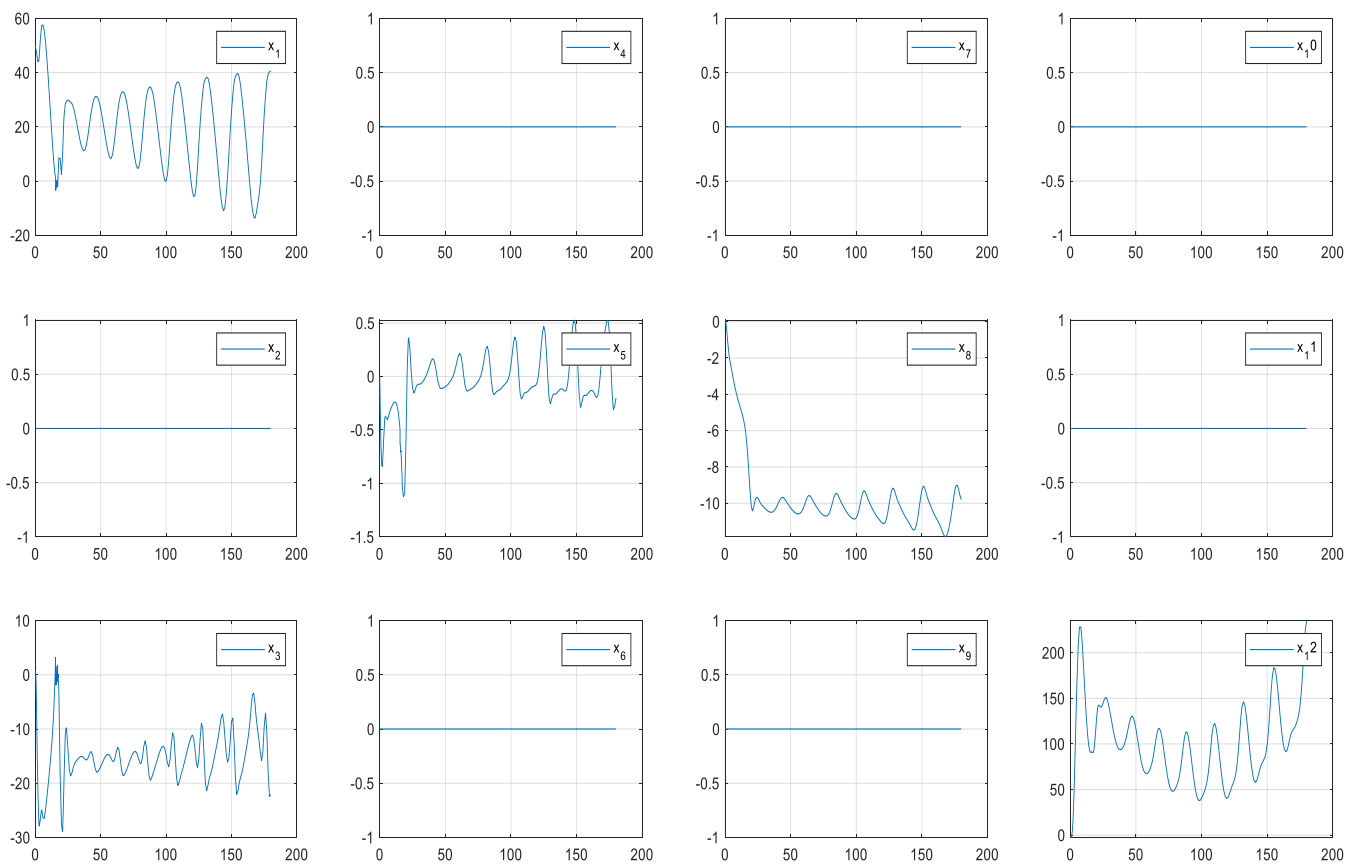
Fig. 6: Output of the States without the Ground Effect Influence
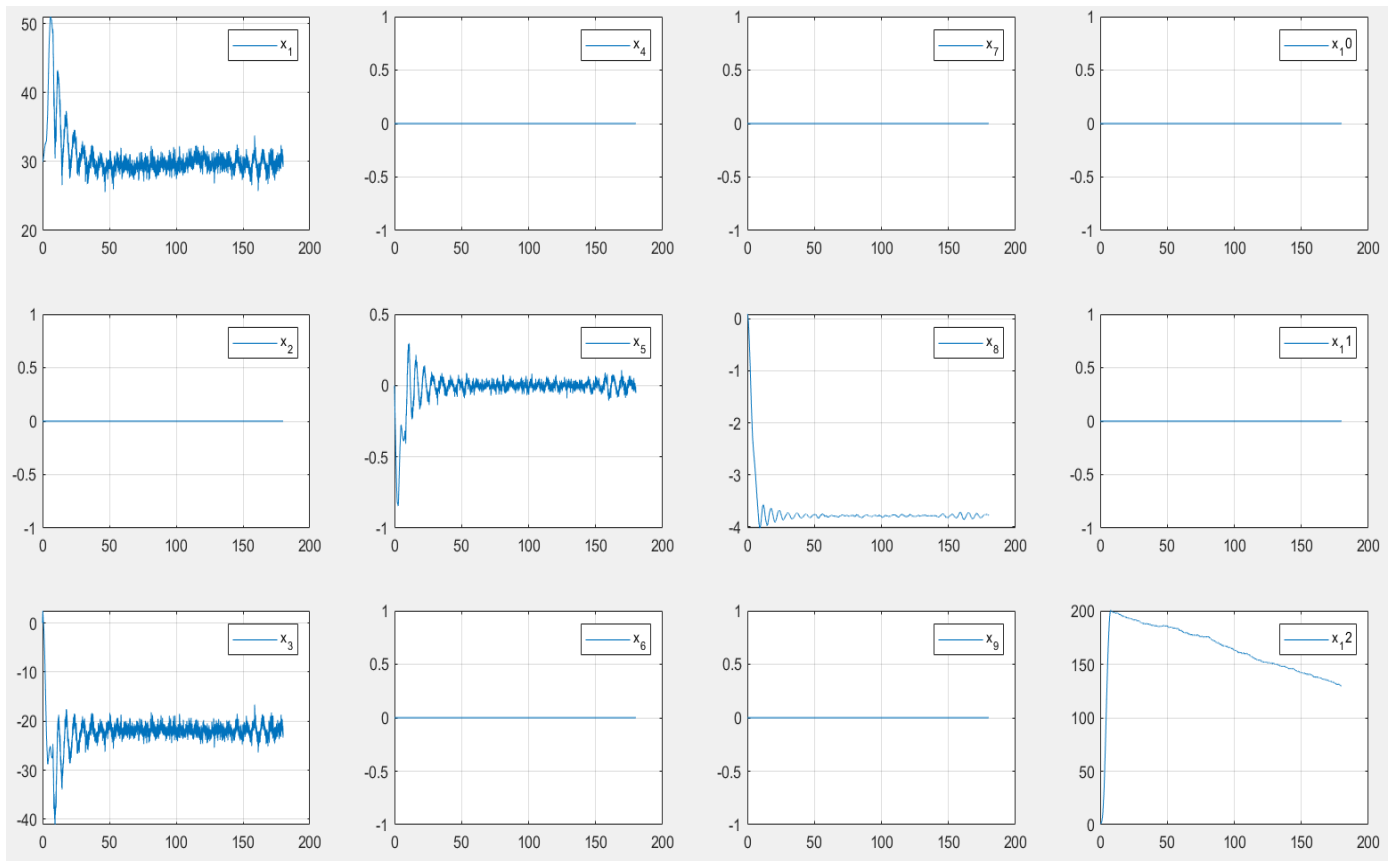
Fig. 7: Output of the States with Ground Effect Influence at 5˚ Pitch Angle
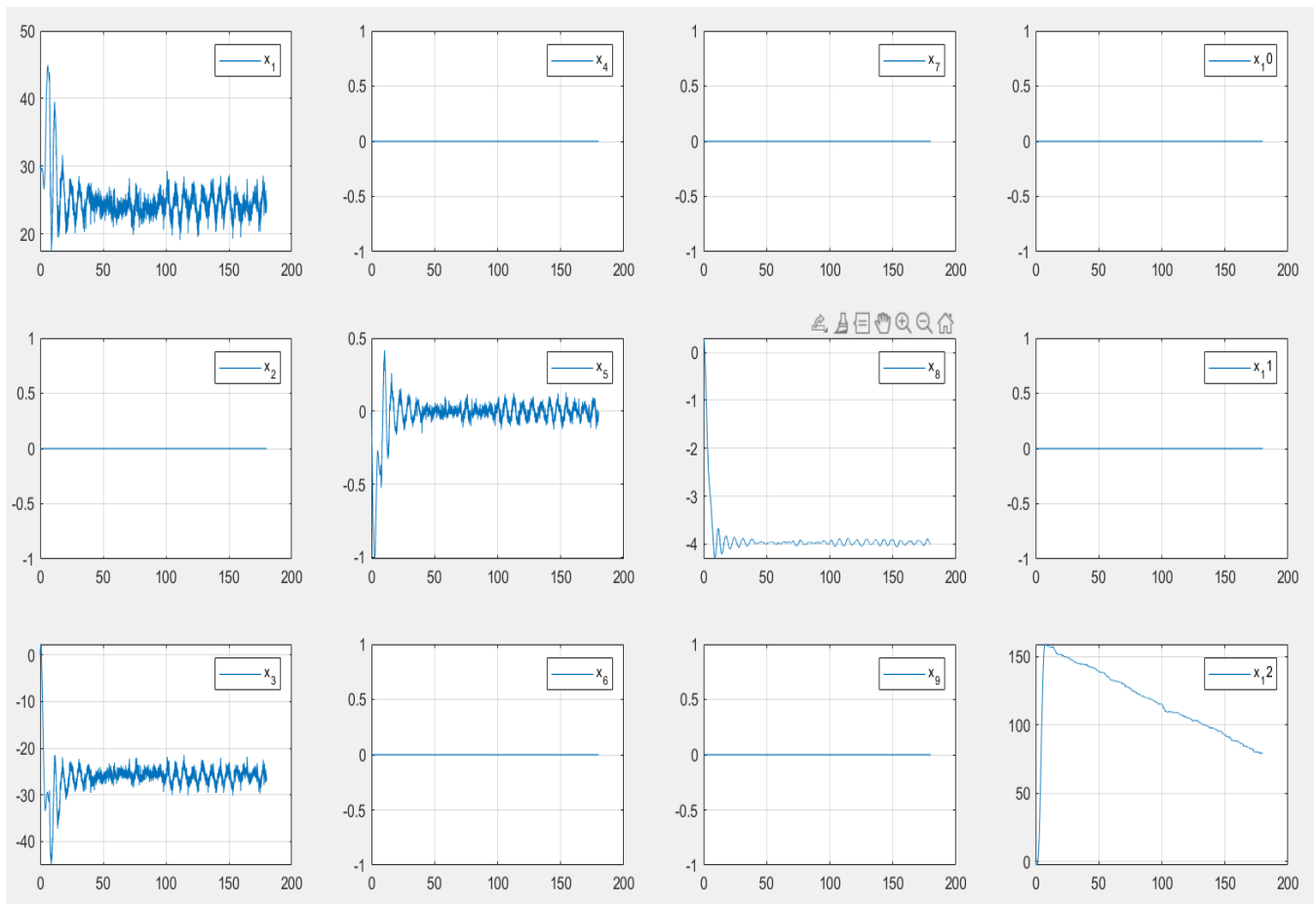
Fig. 8: Output of the States with Ground Effect Influence at 17˚ Pitch Angle
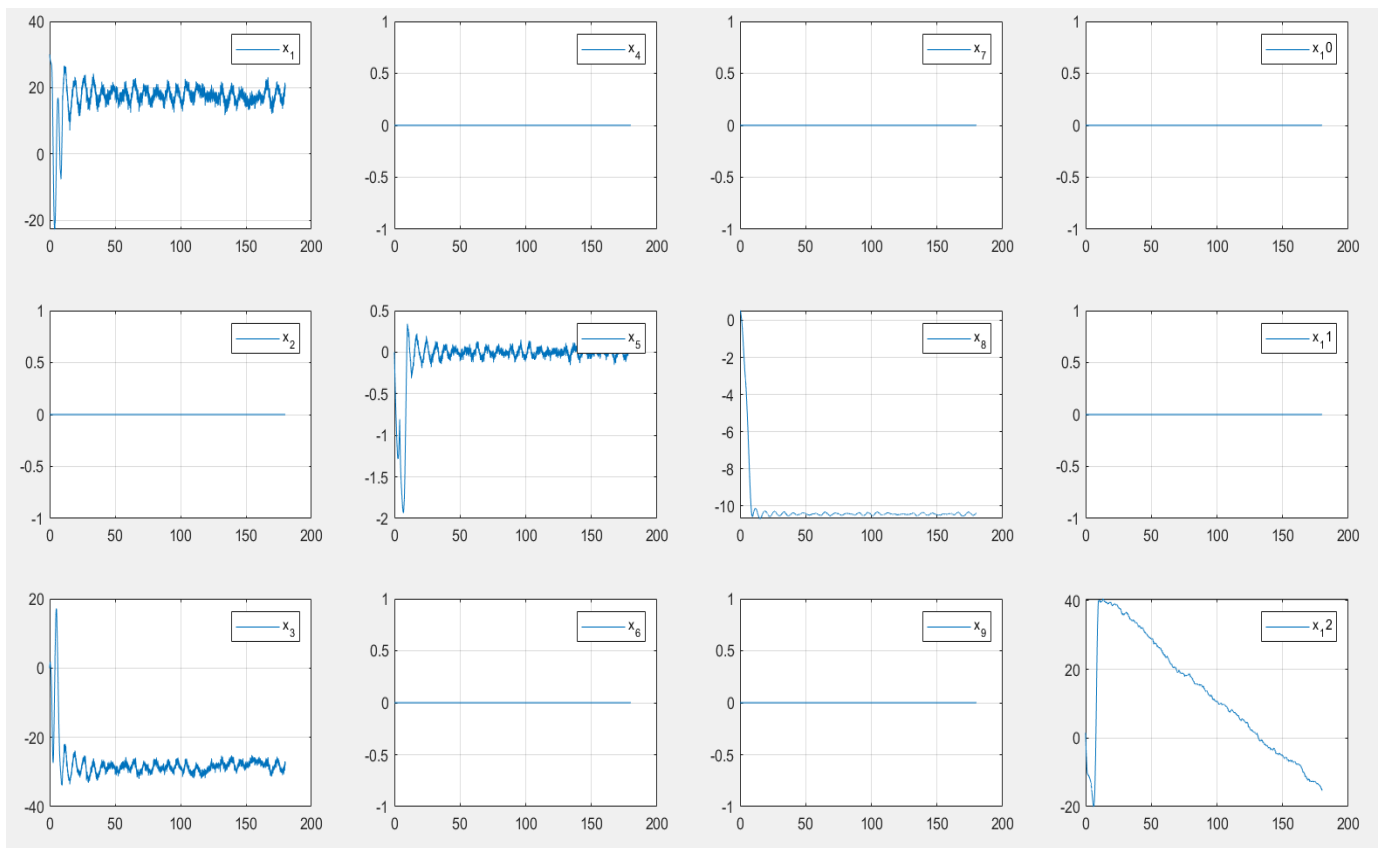
Fig. 9: Output of the States with Ground Effect Influence at 30˚ Pitch Angle
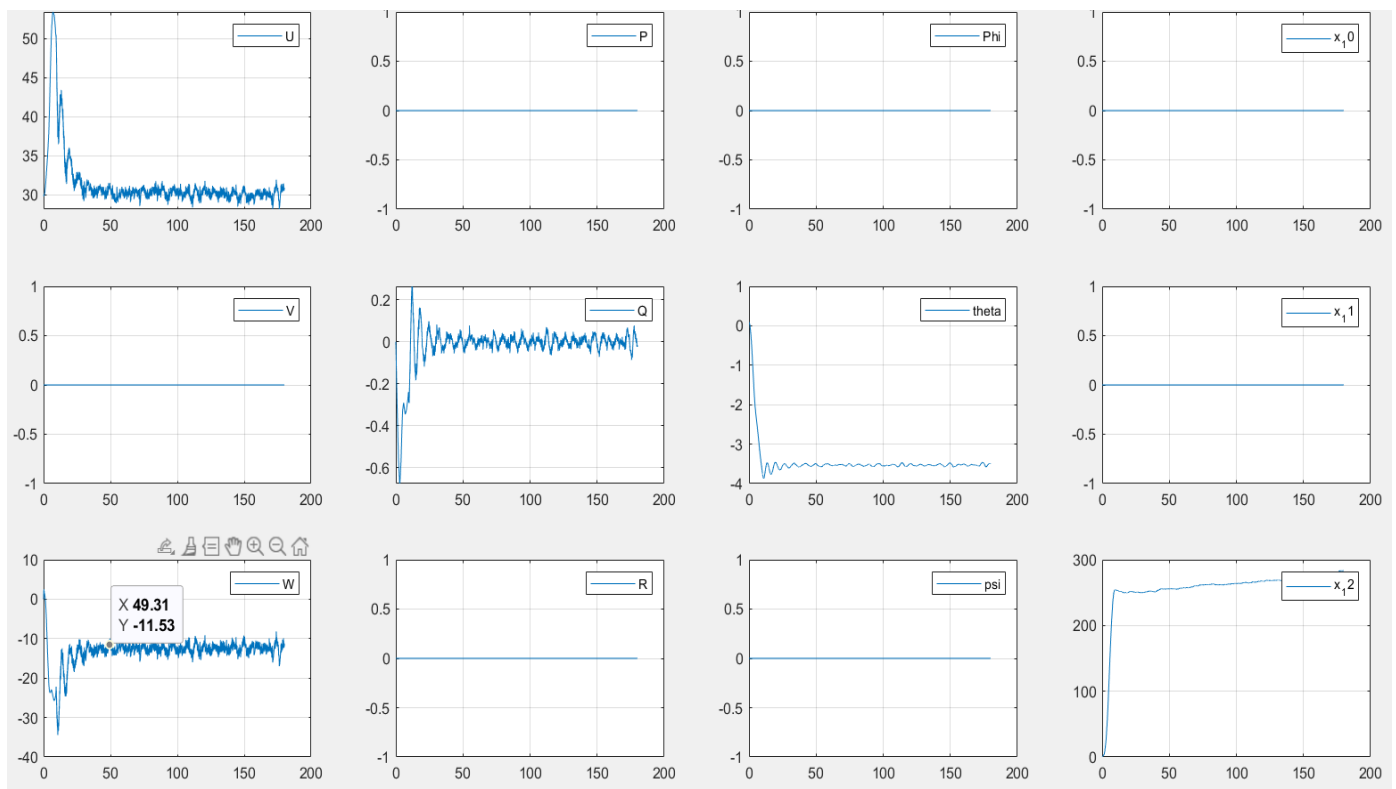
Fig. 10: Output of the States in horizontal motion at 63% Throttle Setting
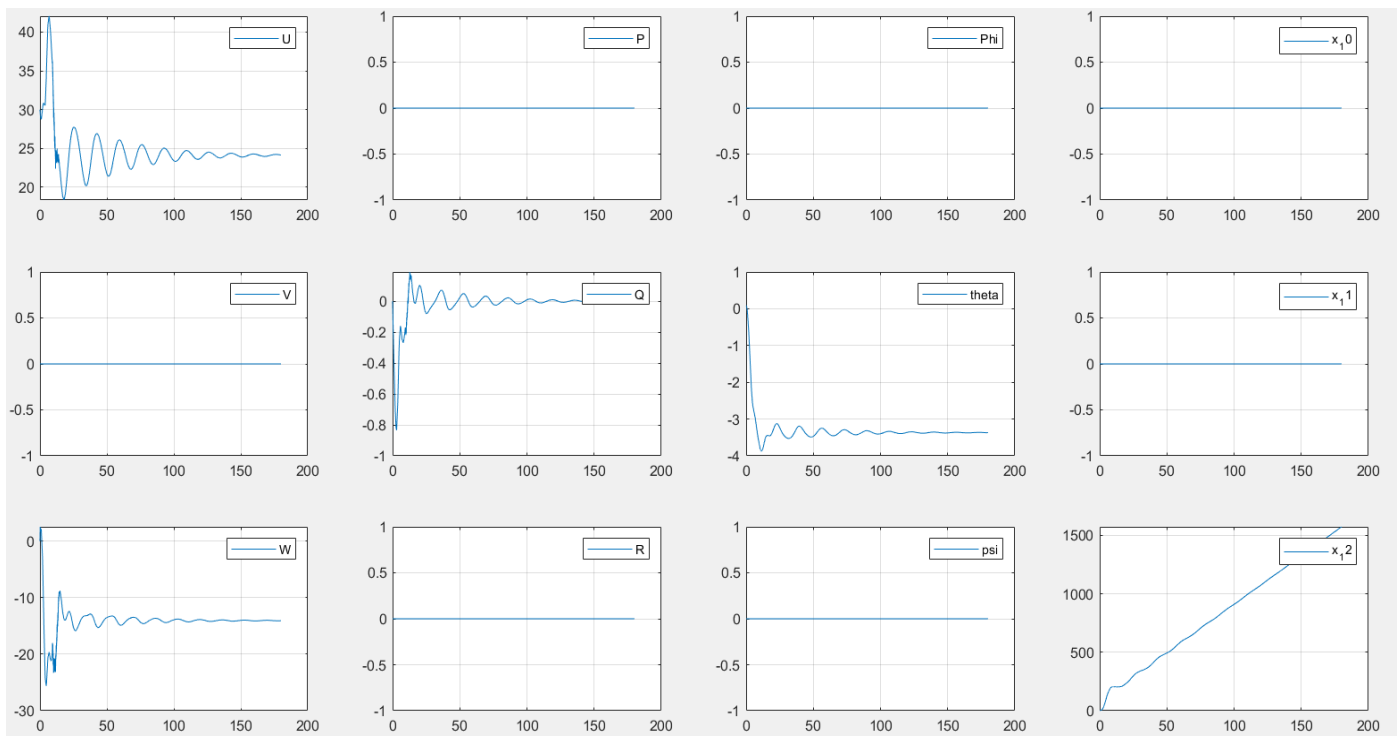
Fig. 11: Output of the States when vertical mode is activated at 74% Throttle Setting

IV. DISCUSSION

Velocity in X-axis

In the results presented above, the examination of velocity in the x-direction provides a contrast between a model within the ground effect and one moving in free air stream, which is illustrated **Fig. 13**. In the presented plots, the graph on the right shows simulation within ground effect whereas the graph on the left shows simulation without ground effect. Based on the plots, it is evident that the model exhibits superior stability characteristics within the ground effect, as compared to when in motion within an unbound airstream. This is synonymous with a waveform of relatively diminished amplitudes and higher frequency. After an initial application of a 50 m/s velocity, the model within ground effect maintains a velocity averaging approximately 32 m/s after a period of about 30 seconds. On the other hand, the model without a ground effect component is characterized by a waveform of increasing oscillations showing a lack of inherent stability. This waveform is of a relatively lower frequency and with greater amplitude, oscillating at about 20 m/s. This thus shows that the ground effect has a positive influence on both the performance and stability properties of the proposed model.

Velocity in z-axis

There are also notable differences seen in the z-direction velocity between simulations of the model with the ground effect influence as compared to the model without this influence. This discrepancy is illustrated in **Fig. 14.** In the figure, the illustration on the left represents the model influenced by the ground effect, whereas the model on the right shows the model in motion within an unbound air stream. From the illustration, it is clear that the ground effect model exhibits more stability properties as compared to that without the ground effect influence. This is evidenced by a waveform with significantly diminished amplitude for the ground effect model, as compared to the model without ground effect. As oscillations diminish on the left illustration with respect to time, they tend to increase on the right illustration within the same timeframe. Both simulations depict negative values of velocity along the z direction, which according to the frame of reference points downward. This thus shows a gain in the height of the model, which is in the opposite direction pointing upwards, hence the negative values.

Pitch Rate

Another element affected by the simulation of the model within the given constraints is the pitch rate. Contrasts between the model with the ground effect influence and that without this influence are illustrated in **Fig. 15**. In the illustration, the model within the ground effect, on the left, exhibits more stability properties as compared to the model without the ground effect influence, shown on the right. This is evidenced by a waveform whose amplitude diminishes over time, in left illustration, as compared to one where the amplitude is ever-increasing with time, on the right. Pitch rate is affected by the deflection of the elevator control input. After this initial deflection however, the pitch rate reverts to an average of zero with both the presented graphs oscillating around this mark.

Pitch Angle

The results presented for models also show changes in the pitch angle, which is synonymous with the state denoted by x8. These changes are illustrated in **Fig. 16**. In the illustration, while the amplitude for the waveform on the left diminishes over time, the

waveform on the right has amplitude that increases over time. This thus shows that there is a significant amount of stability exhibited by the model with the ground effect influence as compared to that without this influence.

Z position of Center or Gravity

The results also reveal changes in the z position of the center of gravity, or the height of the model. These changes are illustrated in **Fig. 17.** The figure on the left represents z-position or height of the model with the ground effect influences, whereas that on the right represents a model without ground influence parameter. In the first illustration, the height initially increases due to a change in the pitch angle before gradually decreasing. The second illustration illustrates oscillating motion and lack of a steady state, showing the instability of the system without the ground effect influence. The response, shown for the model within the ground effect is typical for an aerodynamic body, since a change in the pitch angle affects lift and therefore the height of the body. It should however be noted, that for an ideal ground- effect vehicle (GEV), the height above the ground surface should be restricted to a few feet.

Angle of Attack

The results also depict the effect that a change in the angle of attack has on the response of the established dynamic system. Effect on the longitudinal velocity at various pitch angles is used to demonstrate these discrepancies and presented in **Fig. 18**. The illustration shows velocity in the x-direction at 5 degrees, 17 degrees and 30 degrees angle of attack, respectively. The depicted waveforms show that there are minimal perturbations, synonymous with the least amplitude, at 5 degrees. This translates to minimal vibrations or disturbances of the body at 5 degrees. All the models achieve initial relative stability after about 30 seconds. The model at 17 degrees, however, begins to show signs of instability after about 100 seconds. The model appears to be most stable at five degrees where the velocity is maintained at 30 m/s. At 17 and 30 degrees pitch angle, some of the initial velocity is lost, with the model settling at about 25 m/s for the 17 degrees pitch angle and about 20 m/s at 30 degree pitch angle.
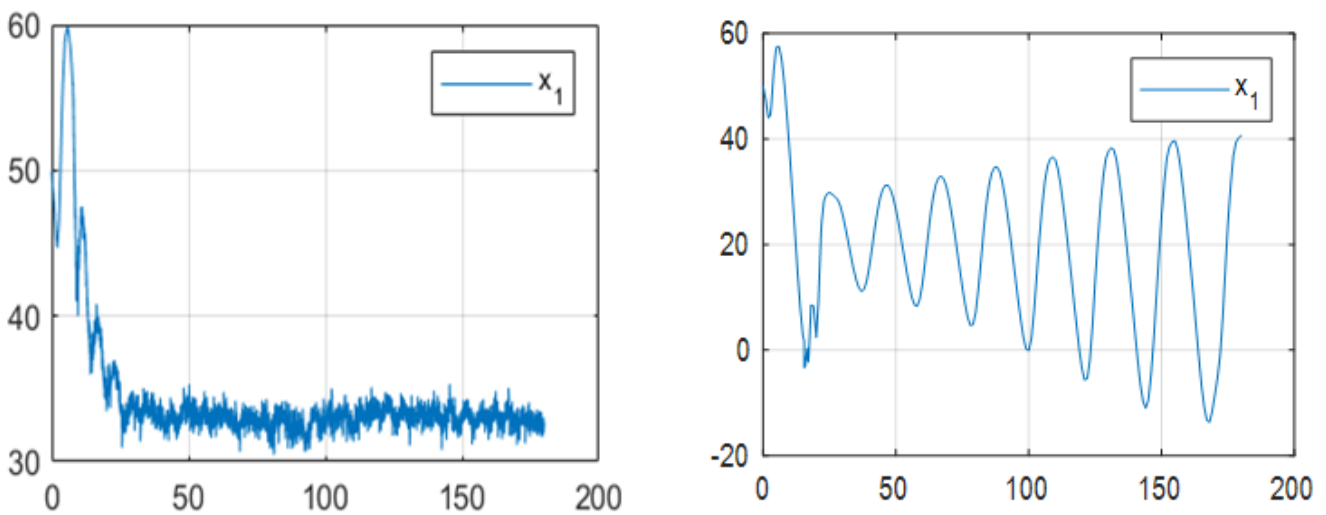

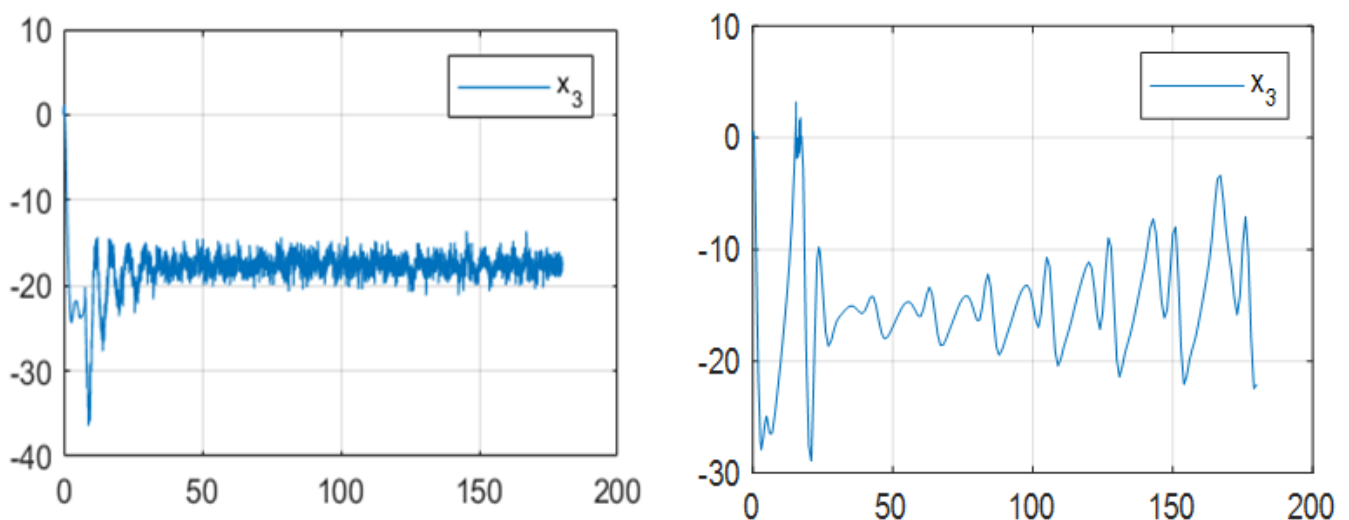**Fig. 12:** Comparison of Velocity in x-direction within Ground Effect vs. without Ground Effect

Fig. 13: Comparison of Velocity in z-direction within Ground Effect vs. without Ground Effect
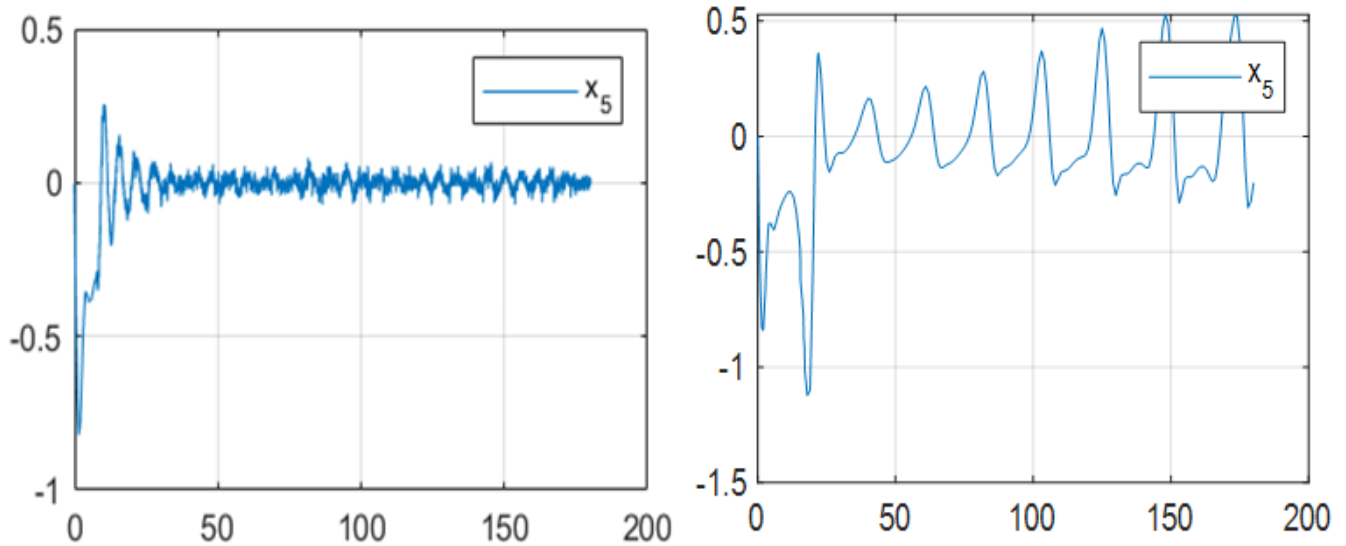
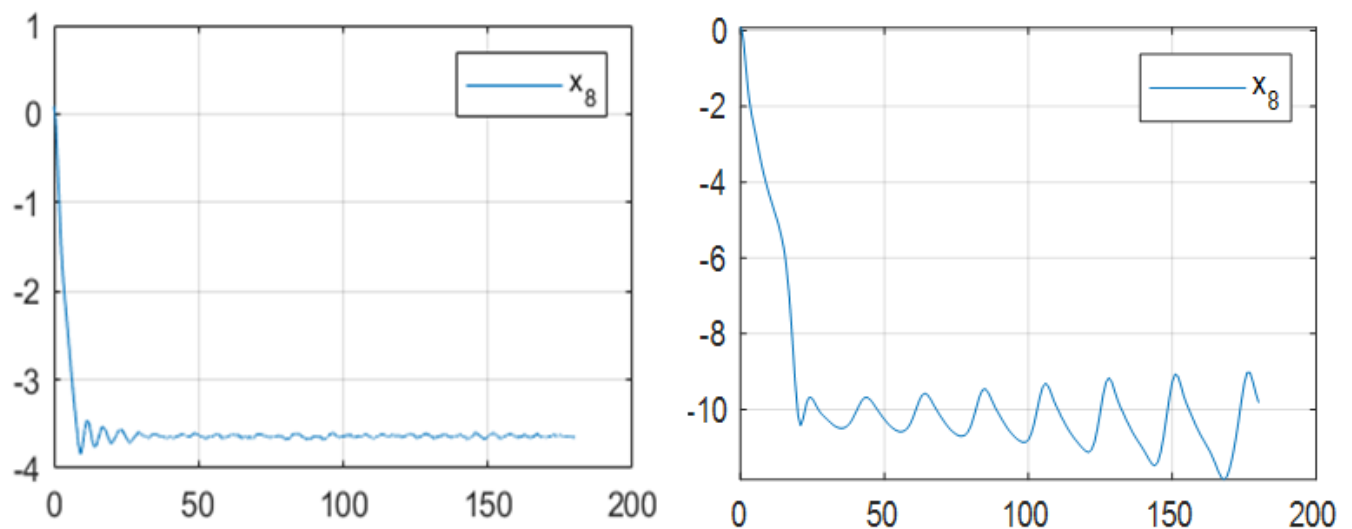**Fig. 14**: Comparison of Pitch Angle within Ground Effect vs. without Ground Effect

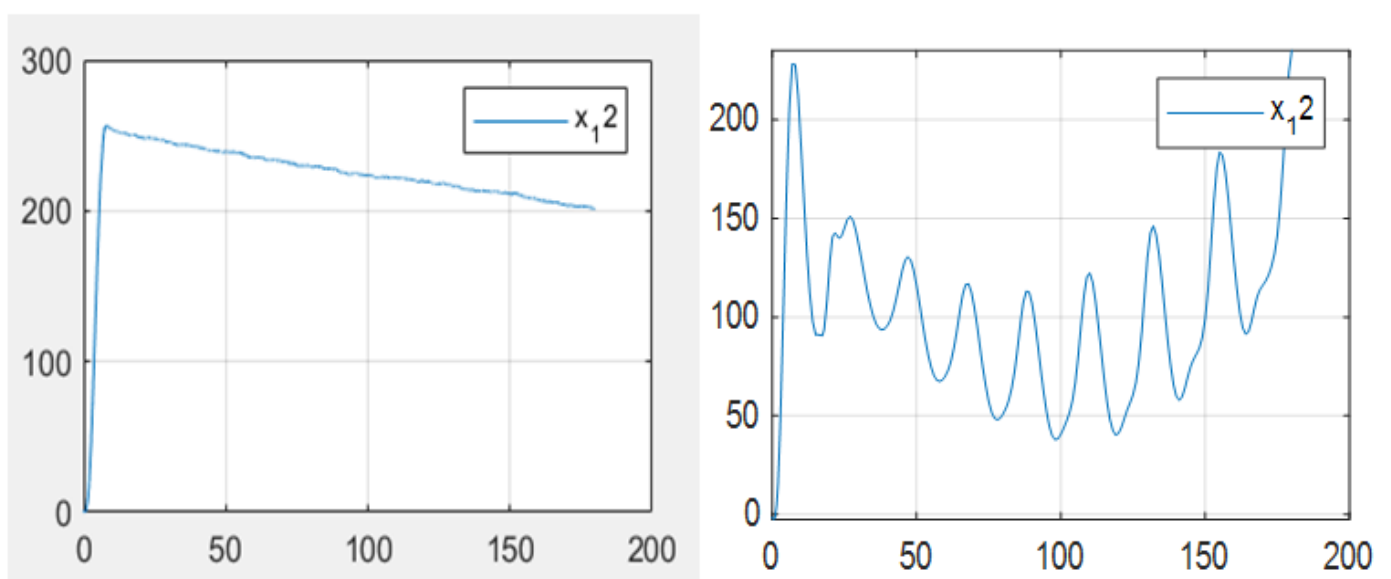**Figure 15**. Comparison of Pitch Rate within Ground Effect vs. without Ground Effect

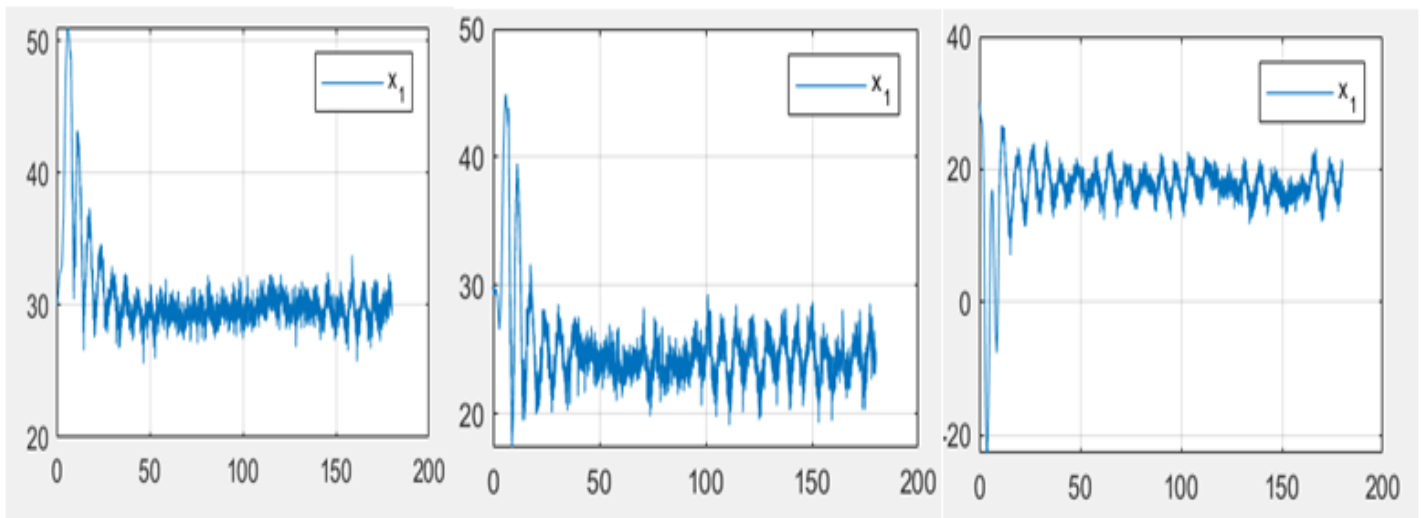**Figure 16.** Comparison of Pitch Rate within Ground Effect vs. without Ground Effect

Figure 17. Differences in Longitudinal Velocity at 5˚, 17˚and 30˚Pitch Angles Respectively

Vertical Motion

The model is also simulated to portray preliminary results of the concept's dynamics, when vertical thrust is produced by a number of nozzles underneath the FAB. The thrust forces produced by these nozzles are modeled as resultant force acting through the center of gravity in opposition to gravitational force. The resultant force is divided into the combination of force produced by the right set of nozzles fed by Engine fan 1 and the left set of nozzles fed by Engine fan 2. The results are simulated at a throttle setting of 0.13 rads for control inputs u4 and u5.

An examination of the velocity along the x-axis as illustrated in figure 1, shows major differences with the model in horizontal motion maintaining a velocity of around 30 m/s whereas, this velocity in the vertical mode drops to about 24 m/s. Results of the horizontal motion also show increased vibrations in comparison to the vertical motion. This can be attributed to increased airflow when the model with movement in the horizontal direction, as compared to vertical motion. These discrepancies are illustrated by **Fig. 19.**

Differences between the horizontal and vertical mode of the concept's motion also extend to velocity along the z-axis. Although both modes show velocities in the z direction, the vertical mode of motion has steady and significantly higher velocity along this axis as compared to the horizontal mode. This is because in the horizontal mode, velocity along the z-axis is primarily influenced by the pitch angle and lift as a result of the wing's aerodynamic properties. On the other hand in the vertical mode, velocity in the z-axis is primarily facilitated by the vertical thrust as a result of vectored force from the engines being produced by nozzles in the skirt of the Airboat. Since this force is more consistent, the plots of w exhibit smoother characteristics and thus more stability as shown in **Fig. 20.**

The final major difference between the horizontal and vertical modes is shown by the z-position in the earth frame, which also denotes the height of the model. In this regard, both the modes depict an increase in height. However, the horizontal mode shows the model's increase in height slowing down after a fraction of the time. On the other hand, z-position of the model in relation to the earth continues to increase consistently throughout the period as shown in **Fig. 21**. This shows the potential of the vertical mode to sustain a change in the concept's height and thus promote vertical motion.
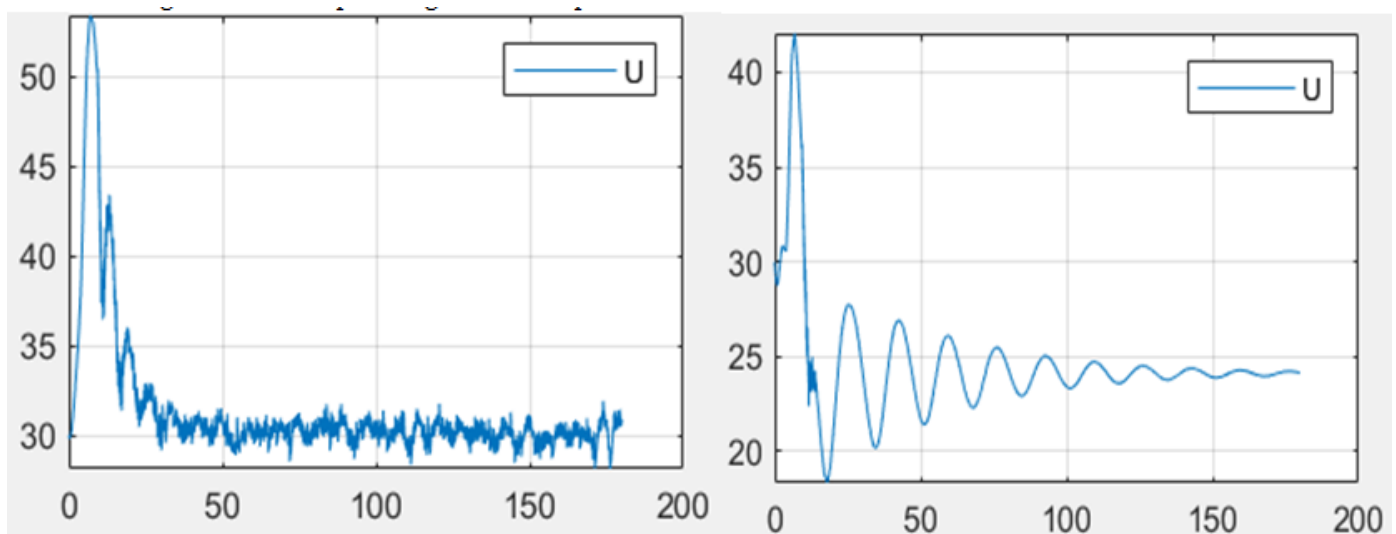

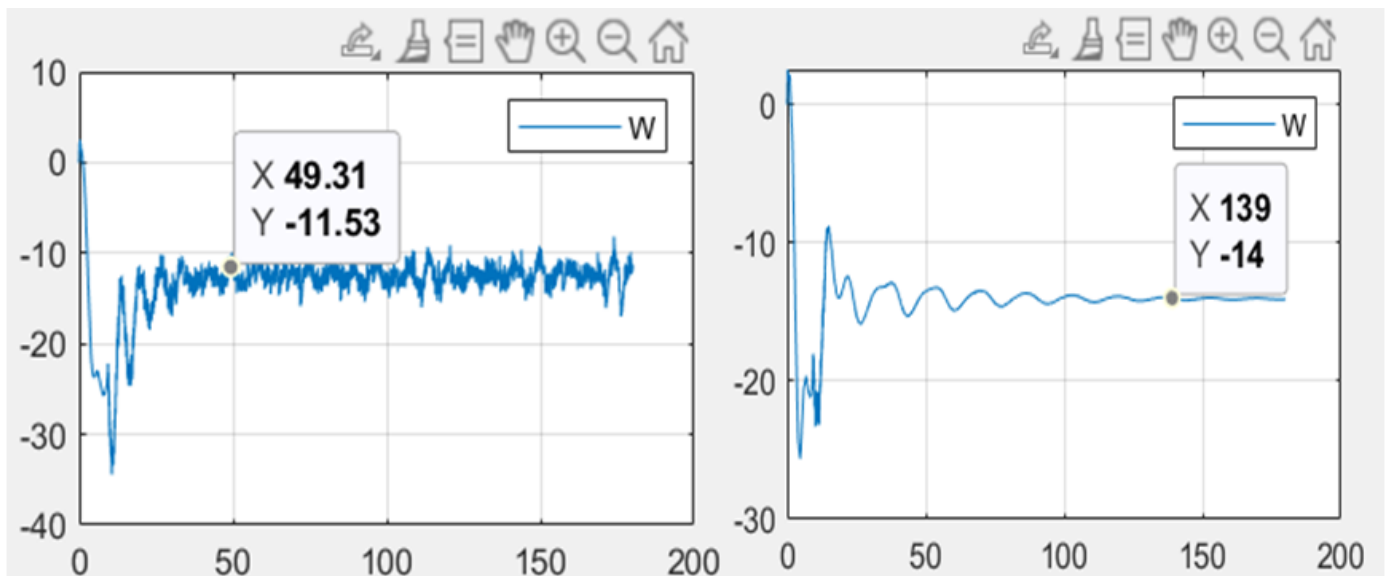**Fig. 18**: Velocity in x-axis in horizontal motion vs. vertical mode

Fig. 19: Velocity in z-axis in horizontal vs. vertical modes
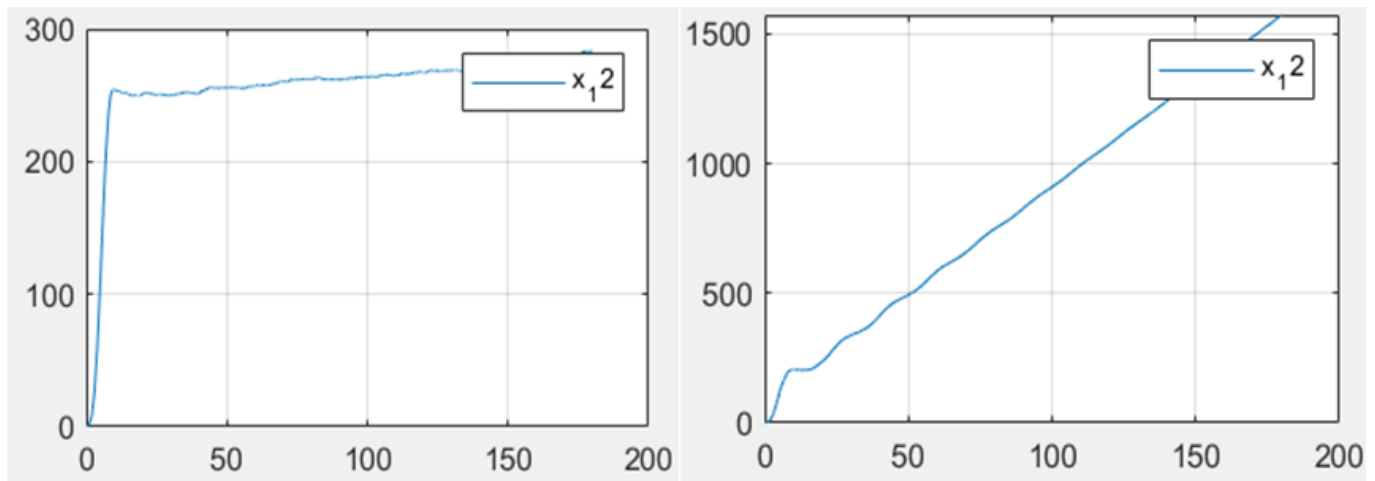

Fig. 20: Change in z-position (height) in horizontal vs. vertical modes

V. CONCLUSION

The implementation of the mathematical model for the FAB on the MATLAB platform was useful as a means of determining the controllability of the proposed design. Once implementation of the model had sufficed, the results revealed that indeed, control of the FAB could be achieved with minor changes to the proposed design. Among the changes that were incorporated was the inclusion of a tail section to improve the dynamic properties and stability of the model. Simulation of the design revealed that the incorporation of the ground effect influence parameter was necessary for ideal maneuverability and control of the design. The design also demonstrated that the use vertical motion could be achieved with the vectoring of thrust through nozzles in the skirt section underneath the FAB.

The results presented were based on a non-linear dynamic model. Future works could thus encompass the linearization of the model and the incorporation of a feedback system to minimize the error within the system, as a precursor to achieving a robust control design for the concept. Once robust control has been established, a scaled experimental model could then be developed to test the aerodynamic properties of the concept.

REFERENCES

[1] S. Jamei, A. Maimun, S. Mansor, N. Azwadi and A. Priyanto, "Design Parametric Study of a Compound Wing-in-Ground Effect. II: Aerodynamics Coefficients", *Journal of Aerospace Engineering*, vol. 29, no. 1, p. 04015023, 2016. Available: 10.1061/(asce)as.1943-5525.0000497.

[2] Mohd Zaid, M. Z., Arifin, M., "Aerodynamic Design for a High-Speed Airboat Craft", *Universiti Selangor (UNISEL)*, 2015.

[3] Abramowski, Tomasz. "Numerical investigation of airfoil in ground proximity." *Journal of theoretical and applied mechanics* vol.45, pp.425-436, 2007.

[4] Wetmore, J. W., and L. I. Turner Jr. "Determination Of Ground Effect From Tests Of A Glider In Towed Flight",1940.

[5] Rauw, M. "A Simulink Toolbox for Flight Dynamics and Control Analysis." In *Zeist, The Netherlands* (Issue February), 2001. Available: http://www.et.byu.edu/~beard/classes/ece682rweb/www-randy/fdcmanual.pdf

[6] Lambrechts, Paul F., Samir Bennani, Gertjan Looye, and Anders Helmersson. "Robust flight control design challenge problem formulation and manual: the research civil aircraft model (RCAM)." *Technical Publication TP-088-3, Group for Aeronautical Research and Technology in Europe GARTEUR-FM (AG08),* 1997.

[7] "EPPLER 857 AIRFOIL (e857-il)", *Airfoiltools.com*, 2020. [Online]. Available: http://airfoiltools.com/airfoil/details?airfoil=e857-il. [Accessed: 05- Dec- 2020].

Modeling and Simulation of Single Phase Grid Connected Photovoltaic System

Dr. Arun Moyal

Associate Professor
Department of Electrical and Electronics Engineering
SRM Institute of Science and Technology

Abstract: **This research work presents modelling of 10kw single-phase grid-connected Photovoltaic system with the use of MATLAB / Simulink software. This research paper outlined the design of PV model by the help of mathematical equations, solar maximum power point tracker (MPPT), DC/DC Boost converter, single-phase full-bridge inverter with pulse width modulation (PWM) switching technique and phase lock-loop (PLL). To design the proposed model, firstly all the parameters which are necessary, has been calculated and the system integration is done by using MATLAB/Simulink software. The Simulink results represents that the proposed model is able to synchronize with grid system, which has matching frequency and amplitude. Along with an appropriate low pass LC filter circuit is designed, Which reduces the total harmonic distortion (THD) in the ac output voltage significantly i.e. from 67.99% to 1.54%.The Modelling technique is very simple, Which is discussed in detail in this paper.**

Keywords: **PVcell; PVarray; P&OMPPT algorithms; Boost converter; single phase inverter; PLL, LC filter.**

I. INTRODUCTION

Now a days the requirement of electric energy increases gradually. As a result, we are focusing on rapid production of that. The most common method of power production is the thermal power generation. And the use of coal produces flue gas and ash which is responsible for atmospheric pollution and greenhouse gas.

Hence, we should focus on alternate source for the production of electric energy from non-renewable sources. As it is a clean and permanent source of energy.

Time comes to hold the hands of renewable energy which comprises solar energy, tidal energy and wind energy.

Solar energy becomes a most important and efficient form of energy production from all the forms of renewable energy as it needs fewer maintenance. Along with that it has no pollution and long life. To deliver the power to the load or to grid, power converters are used along it. So that generated power can be transferred most efficiently. The complete is called as photovoltaic system. The photovoltaic system has two types from its configuration and application, i.e. grid connected system and stand-alone system [1].

Grid connected solar PV system has more advantages as compare to the standalone PV system. Here exchange of electricity can be made possible from or to the electric grid depends upon the load demand. Hence the cost of electricity bill will be reduced automatically because the net electricity consumption is condensed by directing the extra electricity to the grid. The main advantage of using grid connected system is, it doesn't require any battery backup system by which there is no storage losses in the system so that more power can be delivered to the load [2].

In this paper, the detail modelling of 10kW grid connected PV system in MATLAB/Smulink has been discussed. The proposed modelled system consists of a solar PV array, MPPT (P&O algorithms) to extract maximum power the PV array to feed the system, DC-DC boost converter for regulation and boosting the output of PV array, a single phase inverter to convert DC power into AC power an LC filter to filter harmonics from the inverter output.

II. PHOTOVOLTAIC MODEL

From the study of physics, it has been cleared that Photovoltaic cell is a semiconductor device with thin wafer fabrication. The solar radiation is consisting of beam of electromagnetic wave. According to the law of physics by the great scientist, Einstein i.e. $E=h\lambda$, Which describes the photovoltaic effect and its working principle, Means when the spectrum of electrons in the form of solar irradiance fall on the PV cell, which is a P_N junction diode that converts the sunlight directly into the direct electricity (DC).The definition of solar irradiance is 'The rate of flow solar intensity per unit area (kW/m2)'. PV cell is current source rather than voltage source. The output of the PV cell is DC in nature rather than AC. The generated photons, which are obtained from solar panel will be get absorbed by the further electric system only if the those photons crosses the band-gap energy barrier of that semiconductor which is used for that PV cell design, if not they will create electron-hole pair.[1-3].The pv output power generation depends on mainly two parameters i.e. solar irradiance and temperature, where the solar irradiance directly proportional to the power generation mean while temperature is inversely proportional to it. By these environmental effects PV cell has nonlinear I_V & P_V characteristics.

A. *Solar Cell:*

It is one type of P-N junction diode. A single solar cell is insufficient for the application because it capable of producing maximum 2-watt power [13].

B. *Solar module:*

   To overcome the insufficient power generation of PV cell, a number of PV cell will be connected in series and parallel to give rise the sufficient power for our normal application requirement, this is called as solar module.

C. *Solar array*:

When the solar module connected to the electrical equipment to transfer the generated electricity from the cell to the load, this complete unit is called as Solar array. According to the demand of the load the solar module can be connected in series and parallel to comprise the PV array. PV array modelling has been done by considering single diode of PV cell [1]. The basic equations and circuit diagram came into consideration for the modelling of solar cell. When the number of solar cell and solar panel will be connected in series or parallel then the equations will be changed according to them.

The equivalent circuit diagram of a single solar cell is shown in Fig. 1.
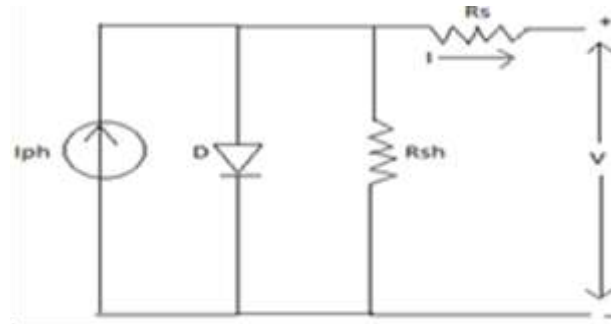

Figure 1: Single diode model of PV Cell.

The below written equations from (1) to (6) are used to model the single solar cell where equation (7) represents the number of cells connected in series and parallel.

$$I = Iph - Id - Ish \qquad (1)$$

$$Iph = [Isc + Ki(Tc - Tref)]G \qquad (2)$$

$$Id = Is\left[\exp\left(q\left(\frac{V + I * Rs}{Ki * Tc * A}\right) - 1\right)\right] \qquad (3)$$

$$Ish = (V + IRs) \div Rsh \qquad (4)$$

$$Is = Irs\left(\frac{Tc}{Tref}\right)^{3\exp}\left[\frac{qEg\left(\frac{1}{Tref} - \frac{1}{Tc}\right)}{kA}\right] \qquad (5)$$

$$Irs = \frac{Isc}{[\exp\left(\frac{q * Voc}{Ns * k * A * Tc)}\right) - 1]} \qquad (6)$$

$$I = NpIpv - NpI0\left[\frac{\exp\left(\frac{(V + IRs)}{Ns}\right)}{ANVth} - 1\right] - \frac{V + IRs}{Rp} \qquad (7)$$

Where:
G: Solar irradiance
 I: PV output current
Iph: Current from PV cell (Photo current)
Is: Cell reverse saturation current
Irs: Reverse current in the cell.
q: Electric charge (1.6e-19C)
Id: Schottky diode current.
Ish: Current from shunt resistor
Ki: Cell current temp. Coefficient

Tc: Cell temperature
Tref: Ambient temperature (25℃)
A: PV cell ideal factor
N: Total number of modules
K: Boltzman'sconstant (1.38e-23 J/K)
Eg: Energy band-gap.
Ns:Number of series connected solar panels
Voc: PV cell open circuit voltage
Isc: PV cell short circuit current
V: PV Boltzmann's voltage
Rs: Series resistance
Rsh: Shunt resistance
Np:Number of parallel connected solar panels

C. *Solar irradiance(G):*
'The rate of flow of solar intensity per unit area' is recognized as solar irradiance. The solar irradiance variable in nature it varies according to the geographical regions. It has directly proportionality property with the generated photo current. 1000W/m2 solar irradiance has been taken as standard test condition in world wide.

D. *PV Output Current(I):*
The output current of PV is the summation of mainly three current sources that are photo current, Schottky diode current and the current through shunt resistance of the solar array. It has been represented in the equation (1) and modelling of I shown in the fig.2
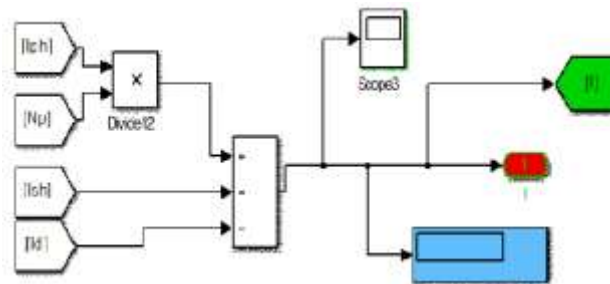

Figure 2: PV output current Modelling

E. *Photo Current (Iph):*
The electric current obtained from photosensitive diode when this diode is exposed to the sunlight is called as photo current. The photo current has been represented in the equation (2) and its modelling shown in the fig.3.
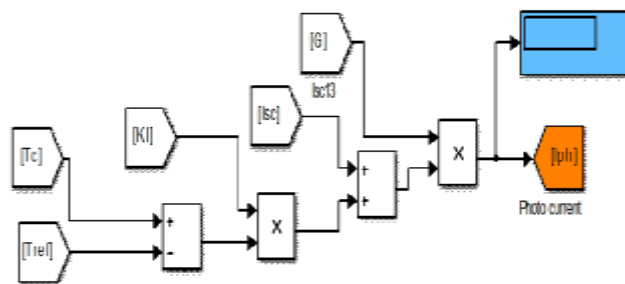

Figure 3: Photo Current Modelling

G. *Diode Current (Id):*

The Current has been obtained through the Schottky diode, is known as diode current. The equation (3) represents the diode current, from the equation it can be observed that Id depends upon the reverse saturation current. Fig.4 represents the diode current model.
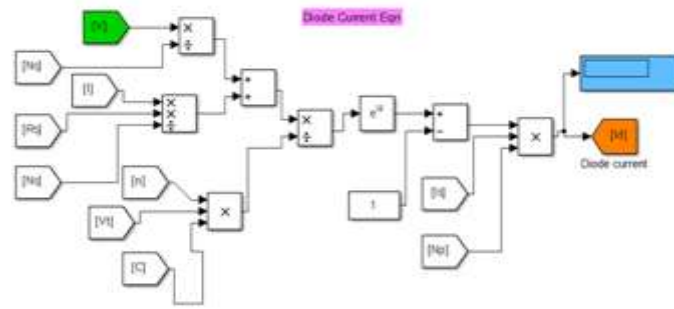
Figure 4: Diode Current Modelling

F. *Cell reverse saturation current (Is):*

When the solar cell is exposed to the low intensity of solar light then cell reverse saturation current will be developed within the solar cell. The reverse saturation of one diode will affect another diode. The recombination in the device has been measured by the Is. In equation (5) the reverse saturation current is represented and its modelling shown in the fig.5
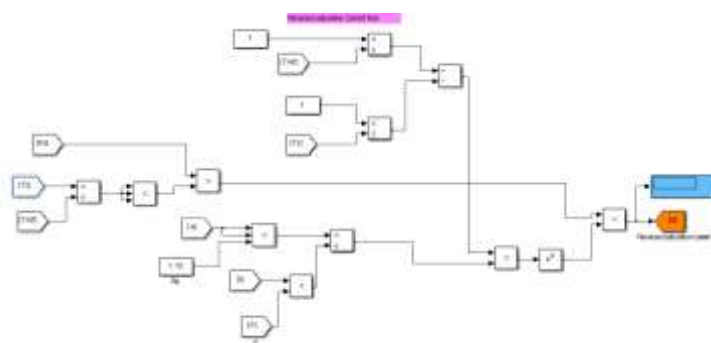

Figure 5: Reverse saturation current Modelling

E.   Cell Reverse Current (Irs):

The cell reverse current depends upon the open circuit voltage, short circuit current and cell ambient temperature. The equation (6) represents the reverse current and its modelling shown in the fig.6.
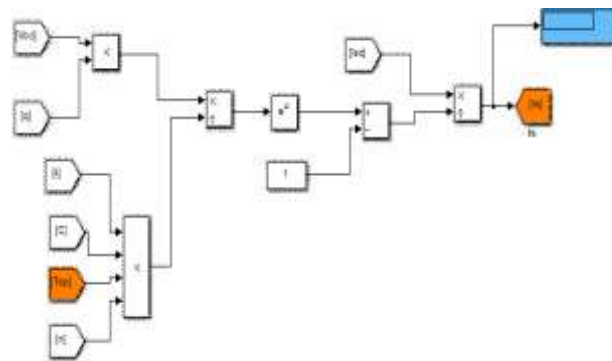

Figure 6: Cell Reverse current Modelling

F.   *Series resistance (Rs):*

While designing the solar cell the series resistance value is kept very low and some manufacture ignore it because it is connected in series with load, so that if we take Rs value high then the current from the cell to load decreases because of the property of the resistance.

G.   *Shunt resistance (Rsh):*

By reducing the cell leakage current the power loss will be reduced too, it can be achieved when the cell shunt resistance will be kept high. Because it plays an obstacle path for the current flow to the ground. So virtue of that maximum amount of current will flow to the load through low series resistance path. It plays important role at low intensity levels. The current through the shunt resistor is called as shunt current and it has represented in the equation (4). The modelling of shunt current has shown in the fig.7.
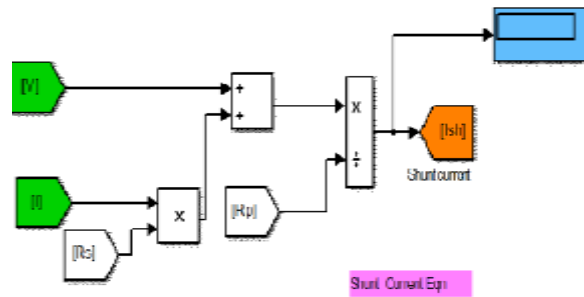
Figure 7: Shunt Current Modelling

H. *Modelling of PV array:*
The PV array of 10kW has been modelled by taking 5 sun hours from 350W solar panels. In Appendix-A the datasheet of this panel is given. The values of parameters given in the datasheet are being used in the design of PV array model. PV array has been modelled using all equations (7). The complete modelling of PV array has been shown in fig.8.
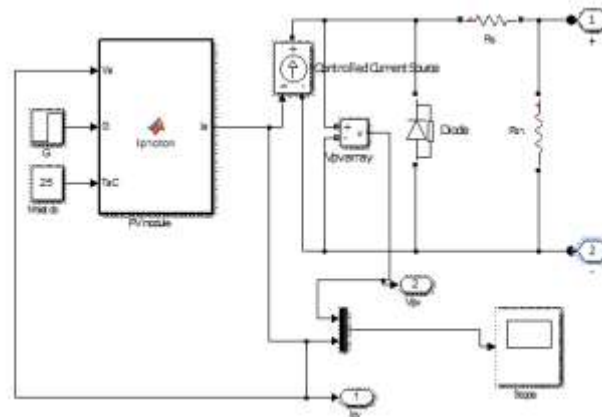

Figure 8: Complete PV array modeling.

III.   MAXIMUM POWER POINT TRACKING (MPPT)

.Now a days it has been observed electricity generation from photovoltaic system increasing rapidly, so that it can be taken into consideration as a prominent alternative source to fossil fuels. However the initial cost for installation is quite and also its efficiency is typically low (18%-22%). To emphasize the efficiency another important feature is added to the PV system which can track the maximum power from the PV array [8]. That special feature is known as maximum power point tracker (MPPT). It is used in both grid connected and standalone system, because temperature and solar radiation changes throughout the day along different seasons and also different geographical conditions. Since there are various MPPT approaches available in the literature, which are mainly the fixed duty cycle method, constant voltage (CV), perturb and observe (P&O), and incremental conductance (IC). Among all P&O technique has been considered for this proposed model. MPPT is nonlinear because it considers the climatic conditions (i.e. temperature, irradiance, cloud, wind velocity) at each and every second at that geographical region where it is working.

A.   *Perturbation observation (P&O) method:*
Typically, P&O method has been used for tracking the MPP in the P_V curve. A minor Perturbation has been introduced in this technique, to cause the power variation of the PV array and it has observed .In this technique the power obtained from PV array has been measured periodically and then present obtained power is compared with the previously obtained power .If this technique the power curve has been observed and the process will be continued if the power increases or else the perturbation will be reversed. This algorithm technique can be applied to the array voltage or module. In this technique to check the power is increasing or decreasing, the PV module voltage has been checked first. The operating point of PV module will be on the left of the MPP, when the PV module voltage increases which leads to increase the power [9]. Further perturbation has required towards the right to reach MPP. If it is observed that increase in voltage leads to decrease in power that means the operating point is on the right of the MPP and hence further perturbation toward the left has been required to reach MPP.
The flow chart of the adopted P&O algorithm for the charge controller is shown in fig. 9. This MPPT algorithm is quite simple, easy to implement. Its cost is low with high accuracy [8]. In application it is found that it most effective.
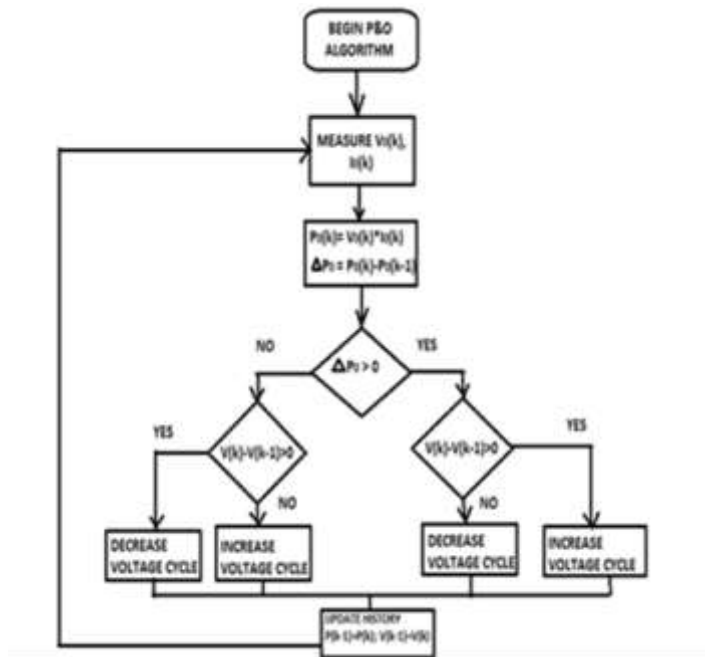
Figure 9: Flowchart of P&O Algorithm

<center>IV.   **BOOST CONVERTER**</center>

A DC-DC boost converter has been implemented to boost and the regulate the PV array output voltage [4-6]. The voltage obtained from the PV module will be fed into the boost converter and it is regulated by the MPPT tracker through the gate pulse into the use IGBT of the boost converter. The parameters values have been obtained by the equation (8) to (10). The boost converter circuit model has shown in the Fig.10.

The converter output is given by:

$$Vout = Vin/{1-D} \qquad (8)$$

$$L > Vin * D/f * \Delta I \qquad (9)$$

$$C1 = C2 = Vout * D/2f\Delta Vout * Rload \qquad (10)$$

Where, Vout is nominated for output voltage, Vin for the input voltage, D is for duty cycle, f is the converter frequency, ΔI represents current ripple, $C1$ and $C2$ are the capacitances of the capacitors, $\Delta Vout$ is given for the output voltage ripple and $Rload$ is for the load resistance given by $Vout/Iout$.
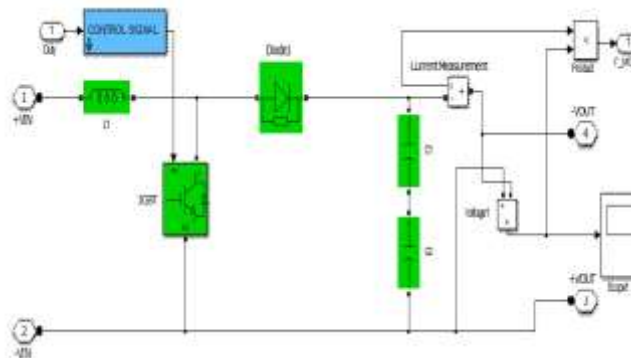

Figure 10: Boost Converter Modelling

<center>V.   **DC to AC Converter:**</center>

To convert DC power into AC, Single phase voltage source converter is used. In the inverter, the on and off period of the IGBT has been controlled by the gate signals. Inverter control loop generates these gate signals. The inverter control loop which has been designed for the proposed work consists of Phase locked loop (PLL) and 2-level PWM generator, which are Simulink blocks. Single phase grid voltage and current are inputs to the control loop. The controlled PWM signals has been obtained from the inverter control loop [7-9]. The controlled PWM signals are being used for switching on and off of IGBT switch in inverter. After all this

process the inverter starts to generate single phase synchronized sinusoidal voltage and currents. To reduce the voltage and current harmonics from the inverter output, then the low pass LC filter circuit has been implemented along with the inverter circuit.

A: Phase locked loop (PLL)

The wide ranges of applications of PLL circuits in telecommunication and in system engineering has been found. In its feedback look, it contains an adjustable frequency oscillator and a phase detector. From the oscillator the periodic signal has been produced and then that periodic signal will be compared with the period of the input signal to the PLL circuit by the phase detector. To keep the phase match, meanwhile the oscillator adjusts the phase of the signal. In this case, PLL has been used to monitor the AC grid frequency utility and then signal matches to the frequency is being generated. For any change in the grid frequency, the PLL circuit should response and then the signal will be used for the synchronous of the switching of inverter [10-11].

To have a PLL module in the grid connected system is essential. In the PLL loop the grid AC voltage has been taken as a reference for the generation of the estimated grid frequency and the estimated phase angle. Then the two signals have been compared with the reference input signals and the feedback the signal in every single point by the phase detector. A terrain of   pulse will be produced from the phase detector when the phase of the two-input signal is different. The degree of phase difference is being proportional with the width of the pulse. For making equal inverter output and grid angle, PLL plays an important role. The modelled PLL block is shown in the Fig.11.
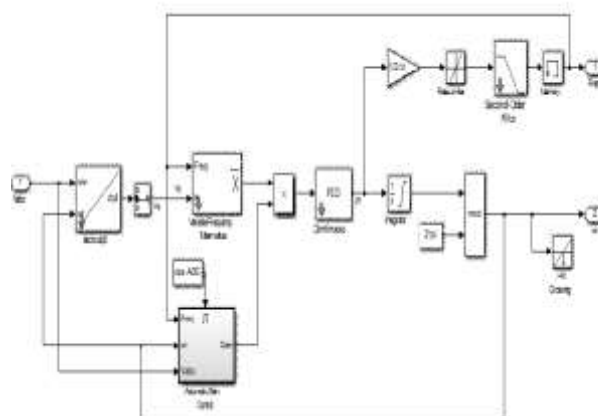

Figure 11: PLL Converter Modelling

B: LC filter:

For filtering the inverter output a LC low pass filter is being used in this paper. By using it the harmonics has been reduced from the output voltage. In the perfect voltage source, the distortion in voltage will not occur even if there will be any imbalance load or nonlinear load. The inverter output impendence must be kept zero [12]. In the low pass filter the capacitance value should be increased and the inductance value should be limited at the chosen cut-off. To reduce the reactive power in the system, the values of inductance and capacitance should be determined. The value of the internal resistance of the inductor is taken as very small. The single-phase LC filter can be calculated by equation (11).

$$Voltage\ gain = \frac{Vin}{Vout} = \frac{1}{LCS2 + RCS + 1} \qquad (11)$$

For investigation the filter is made in the frequency domain. In equation (12) represents the pick-up voltage for a low pass LC filter.

$$H(j\omega) = \frac{W_p^2}{s^2 + \frac{sW_p}{Q} + W_p^2} \qquad (12)$$

Where, Wp and Q represents the natural oscillating frequency and quality factor respectively. It is demonstrated with explanation of peaked resonances in (13), or $Q > \frac{1}{\sqrt{2}}$,the frequency at which H(jω) has maximized and the corresponding maximum shown on (14)

$$\frac{W}{W_p} = \sqrt{(1 - \frac{1}{2}Q^2)} \qquad (13)$$

$$H(j\omega)_{max} = \frac{Q}{\sqrt{(1 - \frac{1}{4}Q^2)}} \qquad (14)$$

The sufficiently large Q will be obtained, when Q> 5, W/Wp=1 and H(jω) max=Q. By arranging equation (13) and then by comparing with the equation (11) will results

$$LC = \frac{1}{W_p^2} \qquad (15)$$

$$RC = \frac{1}{QW_p} \qquad (16)$$

The value of Capacitance(C), inductance (L) and resistance (R) has been obtained by solving the equation (15) and (16).

VI.   SIMULATION AND RESULTS

The 10kW designed grid connected system has been tested with Single phase 1.5 kW load. The complete grid connected model is shown in the fig.12. The total harmonic current compensation has been implemented in the proposed model by using a LC low pass filter. In the proposed system the rms value of the voltage source (grid)has been given 220v along with the single-phase universal bridge rectifier nonlinear RL load across it, by virtue of this nonlinear load the harmonics has been introduced into the system. The Grid synchronization has been obtained by Using PLL represented in the fig.13. In fig.14 represented the power obtained from this 10kW model. When the inverter output is less than the load demand at that point the grid supplies the power, it can be analyzed from the positive half of the power plot. On the other hand, when the output of inverter is more than the load demand, then the extra amount electricity will be fed to the grid, it can be analyzed from the negative half of the power plot. The Total Harmonic Distortion (THD) spectrum in the system without filter is shown in Figure 14, which indicate a THD of 67.99%. The THD with LC lowpass filter is observed to be 1.54% which is within the allowable harmonic limit. Figure 15 shows the THD spectrum with LC low pass filter in the circuit.
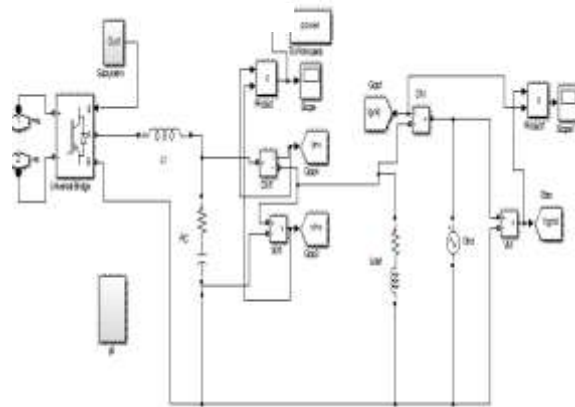

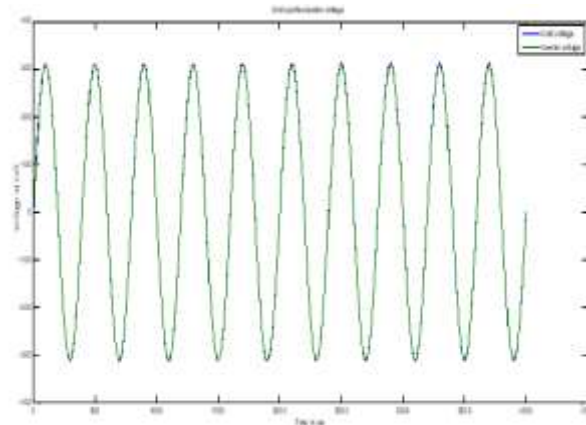Figure 12: Single phase Grid connected system modelling

Figure 13: Output Synchronized Voltage wave form
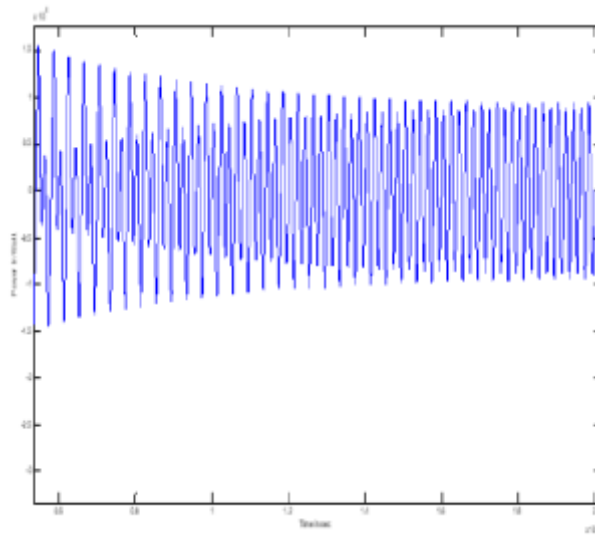
Figure 14: Output Power wave form
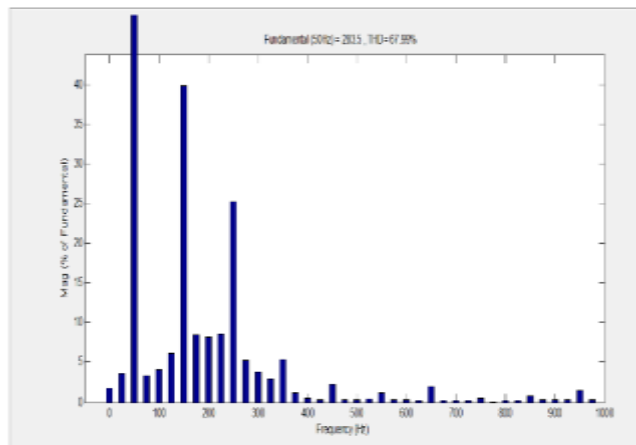
Figure 15: FFT analysis of voltage without filter circuit
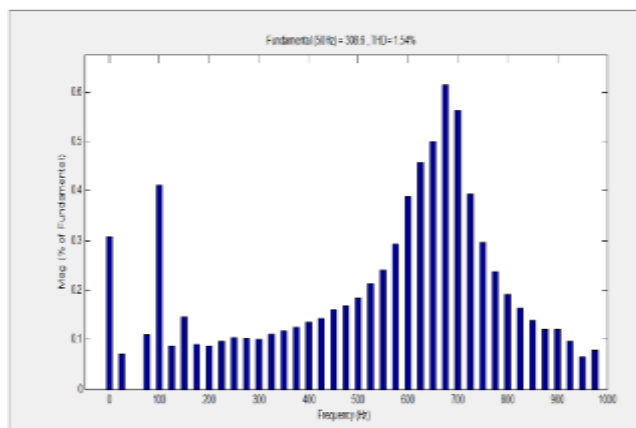
Figure 16: FFT analysis of voltage with filter circuit

VII.   CONCLUSION

The modelling of 10kW grid connected photovoltaic system by aiming at home based solar PV application is being proposed in this paper. The modules which we are using in the model have defined in the details. For maximizing the output obtained from the PV array, P&O algorithm based MPPT was used along with the boost converter. For the propose of application and also for feeding to the load, an inverter was designed which converted the DC voltage and current to AC values along with the LC filter, the THD was significantly reduced from 69.77% to 1.54%..The inverter was designed along with PLL, which locked the phase of the grid and inverter voltages. The model is designed successfully using MATLAB/Smulink software. Future work is to implement this model in real time and design the three phase grid connected system by taking the same datasheet of PV array.

APPENDIX-A

In Appendix electrical parameters are stated which are used in simulation.

PARAMETER	VALUES
Ki	0.00023A/K
Irr	0.00002A
K	1.38065×10^{-23} J/K
Q	1.6022×10^{-19} C
A	2.15
Eg0	1.66ev
α	4.73×10^{-4} ev/k
β	636k
Np	4
Ns	90
Iscr	3.75A
Tr	40 °C
Vnormal	47.1v
Inormal	8.9A
Pmax	350Watt

REFERENCES

[1] Chedid, R.; Tajeddine, R.; Chaaban, F.; Ghajar, R., "Modeling and simulation of PV arrays under varying conditions," In Mediterranean Electrotechnical Conference (MELECON), 201417th IEEE , vol., no.,pp.536-542

[2] M. G. Villalva, J. R. Gazoli and E. R. Filho, "Comprehensive Approach to Modeling and Simulation of Photovoltaic Arrays," in IEEE Transactions on Power Electronics, vol. 24, no. 5, pp. 1198- 1208.

[3] Gow, J.A.; Manning, C.D., "Development of a photovoltaic array model for use in power-electronics simulation studies," in Electric Power Applications, IEEE Proceedings, vol.146, no.2, pp.193-200

[4] Analysis of photovoltaic cells with closed loop boost converter, International Journal of Advances in Engineering & Technology, Mar. 2013. ©IJAET ISSN: 2231-1963.

[5] A. A. Bakar, W. M. Utomo, S. A. Zulkifli, E. Sulaiman, M. Z. Ahmad,and M. Jenal, "DC-DC Interleaved Boost Converter using FPGA," in *IEEE Conference on Clean Energy and Technology*, 2013, pp. 97–100.

[6] A. A. Bakar, W. M. Utomo, T. Taufik, and S. Aizam, "Dc / Dc BoostConverter With Pi Controller Using," *ARPN J. Eng. Appl. Sci.*, vol. 10,no. 19, pp. 9078–9082, 2015.

[7] "A New Approach to Design of an optimized Grid Tied Smart Solar Photovoltaic (PV) System". International Journal of Advancements in Research & Technology, Volume 1, Issue6, ISSN 2278-7763, November-2012

[8] S. Borekci, E. Kandemir, and A. Kircay, "A Simpler Single-PhaseSingle-Stage Grid-Connected PV System with Maximum Power PointTracking Controller," *Elektron. ir Elektrotechnika*, vol. 21, no. 4, pp.44–49, 2015.

[9] A. H. Mollah, P. G. Kpanda, and P. P. Ksaha, "Single Phase Grid-Connected Inverter for Photovoltaic System with Maximum Power," pp.648–655, 2015Power Electronics, Mohan, Undeland, Riobbins.

[10] K N Dinesh Babu, Ramaprabha, Ramabadran, Veeraraghavalu Rajiniand Bansal Kamal, "Charge Pump Phase Locked Loop SynchronizationTechnique in Grid Connected Solar Photovoltaic Systems," *IOSR J.Comput. Eng.*, vol. 16, no. 1, pp. 91–98, 2014

[11] M. Barnes and Siyu Gao, "Phase-Locked Loops for Grid-Tied Inverters:comparison and testing," *8th IET Int. Conf. Power Electron. Mach.Drives (PEMD 2016)*,no. c, p. 6 .-6 ., 2016.

[12] A.A. Bakar, M.A.N. Amran, S. Salimin, M.K.M. Jamri and A.F.H.A.Gani" Modeling of Single-Phase Grid-Connected usingMATLAB/Simulink Software" 2019 IEEE Student Conference on Research and Development (SCOReD)October 15-17, 2019, Seri Iskandar, Perak, Malaysia

[13] http://pveducation.org/pvcdrom

University Students' Self-efficacy in Online Learning Due to COVID-19

[1]Erni Tanius, [2]Nur Iman Aqila Alwani, [3]Salman Abdul Muein

[1]Lecturer, [2]Student, [3]Student
Faculty of Business and Accountancy,
Universiti Selangor, Shah Alam, Selangor, Malaysia

Abstract: the pandemic COVID 19 shocked the world; it changes everybody's life, especially in education and online learning becomes a new culture. Hence, this study will identify the correlation between learners' motivation, computer anxiety, and social support with self-efficacy on online learning technology due to COVID 19 pandemic. Besides, to determine if there are any gender and age differences in their perception of online learning technology. 166 students in a university were using online learning for the first time participated in this study. The correlation analysis and chi-square are used to answer the objective of the study. The result indicated that online learning technology experience, learners' attitudes, learners' motivation, computer anxiety, and social support correlate with self-efficacy on online learning technology. Furthermore, the finding revealed that male and female respondents and different ages have similar opinions on the factors that contribute to online learning technology.

Index Terms: Self-efficacy, university' students, online learning technology experience, learners' attitudes, learners' motivation, computer anxiety, and social support

_____

I. INTRODUCTION

The COVID 19 pandemic affected almost all the countries, including Malaysia. Hence, Malaysian Prime Minister Muhyiddin Yassin officially announced the Control Movement Order (CMO) based on the Prevention and Control of Infectious Diseases Act 1988 and the Police Act 1967 On 16 March 2020, [1]. As a result, it changes every segment of life, especially in the education system. The educational institutions closed, and home-based learning by using online learning technology is mandatory.

Due to sudden implementation, the stakeholders in education claimed they are not ready. There are some issues related to online learning technology issues such as technology-related anxiety due to out of one's comfort zone, inequity in evaluation, and perceived incapacity or difficulty in peer interaction and the presentations [2]. Another problem highlighted by Bandura, which is self-efficacy on online learning technology, is learners' ability to manage their learning.

Literature indicated that motivation, readiness, and self-regulated learning contribute to students' self-efficacy toward online learning technology. [4]. besides, it requires skills in computer, internet, and information-seeking skills [5].

Hence, the objective is to identify a correlation between factors contributing to self-efficacy in online learning and students' performance. Besides, to determine if gender and age wBesidesfluence it. However, this study only focuses on online learning technology experience, learners' attitude, learners' motivation, computer anxiety, and social support as the factors contribute to self-efficacy on the university students' online technology.

II. LITERATURE REVIEW

Self-efficacy

Bandura [6] defined self-efficacy as the belief of an individual in their ability to fulfill a task in a different circumstance. He added that it is affecting the individual's choice of behaviors, commitment, and persistence. Besides, it will influence goal choices [7], and the degree of perseverance met with difficulties [7, 8]. Self-efficacy is influenced by four factors: mastery experience, vicarious experience, verbal or social persuasion, and physiological and affective states [8].

Meanwhile, Alqurashi [5] refers to self-efficacy as the belief in one's ability to organize and carry out the courses of action necessary to achieve these achievements. It predicts the motivation, execution, and the degree to which individuals' desire a specific outcome compared to other alternatives [8]. Individuals with high self-efficacy often show a good feeling of well-being and overall high self-esteem [10]. The self-efficacy sources include experience in accomplishing a task, vicarious experience, and verbal persuasion [11]. It also affects the physiological and perceives the ability of individuals' awareness [9].

Self-efficacy influences personal objectives directly and indirectly and relates with academic setting motivates and achievement [8]. As well as encourages the elimination of unwanted emotional reactions. Finally, students with higher academic self-efficacy experience less stress in school than those who doubt their self-efficacy and abilities [12].

Online Learning Technology Experience

Online learning' is referred to as courses offered entirely online; that fully or only partially use any electronic device or network [17, 18]. In teaching and learning, the physical classroom is replaced with web-based technologies [19]. It knows as distance learning, e-learning, online learning, blended learning, web-based learning, virtual learning, tele-education, cyberlearning, internet-based learning, and distributed learning [16].

Meanwhile, online learning technology experience defines by Keller and Chitnis[13] and Tharhini [14] as the use of information and communication technology (ICT). It provides education knowledge where teachers and learners are divided by distance, time, or both to improve learning experience and success. Online technological trends become trends, especially on online purchases, reading, and finding directions [15].

Online learning technology can improve the understanding of learning. Besides, it increases the more robust sense of community among students and reduces withdrawal or failure [20]. On the other hand, [20] said that online learning technology is difficult to understand, especially when the computer is slow or low internet. It creates more problems rather than its solution. Hence, the learner technology experience is crucial to ensure the online learning technology is booming.

Learners Attitude

Guyer, Joshua, and Fabrigar, Leandre [22] define learners' attitude as a relatively general and permanent assessment of an object, person, or concept in a positive to negative dimension. Meanwhile, Dursun, Donmez, and Akbulut [23] said it is an individual attitude towards the learning situation. It represents both positive or negative conduct and reflection of feelings and information of a specific idea or subject matter [24].

Attitude plays a vital role in online learning [25] as it is crucial and necessary to accept and adopt online learning [21]. Meanwhile, Rhema & Miliszewska [26] added that age, gender, confidence level contribute to the learners' motivation. Besides, technical skills such as frequency of computer use, ICT work experience, own technical possession, ICT access, and ICT training history [27]. Finally, Peytcheva-Forsyth, Yovkova, and Aleksieva [27] conclude that online learning's critical factor depends on the learner's attitude and perception towards online learning itself [27].

Learners' Motivation

Brown [28] describes motivation as an inner force, impulsive, emotional, or desire which moves one to the action. It is crucial to learn and influence what, when, and how we learn and is a significant performance factor [29]. Motivation use of tactics to help achieve objectives [30] and affect what learner learns how they learn, and when they decide to learn [29].

In learning by using technology, motivation plays as self-regulated learning for learners [31]. The main characteristics of motivations are specific, motivation, goals of success, confidence, self-efficacy, and confidence in power [32]. It is an intrinsic motivation in online learning [29] and influences the learners' ability to perform their tasks [6]. Lastly, Ullah and Obaid [21] conclude that the learners' motivation in online learning can enhance the productivity of students.

Computer Anxiety

Computer anxiety refers to a fear of computers' emotional responses, including disturbance, fear, apprehension, and agitation. it causes unnecessary fear of physiological effects [35]. Salamah, Ganiardi, and Kusumanto [36] claimed that computer anxiety is a negative stress was associated with one specific form of stress computer beliefs, problem, a problem with the use of computers, and machine rejection. In the times, V. Celik and E. Yesilyurt [37] found out that computer anxiety, attitude to technology, perceived computer self-efficacy are important predictors of teacher candidates' attitude toward using computer supported education. Saadé, Kira, Mak, and Nebebe [38], found out that essential students have experienced anxiety with online learning classes. They also indicated that female students are more anxious about taking online courses than males. However, Thinakaran, Ali, and Husin [39] said that the level of anxiety about using computers amongst undergraduate students is low.

Social Support

Sahin-Baltaci and Karatas [40] describe social support as the knowledge that allows the person to believe they are cherished, respected, cared for, and a member of the social network. It is as an appreciation through the exchange of physical or psychosocial means [41]. The social support received reflects significant others' existing resources, such as family members, friends, and partners [42]. The social support for online learning in tertiary institutions is crucial, especially for support from the community, family, and community, said Andi Wahyu Irawan, Dwisona [43]. A study by Lai et al. [44] found similar results: the parents play a significant role in supporting their children. Finally, Sawahel [45] recommended that higher education policy-makers collaborate with the telecommunication industry to provide internet facilities for faculty members and students to facilitate online learning.

III. METHODOLOGY

The collected data in this study is using primary data by constructing a questionnaire. 166 respondents from the university in Shah Alam joined in this study. The variables developed from previous related studies and designed purposely to answer the study's objective. Finally, the data analyzed by using descriptive statistics, correlation, and the Chi-Square test.

Reliability Test

The pilot test was conducted to identify the questionnaires' reliability; the pilot test is conducted to 30 respondents. The Mallery (2003) used to determine the internal consistency of items in the scale.

Table 1: Reliability Test

Dimension	Cronbach's Alpha
Online Learning Technology Experience	.807
Learners' Attitude	.831
Learners' Motivation	.954
Computer Anxiety	.872
Social Support	.945
Self-Efficacy	.948

As shown in table 1, the result indicated Cronbach's Alpha values for each variable above 0.8. Hence, the variable considers reliable and appropriate use as the variable for this study.

IV. FINDING

The background of Respondents

Table 2 Summary of Respondent

Demographic Variables		Frequency (N)	Percent (%)
Gender	Male	58	34.9
	Female	108	65.1
Age	21 or less	44	26.5
	21-25	107	64.5
	26 or more	15	9.0
Religion	Muslim	146	88.0
	Buddha	2	1.2
	Hindu	5	3.0
	Christian	12	7.2
	Others	1	.6
Ethnic	Malay	137	82.5
	Chinese	1	.6
	Indian	7	4.2
	Others	21	12.7
Program	HRM	66	39.8
	Business	33	19.9
	TESL	30	18.1
	Medical	7	4.2
	Engineering	19	11.4
	Others	11	6.6
Education	Diploma	69	41.6
	Degree	97	58.4
Platform	BigBlueButton	60	36.1
	Zoom	27	16.3
	Google Meet	42	25.3
	Google Classroom	19	11.4
	Others	18	10.8

Based on table 2, more than half of the respondents (65%) are female and 58 (34.9%) are male. Majority or 107 (64.5%) in the age of 21 to 25 years old, followed by 21 years old or less (44 or 26.5%). Mainly they are Muslim (146 or 88%) and the second is Christian (12 or 7.2%). In term of ethnicity, mostly Malay (82.5%) and others (12.7%) it includes international students and students from Sabah and Sarawak). 39.8% of respondent's study Human Resource Management students, 19.9% Teaching English as Second Language (TSEL) students meanwhile engineering students contribute to 11.4% of respondent in this study. The proportion of level study, the bachelor students slightly higher (58.4%) compare to Diploma students (41.6%). The respondents claimed that they used Big Blue Button as the primary online learning platform (36.1%), another 25.3% said they are using Google Meet, and 16.3% used Zoom.

Correlation Analysis

The analysis would like to identify the correlation between factors that contribute to self-efficacy (online learning technology experience, learners' attitude, learners' motivation, computer anxiety, and social support) and self-efficacy for using online learning technology in universities at Shah Alam. The correlation analysis will be based on the following hypotheses:

Ho: There is no significant correlation between factors that contribute to self-efficacy (online learning technology experience, learners' attitude, learners' motivation, computer anxiety, and social support) and self-efficacy for using online learning technology in universities at Shah Alam.

H1: There is a significant correlation between factors that contribute to self-efficacy (online learning technology experience, learners' attitude, learners' motivation, computer anxiety, and social support) and self-efficacy for using online learning technology in universities at Shah Alam.

In the meantime, Pearson's correlation coefficient is used to measure the strength of a linear relationship between paired data. It is based on Evans (1996) suggests for the absolute value of r:

· .00-.19 "very weak."

☐ .20-.39 "weak"

☐ .40-.59 "moderate"

☐ .60-.79 "strong"

· .80-1.0 "very strong"

Table 3: Correlation Table between Factors of Self-Efficacy and self-efficacy on Online Learning Technology

		totaldv1	Totaliv1
Experience	Pearson Correlation	1	.495**
	Sig. (2-tailed)		.000
	N	166	166
Learner's attitude	Pearson Correlation	1	.313**
	Sig. (2-tailed)		.000
	N	166	166
Learner's motivation	Pearson Correlation	1	.578**
	Sig. (2-tailed)		.000
	N	166	165
Computer Anxiety	Pearson Correlation	1	.158*
	Sig. (2-tailed)		.042
	N	166	166
Social Support	Pearson Correlation	1	.695**
	Sig. (2-tailed)		.000
	N	166	166

**. Correlation is significant at the 0.01 level (2-tailed).

Overall, as shown in table 3, there is a positive correlation between all the factors contributing to self-efficacy. They are online learning technology experience, learners' attitude, learners' motivation, computer anxiety, and social support) Furthermore, self-efficacy for using online learning technology, all the p-value<0.05. Hence the H1 accepted, and Ho rejected. It can conclude that online learning technology experience, learners' attitudes, learners' motivation, computer anxiety, and social support significantly influence the respondents' self-efficacy for using online learning technology.

However, the strength differs from weak to strong. Based on above table there was a strong, positive correlation between social support and self-efficacy (r = .695, N=166, p < .001). However, the correlation between learners' motivation and self-efficacy is moderate (r = .578, N=166, p < .001). It is similar to correlation between online learning experience and self-efficacy (r = .495, N=166, p < .001). Result indicated that learners' attitude has weak correlation with self-efficacy (r = .313, N=166, p < .001). Finally, the result revealed that computer anxiety has very weak correlation with self-efficacy(r = .158, N=166, p < .001).

The respondents in this study agreed that the main factors that correlate with their self-efficacy on online learning technology are social support. It means that support from their parents, lecturers, and friends plays a vital role in influencing their self-efficacy using online learning technology. It is exciting to show that their motivation and attitude only moderately influence their self-efficacy on online learning technology. Finally, even though computer anxiety has significant with self-efficacy, however, it is very weak. It is a good sign that mainly respondents have experience in online technology; this is the first time online learning has become mandatory.

Chi-Square Test

In this study, researchers are running the Chi-Square test to identify the relationship between the respondent's genders, the respondent's age, and the dependent variable (self-efficacy) to identify the relationship.

The analysis of the chi-square based on the following hypothesis:

Ho: There is no significant relationship between genders and self-efficacy in online learning technology universities at Shah Alam.

H1: There is a significant relationship between genders and self-efficacy in online learning technology universities at Shah Alam.

Table 4 Chi-Square Table between Genders and Self-Efficacy

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	31.133[a]	23	.120
Likelihood Ratio	37.820	23	.027
Linear-by-Linear Association	2.474	1	.116
N of Valid Cases	166		

a. 36 cells (75.0%) have an expected count of less than 5. The minimum expected count is .35.

As shown in table 4, shows that there is no significant relationship between genders and self-efficacy. Since the p-value is greater than .005 (Pearson Chi-Square = .120 > .005), H0 is accepted and H1 is rejected. It shows that there is not enough evidence to suggest a significant relationship between genders and self-efficacy. Therefore, genders were found no relationship between self-efficacy.

Table 5 Chi-Square Table between Age and Self-Efficacy

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	55.477[a]	46	.160
Likelihood Ratio	65.264	46	.032
Linear-by-Linear Association	4.564	1	.033
N of Valid Cases	166		

a. 62 cells (86.1%) have an expected count of less than 5. The minimum expected count is .09.

The analysis of the chi-square result is based on the hypothesis below:
Ho: There is no significant difference between age and self-efficacy on online learning technology in Shah Alam universities.
H1: There is a significant difference between age and self-efficacy on online learning technology in Shah Alam universities.
As shown in table 4, there is no significant relationship between age and self-efficacy. Since the p-value is greater than .005 (Pearson Chi-Square = .160 > .005), H0 is accepted and H1 is rejected. It shows that there is not enough evidence to suggest a significant relationship between age and self-efficacy. Therefore, age was found no relationship between self-efficacy.

V. Conclusion and Recommendation

This study's most significant finding reveals that students have self-efficacy on online learning technology, even though this is the first time they use it as mandatory learning. The study also highlighted that social support in online learning. Interestingly, the study's findings also indicated that females and males and different ages have similar opinions on the factors that contribute to online learning technologies.

Overall, the study is beneficial to higher learning institutions, academicians, students, and society. Besides, it contributes to the world of knowledge in the area of technology for teaching and learning. Each of the stakeholders can know their role and contribution to the ease of online learning.

However, this study has some limitations, such as the key factors limiting to online learning technology experience, learners' attitudes, learners' motivation, computer anxiety, and social support. Besides, the sample's number only limit to universities in a city, which may not generalize the large population. Hence, future study is needed with other different factors and with the large population. Finally, the comparison study among universities and different states or different countries, or different methodology such as qualitative, can understand more on factors that contribute to self-efficacy on online learning among university students.

REFERENCES
[1] Tang, A. (2020). "Malaysia announces movement control order after spike in Covid-19 cases (updated)". The Star. Retrieved on 18 March 2020.
[2] Gillett-Swan, J. (2017). The Challenges of Online Learning: upporting and Engaging the Isolated Learner. Journal of Learning Design, 10(1), 20.
[3] Hodges, C. B. (2018). Self-efficacy in the context of online learning environments: A review of the literature and directions for research. Performance Improvement Quarterly, 20(3-4), 7-25.
[4] Keskin, S., & Yurdugül, H. (2020). Factors Affecting Students' Preferences for Online and Blended Learning: Motivational Vs. Cognitive. European Journal of Open, Distance and E-Learning, 22(2), 72-86.
[5] Alqurashi, E. (2016). Self-Efficacy in Online Learning Environments: A Literature Review. Contemporary Issues in Education Research (CIER), 9(1), 45-52. https://doi.org/10.19030/cier.v9i1.9549
[6] Bandura, A. (1997). Self-efficacy: The exercise of control. W H Freeman/Times Books/ Henry Holt & Co.
[7] Bandura, A., & National Inst of Mental Health. (1986). Prentice-Hall series in social learning theory. Social foundations of thought and action: A social cognitive theory. Prentice-Hall, Inc.
[8] Lee, P. C., & Mao, Z. (2016). The relation among self-efficacy, learning approaches, and academic performance: an exploratory study. Journal of Teaching in Travel & Tourism, 16(3), 178–194.

[9] Hendricks, K. S. (2016). The Sources of Self-Efficacy: Educational Research and Implications for Music. Update: Applications of Research in Music Education, 35(1), 32–38.

[10] Flammer, August. (2015). Self-Efficacy. 10.1016/B978-0-08-097086-8.25033-2.

[11] Krishnan, A., Barnett, K., McCormick, J., & Newcombe, G. (2016). A social cognitive investigation of Australian independent school Boards as teams. Journal of Educational Administration, 54(3), 288–304.

[12] Verešová, Marcela & Foglová, Lucia. (2018). Academic Self-Efficacy, Approach to Learning and Academic Achievement. 10.5772/intechopen.70948.

[13] Keller, M.J., and Chitnis, A.B. (2007) Insights into the evolutionary history of the vertebrate zic3 locus from a teleost-specific zic6 gene in the zebrafish, Danio rerio. Development genes and evolution. 217(7):541-547.

[14] Tarhini, A., El-Masri, M., Ali, M., & Serrano, A. (2016). Extending the UTAUT model to understand the customers' acceptance and use of internet banking in Lebanon. Information Technology & People.

[15] Schindler, L.A., Burkholder, G.J., Morad, O.A. et al. Computer-based technology and student engagement: a critical review of the literature. International Journal of Education Technical High Education 14, 25 (2017).

[16] Sun, A., & Chen, X. (2016). Online education and its effective practice: A research review. Journal of Information Technology Education, 15.

[17] Dwyer, R. J., Kushlev, K., Dunn, E. W. (2018). Smartphone use undermines enjoyment of face-to-face social interactions. Journal of Experimental Social Psychology, 78, 233-239. doi:10.1016/j.jesp.2017.10.007

[18] Guragain, N. (2016). E-Learning benefits and applications. Bachelor of Engineering Information Technology. Helsinki Metropolia University of Applied Sciences. Retrieved 12/7/2018 from: https//www.ILeseus,fi>Guragain Nischal.

[19] Nortvig, A. M., Petersen, A. K., and Balle, S. H., (2018). A Literature Review of the Factors Influencing ELearning and Blended Learning in Relation to Learning Outcome, Student Satisfaction and Engagement. The Electronic Journal of e-Learning, 16(1), pp. 46-55

[20] Nguyen, T. (2015). The Effectiveness of Online Learning: Beyond No Significant Difference and Future Horizons. MERLOT Journal of Online Learning and Teaching. Vol. 11, No.2.

[21] Ullah, Obaid. (2018). Students' Attitude towards Online Learning at Tertiary Level.

[22] Guyer, Joshua & Fabrigar, Leandre. (2015). The attitude-behavior link: A review of the history.

[23] Dursun, O. O., Donmez, O., & Akbulut, Y. (2018). Predictors of Cyberloafing among Preservice Information Technology Teachers. Contemporary Educational Technology, 9(1), 22-41.

[24] Hussein, Z., Harun, A., & Oon, S. W. (2016). The influence of the smartphone user's characteristics on the intention to use of M-health. International E-Journal of Advances in Social Sciences, 2(5), 598-602.

[25] Zabadi, A. M., & Al-Alawi, A. H. (2016). University students' attitudes towards e-learning: University of Business & Technology (UBT)-Saudi Arabia-Jeddah: A case study. International Journal of Business and Management, 11(6), 286-295.

[26] Rhema, A., Miliszewska, I., & Sztendur, E. (2013). Attitudes towards e-Learning and Satisfaction with Technology among Engineering Students and Instructors in Libya. Proceedings of the 2013 InSITE Conference.

[27] Peytcheva-Forsyth, R., Aleksieva, L., & Yovkova, B. (2018, December). The impact of technology on cheating and plagiarism in the assessment–The teachers' and students' perspectives. In AIP conference proceedings (Vol. 2048, No. 1, p. 020037). AIP Publishing LLC.

[28] Brown, A. (1987). Metacognition, executive control, self-regulation, and other more mysterious mechanisms. Metacognition, motivation, and understanding.

[29] Hartnett, M. (2016). Motivation in online education. Singapore: Springer.

[30] Zhao, L. (2015). The Influence of Learners' Motivation and Attitudes on Second Language Teaching□. Theory and Practice in Language Studies, 5(11), 2333-2339.

[31] Alario-Hoyos, C., Estévez-Ayres, I., Pérez-Sanagustín, M., Kloos, C. D., & Fernández-Panadero, C. (2017). Understanding learners' motivation and learning strategies in MOOCs. The International Review of Research in Open and Distributed Learning, 18(3).

[32] de Barba, P. G., Kennedy, G. E., & Ainley, M. D. (2016). The role of students' motivation and participation in predicting performance in a MOOC. Journal of Computer Assisted Learning, 32(3), 218-231.

[33] Chua, S. L., Chen, D. T., & Wong, A. F. (1999). Computer anxiety and its correlates: a meta-analysis. Computers in human behavior, 15(5), 609-623.

[34] Achim, Nur`ain & Kassim, Arraqib. (2015). Computer Usage: The Impact of Computer Anxiety and Computer Self-efficacy. Procedia - Social and Behavioral Sciences. 172. 701-708. 10.1016/j.sbspro.2015.01.422.

[35] Agah, J. J., Ogbeche, A. T., & Okorie, E. U. (2016). Computer Anxiety, Operation Skills and Attitude As Correlates of Students Preparedness for Computer Based Assessment. International Journal of Education and Research, 4(2), 71-74.

[36] Salamah, I., Ganiardi, M. A., Kusumanto, R. (2015). Computer Anxiety and Computer Attitude towards Computer Self Efficacy (CSE) Polsri Telecommunication Engineering Student on Writing the Final Report. Proceeding of the Electrical Engineering Computer Science and Informatics, 2(1).

[37] Celik, V., & Yesilyurt, E. (2013). Attitudes to technology, perceived computer self-efficacy and computer anxiety as predictors of computer supported education. Computers & Education, 60(1), 148-158.

[38] Saade, Raafat & Kira, Dennis. (2009). Computer Anxiety in E-Learning: The Effect of Computer Self-Efficacy. Journal of Information Technology in Education. 8. 177-191. 10.28945/166.

[39] Thinakaran, R., Ali, R., & Husin, W. N. A. A. W. (2018). A Case Study of Undergraduate Students Computer Self-Efficacy from Rural Areas. International Journal of Engineering & Technology, 7(3.20), 270-274.

[40] Sahin Baltaci, H., & Karatas, Z. (2015). Perceived Social Support, Depression and Life Satisfaction as the Predictor of the Resilience of Secondary School Students: The Case of Burdur. Eurasian Journal of Educational Research, 60, 111-130.

[41] Catabay, C. J., Stockman, J. K., Campbell, J. C., & Tsuyuki, K. (2019). Perceived stress and   mental health: The mediating roles of social support and resilience among black women   exposed to sexual violence. Journal of Affective Disorders, 259, 143–149.

[42] Zhou, G., Gan, Y., Hamilton, K., & Schwarzer, R. (2017). The Role of Social Support and Self   efficacy for Planning Fruit and Vegetable Intake. Journal of Nutrition Education and Behavior, 49(2), 100–106.e1.

[43] Andi Wahyu Irawan .W., Dwisona D. Lestari M. (2020), Psychological Impacts of Students on Online Learning During the Pandemic COVID-19, Jurnal Bimbingan dan Konseling (E-Journal) 7(1):53-60,DOI: 10.24042/kons.v7i1.6389

[44] Lai, B. S., Kelley, M. L., Harrison, K. M., Thompson, J. E., & Self-Brown, S. (2015). Posttraumatic stress, anxiety, and depression symptoms among children after Hurricane Katrina: A latent profile analysis. Journal of Child and Family Studies, 24(5), 1262-1270.

[45] Sawahel W (2020), Social media offers platform for online learning – Study, International Higher Education, Fall Issue, No. 104, 2020.

Wireless Communication using VLC and MIMO Technology

Dr. Nitesh Gupta

Associate Professor and HoD
Department of Computer Science Engineering
Technocrats Institute of Technology, Bhopal, India.

Abstract: **Due to the rapid growths in Light Emitting Diodes, VLC (Visible Light Communication) has received a great attention in last years. Our main aim of this research work is to build the wireless VLC (Visible Light Communication) system which should be able to transmit the data in-between two computers with the use of a visible light. We are using an LED array as the transmitter, Light Dependent Resistor (LDR) as the receiver component and air as the transmission medium. In both the transmitter and receiver modules, we are using Arduino UNO microcontroller board. Two computers have been used to interface the software to the hardware with the help of Arduino IDE installed to both of them. If we want to check the performance of VLC system with MIMO, commercial optical system simulation software called OptiSystem7.0 from Optiwave can be used. The layout diagram for both SISO (Single Input Single Output) and MIMO (Multiple Input Multiple Output) communication has been generated and has been run and the BER (Bit Error Rate) performance is being analyzed. FSO (Free Space Optical) communication channel is used as transmission medium for both SISO and MIMO. Data transmission and reception for 100 meters is done using OptiSystem software. The eye diagram of BER analyzer showed that the maximum quality factor of MIMO is relatively large when compared to SISO**.

Index Terms: **SISO (Single Input Single Output), Visible Light Communication (VLC), Light Emitting Diode (LED), Arduino, MIMO (Multiple Input Multiple Output).**
_____

I. INTRODUCTION

In the last decade, the demand for data usage has increased exponentially. All the peoples want to be connected to internet whole time, on multiple devices at the same time, update the latest happenings at each place etc. With the advancement of IOT (Internet of Things) more and more devices will get connected to the LTE which will result in speed decrement and congestion. Considered multiple options and of them was to utilize the unused visible light spectrum to solve this crisis and it risen the new concept called Light fidelity (Li-Fi). As the meaning of those terms are one and the same. Li-Fi is the kind of visible light communication structure. VLC is also a part of the Optical Wireless Communication. These techniques can enable the communication by modulating the light in the visible spectrum, which can mostly be used for the illumination resolves [1]. Li-Fi is unique because here the same light is being used for communication purpose and also illumination. Radio wave spectrum is very limited and visible light spectrum is made use for the communication determination.

Visible light communication, as the name says it is a communication technique based on visible light. This spectrum is a part of electromagnetic spectrum and that is surely visible to the human eye. The visible light in common terms is simply called as light itself. This mode of communication is wireless. Nowadays, IR (Infrared) systems have been developed to provide more data rate, because the conventional systems such as Bluetooth, radio communication and Wi-Fi had low speed. VLC system uses different colored LED's and some colored LED combinations to produce white light. Some filters will be used in the receiver side to separate different colored lights. White LED's are the most widely used ones in visible light communication system. In order to achieve high data rate in our hardware, we made use of array of LED's. The array of LED's provides better illumination as well as to achieve peak data rate. New modulation and multiplexing techniques are developed and used by the researchers to provide high data rate. LED flashlights and lasers are used in some applications which require high intensity light for long distance communication [1].

Taking Li-Fi as a consideration, it is a type of visible light communication method. It offers unlicensed spectrum and thus users can utilize wider range of bandwidth. Visible light is very much harmless to use, as any health hazards will not happen through it. This is because visible light don't penetrate through the wall, whereas electromagnetic waves can easily penetrate through the walls. Wi-Fi is not permissible in some of the hospitals due to harmful radiations. The direct line of sight (LOS) is one of the basic requirements for any kind of visible light communication. LOS between transmitter and receiver should be proper to achieve better data rate. If any obstacle/object or undesired wave come in between the transmitter and receiver, at that time the line of the sight gets disturbed and it cause denial of service (DoS). But the major advantage of using visible light spectrum is that, any hacker or intruder outside the room will not be able to utilize data. Because of this reason more secure communication takes place [2].

SISO (Single Input Single Output) systems are most of the times used for smaller applications. Adding MIMO (Multiple Input Multiple Output) technology along with VLC is a better idea for larger applications in real time. In this paper we have designed a hardware setup for PC to PC communication using VLC. This is a SISO system and an experimental setup for smaller distance. This can be further improved if high intensity light sources are used. And to check the advantages of including MIMO in VLC system, we did some simulations. The BER (Bit Error Rate) performance of both SISO and MIMO is analyzed. As this is indoor VLC application, distance between transmitter and receiver is set in terms of meters. In case of outdoor scenario, distance can be

increased up to kilometer range. But the FSO (Free Space Optical) channel should be used and atmospheric conditions must be taken into consideration.

II. LITERATURE REVIEW

Some papers which are related to visible light communication, MIMO, LED, free space optics, etc are referred for this project work. Satish R. Devane & Zashi P. Choudhari have designed high sensitive universal Li-fi receiver. The main aim was to enhance the data communication. In this research paper, authors describes the working and characteristic features of LED based visible light communication. They showcase the advantages of using non-hazardous LED light [3]. Shaik.Shakeera et.al designed a Computer to Computer File Transfer system with the use of Li-Fi Technology. The main aim of their work was about text data transmission. Text transmission from PC to PC is executed with better speed than Wi-Fi. Their work is an inspiration to develop hardware model for Li-Fi. In future scope, authors highlighted about Li-Fi hotspots, which can be transmitted in Gbps order [4].

Akash Gupta et.al developed a Cascaded FSO-VLC Communication System. Both VLC and FSO are the major areas of interest in our work. The performance of FSO-VLC system is being analyzed by them. Different indoor and outdoor parameters are considered in their work. Their work provides a solution to spectral congestion problem faced by most of the wireless communication types [5]. Chetna Verma and Chetan Selwal used diversity technique invisible light communication system. Along with that they included 4 QAM (Quadrature Amplitude Modulation) OFDM (Orthogonal Frequency Division Multiplexing) FSO (Free Space Optical) link. Authors simulated utilizing OPTISYSTEM 12 version. They designed 4QAM OFDM FSO link in three different stages. And also the performance of the system for different environmental conditions was simulated and analyzed [6].

Hammed G. Olanrewaju et.al illustrated MIMO-OFDM system in their paper. The BER plots obtained in their simulation show that high performance gains are achieved by using DPWC (Dual Pair-wise Coding) [7]. Fabian Harendran Jesuthasan et.al designed SISO-VLC and 2x2 MIMO setup. They transmitted the audio sound through both the setups. They concluded that quality and receiving range was improved in MIMO-VLC when compared to SISO-VLC system [8].

III. HARDWARE MODEL

The hardware model consists of two PC's (Personal Computers) at both transmitter and receiver side. And also two Arduino UNO boards are required at the transmitter and receiver modules. Arduino UNO is the hardware which is fully based on the microcontroller ATmega 328P. It is having 14 digital input/output pins out of which, we can use 6 as PWM outputs, 6 as analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, a reset button and an ICSP header [9]. LED array is used as source of illumination and as data transmitter [10]. LED arrays are assemblies of LED packages that provide high intensity light. The white LED's are being used in this hardware model. TIP122 is a bipolar transistor and is used at the transmitter side circuit. The main thing to remember about this transistor is that it allows a current of 5 A to flow from the emitter through the collector and 120 mA from the emitter through the base to flow [11]. The hardware is shown in **Fig.1**.
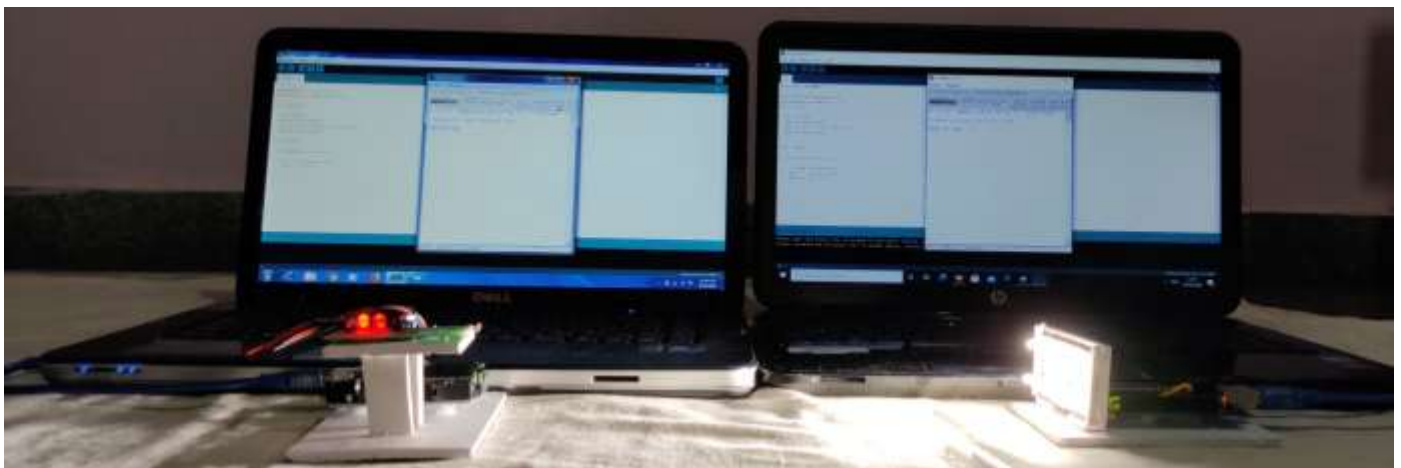

Fig.1: The hardware of PC to PC communication transmitter and receiver

Coming to the receiver side there is a LDR Sensor Module which can be used if we want to detect the presence of light or if we want to measure the intensity of light. The output of this module goes to high level whenever the presence of light is there and it also goes to low level whenever the absence of light is there [12]. A single LDR module will be used and can detect the light for around 15 centimeter distance. The Arduino IDE and X-CTU software (serial terminal software) was installed in both PC's. The embedded C programming is done on Arduino IDE of both transmitter and receiver side and are compiled. Once both transmitter and receiver side codes are compiled without error. The programs are then dumped into Arduino UNO boards after connecting the PC using USB connector. Once connections and program dumping is over, the message is typed on the serial monitor of transmitter side PC. The same message will be displayed on the receiver side PC's serial monitor. The text transmission was successful for smaller distance that is around 15 centimeters. To further check the performance of Visible light communication for larger distance and for real time applications, layout design and simulations are done using OptiSystem software.

IV. SIMULATION SYSTEM MODEL

In this proposed system, commercial optical system simulation software (OptiSystem7.0) from Optiwave is used. The layout diagram for both of Multiple Input Multiple Output & Single Input Single Output have been generated and has been run and the BER performance is being analyzed. A CW (Continuous Wave) laser diode is used at transmitter side with 1W power and visible light frequency. A CW laser with frequency of red color is used, that is 700 nm. A pseudo random bit sequence generator is used for data bits generation which supports a high data rate of about 35G bits/second. Both data bits and laser light will be fed into a Mach-Zehnder modulator. This MZ modulator is used for controlling the amplitude of an optical wave. Optical amplifier is used to increase the signal strength. FSO (Free Space Optical) Channel is used as communication channel. This FSO is not only meant for indoor communication, it is suitable for free space communication as well [13]. FSO is a form of optical communication technology where larger distances can be covered [14]. I have done data transmission and reception for 100 meters. But it is even possible to communicate in terms of kilometers. As this project is based on indoor VLC, a 100 meter distance is more than enough for indoor applications.

At the receiver side, Avalanche photodiode is being used. It is extremely sensitive semiconductor photodiode that feats photoelectric effect to covert light into an electricity. For long range communication, this APD is very much suitable when compared to other diodes [15]. The Bessel filter is enhanced to offer a constant group delay in the filter pass-band, while forfeiting intelligence in the magnitude reply. 3R regenerator is a subsystem based on the Data Recovery component and a NRZ (Non Return to Zero) pulse generator. Instead of connecting the bit error rate analyzer to input signals, this component 3R regenerator can be used to recover the bit sequence. The reference signal is nothing but the output signal itself [16]. Electrical and optical power meters are connected to some components to check the power dissipation over distance.

A general modulation format which can be useful in optical communication is Non-return to zero. It is also known as OOK (On-Off Keying) because during any communication, the light source will be switch on and off and it depends on logical value of binary data signal. The logged trace can be disjointed into 1.5 or 2 bit segments and then they are covered on the top of each other so that it will form an eye diagram. For signal deficiency detection in OOK signaling we can also use eye diagram. BER analyzer is used at the receiver to know the BER performance [17]. As both SISO and MIMO layouts are designs. BER performance of MIMO over SISO is compared. The layout diagram of SISO VLC is as shown in **Fig.2**. A single transmitter and single receiver with one FSO channel are used in layout. The BER analyzer can automatically calculate the bit error rate and a Quality factor.
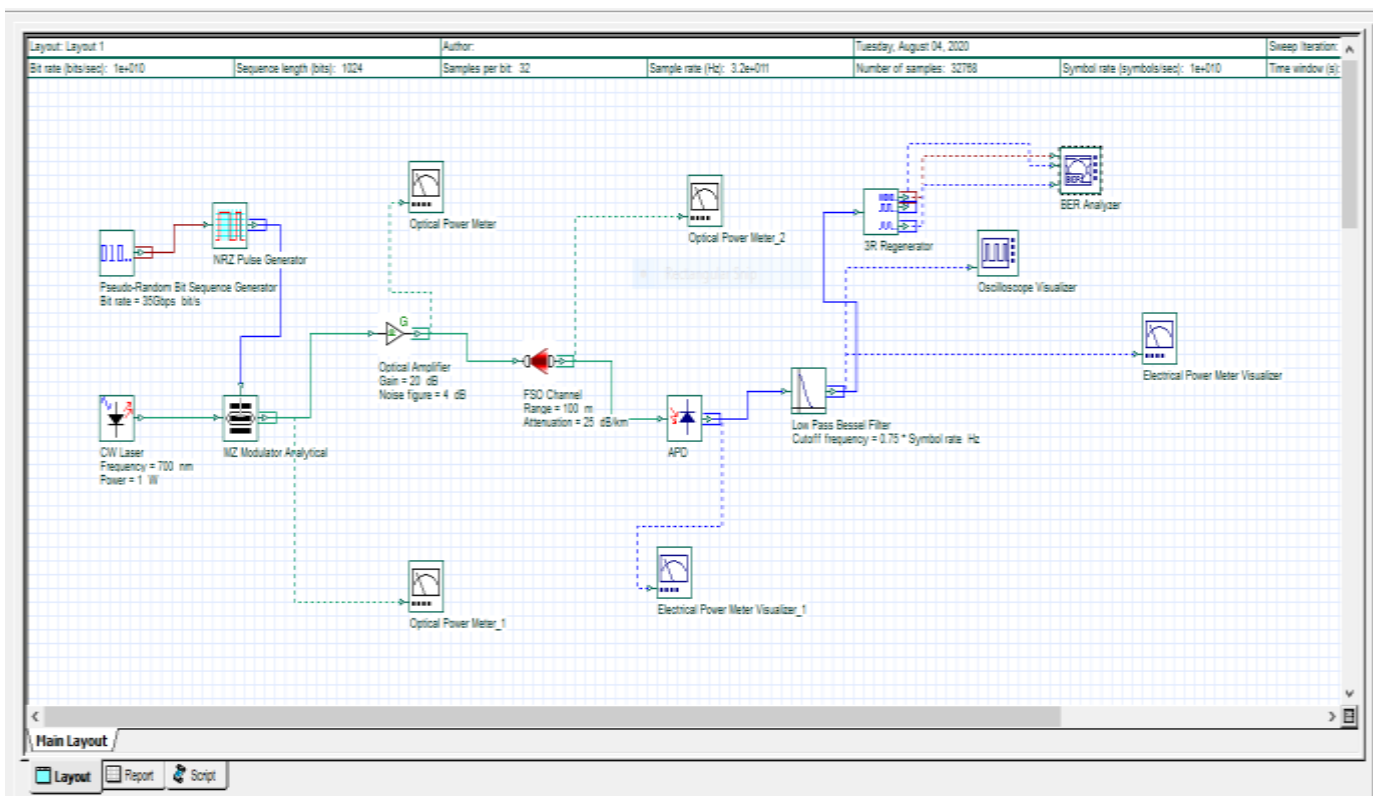

Fig.2: The layout of SISO (Single Input Single Output) Visible light communication transceivers using FSO channel.

MIMO takes benefit from the spatial multiplicity and it receives multiple autonomous copies of same signal at the receiver side. MIMO system will increase signal to noise ratio & BER [8]. The optical amplifier power is increased in the layout design, as we have to transmit more power. The MIMO technology can also increase data rate. And it is also capable of improving the system dependability through spatial multiplicity [7]. In the layout of MIMO transceiver, four transmitters and receivers are used. A 1 to N fork is used to multiply the number of transmitters. And power combiner is used at the receiver side to multiply the receiver blocks. The layout designed for MIMO VLC system using OptiSystem software is shown in **Fig.3 below:**
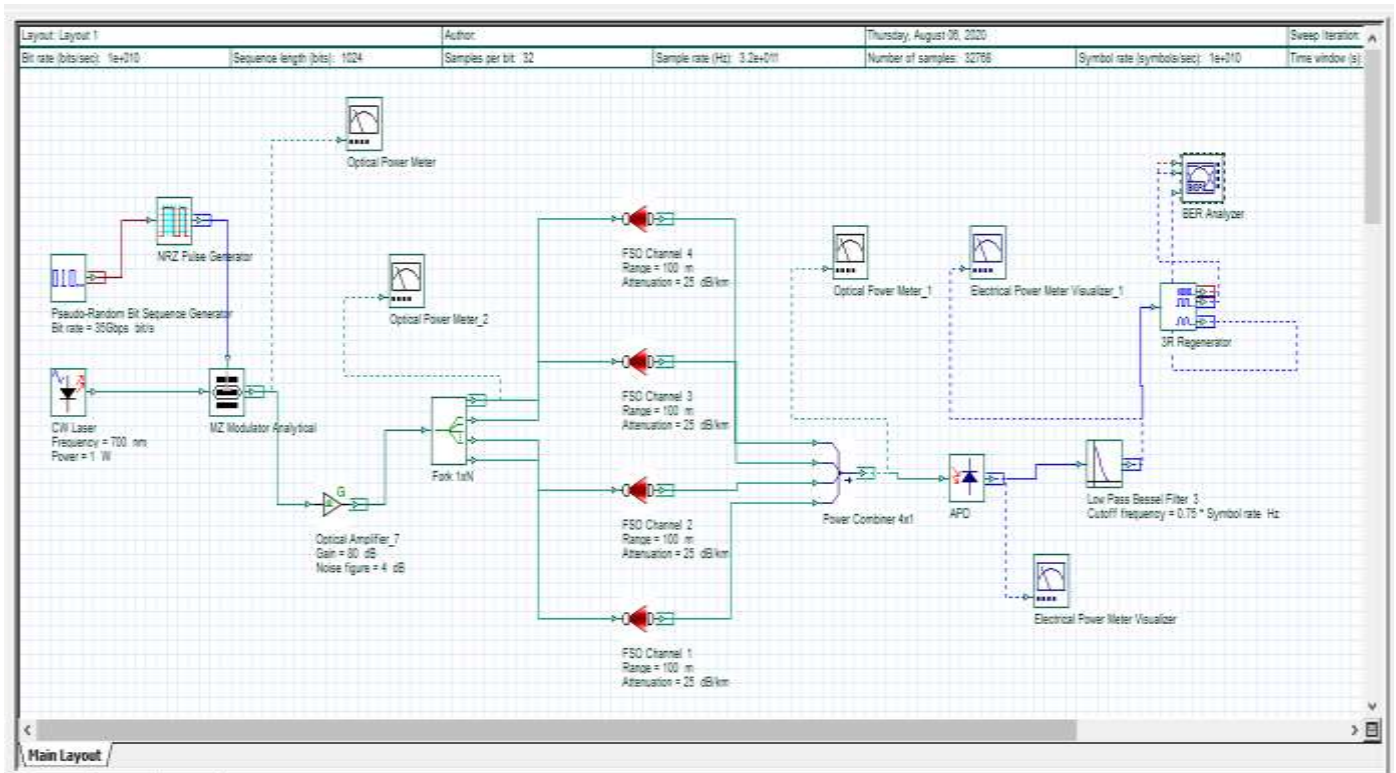
Fig.3: The layout of MIMO (Multiple Input Multiple Output) Visible light communication transceivers (4x4 MIMO) using 4 FSO channels.

V. SIMULATION PARAMETERS AND RESULTS

The Q factor is a degree of how noisy a pulse is, this is for analysis commitments. The oscilloscope will normally produce a report that shows the Q factor number. A larger number of Q factor in the result means that the pulse is relatively free from noise. The eye diagram of BER analyzer shows that the maximum Q factor of MIMO is relatively large when compared to SISO. The BER analyzer output for SISO and MIMO is as shown in Fig.6 and Fig.7 respectively. That is 10381.4 and 10902.6 is the maximum Q factor for SISO and MIMO system respectively. Hence the pulse is relatively free from noise indicating better performance. As the distance between transmitter and receiver is 100 meters, this can be implemented in SISO form and also as MIMO form for larger applications.

Almost all the parameters considered for SISO and MIMO are same except optical amplifier gain. As the number of transmitters and receivers are more in MIMO and there are four FSO channels. The optical amplifier gain is multiplied by four. The simulation parameters and their values are listed below in tabular form. Table 1 show the parameters which are considered for the simulation purpose.

Table 1 Simulation Parameters

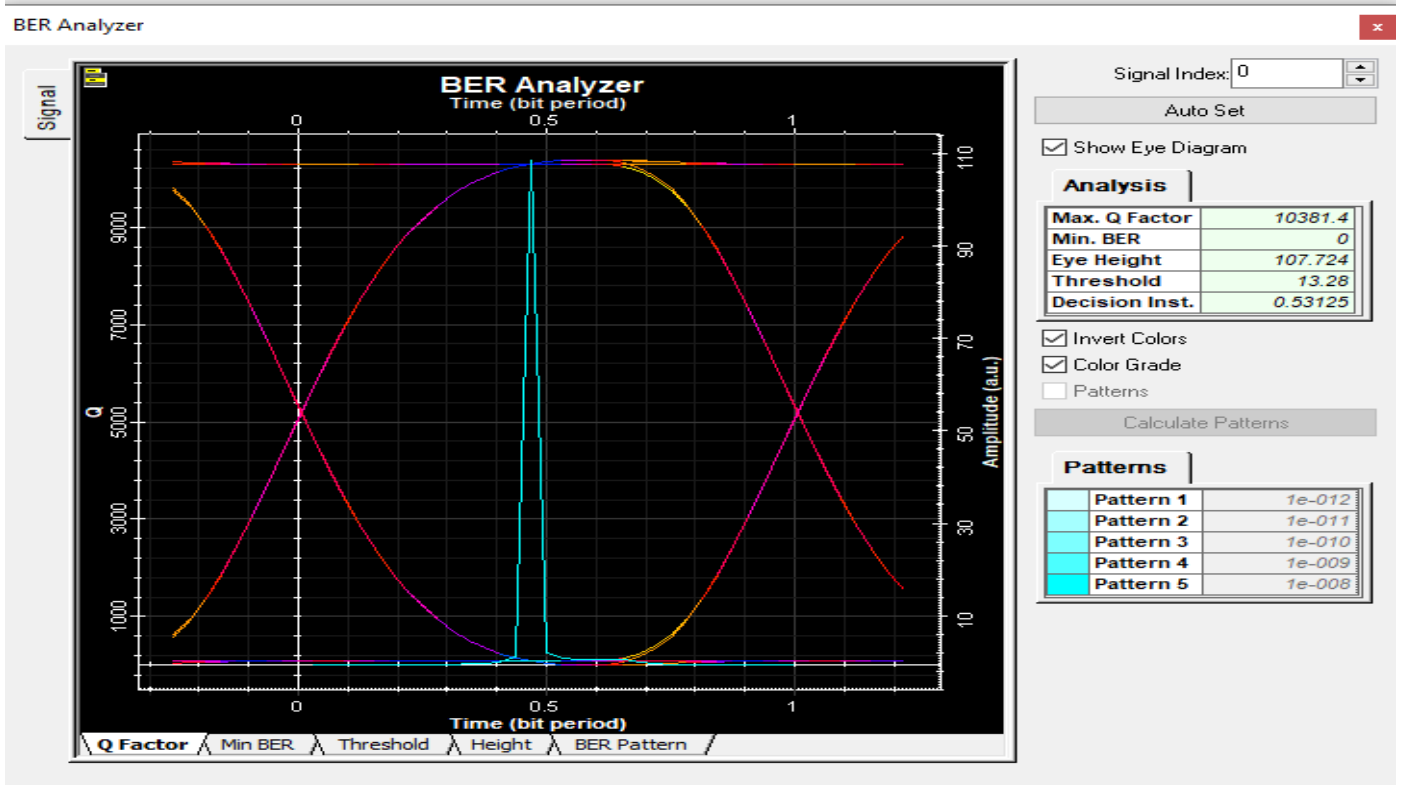| Component	Parameter	value
PR bit sequence generator	Bit rate	35Gbps
CW laser	Frequency Power	700nm 1Watt
Optical Amplifier	Gain Noise figure	20dB (SISO) 80dB (MIMO) 4dB
FSO channel	Range Attenuation	100 m 25dB/Km

Fig.6: BER analyzer output of SISO (Single Input Single Output) Visible light communication transceivers using FSO channel.
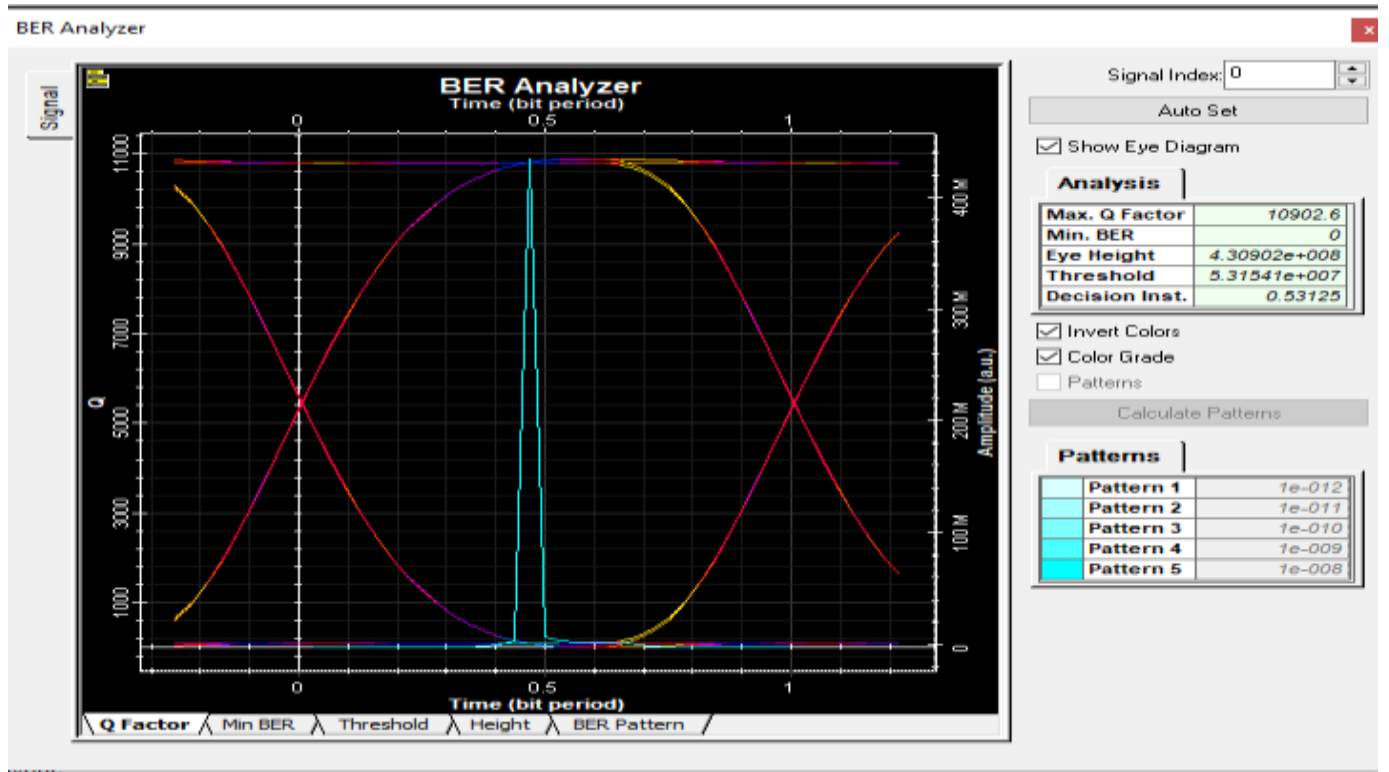

Fig.7: The BER analyzer output of MIMO (Multiple Input Multiple Output) Visible light communication transceivers (4x4 MIMO) using 4 FSO channels

VI. CONCLUSION

This paper is all about data transmission through visible light. Using the visible light spectrum, data transmission from one PC to another is successfully done for smaller distance. For longer distance communication, simulations are done by transmitting data at a bit rate of 35Gbps. Both SISO and MIMO VLC systems are designed and simulated. The distance is set to 100 meters and is

sufficient for indoor VLC system. In future work, FSO channels can be implemented for outdoor communication purpose with distance in terms of kilometers. But, in outdoor VLC, atmospheric conditions should be taken into consideration for speedy communication.

REFERENCES

[1] S. Das, A. Chakraborty, D. Chakraborty and S. Moshat, "PC to PC data transmission using visible light communication," 2017 International Conference on Computer Communication and Informatics (ICCCI), Coimbatore, 2017, pp. 1-5, doi: 10.1109/ICCCI.2017.8117767.

[2] Mr. Yogesh Chawan, Mr. Ramchandra Gaurav, "Data Transfer using Visible Light Communication", 2017 – Volume 4 Issue 2 January 2017, IARJSET

[3] Zashi P. Choudhari and Satish R. Devane. "High sensitivity universal Lifi receiver for enhance data communication". Online International Conference on Green Engineering and Technologies (IC-GET), 2016, Mumbai, INDIA.

[4] M.Lotfy Rabe, Mohammad I Gabar, Tarek Husny, "Data Transmission via Visible Light Communication (VLC) Technique", Volume 5 Issue 9, September 2016, IJIRSET (ISSN: 2319-8753)

[5] Prashant D. Nehare, Mayur Purohit, Chaitali S. Somase, Piyush Sarode, "Transmission of Data through [Li-Fi] Light Fidelity From One PC to another PC", IRJET, Volume 4 Issue 4, Apr-2017.

[6] Akash Gupta et.al." Cascaded FSO-VLC Communication System". IEEE Wireless Communications, 2017.

[7] Chetna Verma and Chetan Selwal "Visible light communication system (VLC) Using Diversity Technique with 4 QAM OFDM FSO Link", IEEE Xplore , 2018.

[8] Hammed G. Olanrewaju et.al. "Pairwise Coding for MIMO-OFDM Visible Light Communication". IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS, 2019.

[9] Fabian Harendran Jesuthasan et.al." Implementation and Performance Evaluation of a MIMO-VLC System for Data Transmissions". IEEE, 2019.

[10] https://www.arduino.cc/en/Main/Boards

[11] https://www.prophotonix.com/resources/technical-overviews/led-array-methods/

[12] http://henrysbench.capnfatz.com/henrys-bench/arduino-output-devices/tip122-arduinorelay-tutorial/

[13] Liang K., Chow C.W., Liu Y. "RGB visible light communication using mobile-phone camera and multi-input multi-output". Opt. Express.2016.

[14] Zhitong Huang et.al." Hybrid Optical Wireless Network for Future SAGO-Integrated Communication Based on FSO/VLC Heterogeneous Interconnection". IEEE Photonics Journal, 2017.

[15] Milica Petkovic." Outage Probability Analysis of RF/FSO-VLC Communication Relaying System". IEEE.

[16] https://en.wikipedia.org/wiki/Avalanche_photodiode

[17] https://optiwave.com/forums/topic/3r-regenerator/