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Indian Journal of Mechanical and Thermal Engineering

Aims and Scope

Indian Journal of Mechanical and Thermal Engineering is a peer-reviewed journal for the presentation of original contributions and the exchange of knowledge and experience on the sciences of heat transfer and thermodynamics, and contribute to the literature of engineering sciences on the national and international areas but also help the development of mechanical engineering. engineers and academicians from disciplines of power plant engineering, energy engineering, building services engineering, HVAC engineering, solar engineering, Wind engineering, Nano engineering, surface engineering, thin film technologies, and computer aided engineering will be expected to benefit from this journal's conclusions.

Indian Journal of Mechanical and Thermal Engineering

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Contents

Morphometric Analysis of Wadi QENA using SRTM DEM and GIS analysis

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ABSTRACT

In this article, Shuttle Radar Topography Mission (SRTM) Digital Elevation Models (DEMs) data was processed and analyzed using GIS techniques to extract the morphometric parameters of Wadi Qena. This basin subdivided here into 24 sub-basin. The quantitative analysis of the drainage basin revealed values of bifurcation ratio, drainage density, circularity ratio, elongation ratio, form factor, stream frequency and drainage intensity of the studied sub-basins. Analysis and interpretation of the morphometric parameters indicated that few sub- basins vulnerable to flood hazards resulting high runoff in areas of high relief and slope. However, the rest of sub-basins of moderate to low runoff capacity. The quantitative analysis of the studied basin and sub-basins presented meaningful information about the basin characteristics.

Keywords: GIS, Wadi Qena, Morphometric analysis

1. INTRODUCTION

Remotely-sensed digital elevation model (DEM) obtained from SRTM is widely used for analyzing the drainage networks to extract the geomorphic, morphotectonic, morphometric parameters (El Basstawesy et al., 2010; Abdelkareem and El-Baz 2015 a, b; Withanage et al., 2014; Abdalla et al., 2014) and extraction of the tectonic features reflected on topography (Abdelkareem and El-Baz 2015 c, d). Drainage networks extraction also used in lineament extraction and analyses of the drainage basin (Jordan et al., 2005; Simpson 1992), predict the past hydrologic conditions (Strahler 1964; and reconstruction of paleodrainage systems (Abdelkareem et al., 2012 a; Abdelkareem and El-Baz 2016). Morphometry is defined as the measurement and mathematical processing of the configuration of the earth's surface and of the shape and dimension of its landforms (Clarke, 1966). Morphometric methods, though simple, have been applied for the analysis of area-height relationships, determination of erosion surfaces, slopes, relative relief and terrain characteristics, river basin evaluation, watershed prioritization for soil and water conservation activities in river basins (Kanth, 2012). The use of GIS technique in the morphometric analysis has proven to be a powerful tool in recent years particularly for remote areas with limited access. The aim of the present study is to understand the morphometric characteristics of wadi Qena basin.

2. STUDY AREA

Wadi Qena is located in the Eastern Desert of Egypt that lies between latitudes 26 0 10\ to 28 0 5\ N and longitudes 320 31\ to 320 45\ E ; it`s area is covering about 15746. 5 km2. It represents the major valley

of the Nile basin that straddles the eastern Sahara (Abdelkareem and El-Baz 2015 d, Abdelkareem et al., 2012 b. It easily accessible by the asphaltic roads from Qena city along Qena- Safaga road. It also accessible along the Red Sea-Sohag-Asyut road that crossing the Ma'aza Plateau and the Red Sea highlands. However, it is difficult to accessible from north Wadi Qena because of the absence of asphaltic roads and long distance of more than 100 km. It is the region of the most promising areas for future development expansion to the proximity of the River Nile.

Table 1. The calculated parameters and the references of the sub-basins of Wadi Qena

No	Parameter	Symbol/Formula	Reference
1	Stream No. (Nu)	Nu= N1+N2+ +Nn	Horton (1945)
2	Stream length (Lu)	Lu= L1+L2+ +Ln	Strahler (1964)
3	Stream length ratio (R_l)	Rl=Lu/Lu-1	Horton (1945)
4	Bifurcation ratio (Rb)	Rb= Nu/Nu+1	Schumm (1956)
5	Basin Length (Lb) (km)	L_b = the longest in the basin in which are end being the mouth	Gregory and Walling(1973)
6	Area (A) (km)	A	Schumm (1956)
7	Perimeter (P) (km)	P	Schumm (1956)
8	Form factor (Rf)	Rf = A/(Lb)2	Horton (1932)
9	Elongation ratio (Re)	Re = 2?(A/π) / Lb	Schumm (1956)
10	Texture ratio (T)	T = N1/P	Schumm (1965)
11	Circulatory ratio (Rc)	Rc = 4πA/P2	Miller (1953)
12	Stream frequency (Fs)	F_s = ?N_u/A	Horton (1945)
13	Drainage density (Dd)	D_d = ?L_u/A	Horton (1945)

Figure 1. : Location map of wadi Qena basin

4. RESULTS OF DRAINAGE ANALYSIS AND MORPHOMETRIC PARAMETERS

The stream network analysis of entire Wadi Qena basin revealed a 7th order stream, supposing a mature drainage pattern (Abdelkareem and El-Baz 2015 d). Our results reveal that WQ subdivided into 24 sub-basins. The calculated parameters and the references are listed in table 2. The drainage networks analyses of Wadi Qena show dendritic, parallel, and radial drainages on sedimentary rocks, however, the basement shows irregular drainages (Abdelkareem, 2012). The dendritic drainage pattern associated with the limestone plateau that are underlain by homogenous rocks. The major streams at the sedimentary sequence along the main Wadi course are of parallel pattern and the small tributaries join the main stream as trellis that reflects steep slope.

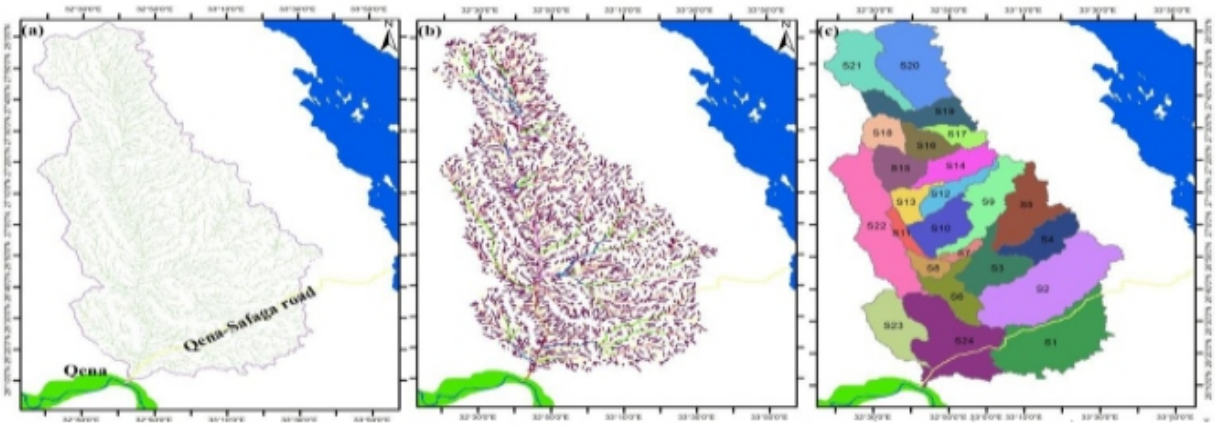

Figure 2. (a) drainage networks; (b) stream order; (c) sub-basins of Wadi Qena

Table 2. Morphometric parameters of Wadi Qena

Basin_NO	U	Nu	Lu	Rb	A	P	Lb	Rf	Re	T	Rc	Fs	Dd
1	6	2240	2324.46	4.45	1469.35	336.6	59.872	0.41	0.722	5.15	0.16	1.52	1.58
2	7	2724	3019.05	3.77	1796.26	324.2	75.275	0.317	0.635	6.51	0.21	1.52	1.68
3	6	848	1036.24	3.5	1871.35	217.4	36.785	1.383	1.327	3.08	0.5	0.45	0.55
4	5	760	737.89	4.96	493.81	183.2	41.708	0.284	0.601	3.23	0.18	1.54	1.49
5	6	1200	1248.87	3.99	775.33	251.3	54.047	0.265	0.581	3.72	0.15	1.55	1.61
6	6	670	807.318	3.62	465.82	215.1	42.003	0.264	0.58	2.47	0.13	1.44	1.73
7	4	153	166.35	4.95	92.24	78.74	22.383	0.184	0.484	1.54	0.19	1.66	1.8
8	5	274	333.12	3.9	195.89	123.6	14.411	0.943	1.096	1.73	0.16	1.4	1.7
9	6	1125	1197.36	3.93	721.67	293.1	66.892	0.161	0.453	2.95	0.11	1.56	1.66
10	6	825	1004.72	3.69	566.56	181.6	25.049	0.903	1.072	3.51	0.22	1.46	1.77
11	5	221	244.432	0.64	157.26	130.9	35.838	0.122	0.395	1.33	0.12	1.41	1.55
12	5	465	535.95	4.43	317.72	188.2	47.306	0.143	0.425	1.99	0.11	1.46	1.69
13	5	495	484.09	4.97	271.88	135.8	20.022	0.678	0.929	2.2	0.19	1.82	1.78
14	6	666	802.17	3.75	467.8	186.2	44.21	0.239	0.552	2.84	0.17	1.42	1.71
15	5	642	766	4.91	439.12	132.1	27.556	0.578	0.858	3.81	0.32	1.46	1.74
16	5	325	610.42	3.99	340.46	139.1	18	1.051	1.157	1.47	0.22	0.95	1.79
17	5	344	381.51	4.4	228.37	125.1	31.471	0.231	0.542	2.16	0.18	1.51	1.67
18	6	453	544.91	3.46	314.24	117.8	26.669	0.442	0.75	0.28	3.07	1.44	1.73
19	6	812	1002.21	3.7	566.63	230.5	17.526	1.845	1.533	2.72	0.13	1.43	1.77
20	6	1674	2196.42	4.24	1187.02	261.7	51.242	0.452	0.759	4.91	0.22	1.41	1.85
21	6	1134	1194.96	3.95	757.9	244.9	56.73	0.235	0.548	3.64	0.16	1.5	1.58
22	6	1969	2120.33	4.48	1377.65	373.4	92.398	0.161	0.453	4.07	0.12	1.43	1.54
23	6	911	986.47	3.83	646.05	210.8	50.317	0.255	0.57	3.37	0.18	1.41	1.53
24	6	1987	2495.28	4.47	1404.01	338.8	54.788	0.468	0.772	4.57	0.15	1.42	1.78

4.1 Bifurcation ratio (Rb)

The Bifurcation ratio (Rb) can be computed by dividing the number of streams in a given order by the number in the next higher order (Schumm 1956). The values of Rb in table 2 are higher in many sub-basins such as S4, S7, S13, S15 that range from 4.482 to 4.973, but the lower in S11 that has 0.641.

4.2 Stream length ratio (Rl)

The Stream length ratio (Rl) is defined as the length of the mainstream in the sub-basin. It`s value ranges from 0.4381 to 0.9512; which the higher value in S7, S11 that reveal elongated basins. However, S3, and S15 are not elongated but almost sub-circular.

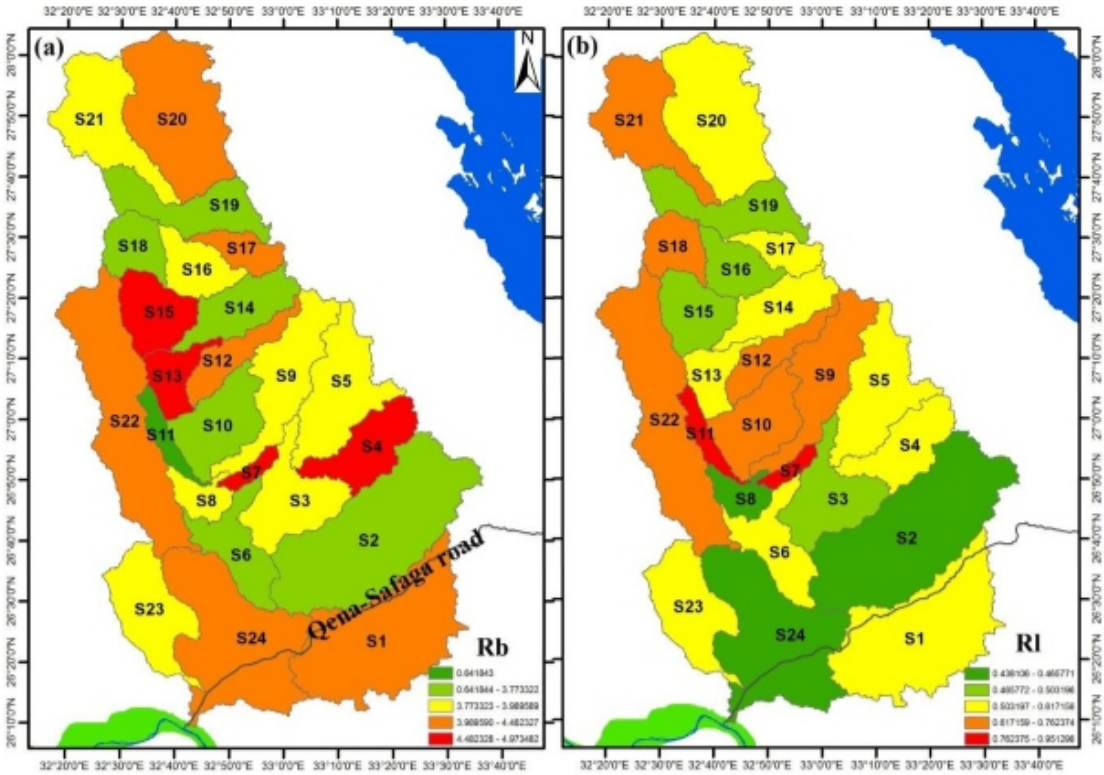

Figure 3. (a) Bifurcation ratio (Rb), and (b) Stream length ratio (Rl)

4.3 Basin length (Lb)

According to Gregorg and Waling (1973), the length of the basin (Lb) is the longest dimension of the basin parallel to the principal drainage line. The length of the studied Wadi Qena sub-basins ranges from 14.41 (S8) to 92.39 km (S 22). However, S2, and S22 area the most elongated basins in length based on computed Lb in table 2.

4.4 Basin area (A)

The total area projected upon a horizontal plane termed "Area" of the basin(Schumm1956). The reform the area (A) of Wadi Qena sub basins ranges from 92.249 (S7) to 1871.351 (S3) km2. Large areas contains several streams rather than the small one, this collect much water to the outlet such as sub-basins S1, S2, S3, S20, S22, and S24.

4.5 Basin perimeter (P)

Perimeter is the length of the boundary of the basin (Schumm (1956). It is measured along the divide between watersheds and may be used as an indicator of watershed size and shape. The perimeter of Wadi Qena sub-basins ranges from 78.743 (S7) to 373.401 (S22) km. We observe a positive relation between of Area and Perimeter, as the sub-basins of high area are of high Perimeter e.g., S2, S22, S24, and S1.

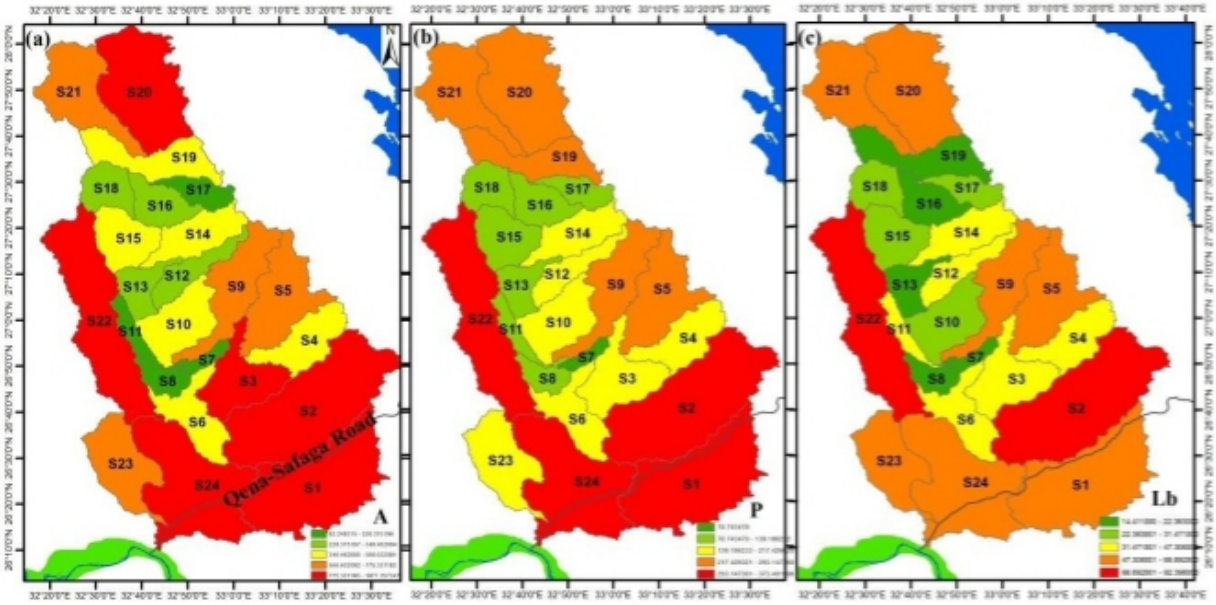

Figure 4. (a) Basin area (A), (b) Basin parameter (p), and (c) Basin length (Lb)

4.6 Elongation ratio(Re)

The elongation ratio (Re) is the ratio between the diameter of the circle of the same area as the drainage basin and the maximum length of the basin (Schumm, 1956). It is a very significant index in the analysis of the basin shape which helps to give an indication about the hydrological character of a drainage basin. The Re ranges from 0.39 (S11) to 1.53 (S19). The Re values (Table 2) are higher in sub-basins S19, S16 but the lower values are in S 11, S12, S19, and S22. Many sub-basins reveal circular shape such as S10, S8, and S3 but the more elongated sub-basins are S11, S22, S9, and S7.

4.7 Form Factor (Rf)

The form factor (Rf) may be defined as the ratio of the area of the basin to the square of basin length (Horton, 1932). The values of form factor would always be less than 0.7584 (perfectly for a circular basin). It is the quantitative expression of drainage basin outline form. The elongated basin with low Rf indicates that the basin has a flatter peak with a longer duration. The Rf range from 0.122 (S11) to 1.84 (S19). The Rf values (Table 2) are higher in sub-basin S19, S3, S16, S8, but the lower values are in S11,S2, S9, S22, S12, S6 that range from 0.1207 to 0.254 .

4.8 Circularity ratios (Rc)

Miller (1953) defined the Circularity Ratio (RC) as the ratio of basin area to the area of a circle having the same circumference as the perimeter of the basin. The author described that the circularity ratios range from 0.4 to 0.5 which indicates strongly elongated and permeable homogenous geologic materials (Withanage et al., 2014). Rc ranges from 0.11 (S9, S12) to 3.07 (S18). Higher the value of Rc S18, S3, and S15 and lower values in S6,S9,S11,S12,S19,S 22.

4.9 Texture ratio (T)

The texture ratio (T) of Schumm (1965) is the ratio of first order population Nu1 to the perimeter (P) of the basin. Based on the computed data in table 4.3 and the distribution of the T values on the studied sub-basins, the T values range from 0.28 to 6.5. This revealing that S1, S2, and S20 of the higher population against the other sub-basins. This allowed to collect much surface water and promoting flood risks.

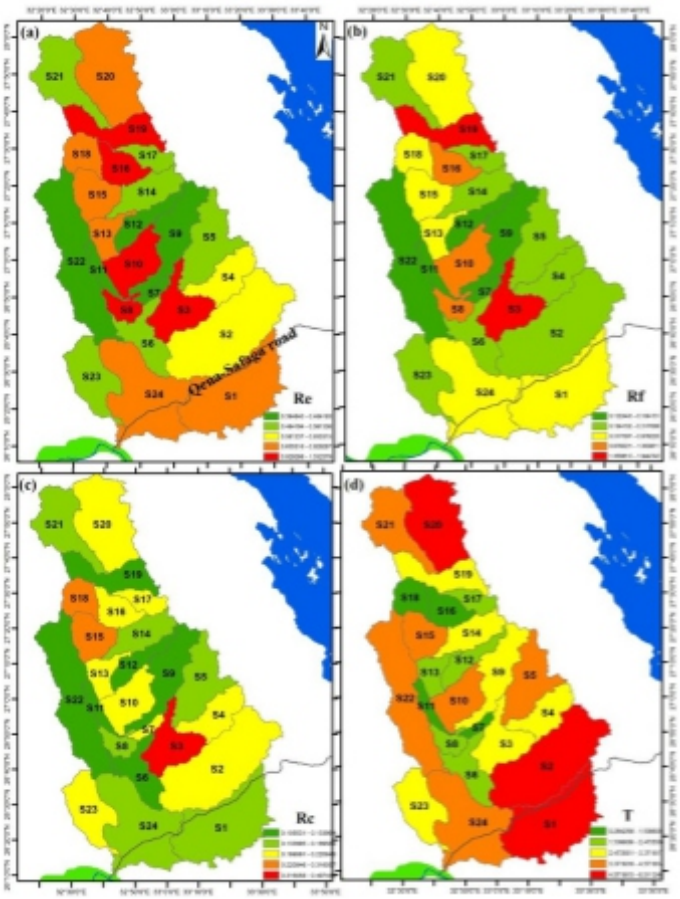

Figure 5. (a) Elongation ratio (Re), (b) Form Factor (Rf), (c) Circularity ratios (Rc), and Texture ratio

4.10 Stream frequency (Fs)

Horton (1932) described the stream frequency (Fs) as the total number of stream segments of all orders per unit area (Table.2). It depends on lithology, structures, infiltration capacity, vegetation cover, relief and amount of rainfall infiltrate to recharge the aquifers. The computed Fs range from 0.45 (S3) to 1,82 (S13). Higher values of Fs reveal fast runoff and the high peak of flood risk such as sub-basins S13, S7.

4.11 Drainage density (Dd)

Horton (1932) defined the drainage density (Dd) as an important indicator of the linear scale of landform elements in stream eroded topography (Horton, 1932). The Dd is defined as the ratio of total length of streams of all orders within the basin to the basin area, which is expressed in terms of km/km2.

Dd values may be 1 km per km2 through very permeable rocks; it`s valued range from 0.5537 (S3) to 1.8503km/km2 (S20). Areas of high drainage density relatively high runoff, promoting flood risk. Low Dd reflects erosion-resistant fractures hard rocks and most rainfall infiltrates to recharge the shallow aquifers.

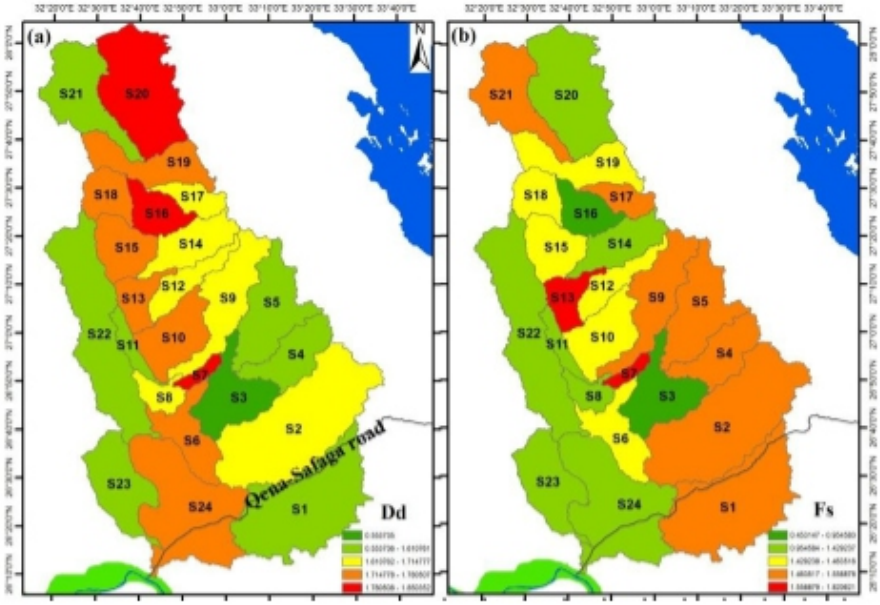

Figure 6. (a) Stream frequency (Fs), and (b) Drainage density (Dd)

6. SUMMARY AND CONCLUSION

Wadi Qena is one of the most important valleys in the Eastern Desert of Egypt. It links the Red Sea, Asyut, Qena, Sohag, and Luxor governorates. It is the region of the most promising areas for development area. It lies between latitudes 26 0 10\ to 28 05\ N and longitudes 320 31\ to 320 45\ E ; it`s covered the area about 15746. 5 km2 .

We computed morphometric analysis for the entire Wadi Qena basin to delineate understand the hydrologic conditions. We subdivided wadi Qena into 24 sub-basins. Several morphometric parameters were mathematically computed using GIS such as bifurcation ratio(Rb), stream length ratio(Rl), basin length(Lb), basin area(A), elongation ratio(Re), form factor(Rf), circularity ratio(Rc), texture ratio(T), stream frequency(Fs), and drainage density (Dd). These parameters spatially distributed to show the higher and lower values of the studied sub-basins.

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Solar Powered Z-Source Neutral Point Clamped Five Level Inverter Performance Analysis by Using SPWM and SVPWM technique

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ABSTRACT

The Scope of this paper is to reduce the harmonic content and to boost the output voltage by introducing an emerging technique termed as Z-Source multilevel inverter. The Z-Source inverter had overcome many drawbacks in traditional inverters (Voltage source & Current source Inverters). The main advantage of Z-Source inverter is the presence of shoot through period (Short circuit) which plays a important role in boosting the voltage .When the number of level in the output voltage of multilevel inverter is increased then accordingly the harmonics content is also reduced. Normally for a multilevel inverter the output voltage is restricted to summation of all the input voltage values .To enhance this feature Z-Source is introduced with multilevel inverter to obtain boosted voltage along with low harmonic distortion .The proposed methodology analysis the Z-Source Neutral point clamped inverter using Space vector modulation technique with MATLAB Simulink model and the related parameters are analyzed.

Index Terms – Boosted output voltage, Neutral Point Clamped Inverter (NPCI), Reduction in harmonic content, Shoot through state, Space Vector Pulse Width Modulation Technique (SVPWM), Z-Source Inverter.

I. INTRODUCTION

In recent years, multilevel inverters have drawn significant attention in research and high power applications such as Flexible AC Transmission Systems (FACTS), renewable energy resources, power quality devices , etc [1]-[4]. Such power converters have been the prime focus of power electronic researches in order to improve their performance, reliable, energy efficient at minimum cost. The important task of multilevel inverter is producing a sinusoidal voltage waveform from DC sources.

The major advantages of multilevel inverters are:

1. High voltage capability with voltage limited devices
2. Low harmonic distortion
3. Reduced switching losses
4. Increased efficiency
5. Good electromagnetic compatibility

Among several reported topologies, diode-clamped multilevel inverter, cascaded H-bridge multilevel inverter and flying capacitor multilevel inverter are very used [2]. To control these multilevel inverters several carrier-based PWM strategies and space vector PWM (SVPWM) have been reported [11]-[12].

Some other methods such as harmonic optimization attempt to reduce or eliminate harmonic in multilevel inverters [3].

Traditional inverters are known to produce an output voltage that is lower than the DC source voltage. In order to reach boosted voltage with available switching devices Z-Source inverters were invented in 2003 [4].

This structure uses unique X-shaped inductance-capacitance (LC) impedance network that is connected between the DC link and the AC side. There are shoot-through states in Z- source inverter. These states boost voltage and LC impedance network prevent short circuit problems. Recently, new topologies of multilevel Z-source are introduced [7], [13]-[5]-[6].

These structures are used in clean energy harnessing such as photovoltaic (PV) arrays, fuel cells, etc that have low DC voltage [6]. Some papers attempt to introduce special structures to reduce the number of elements of multilevel Z-source inverter .

In this paper, a five-level Z-source Neutral Point Clamped inverter is used to introduce advantages and disadvantages of Space vector pulse width modulation.

A. Block Diagram of Proposed Work

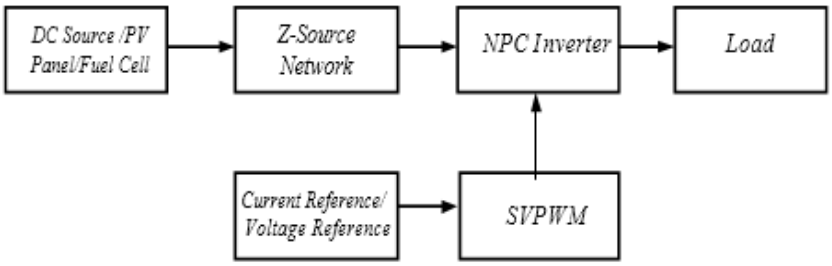


Fig 1. Block Diagram

The DC source may be any renewable DC source like solar photovoltaic or fuel cells. The Z source network exhibits both voltage buck and voltage boost capability. The inverter that considered here is Neutral Point Clamped Inverter (NPCI) also known as Diode Clamped Multilevel Inverter (DCMLI) for three level output voltage. The modulation technique adopted is Space Vector Pulse Width Modulation (SVPWM).

II. MULTILEVEL INVERTER

Multilevel inverter obtain a desired output voltage from several level of input DC voltage Sources. With an increasing number of DC voltage Source ,the inverter voltage output will be nearly SINUSOIDAL

In recent years, the multilevel inverters are widely used in high power applications such as large induction motor drives, UPS systems, flexible AC transmission System (FACTS).

The term multilevel began with three level converter .However the elementary concept of multilevel converter to achieve higher power by using semiconductor switches with several lower voltage dc sources. Capacitors, batteries, and renewable energy voltage sources can be used as the multiple dc sources. The commutation of the power switches aggregate these multiple dc sources in order to achieve high voltage at output; however the rated voltage of the power semiconductor switches depends only upon the rating of the dc voltage sources to which they are connected.

The multilevel inverter has several outcomes over a conventional two-level converter that uses high switching frequency pulse width modulation (PWM).The attractive features of a multilevel converter can be briefly summarized as follows.

1. Staircase Waveform Quality : Multilevel converters not only can generate the output voltages with very low distortion ,but also can reduce the dv/dt stress therefore Electromagnetic compatibility EMC is reduced

2. Common mode (CM) voltage : Multilevel converter produces smaller CM voltage therefore the stress in the motor is reduced

3. Input current : Multilevel converter can draw input current with low distortion

4. Switching Frequency: MLI will operate in both fundamental and high switching frequency. Note that lower switching frequency usually means lower switching loss and higher efficiency

Classification of Multilevel Inverter Based On Source

Three different topologies have been projected for multilevel converters:

1. Diode clamped multilevel inverter (DCMLI)
2. Flying capacitor multilevel inverter (FCMLI)
3. Cascaded multilevel inverter (CMLI)

Several modulation and control strategies have been developed or being used for multilevel converters including the following

1. Multilevel sinusoidal pulse width modulation (MSPWM),
2. Multilevel selective harmonic elimination
3. Space-vector modulation (SVM).

A) Diode Clamped Multilevel Inverter

The widely used multilevel topology is the diode clamped inverter, in which the diode is used as the clamping device to clamp the dc bus voltage to achieve steps in the output voltage. Each of three phases of the six level inverter shares a common dc bus, which has been subdivide by five capacitors into six levels. The voltage across each capacitor is Vdc and the voltage stress across each switching device is limited to Vdc through the clamping diodes. State condition 1 means the switch is ON and 0 means the switch ids OFF. Each phase has fi9ve complementary switch pairs such that turning on one of the switches of the pair that the other complementary switch be turned OFF. In general the voltage across each capacitor for an N level diode clamped inverter at steady state is Vdc/n-1.

In general for a N level diode clamped inverter, for each leg 2(N-1) switching device,(N- 1)*(N-2) clamping diodes and (N-1) dc link capacitors are required

B) Flying capacitor multilevel inverter

The capacitor clamped inverter alternatively known as flying capacitor was proposed by Maynard and Foch .The flying capacitor involves series connection of capacitor clamped switching cells. The structure of this inverter is similar to that of the diode clamped inverter except that instead of using clamping diodes, the inverter uses capacitors in the place. The circuit topology has a ladder structure of dc side capacitor where the voltage on each capacitor differs from that of the next capacitor. One advantage of the flying capacitor based inverter is that it has redundancies can synthesize on output voltage .Unlike the diode clamped inverter, the flying capacitor inverter does not require all of the switches that are on be in a consecutive series.

In addition to (m-1) dc link capacitors, the m-level flying capacitor multilevel inverter will require (m-1) x (m-2)/2 auxiliary capacitor per phase if the voltage rating of the capacitor is identical to that of the main switches

C. Cascaded multilevel inverter

In single phase structure of an m-level inverter each separate dc source (SDCS) is connected to a single phase full bridge of H-bridge, inverter .Each inverter level can generate three different voltage output

+Vdc 0 and -Vdc by connecting the DC source to then AC output by different combination of the four switches S1,S2,S3 and S4.The AC output of each of the different full bridge inverter levels are connected in series such that the synthesized voltage waveform is the sum of the inverter output. The number of output phase voltage level m in a cascade inverter is defined by m = 2s+1, where is the4 number of separate DC sources. Multilevel cascaded inverter has been proposed for such application as static var generation, and interfaces with renewable energy sources and for battery based application. Cascaded inverter are ideal for connecting renewable energy sources with an AC grid, because of the need for separate DC sources, which is the case in application such as photovoltaic or fuel cells.

III. Z-SOURCE INVERTER

A. Introduction

There exist two traditional converters: voltage-source and current-source converters. The ac output voltage is limited below and cannot exceed. The dc-rail voltage has to be greater than the ac input voltage. Therefore, the V-source inverter is a buck inverter for dc-to-ac power conversion and the V-source converter is a boost rectifier for ac-to-dc power conversion An output LC filter is needed for providing a sinusoidal voltage compared with the current-source inverter, which causes additional power loss and control complexity. The dc current source can be a relatively large dc inductor fed by a voltage source such as a battery, fuel-cell stack, diode rectifier. To overcome the problems of the traditional V-source and I-source inverter a new concept was developed in year 2002 by Dr. F.Z. Peng. This involves combination of VSI and CSI to form a cross coupled network of two inductors and two capacitors, known as Impedance Network (Z-source network).

A Z-source inverter is a type of power inverter, a circuit that converts direct current to alternating current. It functions as a buck-boost inverter without making use of DC-DC Converter Bridge due to its unique circuit topology.

B. Working Principles of Z-Type Inverter

The figure presents a scheme of basic 3-phase Z-inverter. In distinction from VSI and CSI inverters, on DC side of Z-inverter occurs a D diode and a Z-source of “X” shape, composed of two capacitors C1 and C2 and two chokes L1 and L2. The D diode prevents forbidden reversed current flow.

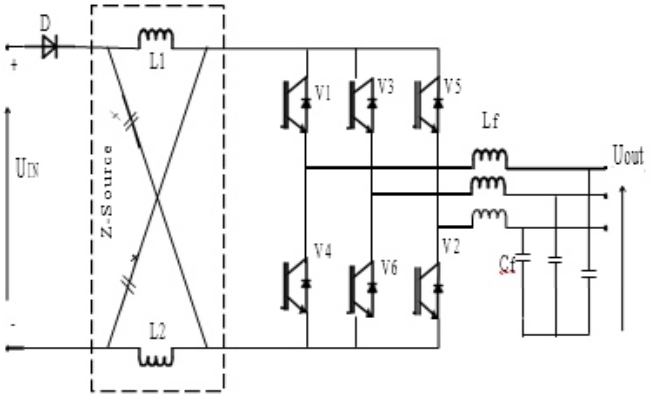
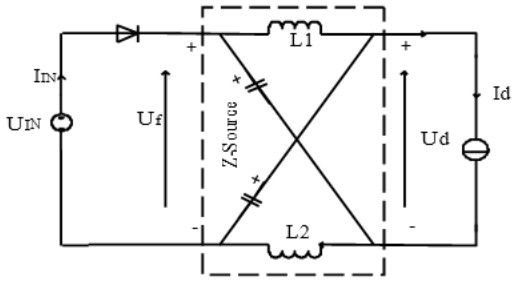


Fig 2. Basic Scheme of 3 –phase Z inverter

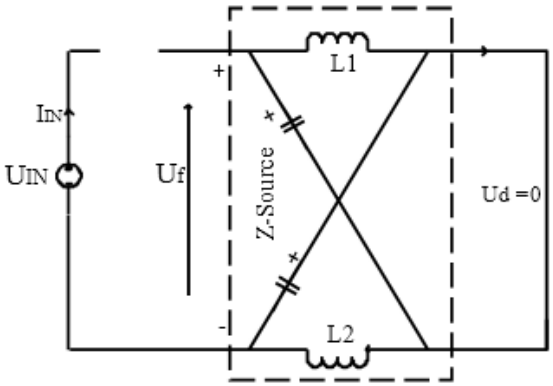
For this reason application of Z-inverter is possible only where there is no necessity for energy return to UIN source, further it is even forbidden in case of fuel cell or photo-voltaic cell. It should be marked that the same as D diode function can be server by other power electronics systems including ex. Diode rectifier or typical boost-converter".

Source Z serves as power storage and guarantees double filtration grade at the input of the inverter, and therefore dumping current ripples and voltage pulsation in the DC circuit. Concluding, requirements for chokes and capacitors in Z-source are less restrictive than in VSI or CSI inverters. In a case where chokes L1 and L2 have very low inductance (≈ 0), Z-source is created only from parallel connected capacitors C1 and C2. Then Z-inverter simply becomes VSI system and condensers in DC circuit are the only storage for energy and at the same point are a cell for filtration of voltage pulsation. Analogically when capacitors C1 and C2 are of low capacity (≈ 0), Z-source is diminished to two chokes L1 and L2 that are parallel connected, and Z- inverter system becomes CSI system. Chokes in DC circuit of CSI system and capacitors in DC circuit of VSI system must be of greater inductance and capacity (their dimensions) than in case of Z-inverter.

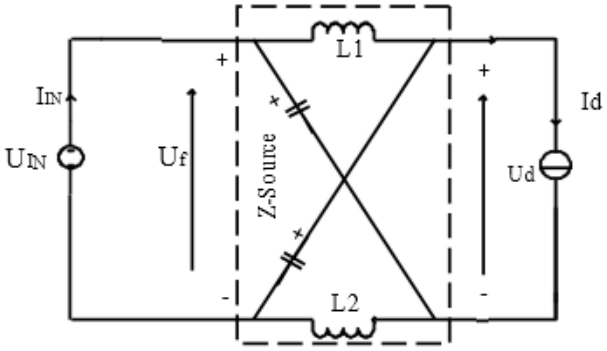
Typical 3-phase VSI system can assume eight allowed (permitted) states: six active states (while exchange of instantaneous power between the load and DC circuit) and two null states (when the load is shorted by lower or upper group of transistors). Whereas, 3-phase Z-inverter system can assume nine permitted states that is one more than in VSI system



a) General configuration



b) In Shoot through state



c) In non-shoot through states

Fig 3. Equivalent schemes of Z-inverter

Additional ninth state is the third null state, occurring when the load is being shorted simultaneously by lower and upper group of transistors. This state, is defined as „ shoot-through "state and may be generated in seven different ways, however equivalent procedures:

independently through every branch (3 procedures), simultaneously through two of the branches (3 procedures), simultaneously through all of the three branches (1 procedure). The main, unique characteristic of Z-inverter is that shoot-through state permits to rise output voltage, above the supply voltage UIN

Figure 3 describes simple equivalent schemes of Z-inverter, examined from the clap site of DC, where a source ud shapes inverter bridge V_1-V_6 . In the shoot-through states (Fig.4b) a D diode is polarized reversely and does not conduct the inverter bridge input voltage u_d=0, and energy stored in capacitors C_1 and C_2 is transferred to the chokes L_1 and L_2. In non-shoot- through" states, where every combination of the chokes V_1-V_6 that is allowed in VSI system is possible, the D diode conducts, and the voltage ud increases stepwise from 0 to its maximum ud*.

Since Z-source is symmetric circuits, when C_1=C_2 and L_1=L_2

and low voltage pulsation U_{c1} and U_{c2} due to impulse period T, it can be recorded as

$$U_{c1} = U_{C2} = U_C \text{ , } uL1 = u_{L2} = u_L \quad (1)$$

where

U_C – mean value of voltage in capacitors,

u_L – instantaneous voltage in chokes.

Considering (1) and equivalent schemes of Z-inverter (Fig.4), voltage ud is calculated on the basis of following dependences

(a) in shoot-through states (Fig.2b) in time TZ

$$u_L = U_C \text{ , } u\,f = 2\ \ U_C \text{ , } u_d = 0 \qquad (2)$$

b) in "non-shoot-through" states (Fig.2c) in time TN $u_L = U_{IN} - U_C$,

$$u\,f = U_{IN} \text{ , } u_d = U_C - u_L = 2\ \ U_C - U_{IN} \quad (3)$$

where u_f – Z-source input voltage.

If taken into consideration, that in a time period

T = TZ+TN, in steady state overage voltage in chokes UL=0, then on the basis of (2) and (3) we obtain

$$U_L = \frac{T_Z \cdot U_c + T_N \cdot (U_{IN} - U_C)}{T} = 0 \qquad (4)$$

and

$$U_C = U_d = U_{IN} \cdot \frac{T_N}{T_N - T_Z} = U_{IN} \frac{1-D}{1-2.D}$$

where

$D = T_Z/T$-"shoot-through" coefficient, satisfying a condition D<0.5.

Similar procedure, on the basis (3) and (4) determines the value u_{d*} of voltage u_d in "non-shoot- through" states:

$$u_d^* = U_C - u_L = U_{IN} \frac{1}{1-2.D} \qquad (5)$$

where

$1/(1-2 \cdot D) = T/(T_N - T_Z) \geq 1$ - peak factor, determining the value ud* voltage $U_{IN.}$

The value u_{d*} determines output voltage amplitude u_{OUT}(max) of Z-inverter. When applying sinusoidal PWM algorithm the amplitude equals

$$U_{out(max)} = M.\frac{u_d^*}{2} = \frac{M}{1-2D}.\frac{U_{IN}}{2} \qquad (6)$$

where M – modulation index, of maximum value limited by inequity M ≤ 1-D, related to time T_Z of shoot through states. As it results from the equation (6), Z-inverter output voltage amplitude u_{OUT}(max), can be as well lower as higher than in typical VSI system with sinusoidal PWM,

$$u_{OUT}(max) = M \bullet UIN/2.1$$

IV. MODULATION TECHNIQUES

1. Sine-Triangle Pulse Width Modulation

The principle of the sinusoidal PWM scheme for the two-level inverter is illustrated in Fig-2, where V_{mA}, V_{mB}, and V_{mC} are the three-phase sinusoidal modulating waves and Vcr is the triangular carrier wave. The fundamental frequency component in the inverter output voltage can be controlled by amplitude modulation index,

$$m_a = V_m / V_{cr} \qquad (1)$$

where V_m and V_{cr} are the peak values of the modulating and carrier waves, respectively. The amplitude modulation.

Index ma is usually adjusted by varying Vm while keeping Vcr fixed. The frequency modulation index is defined by

$$m_f = f_m / f_{cr} \qquad (2)$$

where, fm and fcr are the frequencies of the modulating and carrier waves, respectively. The gating signals for conventional two-level inverter using SPWM can be derived as follows. The operation of switches S_1 to S_6 is determined by comparing the modulating waves with the carrier wave. When $V_{mA} \geq V_{cr}$, the upper switch S1 in inverter leg A is turned on. The lower switch S4 operates in a complementary manner and thus is switched off. The resultant inverter terminal voltage VAN, which is the voltage at the phase A terminal with respect to the negative D_C-link bus „N", is equal to the D_C voltage V_d. When VmA $< V_{cr,}$ S_4 is on and S1 is off, leading to VAN = 0. Since the waveform of VAN has only two levels, V_d and 0, the inverter is known as two level inverter

Fig 4. Sinusoidal Pulse Width Modulation

2. SPACE VECTOR MODULATION

A. Introduction

Space vector modulation (SVM) is an algorithm for the control of pulse width modulation (PWM).[1] It is used for the creation of alternating current (AC) waveforms; most commonly to drive 3 phase AC powered motors at varying speeds from DC using multiple class- D amplifiers. There are various variations of SVM that result in different quality and computational requirements. One active area of development is in the reduction of total harmonic distortion (THD) created by the rapid switching inherent to these algorithms.

B. Space Vectors

The technique of the space vector modulation involves the concept of space vector. In any three phase machine, the stator coils are distributed in space in a symmetrical manner i.e. each coil is placed at 120 degree with respect to each other. In this method the five phase quantities can be transformed to their equivalent 2-phase quantity either in synchronously rotating frame or stationary reference frame.

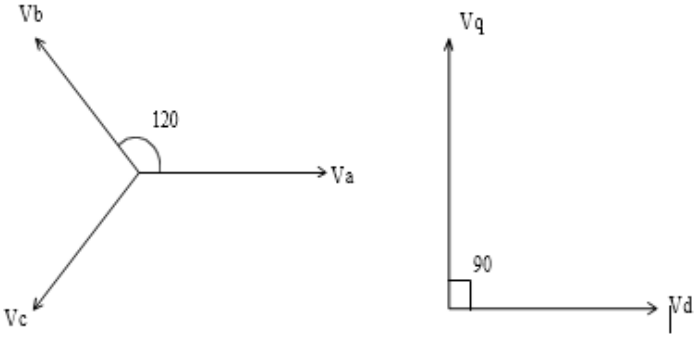


Fig 5. Three Phase Quantities Transformed into Two Phase

From this 2-phase component the reference vector magnitude can be found and used for modulating the inverter output. Let the three phase sinusoidal voltage component be,

$$V_a = V_m \sin \omega t$$

$$V_b = V_m \sin (\omega t - 120)$$

$$V_c = V_m \sin (\omega t - 240)$$

Equating the three phase machine quantities, we get

$$V_a + V_b + V_c = 0 \quad (1)$$

$$Vd = -3/2(Vb) + 3/2(Vc) = 3/2 Vm \cos \omega t \quad (2)$$

$$Vq = Va - Vb/2 - Vc/2 = 3/2 Vm \sin \omega t \quad (3)$$

Rotating vector,

$$Vref=Vd=Vq=3/2e^{\wedge}(j\omega t) \qquad (4)$$

From equation (4) it can be seen that space vector moves with constant angular velocity and constant amplitude. In case of non-sinusoidal quantities, the space vectors will not necessarily move with constant amplitude or constant angular velocity. The output of the inverters which are usually used in various applications are not perfectly sinusoidal. It contains appreciable amount of harmonics. So, the space vector of the stator voltages in these cases if of amplitude Vdc moving in steps and not with a constant angular velocity. In space vector modulation, a reference vector of the stator voltages is generated, which is made to move in the d-q plane in small steps so that it appears to move smoothly, as in the case with sinusoidal supply. The space vector modulation is based on the space vector representation of the voltages in d-q plane. After the transformation to the two phase quantities, the power as well as the impedance remains unchanged. In space vector modulation we try to generate a voltage reference vector at a point of time and the voltage reference vector Vref is sampled which approximately by a time sequence of five well defined switching state vector nearest to the reference vector. This is done by sampling the switching state vectors in such a way that the total volt seconds generated by these vectors over an interval T_s equals the volt seconds generated by the reference vector T_s.

C. Design Procedure

Step I

To assume the Peak voltage value (V_m) Time period (t)

Delta ($\pi/2$)

Step II

To Calculate the Vref Values $Va\_ref = Vm \sin(\omega t + \pi/2)$

$Vb\_ref = Vm \sin(\omega t - 2\pi/3 + \pi/2)$ $Vc\_ref = Vm \sin(\omega t + 2\pi/3 + \pi/2)$

Step III

(i) To transfer the abc Parameters into dq Parameters

(ii) To find the magnitude and theta values from dq Parameters

Va Vb Vc ⟶ Vq & Vd ⟶ Magnitude & theta

Step IV Identification of Sectors from theta values

Theta → Sector Identification and ensure each sector having angle of 60°each (theta1)

$$\beta = \text{int}\,[\theta/60] + 1$$

$$\gamma = \text{rem}\,[\theta/60] = \theta_1$$

Step V To find the Magnitude of Vαref and Vβref &

Theta 1

$$V\alpha = Vm\ \text{Cos}\,[\theta 1 * \pi/180]$$

$$V\beta = Vm\ \text{Sin}\,[\theta 1 * \pi/180]$$

Step VI Identification of Sectors by using K_1 and K_2 values

$$K_1 = \text{int}\,[V_\alpha + V_\beta/\sqrt{3}]$$

$$K_2 = \text{int}\,[2V_\beta/\sqrt{3}] \quad K_1 \text{ \& } K_2 \text{ are integers}$$

Step VII

To find $V_{\alpha i}$ and $V_{\beta i}$

$$V_{\alpha i} = V\alpha - K_1 + 0.5K_2$$

$$V_{\beta i} = V\beta - K_2 h = V\beta - \sqrt{3}K_2/2 \qquad (h = \sqrt{3}/2)$$

Step VIII

To find the location of Reference vector P

Case I

$$\text{If } \sqrt{3}\,V_{\alpha i} \geq V_{\beta i} \text{ or } \sqrt{3}\,V_{\alpha i} \leq V_{\beta i}$$

1. True means P is at Δ1
2. False means P is at Δ2

Step IX

To find out the type of triangle (Type I or Type 2)

(I) P at Δ2 common for type 2 triangle

$$V_{\alpha 0}^{S} = 0.5 - V_{\alpha i}$$

$$V_{\beta 0}^{S} = \sqrt{3}/2 - V_{\beta i}$$

(ii) P at Δ1 common for type 1 triangle

$$V_{\alpha 0}^{S} = V_{\alpha i}$$

$$V_{\beta 0}^{S} = V_{\beta i}$$

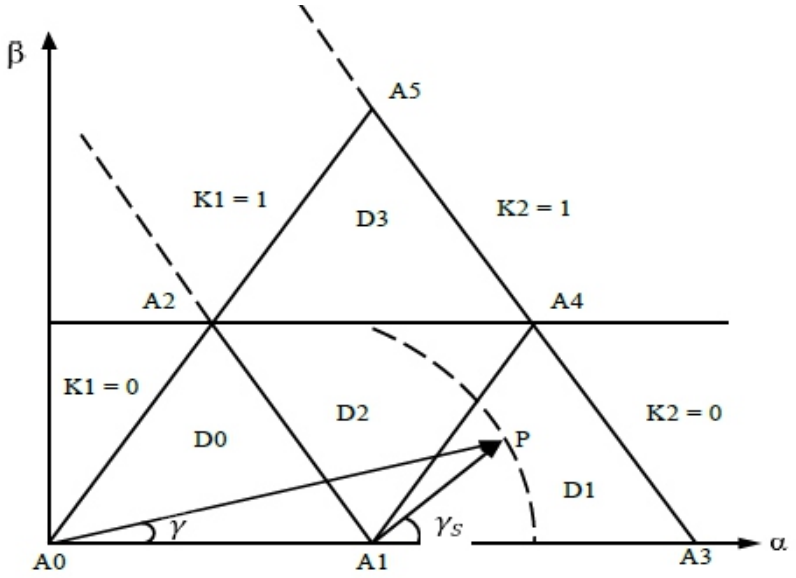


Fig 6 Determination of Triangle

Step X Triangle number calculation

For type I triangle

$$\Delta j = K_1^2 + 2K_2$$

For type II triangle

$$\Delta j = K_1^2 + 2K_2 + 1$$

Step XI

Determination of ON time by two level SVPWM unit

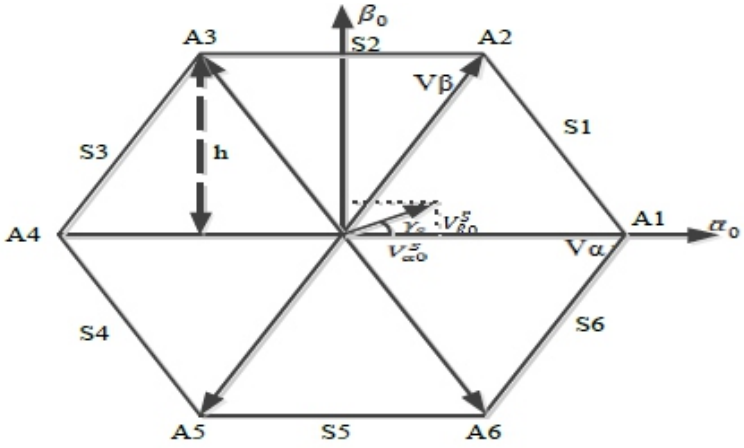


Fig 7 Space Vector Representation of Two Level Inverter

$$V\alpha = (1,0)$$

$$V\beta = (0.5, h)$$

$$V^s = (V_{\alpha 0}^S \; V_{\beta 0}^S)$$

Space vector diagram for two level inverter by using this diagram the volt second balance is given by

$$V^s T_S = V_a t_a + V_b t_b$$

Time balance is given by

$$T_S = t_a + t_b + t_0$$

In $\alpha_0 - \beta_0$ axis

$$V_{\alpha 0}^S T_S = 1.t_a + 0.5\, t_b$$
$$= t_a + 0.5\, t_b$$

$$V_{\beta 0}^S T_S = h.t_b + 0.\, t_a$$

$$= h.t_b$$

because

$$V\alpha = (1,0)$$

$$V\beta = (0.5, h)$$

$$V^s = (V_{\alpha 0}^S \; V_{\beta 0}^S)$$

Calculation of ON time

$$V_{\alpha 0}^S T_S = t_a + 0.5\, t_b$$

$$V_{\beta 0}^S T_S = h.t_b$$

$$t_b = \frac{V_{\beta 0}^s T_s}{h}$$

Therefore

$$t_a = V_{\alpha 0}^S T_S - 0.5 \frac{V_{\beta 0}^s T_s}{h}$$

$$= T_s \left\{ V_{\alpha 0}^s - \frac{V_{\beta 0}^s T_s}{2h} \right\}$$

$$t_0 = T_s - t_a - t_b$$

Step XII

Generation of gating signals

D. Circuit Diagram of Proposed System

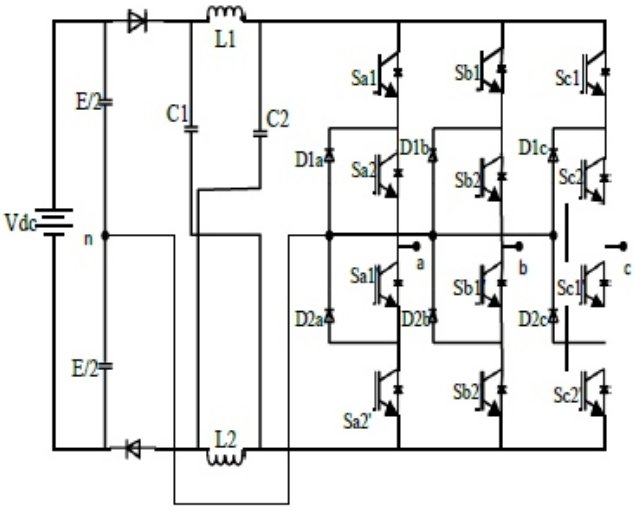
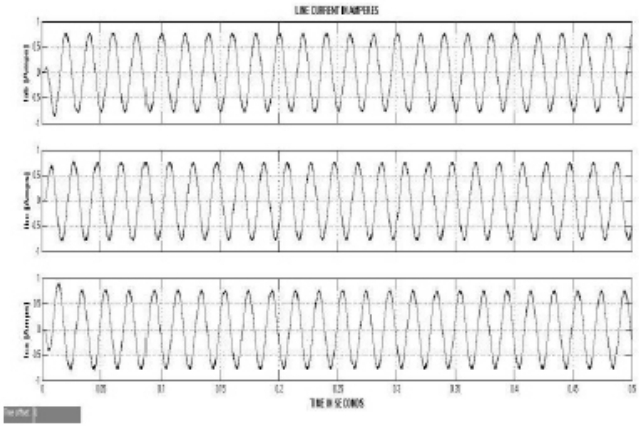


Fig 8 Proposed Circuit Diagram of ZNPC

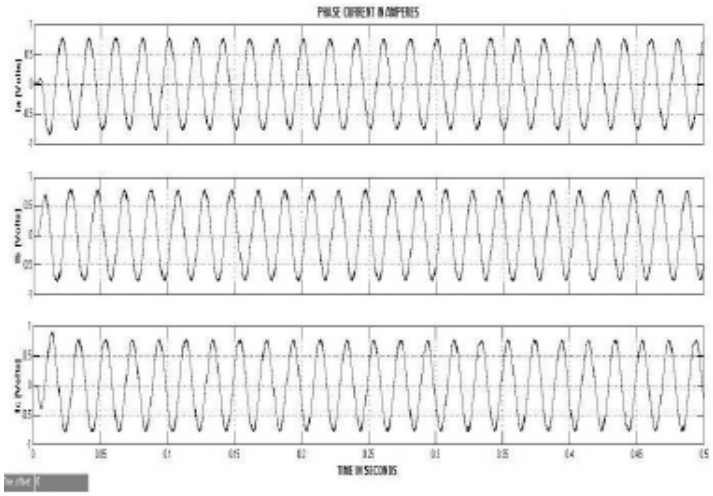
The circuit diagram of proposed system shows five level Z-source NPC inverter where the only difference compared with the traditional inverters is the inserted Z-source network and a passive diode D between dc supply and inverter circuitry. The two-port network is built using a split inductor and two shunt capacitors, whose X-shape structure allows switches from any phase-leg to turn ON simultaneously with the input diode D naturally reverse-biased to create a shoot through state without damaging the semiconductor device due to natural property of current production by inductors.

V. RESULTS AND DISCUSSIONS

Here the Z source Neutral Point Clamped Inverter using Space Vector Pulse Width Modulation Technique with PV panel as source is implemented. The performance parameters like Phase voltage, Line voltage Load current and THD are analyzed using MATLAB Simulink and the result are given below

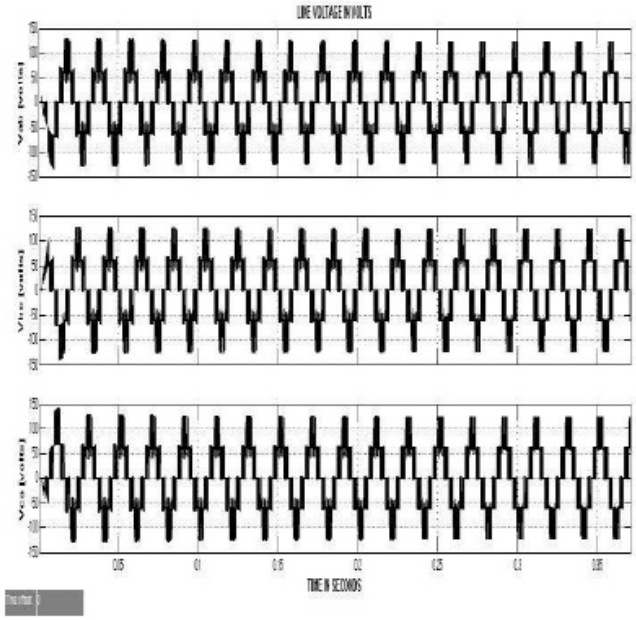


(a)

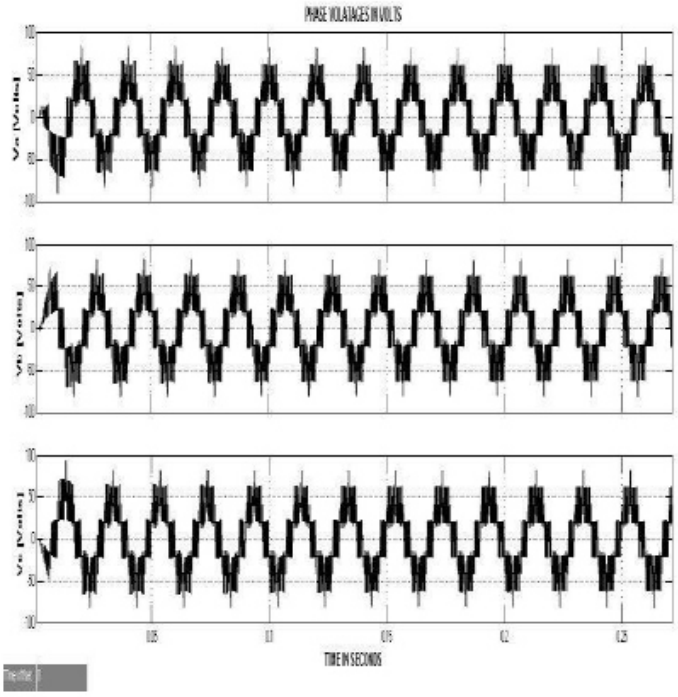


(b)

Fig 9. Simulated (a) Line Current and (b) Phase Current Waveform

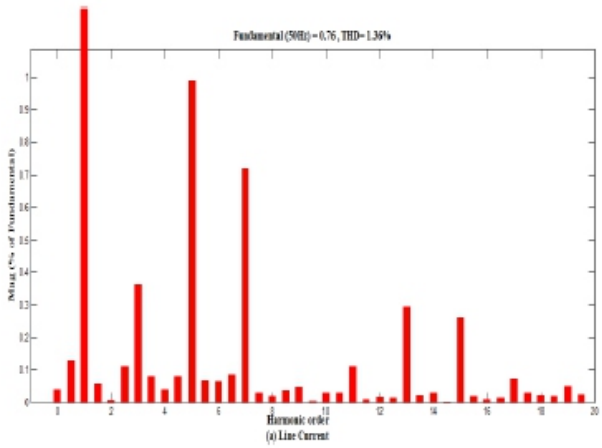


(a)

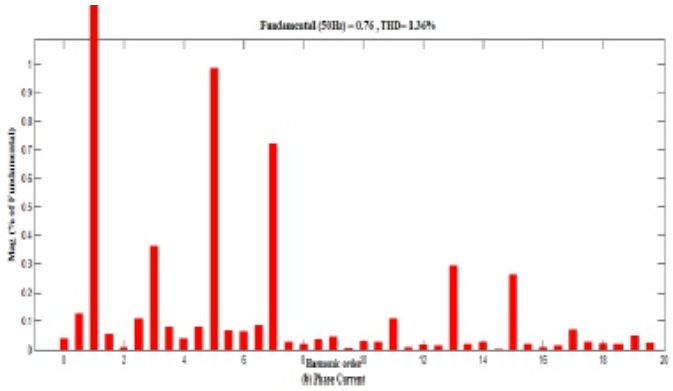


(b)

Fig 10 Simulated (a) Line Voltage and (b) Phase Voltage Waveform

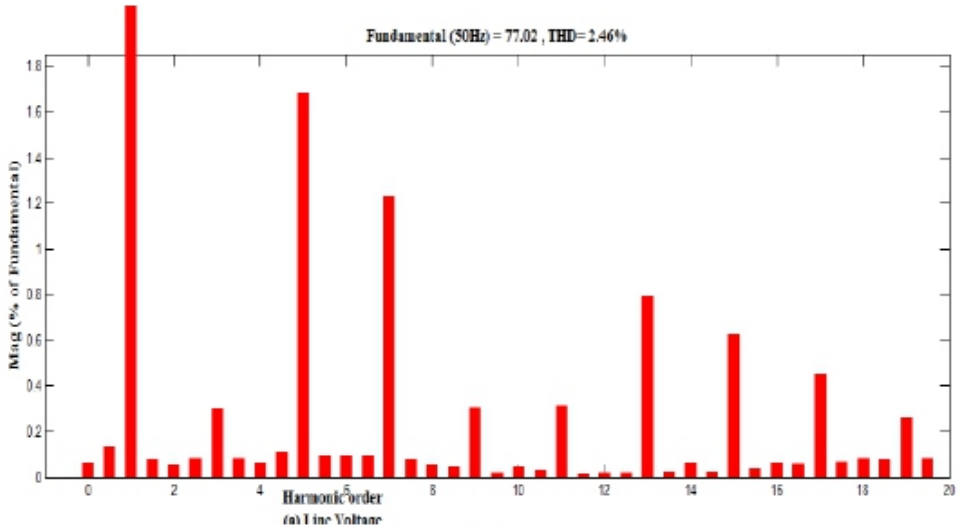


(a)

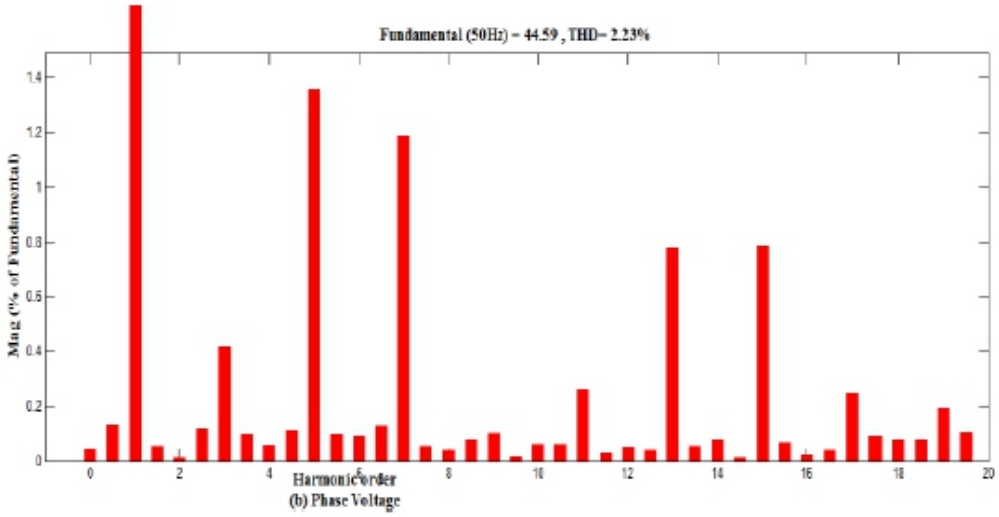


(b)

Fig 15 FFT Plot for output (a)Phase Current (b) Line Current of Five level ZNPC (PV Source) inverter using SVPWM technique



(a)



(b)

Fig 16 FFT Plot for output (a) Line Voltage and (b)Phase Voltage of Five level ZNPC (PV Source) inverter using SVPWM technique

Comparison of SPWM and SVPWM techniques by analyzing various parameters

Table 1.Comparison of SPWM and SVPWM Techniques

S. No	Performance Analysis Parameters	Sinusoidal PWM Technique	SV PWM Technique (DC Source)	SVPWM with PV Panel as Source
1	**Phase Voltage Magnitude**	**62**	**72**	**81**
2	**Phase Current Magnitude**	**0.9**	**0.75**	**0.9**
3	**Line Voltage**	**107**	**120**	**140**
4	**Line Current**	**0.9**	**0.75**	**0.9**
5	**Phase voltage THD**	**9.45%**	**6.81%**	**2.23%**
6	**Phase Current THD**	**3.85%**	**3.36%**	**1.36%**
7	Line Voltage THD	9.41%	6.72%	2.46%
8	Line Current THD	3.85%	3.36%	1.36%

Table 2 THD Analysis of Various Switching frequencies

S. No	*Switching frequency (f =1/T)*	*Line Voltage THD*	*Line Current THD*	*Phase Voltage THD*	*Phase Current THD*
1	*1/3000 = 3.333 KHz*	*2.46%*	*1.36%*	*2.23%*	*1.36%*
2	1/3500 = 2.857 KHz	4.83%	3.02%	7.39%	3.02%
3	1/4000 = 2.5 KHz	9.35%	5.89%	10.90%	5.89%
4	1/4500 = 2.222 KHz	6.67%	4.26%	6.16%	4.26%
5	1/5000 = 2 KHz	6.01%	3.92%	6.87%	3.92%

From the above analysis we conclude that Space Vector PWM technique is more superior to the Sinusoidal PWM technique for multilevel inverter in various industrial application

VI. CONCLUSION

This paper presents the design of a Z-source NPC inverter that can perform buck-boost dc-ac energy inversion. Under special operations with respect to the partial dc-link shoot- through, which profitably appear in the operation of Z-source NPC inverter, the Z-source network shows much different operational principles and boost characteristics. Modulation wise, the proposed inverter can be controlled using Space Vector Modulation techniques with a slight modification of three-phase references. The theoretical findings, together with the practicality of the inverter, have been analysed using PSIM and MATLAB/Simulink model under both normal and voltage boost conditions.

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Supplier Selection and Evaluation – An Integrated Approach of QFD & AHP

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ABSTRACT

In current scenario strong competitive pressure forces several organizations to available their products and services, cheaper, faster and improved than the rivals to their valuable customer. Managers have come to comprehend that they cannot do it individually without suitable vendors. Supply Chain Management empower the flows of material, information and funds in a association consisting of customers, suppliers, manufacturers and distributors, which beings raw materials, maintain by internal operations complete with distribution of finished goods. In the continually changing world, assortment of appropriate vender is facilitating in supply chain management, selection of right vendor is extremely useful part of purchasing department. This paper seeks to propose a methodology to integrate the Analytical Hierarchy Process (AHP) for right supplier selection and evaluation and Quality Function Deployment (QFD) analysis to enhance the effectiveness of outsourcing decisions. A selection that combines the subjective factors and objective factors and attitude of the decision maker decide the best supplier in the supply chain management system. The proposed integrated model could be used for supplier selection, which involves several quantitative and qualitative factors. Also could be used to determining the optimum order quantity. The propose method is a group decision making approach which shadows the traditional approaches of supplier selection.

Keywords – Multi-criteria Decision Making, Operation Research, Supplier selection & evaluation, Analytical Hierarchy Process, Quality Function Deployment

INTRODUCTION:

In todays market forces demands to every organization to convert itself into a virtual organization, for cost-effectiveness and better quality. By the virtual corporation we mean that the main function of the company is to make the core of the product and depend on a large number of suppliers for the rest of the sub-assembly needed for blending the product. Therefore a large number of the work is outsourced. So, the quality of the product not only depends on the organization but also the raw materials supplied for the sub assembly from the suppliers. Business today is in a global environment and no one can stop this process of globalization. This has created a competitive market regardless of location or primary market. This competition has given customers tremendous freedom of choice, which ultimately increases their expectations by leaps and bounds. Strong competitive pressure forces many organizations to provide their products and services, faster, cheaper and better than the competitors to customers. That is why organizations have to strengthen their supply chain by identifying and partnering with the strongest suppliers. The suppliers should also fulfil certain conditions provided by

the company like health and safety, finance, environmental responsibilities etc. Therefore supplier selection and evaluation in supply chain management is one of the most critical functions for the success of an organization and is a multi-criterion decision making process including both tangible and intangible factors. According to Kumar ET al. (2004) has observed that supplier selection deals with issues related to the selection of right suppliers and their quota allocations. When making the decision of supplier selection, enterprises should begin by developing a common understanding of their specific issues and objectives. They should learn as much as possible about suppliers‟ system to lessen their superficial similarities, they should prevent project costs from escalating by asking suppliers to commit to long-term pricing strategies, they should evaluate how closely the suppliers meet specification and how well they will be able to boost control system performance (Woll,2000). Most of the companies are spending considerable amount of their revenue on purchasing, which involve selection of appropriate suppliers.

In this study an integrated approach of Analytical Hierarchy Process (AHP), Quality Function Deployment (QFD) and Selection Index (SI) is proposed for rating and choosing the best supplier using cost as the prime index of selection. The following sections are organized as follows: section 2 shows the past research done by the researchers, followed by the notations used in the paper work .Then AHP method has been discussed in section 4. Section 5 includesthe discussion of the assumptions and proposed methodology. Validation of the methodology is highlighted in section 6. The analysis of the result is discussed in the section 8. Finally, we conclude the paper in section 9.

1. LITERATURE REVIEW:

Selection of appropriate suppliers is one of the fundamental strategies for enhancing the quality of output of any organisation, which has a direct influence on the company‟s reputation. The importance of supplier selection has been stressed in the literature (Weber et al., 1991). As pointed out by (Bhutta and Huq, 2002), the supplier selection problem requires the consideration of multiple objectives, and hence can be viewed as a multi-criteria decision making (MCDM) problem. Many more methods and procedures, including simple weighted rating , AHP, multi- attribute utility theory, mathematical Programming, game theory, principal components analysis and neural networks, have also been suggested in the literature (Leenders et al.,2006; Monczka et al., 2002; Talluri et al., 2006). DEA has also been suggested in the literature for vendor performance evaluation (Weber, 1996; Weber and Desai, 1996; Weber et al., 1998, 2000; Narasimhan et al., 2001; Talluri et al., 2006; Wu et al., 2007). Many researchers formulated the supply selection problem as various types of mathematical programming models. Such as Linear Programming (Talluri and Narasimhan, 2005; Ng, 2008), integer linear programming (Talluri, 2002; Hong et al., 2005), integer non-linear programming (Ghodsypour and O'Brien, 2001), Goal Programming (Karpak et al., 2001) etc.

Many researchers applied integrated AHP approaches to evaluate the performance of suppliers and select the best supplier. Such as integrated AHP and Bi-negotiation (Chen and Huang, 2007), integrated AHP and DEA (Ramanathan, 2007; Saen, 2007; Sevkli et al., 2007), integrated AHP, DEA and artificial neural network (Ha and Krishnan, 2008), integrated AHP and Fuzzy (Kahraman et al., 2003; Chan and Kumar, 2007), integrated AHP and mixed integer non-linear programming (Mendoza and Ventura, 2008), integrated AHP and GP (Wang et al.,2004,2005; Kull and Talluri, 2008; Percin,2006; Mendoza et al.,2008). The most popular individual approach adopted in supplier evaluation and selection literature is DEA followed by mathematical programming, AHP and so on. But there are various integrated approaches for supplier selection and it was noticed that the integrated AHP approaches are more relevant due to its simplicity, ease of use and great flexibility (Ho, 2008). A prominent weakness of AHP is theshortcoming of AHP due to different judgement by different individuals. It has been criticized that AHP lacks a firm theoretical basis by Belton and Gear (1983).

However, these criticisms were proved invalid by Harker and Vargas (1987) with a theoretical work and examples. There argument was that AHP (Bottani and Rizzi, 2008) is based completely upon firm theoretical establishment and examples as literature survey and routine of various corporations, organizations, agencies demonstrate that AHP is feasible, exploitable management tool for decision making. In Quality Function Deployment (QFD) approach for supplier selection, A house of quality was constructed to identify the features that the purchased product should have in order to satisfy the customers' requirements, and then to identify the relevant supplier assessment criteria (Bevilacqua et al., 2006).The present paper therefore incorporates Selection Index with Cost as the factor with AHP and QFD for acquiring an optimized value and finding the best potential supplier.

2. NOTATION:

Dj = Degree of importance for the jth technical requirement; (j = 1, 2 ... n);

Kij = Quantified relationship between the ith customer requirement and the jth technical criteria in the central relationship matrix; (i = 1, 2... n); (j = 1, 2... n);

Ci = Importance weighing of the ithcustomer requirement; (I - 1, 2 ... n);

Xj= Overall score for the jth Supplier-Alternative; (j = 1, 2...);

Tij = PV value of the jth alternative on the ith Technical criteria; (i=1, 2 ... n); (j=1, 2 ... n);

max = Principal Eigen Value, I.I. = Inconsistency Index.

R.I. = Random Inconsistency Indices. , I.R. = Inconsistency Ratios.

Wi = Final Weight age (Supplier's Ratings) of ith supplier, G.M = Geometric mean

P.V = Priority vector,

C.R = Consistency ratio S1 is Supplier 1;

S2 is Supplier 2, S3 Is Supplier 3 OFM is the objective factor measure
OFC is the objective factor cost SFM is the subjective factor measure
SIi is the supplier selection index ith supplier CF is the Cost Function

3. ANALYTICAL HIERARCHY PROCESS:

The analytic hierarchy process (AHP), originally developed by Thomas Saaty in 1971 (Saaty, 1980; Saaty and Vargas, 1981; Saaty and Vargas, 2000), is a process designed for solving complex problems involving multiple criteria. It is a popular technique often used to model subjective decision making processes because it is conceptually simple, easy to understand, and robust enough to handle the complexities of real-world decisions. The AHP divides a complex decision problem into a hierarchical system of decision elements. A pair-wise comparison matrix of these elements is constructed, and then the normalized principal eigenvector is calculated for the priority vector, which provides a measure of the relative importance (weight) of each element. The procedure for the AHP can be summarized in four steps as follows:

i. Constructing the hierarchical system
ii. Making pair-wise comparisons for the criteria and for the decision alternatives
iii. Calculating the weights and testing the consistency
iv. Calculating the overall priorities for the decision alternatives

A consistency ratio (CR) that estimates the degree of inconsistency should be checked. If inconsistency ratio is<10% then the level of inconsistency is acceptable. Otherwise the inconsistency of the decision matrix is high and the decision maker is advised to revise the elements of the matrix.

4. PROPOSEDMETHODOLOGY:

The following criteria have been taken in the supplier selection process:

1. All the suppliers have similar qualitative and quantitative criteria in the evaluation process.
2. In the analysis, the different Production Capacity of each Supplier has been taken into consideration.

The proposed methodology integrating AHP and QFD (Bhattachariyya et al., 2005) for a Supplier Selection Problem comprises the following steps:

Step 1: The various criteria needed by the customer are identified.

Step 2: The technicalities required to satisfy the customer needs are identified.

Step 3: Central Relationship Matrix is prepared using the specialized knowledge of QFD team.

Step 4: Subsequently, degree of importance for the customer requirements is calculated taking in account the Analytical Hierarchy Process.

Step 5: After that, the degree of importance for the technical requirements is calculated using the following equation:

$$(DOI) = Dj = \sum_{i=1}^{m} K_{ij}\, C_i \qquad (1)$$

Step 6: Normalization of the degree of importance of the respective technical factors are done using:

$$(DOI)_{norm} = \overline{Dj} = \frac{Dj}{\sum_{j-1}^{n} Dj} \times 100 \qquad (2)$$

Step 7: Eventually, the pair wise comparison matrices are structured for each technical requirement using Saaty's nine-point scale.

Step 8: Now, we integrate the above performed steps (6 & 7) in a single table, where the calculated normalized values of the degree of the importance are substituted on one side and the respective data obtained from the five pair wise matrices are transferred to the cumulative table on the other side.

Step 9: Overall Weightings of the Suppliers S_1, S_2 and S_3 are calculated using equation (3).

$$X_j = \sum_{j=1}^{n} \overline{Dj} T_{ij} \qquad (3)$$

Step 10 : The Normalization of the weightings of all the three selected suppliers are done. The normalized weights of the Service Providers accounts for the respective Subjective Factor Measure for the ith Supplier are substituted in the following equation (4).

$$SI_i = C.F[\alpha \times SFM_i + (1-\alpha) \times OFM_i] \qquad (4)$$

Where, $OFM_i = 1/[OFC_i \sum_{i=1}^{n} 1/OFC_i]$

α is the attitude of the- decision maker, $\alpha \geq 0 but\ \alpha \leq 1$

n is the number of Suppliers (n=3 in the present case).

6. VALIDATION OF THE PROPOSED METHODOLOGY:

The proposed methodology has been validated as follows:

Step 1: The various criteria needed by the customer are – Quality , Cost , Design flexibility , After Sale Service , On Time Delivery

Step 2: The technicalities required to satisfy the customer needs are – Reliability , J IT system , Adequate Resources , Corporate and social responsibilities , Ability in IT Technology.

Step 3: The central relationship matrix displaying the degree of relationship between each customer requirement and the corresponding technical requirement is constructed. Here the vertical columns are the Customer Requirements and the horizontal rows are the Technical Requirements respectively. The symbol and the corresponding weights of the symbols used in the matrix are as follows:

Table: 1 Central Relationship Matrix

	Reliabilit	JIT	Adequa	Corporate and	Ability in IT
Quality	•	*	0	-	*
Cost	•	•	•	•	•
Design	•	-	•	-	0
After Sales	•	•	•	0	-
On Time.	•	•	0	•	-

• Strong = 9 * Medium = 5 0 Weak = 1

- No Relationship Exists = 0

Step 4: A decision matrix is constructed to measure the relative degree of importance for each customer requirement, based on the proposed methodology. This is a matrix of 5x5 elements as shown in the matrix below.

The PV values of this decision matrix are [0.2296, 0.4705, 0.04633, 0.0692, and 0.01847] which are obtained by successive normalizations of the evaluated Geometric Mean of each rows.

$$D_{ij} = \begin{matrix} 1.000 & 0.25 & 5.000 & 4.000 & 2.000 \\ 4.000 & 1.000 & 6.000 & 5.000 & 3.000 \\ 0.200 & 0.167 & 1.000 & 0.5000 & 0.200 \\ 0.250 & 0.200 & 2.000 & 1.000 & 0.250 \\ 0.500 & 0.333 & 5.000 & 4.000 & 1.000 \end{matrix}$$

Here Eigen Value and the Consistency of the decision matrix are verified using the Consistency Equations. The Results obtained are as follows;

$$\tau_{max} = 5.3574 \ (5) \ \text{I.I.} = 0.08935 \ (6) \ \text{R.I.} = 1.1S80 \ (7)$$

$$\text{I.R.} = 7.5421\% \ (8)$$

Thus we observe that I.R. <10%, so the level of inconsistency present in the information stored in „Dij" matrix is acceptable. The QFD team, then, puts the PV values into the Transformation matrix as shown in Step 5, 6.

Step 5, 6: The degree of importance for the technical requirements and the corresponding Normalization of the value are calculated as shown in the table 2 below:

TABLE 2: House of Quality

TABLE 2: House of Quality							
		TECHNICAL REQUIREMENTS					
		Reliability	**IT**	**Adequate**	**Corporate and**	**Ability in IT**	**Importance Weighing**
C R	Quality	•	*	0	-	*	0.2429
	Cost	*	•	*	*	•	0,4846
	Design	•		*	-	0	0.0383
	After Sales	•	*	*	o	-	0.0696
	On Time.Delivery	*	•	o	*	-	0.1617
	Degree Of importance for	*4.791*	6.177	3.493	4.121	5.807	
	Normalized Degree Of	19.6	25.63	14.3	16.83	23.7	

Step 7: The pair wise comparisons of the suppliers for each technical requirement are as follows:

For "Reliability" criterion, T1:

	S_1	S_2	S_3
S_1	1	5	2
S_2	1/5	1	1/7
S_3	1/2	7	1

For "Just in Time System" criterion, T2:

	S_1	S_2	S_3
S_1	**1**	***6***	**9**
S_2	**1/6**	**1**	**3**
S_3	**1/9**	**1/3**	**1**

For an "Adequate Resources" criterion, T3:

	S_1	S_2	S_3
S_1	1	4	7
S_2	1/4	1	
S_3	1/7	1/3	1

For "Corporate and Social

	S_1	S_2	S_3
S_1	1	4	9
S_2	1/4	1	5
S_3	1/9	1/5	1

For "Ability in it Technology criterion, T5:

	S_1	S_2	S_3
S_1	1	9	5
S_2	1/9	1	1/4
S_3	1/5	4	1

Step 8: The calculated normalized value of the degree of importance has been put under the column weights while the values obtained from the pair wise matrices are put under the column of weight of the supplier.

TABLE 3: Final Weightages of the Suppliers.

		Important Weight Of Supplier					
Technical	Weights	S_1	S_2	S_3	I.I.	I.R.=I.I./R.I	I.R. (%)
T_1	24.64	0.5416	0.0766	0.3817	0.05805	O.O879	8.79
T_2	28.53	0.7704	0.1617	0.0677	0.02520	0.0381	3.81
T_3	12.91	0.7050	0.2109	0,0840	0.01530	0.0231	2.31
T_4	12.91	0.7087	0.2310	0.0601	0.0336	0.0509	5,09
T_5	20.97	0.7428	0.0632	0.1938	0,03495	0.0529	5,29
	Overall	69.167	13.534	I7.263			

Step 9: Ranking of all the supplier alternatives and selection of the best one using the analogy 'the higher the better" (Ray et at.., 2010). From above table 3 it is clear that S2<S3<S1 i.e. S1 has precedence over S3 and S2.Thus, Service Provider S1 is selected, as it has the highest overall score.

Step 10: The normalized weights of the Service Providers are as follows; S1 = 0.6916 S2 = 0.1353S 3 = 0.1726

Step 11: Putting the values of OFCi in equation (2) we calculate the values of OFMi, which are shown in the following Table:

TABLE 4: Cost Index.

Supplier	Normalized weightages/Subjective Factor Measure(SFM_i)	Objective factor Cost of Supplier(OFC_i)	Objective Factor Measure(OFM_i)
S_1 S_2	O.6916 O.1353	S 1000	0.4105
S_3	O.172	$ 1500	0.2736
		S 1300	0.3157

Further we incorporate this value OFMi and SFMi in Equation (1) to obtain the following equations of SI:

$$SI_1=0.4705[\alpha \times 0.6919 + (1- \alpha) \times 0.4105]$$
$$SI_2=0.4705 [\alpha \times 0.1353 + (1- \alpha) \times 0.2736]$$
$$SI_3=0.4705[\alpha \times 0.1726 + (1- \alpha) \times 0.3157]$$

7. RESULT ANALYSIS:

In this section, we focus, on comparing alternative suppliers with respect to the five technical criteria - reliability, JIT system, adequate resource, corporate and social responsibilities, and ability in IT technology. The factors of each criterion will be analyzed to understand why S1 outperforms the others. The comparison of alternative suppliers with respect to "reliability" is shown in matrix-1 Reliability is very important not only because it is related to safety, but also because it has significant financial impacts. A low customer rating will affect sales, and could result in a long-term financial crisis. Although cheap products can win the market temporarily, if the quality and reliability do not meet customer expectations, the obtained market share will be lost. In this case S1 outperforms the other in terms of satisfying the customer's requirement, Therefore, in the reliability point of view S1 will help to minimize the financial loss.

The comparison of alternative supplier with respect to "JIT" system is shown in matrix.2. S1 gets the highest score because the customer recognizes that S3 does not depend on the JIT system. But supplier S3 assures the supply of product in time, In the JIT system point of view, collaborating with S3 will help to minimize Storage cost.

The comparison of alternative suppliers with respect to "adequate resource." is shown in matrix 3. S1 gets the highest score because it focuses on the capacity of the company. In the evident from AHP and QFD model that Supplier 1 stands-out to be the best supplier with an overall weightage of S2 69.167. This result is further validated by Selection Index graph which shows that Supplier 1 has the highest optimum quantity. In the proposed model, both Qualitative and Quantitative has been considered simultaneously and an overall score has been evaluated for the three suppliers, on an extensive pair wise comparison of factors is carried out.

This approach provides us with many advantages. The first and the foremost is that both cardinal and ordinal factors are measured for the evaluation of alternative suppliers. This guarantees that the evaluated supplier has the highest quality, better reliability, lowest cost etc. Secondly, the quantity ordered is optimum.Thirdly; the proposed method is a group decision making approach. Therefore the projected approach Shadows the traditional approaches of supplier selection. The limitation of the proposed approach is due to AHP. Decision makers have to compare each cluster in the same level in a pair wise fashion based on their own experience and knowledge.

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Proposed Natural Methods for Enhancing Thermal Comfort and Reducing Electricity Consumption in Hun City in Libya

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ABSTRACT

The climate in any place is affected by many factors such as weather seasons and the temperature changing in night and day. Without using additional methods and techniques for thermal comfort, the outdoor increase the difficulty of archive the thermal comfort in houses. The electrify mechanical like air conditions is used widely to achieve the houses thermal comfort. The main challenge of the electricity mechanical is the large energy consumption which leads to increase the money and resources expenses of people and country. The main aim of this study is to explore the current situation of energy consumption and thermal comfort in Hun city in Libya. In order to address this objective, a questionnaire survey with 31 Houses in Hun city was conducted. The significant results of data analysis show that the thermal comfort in the Houses is achieved using electricity, mechanical such as air conditions and fans which expense peoples' money due to the large consumption of electricity. This study has recommended some natural shading and shadows methods to enhance the thermal comfort in houses and reduce the electricity consumption.

Keywords - Electricity Consumption; Thermal Comfort; Hot Dry Climate; Natural Shadows; Natural Shading

I. INTRODUCTION

According to Johansson (2006) the climate is defined as the natural weather condition in a specific area, city, or country (i.e. Hot, cold, or warm climates). The climate in any place is affected by many factors such as weather seasons and the temperature changing at night and day. The climate of outdoor plays important role in the thermal comfort of indoor buildings and houses. Hence, the people looking for thermal comfort in their houses, whatever the nature of outdoor climate (Müller et al., 2014). The thermal comfort of building and houses, conditions is known as the suitable temperature degree in the houses. Without using additional methods and techniques for thermal comfort, the outdoor climate plays important role in decrease or increase the temperature degree in the houses, which increase the difficulty of archive the thermal comfort in houses.

One of the most used approaches to address the houses thermal comfort is the mechanical approaches based on electricity power such as air conditions. Air conditions can be used to cool or heat the weather in the houses in order to achieve the thermal comfort (Aldossary et al., 2015). However, mechanisms like air conditions bring new challenge to people and countries. The energy consumption is one of the main challenges of the houses thermal comfort based on electricity mechanisms. Energy consumption

leads to increase the money expenses of people (e.g. electricity bills), and increase the wasting of countries resources (i.e. gas or petrol).

In Libya, The using of electricity mechanisms to achieve the thermal comfort consumes a large amount of electrical energy in residential buildings equivalent to approximately 70% of the total bill value (Rationalization of electricity consumption SEC 2010). General Electric Company reports in Libya (Figure 1) indicated that in 2012, the proportion of residential building's electrical energy consumption is exceeded 36% of the total consumption of electric power, the industrial sector consumes about 11%, agriculture about 12%, the trade about 14%, and public facilities about 27% (Mokri et al., 2013: Report Company General Electric Libya in2012).

The problem of high electric energy consumption in Libya homes presents the importance of the natural thermal insulation of buildings roofs in order to reduce the heat leakage into the building and thus reduces the consumption of the used electric energy. Architecture engineers try to come with innovative ideas related to house design in order to reduce power consumption and achieve the thermal comfort in houses (Mokri et al., 2013). Various studies focus on the outer shell of residential buildings and how it is impacted by the surrounding environmental conditions and the impact on the house internal climate. The main factors of building design that may affect the outer building shell with surrounding environmental conditions are windows, sidewalls and roofs.

The buildings that are not designed to reduce the effect of surrounding environmental conditions generally depends on other electrical devices such as air- conditioning or electrical heaters to reach thermal comfort in summer and winter, which leads to an increase in electric power consumption rate especially for cooling and heating.

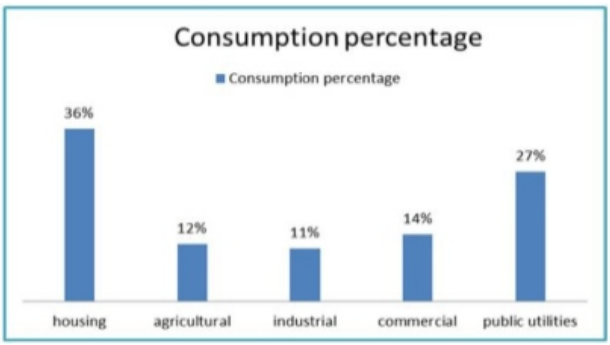

Figure 1: Percentage of electricity consumption per sector in 2012.

This study aims to explore the current situation of energy consumption and comfort in Hun city in Libya also proposed natural methods to enhance thermal comfort of houses and reduce the consumption of electricity energy. Hun city in Libya is selected as case study due to many reasons such as the climate of

Hun city is mainly desert climate where the temperature in winter is considered as cool or cold, and the temperature in summer is hot (Aldbibi, 2007). Hun city suffers from the rigors of weather conditions which increase the difficulty of achieve the thermal comfort in houses.

II. RELATED WORKS

Architecture engineers try to come with innovative ideas related to house design in order to reduce power consumption and achieve the thermal comfort in houses. Various studies focus on the outer shell of residential buildings and how it is impacted by the surrounding environmental conditions and the impact on the house internal climate. The main factors of building design that may affect the outer building shell with surrounding environmental conditions are windows, sidewalls and roofs. The buildings that are not designed to reduce the effect of surrounding environmental conditions generally depends on other electrical devices such as air- conditioning or electrical heaters to reach thermal comfort in summer and winter, which leads to an increase in electric power consumption rate, especially for cooling and heating.

There are various ideas were investigated and several models of natural shadows were developed in the field of outer shell of residential buildings. Some studies focus on the material finished the external surface of building such as cement luster, stone veneer, marble cladding, and concrete tiles. The material of external surface plays important roles in the leakage or the reflection of outside temperature. Hamdan et al. (2012) conducted an experimental investigation that involves the selection of most efficient passive roof of buildings in Jordan. This was achieved by the fabrication of four identical test structures, each one was made by using mild steel angle and galvanized steel sheet. A 0.08 m layer thickness of reinforced cement concrete CRCC roof was cast over each one. Clay thermal insulation over the roof has been found the best material for cooling of building for better comfort conditioning in arid areas, while the white cement structure is the least efficient one.In a study conducted by Alavez-Ramirez et al. (2014), coconut fibre filled precast ferrocement roofing channel components were developed, their thermal behavior was characterized and its performance was compared to precast ferrocement-only roofing channel components in a real-scale prototype house built in CIIDIR facilities in Oaxaca, Mexico. The findings indicated that, coconut fibre filled precast ferrocement roofing channel components experience higher solar radiation intensity, but its thermal damping is 40% and its thermal lag of about three and a half hours. (Nahar et al. (2003) tested eight identical building prototypes to find the best insulated system that reduced the heat on the surface. The dimensions of theses building prototypes are 1, 28 ×, 61 × 1, 1 m3 with mild steel and galvanized steel sides and with a reinforced cement concrete roof. The roof insulation techniques are air void insulation, nocturnal cooling, painting the roof with white cement, covering the roof with Sania a local material, evaporative cooling and broken white glazed tile pieces.

The findings indicated that evaporative cooling found to be the best technique to reduce heat from the roof, which resulted in reaching the thermal comfort inside the buildings, but it needs a huge amount of water so it is suggested that using white glazed tiles stuck over the roof can be used to reduce evaporation and reduced water consumption.

Other studies of natural shadows focus on the color external surface of buildings such as light, medium, or dark colors. The dark colors allow the leakage of outside temperature while the light colors reflect the outside temperature. In a study conducted by (Hernández-Pérez et al., 2014) , the thermal performance of a concrete roof with and without insulation and with two colors has been analyzed using the finite volume method. The boundary conditions of the external roof surface were taken from hourly averaged climatic data of four cities. For the internal surface, it is considered that the building is air-conditioned and the inside air has a constant temperature. The interior surface temperature and the heat flux rates into the roofs were obtained for two consecutive days in order to assess the benefits of a cool roof in different climates. The single white roof configuration was able to reduce the interior surface temperature up to 28 °C at midday in comparison to a roof with the original gray color of concrete. On the other hand, the reflective coating kept the roof close to the inside air temperature in the case of the compound roof; just 3 °C above the set point during the hours with solar radiation.Gao et al.

(2014) conducted a study to investigate how colored roofs reduce the inner temperature of residential buildings and offices in seven Chinese cities which are Beijing, Harbin, Guangzhou, Changchun, Shanghai, Chongqing and Wuhan. The findings indicated that using a white roof instead of a gray roof reduces the inner temperature of buildings in all cities. It was found that a white coating roof saves daily 9% of energy for air conditioning in an office building in Chongqing city. In a factory in Guangdong City, it was found that a white coating roof reduces the inner room temperature from 3-4 degrees and roof heat flux by 66%. The study concluded, depending on experimental results and simulation, that white coating roofs found to be efficient in reducing the inner building temperature which saves energy used for cooling such as air conditioning.

Furthermore, there are studies conducted on the natural shading of outer shell of residential buildings. Various studies focus on surrounding the buildings by natural shading protection like the trees and plants, also the plants and tress is used to protect the building roofs from the outside temperatures.Simpson and McPherson, (1998) examined the possibilities for energy conservation in hot climatic conditions using tree shading. Simpson and McPherson, (1998) evaluate and simulate the effect of tree shading on energy use in housing in the 254 facility in California. They founded that the average in that planting three trees for each property is important to reduce the use of power, cooling,

and the annual peak of 7.1% and 2.3%, respectively. On the other hand Higuchi and Udagawa (2007) assessed the impact of evergreen broadleaf deciduous trees as natural shading method to enhance the thermal comfort and reduce the energy consumption in houses. The researchers reported by planting these trees to shade buildings, savings of up to 20% on annual energy cooling.(Coutts et al., 2013) conducted a study to identify and assess certain methods to mitigate higher urban temperatures to reach thermal comfort. The study aims to find how green and cool roof's performance is depending on their design, vegetation species and watering system. A comparison of four rooftops including green roofs which are planted with Sedum and cool roofs which are coated with white elastomeric paint was conducted in Australia.

The findings indicated that irrigated green roofs reduce the surface heat than non-irrigating green roofs in summer midday. The findings also show that cool roofs are considered a benefit in terms of energy transfer into buildings as the service heat was reduced during the day La Roche and Berardi (2014)stated that Green roofs have been used for the purpose of energy saving in many countries. The potential abilities of green roofs for heating or cooling depend on two factors which are the building features and the climate conditions. Upon that, they conducted a study to measure the green roofs potential energy saving on different roofs which are a non-insulated, green roof, an insulated traditional roof, and a green roof with the variable insulation system and an insulated green roof. These roofs were tested in hot dry region during winter and summer seasons. The findings indicated that the variable insulating system was found to be effective in adjusting the roof thermal capacity. The findings revealed that the variable insulation, green roof and insulated traditional roof obtained the highest indoor temperatures in winter while the insulated green roof and the non-insulated green roof obtained the lowest indoor temperature in summer.

The main gap of the various methods of shadow and shading of buildings is that these methods should be mutated adaptively depend on the temperature (climate) changing of the buildings environment. The regions of hot dry climate like Libya country, the temperature in winter is considered as cool or cold, and the temperature in summer is hot. Also, the temperature is change rapidly when moving from the day to night. Therefore, some shadow and shading could suitable for specific season or period of day while other variables suitable for other seasons or period of day.

III. RESEARCH METHOD

The Hun City environment represents the main case study of this research. The community of this study is composed of of 2850 units of houses; 1000 District the struggling of one floor houses, 600 of District Five Hundred of one floor houses, 500 houses of two floors, and 750 houses of three floors. According

to sampling selection of Sekaran (2006), the data collction sample must be around 379. For this study, a pilot study was conductd in order to invistgate the challenges and situation of thermal comfort in the study area. According to Sekaran (2006), the suitable pilot size of the questionnaire is about 5% - 10% of the actual sample. Thus, the minimum pilot size should be 19 houses. In order to examine the challenges of energy consumption and comfort in Hun city, a semi structured questionnaire was conducted with 31 heads of household in Hun city. The conducted survey was mainly investigated the current situation of electricity consumption and thermal comfort in the study area. On the other hand, a literature of the various natural methods of bullrings and houses shadows and shading was reviewed to propose useful natural methods to enhance the thermal comfort and reduce the electricity consumption in the study area.

IV. RESULTS AND DISCUSSION

The questionnaire of this study consists of four parts which are demographic data; houses information; electrify consumption, and thermal comfort. Regarding to demographic data, the gender of respondents (heads of household) is mixed between male (68%) and female (32%) which indicates the usefulness of collected data based on different gender opinions. On the other hand, the majority of respondents' ages is between 35-39 years (32%), and between 40-64 years (36%). Respondents of these ages could have good knowledge about the thermal comfort and energy consumption in their houses. Moreover, most of respondents are educated (45% are university level, 13% are master level, and 13% are PhD level) which indicates the usefulness of collected data based on good understanding of survey items. Furthermore, most respondent are live in the city from since birth (61% of all respondents). These reflect good understanding of city climate over long years. Additionally, most of respondents' are live in their houses for more than 10 years (74%). Thus, the respondents understand the situation of houses thermal comfort and energy consumption. Lastly, the persons that live in respondents houses are vary form 1-more than 8 persons. Therefore, the collected data represents the thermal comfort and energy consumption based on various numbers of people who live in houses. Table 1 presents the descriptive analysis of the demographic data.

Table 1: Descriptive analysis of the demographic data

Variable		Frequency	Percentage
Gender	Male	21	68%
	Female	10	32%
Age	18-34 years	6	19%
	35-39 years	10	32%
	40-64 years	11	36%
	more than 64 years	4	13%
Levels of education	High School	9	29%
	University	14	45%
	Master degree	4	13%
	PhD	4	13%
How long did you live in the city?	Since birth	19	61%
	Less than 5 years	3	10%
	From 5to 20 years	2	6%
	More than 20 years	7	23%
How long have you been living in this house?	Less than 5 years	4	13%
	From 5 to 10 years	4	13%
	From 10 to 15 years	9	29%
	More than 15 years	14	45%
How many persons are living in the house?	1- 2 persons	1	3%
	3-4 Persons	9	29%
	5-6 Persons	12	39%
	7-8 Persons	8	26%
	>8 Persons	1	3%

Regarding to house information, the respondents' houses are occupied for more than 6 hours per day (87%) which reflect the importance of enhancing thermal comfort and reducing energy consumption in these houses. Most ofthe respondents' houses are one and two stories (87%), with size area between 100-300 M2 (84%), and more than 5 rooms (61%).All of houses roofs colors are medium or dark colors; these colors allow the temperature leaking from outdoor environment. Most of houses external surface materials are cement Laster (35%), or concrete tiles (51%).In the context of houses information, the effeciency of natural shading and shadow methods in the respondents houses are mostly poor. Thus, the natural shading and shadow methods are not used to enhance the thermal comfort in the houses. Table 2 presents the descriptive analysis of the house information.

Table 2: Descriptive analysis of the house information

Variable		Frequency	Percentage
How long is your dwelling occupied per day on average (not including hours of sleep)	3 hours per a day	3	10%
	3-6 hours per a day	1	3%
	6-10 hours per a day	12	39%
	over 10 hours per a day	15	48%
What area is the sizeof your house?	100-150 m²	7	23%
	151-200 m².	7	23%
	201-300 m²	12	38%
	301-500 m²	5	16%
What type of dwelling do you live in?	One story house	12	39%
	Two story house	15	48%
	Three story house	4	13%
How many rooms are there in the your house?	1 Rooms	0	0%
	2 Rooms	0	0%
	3 Rooms	0	0%
	4 Rooms	10	32%
	5 Rooms	2	7%
	More than 5 Rooms	19	61%
What is the color the roof of your house now?	Light Color	0	0%
	Medium color	14	45%
	Dark Color	17	55%
What is the material finished the external surface of your house now?	CementLaster	11	35%
	stone veneer	2	7%
	marble cladding	2	7%
	wood material	0	0%
	concerete tiles	16	51%
Efficiency of Shading Devices that used around houses	Poor	21	68%
	Fair	9	29%
	Good	1	3%
Efficiency Shadow external on houses roofs	Poor	27	87%
	Fair	3	10%
	Good	1	3%

Based on the above Table 2, the shadow and shading methods is not used in the respondents' houses. However, the thermal comfort of houses is critical issue because these houses are occupied by persons for long time per day. Researchers such as La Roche and Berardi (2014), Hernández-Pérez et al. (2014), and Hamdan et al. (2012) were pointed that the natural shadow and shading methods are important to enhance the thermal comfort of houses. Without proper shading and shadow methods, the energy consumption will be increased to achieve the thermal comfort due to large area of respondents' houses (100-500 M, and more than 4 rooms).

Regarding to energy consumption in the respondents house, there are many items were analyzed. All of respondents houses are used the electricity and gas energies to achieve the thermal comfort in their

houses. Most of respondents are considered that the level of energy houses in their houses is medium (45% of respondents) or high (45% of respondents). 90% of respondents see that the level of energy consumption in summer session is high. Also, 87% of respondents see that the level of energy consumption in winter is high. Most of respondents (97% of respondents) expend more than 600 Dinars as monthly cost of energy consumption. Table 3 presents the descriptive analysis of the energy consumption.

Table 3: Descriptive analysis of the energy consumption

Variable		Frequency	Percentage
Energy Types in respondents houses	Electricity	6	19%
	Gas	0	0%
	Electricity and gas	25	81%
	Other	0	0%
Level of Energy Consumption	Responsible	3	10%
	Medium	14	45%
	High	14	45%
Level of Energy Consumption in Summer Session	Responsible	1	3%
	Medium	2	7%
	High	28	90%
Level of Energy Consumption in Winter Session	Responsible	1	3%
	Medium	3	10%
	High	27	87%
Monthly Costs of Energy Consumption	Less than 200 Dinars	1	3%
	200-400 Dinars	14	45%
	400-600 Dinars	16	52%
	More than 600 Dinars	0	0%

The results in the above Table 3 confirmed the problem of energy consumption in Libya to achieve the thermal comfort in houses. Mokri et al. (2013) and RCGEL (2012) argued that the energy consumption is oneof the most main challenges in Libya. It can be noticed from the results that the level of energy consumption is high in both sessions (winter and summer). This because that the climate of Hun city is hot in summer and cold in winter (Aldbibi, 2007) which require energy consumption in both sessions in order to achieve the thermal comfort.

Regarding to descriptive analysis of thermal comfort in Table 4,the air conditions and fans are the main mechanisms based on electricity energy that used to cool the houses in summer session. The air conditioning and fans are almost used all the day to achieve the thermal comfort in summer session. On the other hand, the air conditions and electric radiators are the main mechanisms based electricity energy that used to heat the houses in winter session. The air conditions and electric radiators are almost used all the day to achieve the thermal comfort in winter session.

Table 4: Descriptive analysis of the thermal comfort

Variable		Frequency	Percentage
Cooling Mechanisms in Summer Session	AC	12	39%
	AC & Fans	18	58%
	Fans	1	3%
Period of Using Cooling Mechanisms in Summer Session	All Day	28	90%
	Evening and Night	3	10%
	Night	0	0%
	Evening	0	0%
Heating Mechanisms in Winter Session	AC	19	61%
	Electric Radiators	12	39%
	Other	0	0%
Period of Using Heating Mechanisms in Winter Session	All Day	28	90%
	Evening and Night	2	7%
	Night	1	3%
	Evening	0	0%

Based on the above Table 4, it can be concluded that the electric machines such as AC, fans, and radiators are used widely to achieve the thermal comfort in the respondents' houses.Aldossary et al., (2015) mentioned that the using of electric machines for houses thermal comfort brings new problems like high consumption of energy. Thus, the electric bills costs will be increased and the energy resources will be wasted.

Figure 2shows that the rate of houses temperature (ground and upper floor) is mostly warm or hot in summer session due to high temperature degree of Hun city climate in summer. Thus, the cooling mechanisms using electrical energy are used to decrease the houses temperature in summer session. This because the climate of Hun city in the summer is high (Aldbibi, 2007).

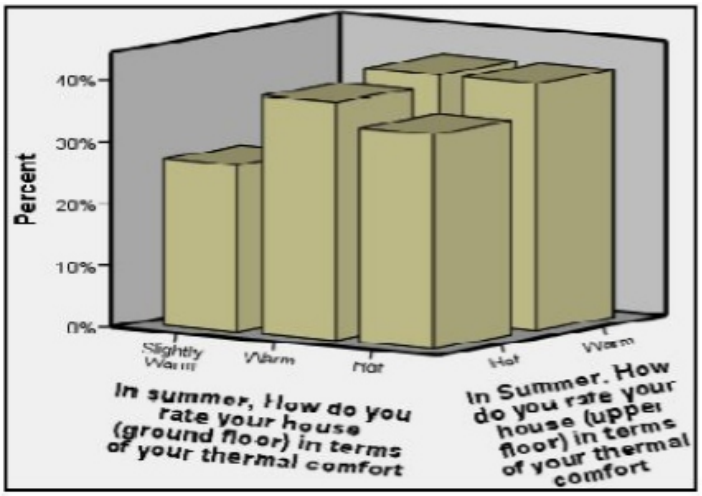

Figure 2: Temperature Rate in Summer Session in Hun City

Figure 3 shows that the rate of house temperature (ground and upper floor) is mostly cool or cold in winter session due to the low temperature degree of Hun city climate in winter. Thus, the heating mechanisms using electrical energy are used to increase the houses temperature in summer session. This because the climate of Hun city is cold in the winter (Aldbibi, 2007).

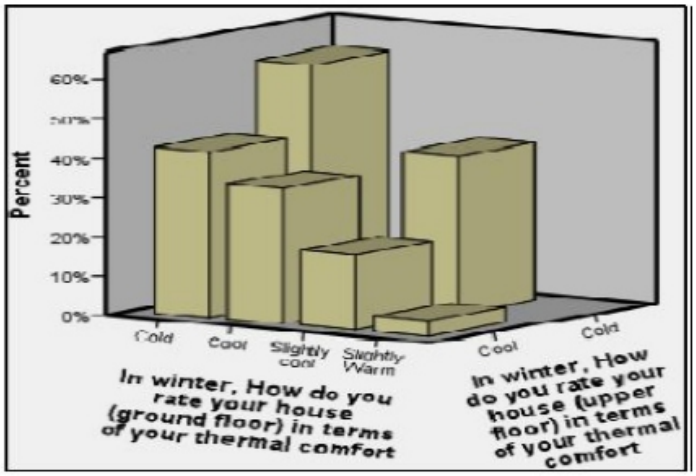

Figure 3: Temperature Rate in Winter Session in Hun City

Based on the survey findings, it can be noticed that that Hun city climate is changing rapidly from winter to summer and from summer to winter. This rapid changing leads the people to use the eclectic energy to achieve the thermal comfort in their houses and consequently increase the expenses of energy consumption. Referring to houses information part, the houses in Hun city are not supported by natural shading or shadow methods to enhance the thermal comfort adaptively and then reduce the energy consumption and expenses.

V. RESEARCH LIMITATIONS

The main limitation of the previous research is weakness of the suggested natural shadow and shading to address the frequent change of dessert climate. The dessert climate is hot in summer and cold in winter. On the other hand, the climate is changed from day to night. Thus, it is necessary to utilize adaptive natural methods of shadow and shading to achieve the thermal comfort in houses whatever the situation of outside climate. Many researchers proposed natural methods and techniques of houses shadow and shading to enhance the thermal comfort (La Roche & Berardi2014;Hernández-Pérez et al., 2014;Hamdan et al., 2012). The main challenge of the various methods of shadow and shading of buildings is that these methods should be mutated adaptively depend on the temperature (climate) changing of the buildings environment. In the regions of hot dry climate like Libya country, the temperature in winter is considered as cool or cold, and the temperature in summer is hot. Also, the temperature is change rapidly when moving from the day to night. Therefore, some shadow and shading could suitable for specific season or period of day while other variables suitable for other seasons or period of day.Some previous works proposed natural shadows methods such as roofs colors, and surface materials to enhance the thermal comfort of houses (Gao et al.2014; Coutts et al., 2013). However, these methods are suitable for cooling or heating the houses temperatures, but not suitable to achieve the thermal comfort depend on the temperature changes (adaptive cooling and heating). Other

related works were proposed the natural shading methods such as protect houses roofs or surrounding houses by trees. However, these methods is almost use for houses cooling rather than heating purposes.

VI. RESEARCH IMPLICATIONS

The integration between green roofs (shading) and color of roof materials (shadow) provided effective result to adjust the thermal comfort of houses adaptively based on the outdoor climate temperature (cooling in summer, and heating in winter). Thus, this research proposed the integration between green roofs using suitable plants or trees architecture, and the suitable color of roofs materials in order to enhance the thermal comfort and reduce the energy consumption of houses in Hun City. The proposed natural methods are important for Hun city houses due to following reasons:

1. Reducing electricity consumption in residential buildings, which contributes to reducing the production of electricity and the expenses of thermal comfort in houses.
2. Attempting to use insulation materials the ceiling of the output of traditional architecture which is characterized by the use of local materials which cost is lower than the electric mechanisms installing, deploying, and maintaining.
3. The electric mechanisms (central cooling or heating) feeding by gas or petrol may lead to weather side effects (i.e. Colostrum pollution). These effects would be reduced using natural techniques and materials in building design.

CONCLUSION AND FUTURE WORKS

This study explores the current situation of thermal comfort and energy consumption in Hun city houses. For this purpose a questionnaire survey was conducted. The significant findings show that the thermal comfort in Hun city houses is achieved using electricity mechanisms. Electricity mechanisms are used for along time per day to heat the houses in winter or cool houses in winter. Thus, the electricity energy consumption and expenses are high. This presents the importance of natural shadows and shading methods to enhance the thermal comfort and reduce the energy consumption in the Hun city house. The main gap of natural shadow and shading methods is that each method is suitable to heat or cool the house temperature, but not effective to cool and heat the house adaptively based on the dynamic change of outdoor temperature. The integration between green roofs and color of roof materials considered as an effective combination to adjust the thermal comfort of the houses adaptively. In the future, a study could be conducted to determine useful combination between architecture of green roofs using suitable plants or trees, and the suitable color of roof materials in order to enhance the thermal comfort of Hun city houses whatever the temperature degree of outdoor climate.

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Techniques used to Formulate Confidential Data by Means of Fragmentation and Hybrid Encryption

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ABSTRACT

Cloud computing is a concept shifting in the approach how computing resources are deployed and purchased. Eventhough the cloud has a capable, elastic, and consistent design, several security concerns restrain customers to completely accept this novel technology and move from traditional computing to cloud computing. In the article, we aspire to present a form of a novel architectural model for offering protection to numerous cloud service providers with the intention to devise and extend security means for cloud computing. In this work, we presented a two-tier architecture for security in multi-clouds; one at the client side, and other at the server side. The article presented a security domination outline for multi-clouds and supports security needs like Confidentiality, Integrity, Availability, Authorization, and Non-repudiation for cloud storage. Through this document we have anticipated, HBDaSeC, a secure-computation protocol to ease the challenges of enforcing the protection of data for information security in the cloud.

Keywords: authorization; cloud computing; novel technology; protection; traditional;

1. INTRODUCTION

The abundance of the digital world continues to augment the necessity of novel storage space as well as net utilities, besides with a growing requirement for additional expenditure for effective handling of storage capacities and network bandwidth for information transmitted. The employment of the distant storage method is achieving esteem, specifically the cloud storage based services, as they grant beneficial architecture. This style supports the communication, storage and intensive calculation of outsourced information on a pay per use business model. This extensive significance in cloud storage services primarily arises from agencies looking for further flexibility and outlay valuable systems. That is the profit of cloud espousal is very substantial in a later period of receptiveness, usefulness, and competence in “Information Technology” service delivery. Consequently, expending huge quantity of assets on buying high-priced application is no longer required. These reasonable profits present the chief crucial inspiration for cloud acceptance as they assist the enterprises plummeting the Capital Expenditure (CapEx), kept to procure permanent assets and the Operational Expenditure (OpEx) which is an ongoing expenditure for accepting a product business or a system.

The clause is structured as ensuing: Section 2 discusses the role of cloud computing and the need of multi-clouds. Section 3 illustrates the importance of security in clouds and principles. Section 4 provides the motivational scenario and the main contributions of the paper. Section 5 highlights the literature survey done. Further, Section 6 describes the techniques used to formulate confidential data by means of fragmentation, and hybrid encryption and discusses Blowfish and Homomorphic encryption in detail. Section 7 explains the proposed HBDaSeC system model and operations to be operated on files in multi-clouds. In section 7 a framework for secure data storage on the cloud is proposed. A detailed description of the framework along with all components and phases are described in the chapter. Section 8 provides notes on the implementation of the framework introduced in section 7 and it also describes the performance of the framework. Section 9 provides concluding remarks and as well as routes for possible enhancements.

Cloud Computing: Characteristics, Service Models and Deployment Model

Over the duration, computing models have transformed commencing scattered, similar, and a grid to cloud computing. Cloud computing can be named as an innovation used to convey benefits through the web as a medium. Cloud com- puting comes with numerous intrinsic abilities such as ondemand resource distribution, abridged management efforts, elastic pricing form, and simple applications and services stipulation.

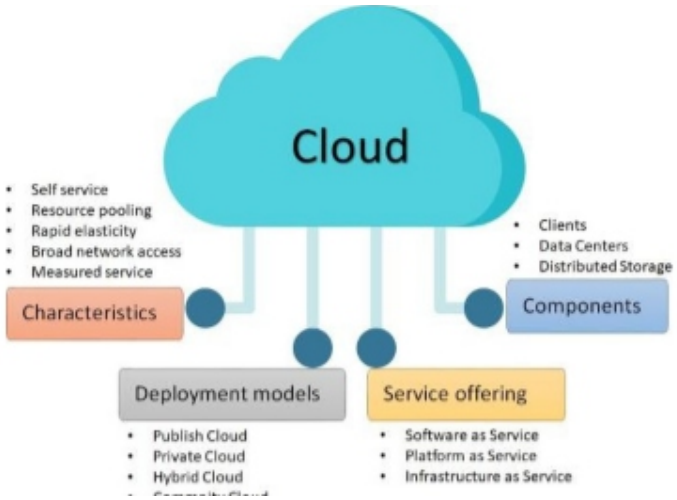

Figure 1. Cloud computing paradigm

Cloud computing comprises three key service models: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS) and their description are presented in Figure 2 below.

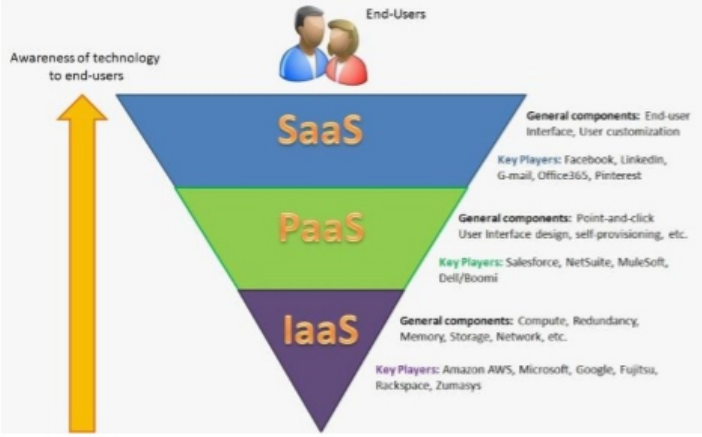

Figure 2. The SPI model

Cloud services can be provided as four basic cloud delivery models as shown in Figure 3. Five major cloud actors each concerned with performing diverse roles are cloud broker, the cloud provider and consumer, cloud auditor, and cloud carrier.

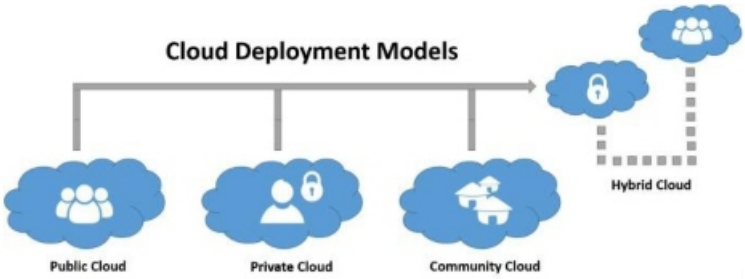

Figure 3. Cloud Deployment models

With the arrival of data, both individuals and enterprises are producing a huge amount of data every day, which profoundly influences our living style. On one hand, the explosively increasing data creates the limits for data storage and data transmission; on the other hand, data has become an important productivity resource. Therefore, it is essential to invent a proficient data sharing model to share huge amounts of data among different individuals or organizations. Obviously, cloud computing is certainly a perfect data sharing tool for its vast storage space and reliable distributed storage system. However, even if there are various advantages of cloud computing, security and privacy concerns are the primary obstacles to wide adoption.

Why Multiclouds are essential? The multi-cloud approach employs two or more clouds and consequently avoids dependence on one individual cloud. Vukolic stated that multiclouds encompass improved trust, protection, and dispersed reliability amid several cloud providers. Abu Libdeh prefers multi-clouds so as to elude “vendor lock-in” by storing user’s information amid various clouds. Multicloud scheme has the capability to lessen the hazard of service accessibility collapse, failure and

corruption of information, privacy hindrance in addition to the view of malicious insiders in the single cloud, increased virtual power by merging the infrastructure of several cloud providers by offering application programming interface abstractions which has made easy the management of multiple cloud providers at the same time, and increased flexibility by offering hardware, software and infrastructure redundancy and seer traffic from different customers through the fastest possible parts of the network. It has incorporated diverse aspects of security like confidentiality, integrity, availability, proficient retrieval and information sharing.

The main multiclouds models are DepSky to construct clouds of clouds andare considered to be the finest model as it provides all the security issues like availability, integrity, and confidentiality and avoids vendor lock-in problem. HAIL is High Availability and Integrity Layer which provides a software layer by combining cryptographic protocols with erasure codes to provide integrity and confidentiality. RACS is a redundant array of independent disks (RAID) like practice solving vendor lock-in problems but it fails to provide con- fidentiality and security issues. InterCloud Storage (ICStore) implements all client-side functionalities as a library and has three layers which offer confidentiality, integrity, reliability, and consistency. MultiCloudDataBase (MCDB) is considered to be the advance side of DepSky and uses distributed method to grant privacy with database management systems.

Security in Clouds

Cloud computing is mentioned to develop dynamically and diverse cloud aspects are mentioned to emerge. The document intends to recognize the security issues linked amid cloud storage and highlighted the significance of security principles used for cloud storage.

Importance of security in cloud computing

The control, suppleness, and easiness of employment of Cloud Computing arrive with a number of challenges/issues. In particular, security has been extensively reported to constitute the main factors which prevent migration to the cloud. Even if a corporation states to include peak class security and does not renovate its security policies from time to time, it will be vulnerable to security breaches in near Vista. In this view, via this manuscript, we intend a novel practice to alleviate the security challenges through Integrated Encryption approach.

The distance amid the user and the physical site of his information construct a hurdle as this information can be leaked by a third party affecting the privacy of customers information. The employment of conventional encryption schemes to encrypt the remote data prior to transfer to the cloud service

provider have been extensively used to viaduct this security breach. However, the customer should provide the secret key to the server to decrypt the information prior to carry out the requisite calculations. Homomorphic encryption permits performing computations on encrypted data without decryption.

Cloud Computing Security Principles

Information security ethics at diverse stages of cloud applications are emphasized by enforcing confidentiality and protection of data. Ramgovind, Eloff, and Smith defined six information security requirements in Cloud computing (Ali et al., 2015).

a) Identification and Authorization: involves verification and validation of cloud user's using security checks for user- names and passwords and then check the permission of access.

b) Authorization: Referential integrity is guaranteed through this process to control and privilege processes in the cloud.

c) Confidentiality: It is a chief prerequisite to preserve power over the information of numerous organizations that could be positioned across some distributed databases.

d) Integrity: is to assure the accuracy and consistency of information.

e) Nonrepudiation: It can be maintained through safety protocols and token provisioning, such as using digital signatures, timestamp, etc.

f) Availability: It is an important factor while considering the delivery model and selecting the service model and must be part of SLA.

The security concerns of distributing information to the clouds laid the driving force for the expansion of data security practice able of addressing the aforesaid critical issues.

Motivational Scenario and the Main Contributions of the Paper

Users deduce that cloud service providers certify that while information is in transit commencing clients premises to the cloud servers, its security constraints would not be distorted, and their information can be transmitted securely to cor- roborate an increased data security. However, the significant security challenges have augmented consequence and should be cautiously addressed.

Thus, cloud clients deal with the challenges of selecting appropriate cloud service providers and assess security implementations depending on their security needs.

Key contributions of the paper are as follows. The subsequent is an outline of our effort:

a) We intend a procedure for safe allocation of cloud data. This practice adeptly offers the reliability assurance to customers as a cloud service provider is considered reliable in storing all the records and these records cannot be exposed to malicious or illegal users.
b) We verified that security in terms of confidentiality and availability of the projected system against attacks.

We authenticate the results of the planned method via analysis and assessment. Our system takes less storage space and execution time to perform the queries and offers better security and is highly efficient.

2. MATERIALS AND METHODS

Security is a vital facet of all information processing conduct and every organization has to extend mechanisms and tools to sustain and guarantee the security of their information resources. Engoulou et al., (2014), had mentioned that a lot of research activities are being carried out to address cloud security threats. The paper motivated the need for effective cloud security countermeasures by discussing the cloud security issues. The motivation of use of multi-clouds was described along with the proposed set of four distinct Multicloud architectures. Each of the introduced architecture provides its own security merits and flaws were started with respect to the security requirements by using diagrammatical presentation. Case studies discussing reallife examples were also mentioned in each scenario. Security, feasibility, and regulation were considered for comparison. Fernández-Alemán et al., (2013), explored cloud security in terms of issues, solutions, and shortcomings. The author correlated data confidentiality and user authentication. Gubbi et al., (2013), suggested the usage of homomorphic encryption for storage on the cloud. The author described security and privacy con- straints, issues, and approaches. Keshavamurthy et al., (2012), aimed to understand the security issues and highlighted the significance of data integrity schemes used for cloud storage. The paper had defined taxonomy to explain all aspects of data integrity considering its attributes like nature of data, deployment model used, and nature of metadata employed. The security attacks and mitigation techniques were discussed. Miorandi et al., (2012), presented a novel architecture of security which acts as an interface amid end users and private cloud ser- vice providers. The major contributions of the paper included high available cloud storage gateway (HASG) architecture. Data reliability and fault tolerance, file fragment algorithm utilizing information dispersal algorithm divided the file into redundant partitions and stored on different cloud storage. Mokhtar & Azab (2015), presented a pioneering method for safe data storage

on the cloud through the collective use of cryptography and Disintegration Protocol and validated Integrity and Confidentially, security constraints against internal and external attacks. Mollah et al., (2017), proposed for a multi- cloud system for encrypting, splitting and storage of data. In case of any failure in existing CSP or two CSP's, a model was proposed for efficient working. The system limitation is increased time but the security is assumed to increase. Nguyen et al., (2015), defined a new scheme called storage correctness and fine-grained access provision (SCFAP) which utilized hierarchical structure to allow users an exclusive access. The storage correctness verification of the outsourced data was done using a token granting mechanism. The future work mentioned was to deploy SCFAP scheme for outsourced data decryption techniques. Raza et al., (2013), emphasized an auditing process involving a TPA to achieve data integrity and privacy. The research on cloud data auditing was mentioned to focus on the verification, privacy preservation and integrity of stored data using cryptographic methods.

Sobh (2006), presented the architecture overview with algorithms for file slicing and encryption and file decryption and Merging. The comparison table of various existing schemes and the proposed model were listed in terms of Turnaround time, encryption process time, eecryp- tion process time, security features (Privacy, Insider attack, secret keys, confidentiality and data integrity) and Reliability features (File formats supported, collusion attack, Key Escrow, Malicious files, File size). The future enhancements suggested implementing dynamic data slicing using 3DES. Weinman (2017), mentioned the use of highly dispersed compute and storage elements in the form of "FOG". Multicloud FOG is a hybrid architecture working together in an integrated fashion providing highly dispersed facilities. A real-life ex- ample is Walmart which uses OpenStack for its private cloud, Rackspace, Azure, and other public clouds.

Srivastava & Nandi (2014), provided a new efficient remote data possession checking (RDPC) protocol based on Homomor- phic Hash function. The presented scheme was mentioned to be secure against several attacks. The performance anal- ysis showed the computation and communication cost to be reduced. Ali et al., (2017), proposed a model called DaSCE (Data security for cloud Environment) with a semi-trusted third party which provided key management, access control, and file assured deletion functionalities. DaSCE is mentioned to utilize Shamir's (k, n) threshold scheme. Scyther tool was used to graphically analyze and verify security protocols.

Zissis & Lekkas (2011), discussed the problems of big data storage in the cloud like data security, data authentication, data integrity, data availability and data de-duplication. Architec- ture, SecSVA: A secure storage, verification, and auditing for big data in the cloud environment were discussed

supporting the data authentication, verification, auditing, integrity and confidentiality for cloud storage. An attribute-based security framework with secure de-duplication for Big data storage in the cloud was discussed. The architecture comprised of various entities like client, data service provider, cloud service provider, trusted party auditor (TPA) and Kerberos server. From the analysis, the proposed scheme was mentioned to withstand different attacks. Wei et al., (2018), suggested for the Multi- cloud environment. The encrypted data block and key blocks are together distributed to multiple cloud service providers. The verification of correctness of data exchange is done using a cryptographic protocol. The erasure correcting code was employed to support reliable data storage for tolerating multiple failures among CSPS.

It evaluated the performance of the proposed large universe cipher-text based attribute-based encryption outsourcing scheme in two hardware platforms like Intel and ARM and employed key encapsulation variant. The secu- rity analysis and performance evaluation showed the planned scheme to be secure and efficient. It discussed generic cloud storage architecture and various securityrequirements considering confidentiality, integrity, and availability. The presented system encrypted only some bits of each data block instead of encrypting the whole file, thereby eliminating computation overhead. The Integrity was checked by the Meta- data created and inserted at the end of the original file. Metadata was encrypted by applying the AES-256 encryption algorithm and the SHA-256 algorithm was used for generating a hash of the original file. The implementation of the proposed approach was done using Amazon S3 Live1 cloud storage and the mechanism was used to validate the integrity check of the uploaded file.

3. RESULTS AND DISCUSSIONS

3.1 Techniques Used to Formulate Confidential Data by Means of Fragmentation, and Hybrid Encryption Encryption Techniques Employed

Encryption is the process of translating plaintext into cipher text and decryption is the reverse of the encryption process. Key size plays a significant role in the encryption and decryption process. Longer the key, more difficult is the process of decrypting the message.

Whenever a message is sent from the sender to the des- tination, an intruder denoted by 'I' can interfere with the communication medium who can affect the system in the following ways:

a) A message can be 'blocked' which violates the availability and thus the message never reaches the destination.

b) Confidentiality can be breached if the message can be 'intercepted' by the intruder which makes it no longer secret.

c) Integrity can be violated if 'content' of the message can be changed or a fake message is sent.

Homomorphic Encryption

Homomorphic encryption is the apt elucidation to resolve cloud computing security issues because its schemes facilitate to execute computations on encrypted information devoid of sharing the secret key essential to decrypt the data.

A Homomorphic encryption is: from Enc (P) and Enc (Q) it is possible to compute Enc (Func (P,Q)), where 'Func' can be one of the operations: +, , exclusive of using the private key. It was developed by Ronald Rivest, Leonard Adle- man, and Michael Detouzosin 1978. Homomorphic encryption (HE) is formed by four functions as shown in Fig.4.

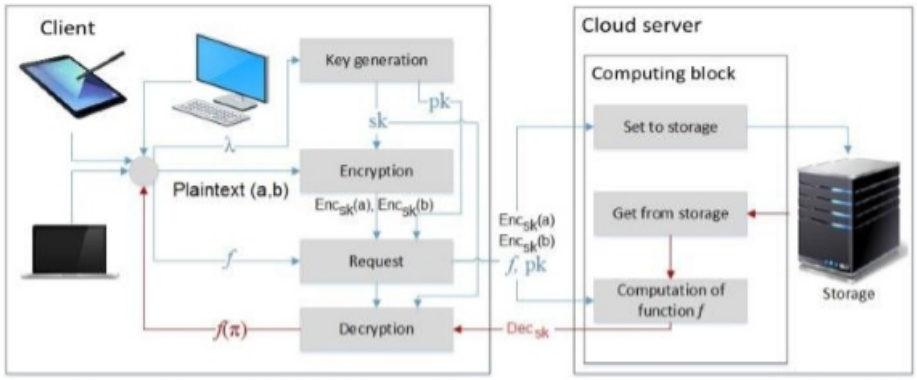

Figure 4. Homomorphic Encryption Functions

Taxonomy of Homomorphic Encryption:

Multiplicatively Homomorphic: When an allowable acton the encrypted information is controlled to multiplication, it is known as Multiplicatively Homomorphic. Notation:

$$E_{nck}(P_1 \Theta P_2) = E_{nck}(P_1) \times E_{nck}(P_2) \qquad (1)$$

where, P , P are plaintexts.

Privacy: HE provides more privacy than the traditional cryptographic techniques as calculations are performed on the encrypted data.

Analysis of disease to find out its treatment without disclosing the details.

Solves Confidentiality constraint problem: HE resolves the confidentiality constraint when shared information is to be operated by diverseclients who want to executedi- verse operations on data.

Paillier: In 1999, Pascal Paillier developed aprobabilistic asymmetric algorithm meant for public key cryptography (Paillier, 1999) and is shown below.

Algorithm 1 Paillier BEGIN

Key Generation: The parameters are:

1) Choose two prime numbers p and q.

2) Compute $n = p \times q$. 1 2

3) Compute $\lambda = \text{lcm}(p-1)(q-1)$.

Additive Homomorphic Encryption: When an allowable operation on the encrypted data is limited to addition, it is said to be Additively Homomorphic. Notation:

$$E_{nck}(P_1 \Theta P_2) = E_{nck}(P_1) + E_{nck}(P_2) \qquad (2)$$

Types of Homomorphic Encryption

Homomorphic encryption is of three types as shown in Table 1 (MahaTeeba et al., 2012). A somewhat Homomorphic performs limited addition and multiplication on encrypted information.

Table 1 : Classification of homomorphic encryption

Parameter	Partial HE	Fully HE
Type of operation supported	It allows either addition or multiplication scheme	It allows both addition and multiplication operations
Computation	It allows a limited number of computations	It allows an unlimited number of computations
Computational efforts	It requires less effort	Requires more efforts
Performance	It is faster and more compact	It has slower performance
Versatility	It is low	It has high
Speed	It is fast in speed	It is slow in speed
Ciphertext size	It is small	It is large
Example	Unpadded RSA, ElGamal	Gentry Scheme

Homomorphic Encryption Applications

HE is considered to be a consolidated element for information security in cloud computing. It has several benefits:

1) Protection of mobile agents: It can provide protection by either using computation with encrypted function or computation with encrypted data by supporting + and operations.

2) Secret sharing scheme: HE can be helpful in the recon- struction of a secret.

3) Banking: Accounts can be encrypted by the private key and stored in the bank's server.

4) Private information retrieval (PIR): Sensitive data could be obtained without describing the nature of information. Any search engine could implement HE to protect users privacy. Choose g such that g Zn 2 and the order of 'g' is a multile of 'n'.

5) Choose public key (n, q) and private key (p, q, λ)

The Encryption Process: of message m to generate ciphertext c such that m < n.

1) Select a random number r < n such that r Zm .

2) Compute ciphertext c such that c =gmrn(modn2)

The Decryption Process: of chiphertext c

1) Ciphertext c < n2.

2) Plaintext m is compute as m = L(cλ mod n2) (modn) END L(gλ

Homomorphic Properties of Paillier:

Paillier cryptosys- tem supports the property of additive homomorphism. In this cryptosystem, the product of two cipher-texts will decrypt to the sum of their corresponding plaintexts. Considering message to be encrypted as m1 and m2, Enc() and Dec() are the encryption and decryption functions respectively and n is from the PublicKey=(n, q), and then the additive homomorphism property can be expressed as follows.

$$D_{ec}(E_{nc}(m_1, n, q)\, E_{nc}(m_2, n, q)) \bmod n_2 = m_1 + m_2 \bmod n \qquad (3)$$

Assume c_1 and c_2 be the cipher-texts of the plaintexts m_1 and m_2. The encryption procedure of Paillier Cryptosystem is,

- $c_1 = gm_1 .rn \bmod n_2$, for some random number r_1 Zn 1
- 2 = gm_2 rn mod n_2, for some random number r_2 Zn . 2

Now $c_1c_2 = gm_1 + m_2 [(r_1r_2)]n \bmod n_2$ represents a valid encryption for $m_1 + m_2$.

Blowfish Algorithm: It is considered to be the fastest symmetric block cipher used in place of DES/IDEA. It was developed in 1993 by Bruce Schenier. It is a 16 rounds Fiestal structure with changeable key length (32-448 bits). All operations are done as addition on 32-bit words and XOR ( ) (Seth, 2016). Blowfish S-Boxes are key dependent. It operates in three phases as depicted below.

Algorithm 2 Blowfish BEGIN

• Blowfish has 16 rounds.

• The input is a 64-bit data element, data.

Data Encryption:

• Divide data into two 32-bit halves: dataL, dataR.

• For i = 1 to 16:

1) Compute the value of dataL by find dataL Compute the value of dataR by find F (d ataL) Pi. 2) Interchange values of dataL and dataR.

• Following the sixtenth round, swap dataL and dataR again to undo the last swap.

1) dataR = da taR P18.

2) dataL = dataL P11.

3) Finally, recombine dataL and dataR to get the ciphertext.

Data Decryption:

• P1, P2, ..., P18 are used in reverse order and is the reverse of the encryption process. END

Graphical representation of the Blowfish algorithm is shown in Figure 5(a) taking into account the fiestal structure. The F function is shown in Figure 5(b).

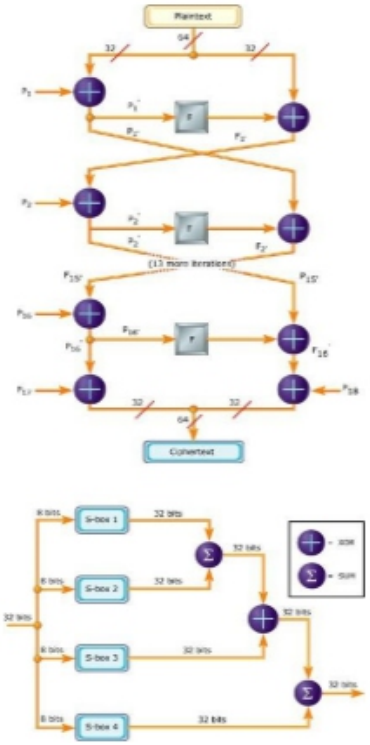

Figure 5. (a) Blowfish algorithm (b) Function module (F)

The function divides 32-bit input into four bytes and uses them as indices into an S-array. The lookup results are XORed together to produce output. P taken is an array of eighteen 32- bit integers. S is a two-dimensional array of 32 bit and stored as 4 × 256.

Fragmentation

The data fragmentation method gives more security to user's data on the cloud. In this, user's data is first divided into multiple parts based on size. It's illustrated in Figure 6.

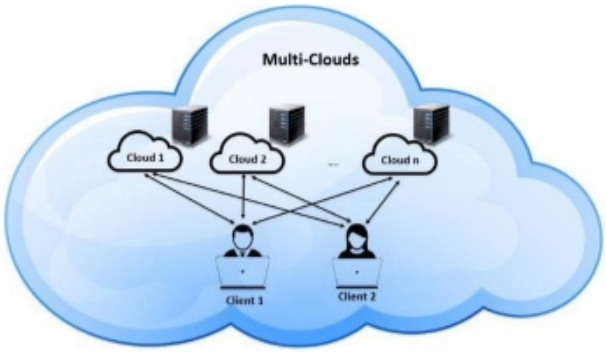

Figure 6. Data Partitioning Architecture

Splitting the input file into segments is important for many reasons:

1) Distributing over multi-clouds is easier than storing a single file on the cloud.
2) Avoids cloud maximum size file problems.
3) Allows better utilization of bandwidth.
4) Facilitate load balancing.
5) Facilitate encryption and decryption process by reducing the size of computed files.

3.1 Proposed Hbdasec System Model

Cloud storage as a service is an emergent drift with attractive characteristics which are lacking in onpremise storage. Nonetheless, each organization is not competent of controlling huge secondary storage or constructs their confidential information centers due to the incurred expenditure of constructing and maintaining such infrastructure. Cloud storage elastic nature can be a vast provision to such organizations. Nevertheless, the failure of managing outsourced data is an intrinsic crisis. Even though the CSP is constrained by a Service Level Agreement to guarantee data security, clients cannot exclusively depend on these agreements. Moreover, dependence on a contractual commitment may fail to identify the malevolent activities of the service provider. So, in addi- tion to the expediency supported by the cloud system, data security issues are also mandatory to be looked upon with a cloud storage service system. Our proposed cloud information storage scheme is illustrated in Figure 7.

The user can perform various operations like upload, download, delete and view the files.

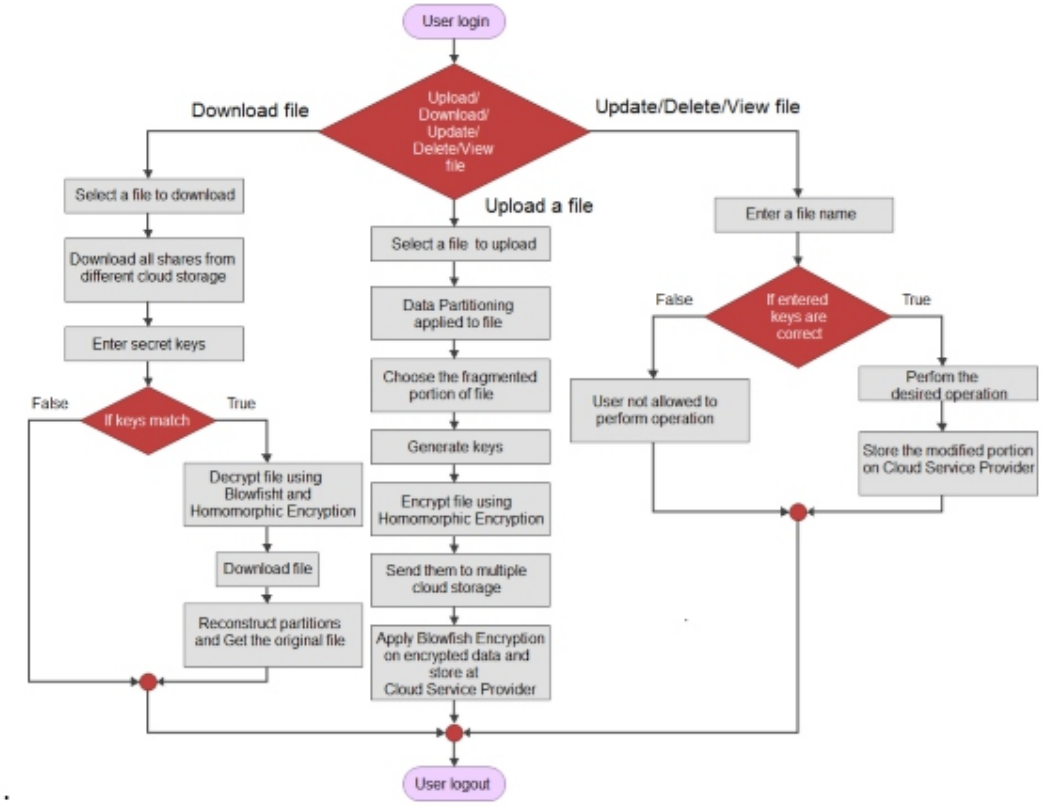

Figure 7. Proposed system model

HBDaSeC Components

The HBDaSeC is the proposed secure secret, fragmented, and encrypted system consisting of 4 steps:

1) Registration

2) Encryption/Decryption

3) Fragmentation

Each time a new user wants to store data in the cloud, the authorized administrator performs the registration of the client. The blend of the encryption techniques helps to diminish the threat of information seepage in multiclouds even further, in the visage of inquiring or hacked CSPs. Furthermore, the availability of information located in the cloud is increased. The recovery procedure is analogous to the storage course involving authentication of Cloud Service Providers and reconstruction of encrypted files.HBDaSeC involves:

1) Secure Storage: The subsequent stride is taken to amass the data given by a data storage provider securely using encryption and trusted authority:

a) Define access rights for user's w.r.t. the files based on rolebased access control.

b) Fragment the files into random numbers based on their type.

Data files are encrypted using the Paillier algorithm at the client end and using the Blowfish algorithm at the server end and secret keys generated.

a) Signatures for encrypted files are generated by SHA-1 etc.

b) An encrypted chunk and its allied signature are sent to the independent CSPs.

2) Secure Verification: In the proposed HBDaSeC scheme, if a user desires to access the chunk stored by data storage provider, subsequent are the steps for uniqueness and access authentication:

a) The request is sent by a client to the administrator for the desired segment.

b) The administrator verifies the access privileges of the clients by role-based access control policy.

c) The client is denied access on non-confirmation of access rights.

3) Secure Auditing: In the planned design given in Fig.4, after step 1 and 2, the client verifies data integrity by the subsequent steps:

a) The client seeks the encrypted information from the cloud service provider.

b) The cloud service provider sends the encrypted data to the client. The client generates the hash checksum using GtkHASh2 GUI. The generated checksums are checked against the checksum stored in its database.

c) The data integrity is confirmed if a match occurs.

d) After confirmation of data integrity, the download operation is said to be complete when the split shares of data are regenerated and merged to get the original file.

System architecture overview

In the next section, we will provide an outline of a design in Figure 4 comprising the storage course from a solitary Healthcare unit (HU) including the data flow and security measures. The system will consist of major components: Cloud service providers, Data users, and Trusted Third Party Auditor. A novel style of security, as a proficient distributable cloud storage gateway acting as an interface between end users and private Cloud service providers, is provided. In this work, we have presented an Innovative mechanism for Secure Data

Storage in Multiclouds for end users to:

1) Provide transparency to users to rely on different cloud storage providers.

2) To enforce double encryption, availability, and integrity.

Our projected system has the subsequent advantages:

1) Permit the consumer to amass data in a safe manner on commercial CSPs since the data is stored in an encrypted form.
2) Let the customer describe an access control policy.
3) The method allows the client to alter the access policy vigorously through Third Party Authority without necessarily decrypting the data.

The progress of a security system HBDaSeC: "A Novel Approach integrating Homomorphic and Blowfish encryption techniques for Secure Data Storage in Cloud" combining Ho- momorphic and asymmetric encryption is illustrated in Fig.8 below. At the client end, the client sends the fragmented and encrypted data with personalized keys on the cloud storage. The work of the server is to re-encrypt the encrypted data. The provision for storing the encrypted file with and without compression is provided at the server side. The client requests for data to the cloud storage server. The server sends the double encrypted data to the client. The client decrypts the obtained results and reconstructs all the partitions to attain the original file.

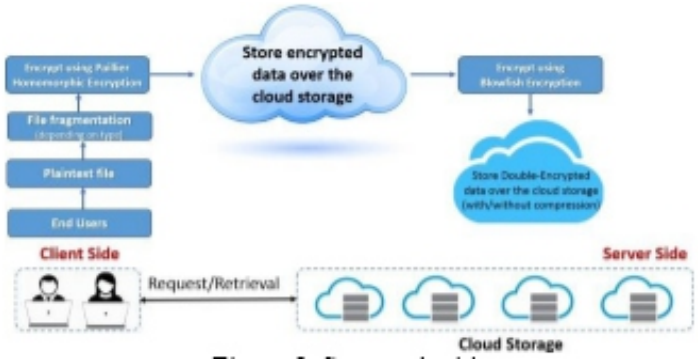

Figure 8. System Architecture

Our approach will convey the latest facet to cloud storage. It assures confidentiality, integrity to the data as in no stage information is exposed in plaintext. The data fragmentation method gives more security to user's data on the cloud. In this, user's data is first divided into multiple redundant partitions based on size. After partitioning, the user's data are encrypted and scattered each share over the Internet to different Cloud service providers. The use of multiple cloud servers provides more security to user's data. If an attacker gets any part of the file, it is impossible to get complete data because the data will be divided and stored on different servers. The following architectural diagram shows the concept of data partitioning and storage on different cloud servers. The deployment of the cloud has twofold benefits for such an approach:

1) The user can retrieve his file in case of temporar ily/permanent unavailability of the provider.
2) Providers can't access the file stored within them.

Only the authorized users are supposed to have full control of the overall security of the data. The clients have the right to access their own specific data and can't overlook other user's data. The cloud service providers are not provided any knowledge about the stored information as the data is stored in encrypted form.

Role of Trusted Third Party Authority at the server side Third party authority has been assigned the authority for changing the attributes is used to set/unset certain attributes to a file to secure accidental deletion or modification of important files and folders. The file can be made immutable i.e. no renaming, no execution, no symbolic link creation, no writable is allowed. We can secure the entire directory and its file content using different switches like +r with +i flag along with the full path of the folder. To synchronously update changes on the disk on any file modification, the 's' attribute set can be used.

HBDaSeC phases

The scheme can be achieved by creating a safe and completely automated information storage and transfer protocol amid CSPs and users having access to numerous storage volumes on the cloud to accumulate his information. The protocol can be implemented in two phases:

1) Upload phase
2) Retrieve phase

The send phase occurs when the file is being saved or restructured in the public cloud storage and retrieve phase occurs when the file is accessed or downloaded from the cloud infrastructure. The file can be stored among available virtual volumes $V_1, V_2, ..., V_n$ with each having certain storage space.

Upload phase: A file to be uploaded is split into numerous smaller chunks to be stored in the existing volumes such that reconstruction of the initial file becomes difficult.

Information associated is:

1) Index of the chunk in the original file which provides the precise position in the file.
2) Virtual volumes(s) where the chunk is stored.
3) Hash sum of the chunk which is used for integrity check.

The chunks are chosen arbitrarily for uploading and conse- quently, the chances of an attack are minimized.

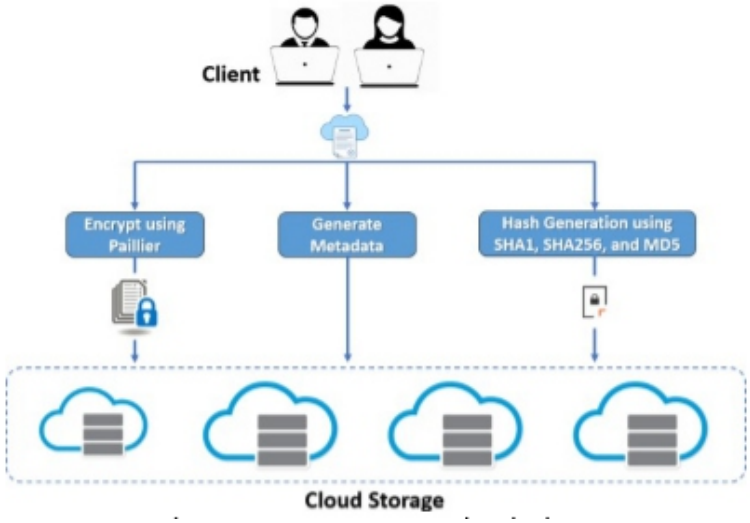

Figure 9. HBDaSeC Upload Phase

Retrieving phase: The chunks are randomly selected in the retrieved phase. When all the chunks are obtained, an integrity check is carried out and using the information in the Index field, the chunks are precisely arranged to generate the original file.

Challenges involved:

1) How to split information into segments that carry the least information with respect to the original file.
2) Storing these portions on public cloud storage volumes in view to diminish the probability of illegal reconstruction.

Encryption and trust-based solution: How effectively the cloud service provider confidentially to cloud service user's data is an important challenge.

The problem associated with leaving the keys with the CSPs or third party can be solved by making cloud service users hold the keys and assign keys to CSPs based on the trust mechanism. CSP provides data storage and data computation services which include searches, addition, modifications, insertions, and deletions.

Three types of operations conducted by CSUs are:

1) Encrypting its own data and send encrypted data to CSP.
2) CSP trustworthiness or availability is evaluated through delays.sh
3) For performing any data computation, sp will need encryption keys and these keys will be assigned by CSU according to the trust values of CSP.

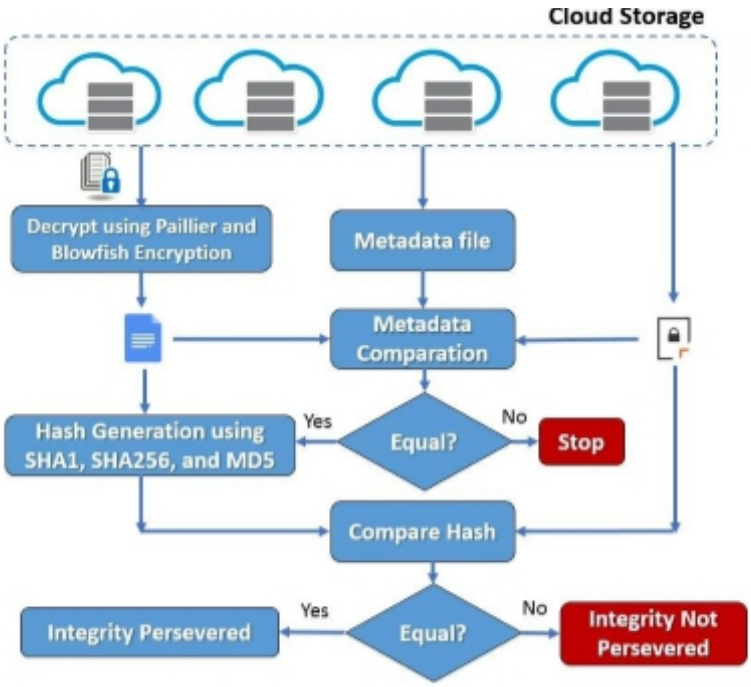

Figure 10. Integrity check phenomenon

Why three parameters are chosen?

We have chosen three cloud security aspects abbreviated as CIA i.e. Confidentiality, Integrity and Availability out of six security principles. Their significance is shown in the Fig.11 below:

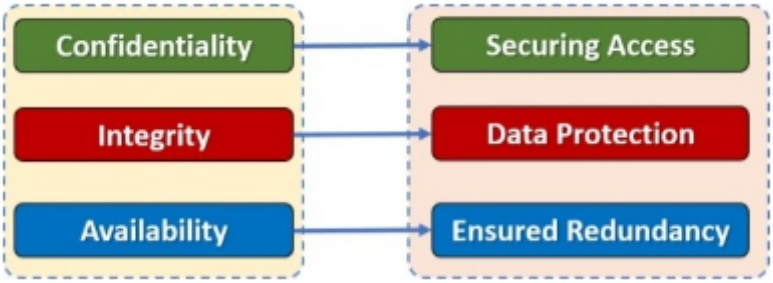

Figure 11. Cloud security aspects

Confidentiality: Confidentiality refers to the prevention of unauthorized access of the data and making sure that only the user who has the permission can access the data. This way the CSP can guarantee the user that his data doesn't get into wrong hands and also increases the users trust in cloud computing and helps it grow faster. Data confidentiality can be ensured through better encryption technique.

Integrity: When the integrity of outsourced data is to be checked, it is not practicable to download all records from the distant server and confirm as it incurs huge communique and computational cost. To evade this great cost, generally, the integrity schemes execute "blockless verification" which allows downloading only metadata and not the real information from the cloud; which is generated by the CSP

and verified at the client end. Efficiency is a major issue in data integrity schemes is calculated as computation, communication and storage expenses incurred.

Data integrity at the client side is done using a GUI called GtkHash. The combination of hashing algorithms are used to verify data integrity like MD5, SHA1, and SHA256 of the file before sending to the server are generated. After the file is being downloaded, the checksums are recomputed. The integrity of data is ensured by the validation of checksums performed at the metadata inserted at the end of the files at the client end. Metadata was encrypted using double encryption and SHA1, SHA256 and MD5 algorithms were used hash of the original file. The comparison between the previously stored and newly generated checksums is made. In case of any breach, the checksums will not match lest a check-mark is associated with the three specific fields.

Availability: Availability is ensured by storing the files both on the clients and server.

Delay incurred: There is always a difference in the traffic movement, at specific time the traffic flow is more whereas at some stage the traffic movement is less. Depending on current buffer usage at server and the data extents to be delivered by client node, the required memory banks can be activated, the memory banks are supplied power which leads to reduced congestion. An optimized approach to minimize delay is to distribute the memory into a number of chunks and then power the memory essential for data transmission. Our proposal will greatly reduce delay.

3.3 Implementation and Analysis Implementation

Oracle Virtual Box3 is a free and open source hypervisor currently developed by Oracle corporation which is easily available and executes as a Virtual Machine. It can be associated with popular operating systems such as Windows XP and Vista, Macintosh and Linux, while additionally associate a large number of visitor operating systems such as Red Hat, Fedora, and Ubuntu, etc. Ubuntu is a free and opensource operating system and Linux distribution based on Debian. For security, Fog can be used to offer an effortlessaccess and service attuned platform. Fog is Rubybased cloud library which allows setting up a license file to join numerous service providers and function equally for generating on-demand service as required.

Three scenarios are considered in HBDaSeC framework:

1) Storage of encrypted data over the cloud using Paillier Homomorphic technique.
2) Store encrypted information over the cloud storage with Blowfish encryption and compression.
3) Store encrypted data over the cloud storage with Blow- fish Encryption and without compression.

We implemented an archetype of HBDaSeC and evaluated the results of HBDaSeC based on time consumption parameters using Ubuntu 16.044 on Oracle VM VirtualBox 5.1.20. Performance evaluation is done along with the experimental setup. Python scripting language 2.7.3 is used for encryption algorithms.

Analysis

The implemented protocol is said to proficiently provide In- tegrity guarantee to users considering Cloud service providers to be loyal against malevolent or unauthorized users. The integrity, availability and confidentiality security constraints against internal and external attacks were validated. NetStress tool was employed to check the attacks.

Table 2 illustrates the client side encryption done using Paillier algorithm on different file types. We have chosen image, text, document, video, and pdf file types in bytes.

Table 2 : Client end side encryption

File Type	File Size (Bytes)	Encrypted File Size (Bytes) Paillier	Decrypted File Size (Bytes)	Encryption Time (S) Paillier	Decryption Time (S) Paillier
Txt	7180	7475	7180	0.035	0.59
Image	23596	23891	23596	0.045	0.022
Pdf	483694	483987	483694	0.29	0.027
Video	4254956	4255251	4254956	0.155	0.154
Docx	23679	23971	23679	0.013	0.009

Table III presents the server side encryption employing Blowfish algorithm.

Table 3 : Server side encryption

File Type	Encrypted File Size (Bytes) Paillier	Encrypted File Size Without Compression (Bytes) Blowfish	Encrypted File Size With Compression (Bytes) Blowfish
Txt	7475	7538	7462
Image	23891	23954	23886
Pdf	483987	484050	484110
Video	4255251	4255314	4256534
Docx	23971	24034	23958

Table IV depicts the encryption time computation done on files with and without compression using Blowfish technique at the server side.

Table 4 : Encryption time with and without compression

Encryption Time (S) Without Compression Blowfish	Encryption Time (S) With Compression Blowfish
13.751	7.85
419.65	74.88
69.185	34.251
66.985	55.059
43.231	41.474

Table V shows Encryption time using both Paillier and Blowfish with and without compression.

Table 5 : Encryption time using both paillier and blowfish

Encryption Time (S) Paillier & Blowfish Without Compression	Encryption Time (S) Paillier & Blowfish With Compression
613.34	214.052

Table VI and Table VII represent transfer rate and delay with memory bank enable and disable for varied number of files.

Table 6 : Transfer rate (memory bank enable and disable)

No. of Files	Transfer Rate (Kbps) (Memory Bank Disable)	Transfer Rate (Kbps) (Memory Bank Enable)
25	5.907	6.2565
50	4.0915	4.4635
75	3.025	3.5085
100	2.524	3.0725

Table 7 : Delay (memory bank enable and disable)

No. of Files	Delay (ms) (Memory Bank Disable)	Delay (ms) (Memory Bank Enable)
25	0.02851	0.001592
50	0.01954	0.001635
75	0.0344	0.001492
100	0.04386	0.001557

Figure 12 – Figure 16 below shows the graph for encrypted text files in bytes using Paillier, and Blowfish (with and without com- pression). The figure shows the graph for encrypted Image files using Paillier, and Blowfish (with and without compression). The figure shows the graph for encrypted docx files using Paillier, and Blowfish (with and without compression). It is clear from Table I that there is a significant saving in storage space for text, image and docx files. Compression of data before transmitting it to the client reduced costs and preserved data integrity.

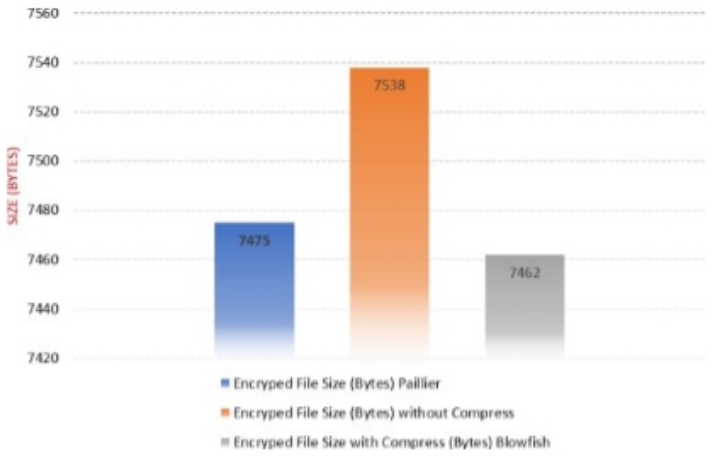

Figure 12. Encrypted text file size using Paillier and Blowfish (with and without compression)

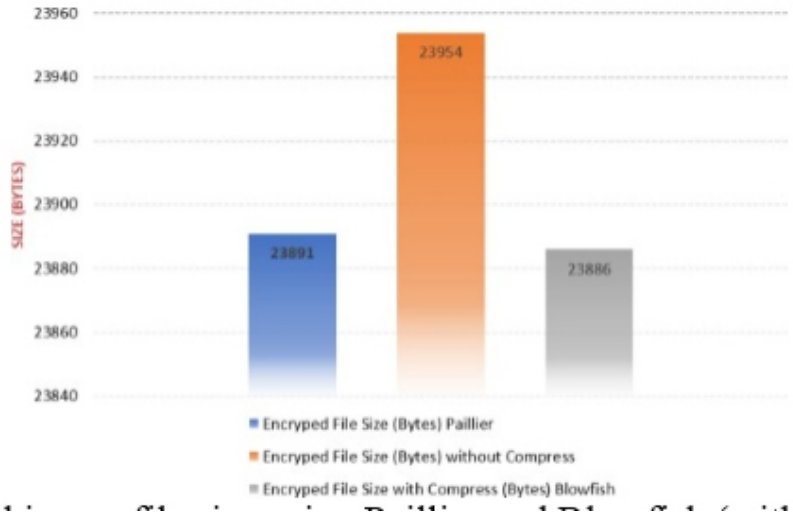

Figure 13. Encrypted image file size using Paillier and Blowfish (with and without compression)

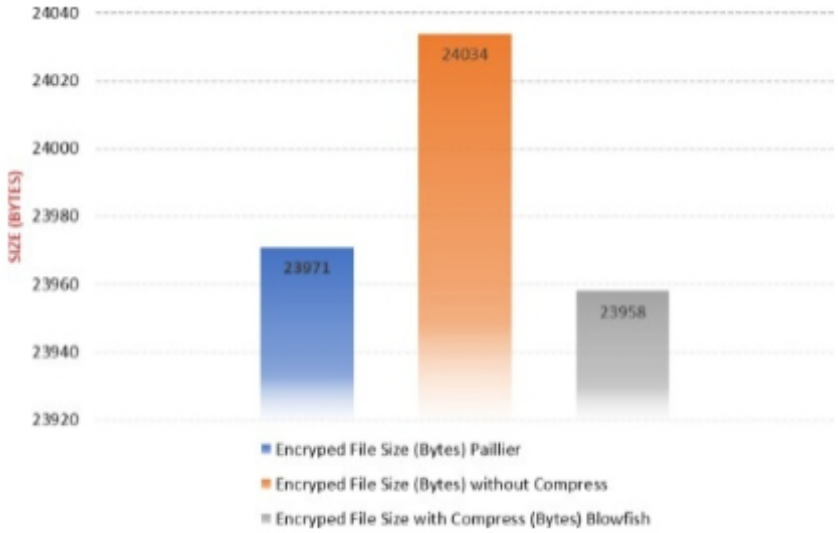

Figure 14. Encrypted docx file size using Paillier and Blowfish (with and without compression)

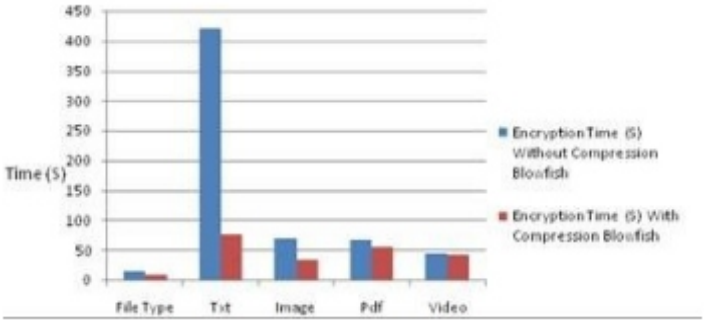

Figure 15. Encrypted all files using Blowfish (with and without compression)

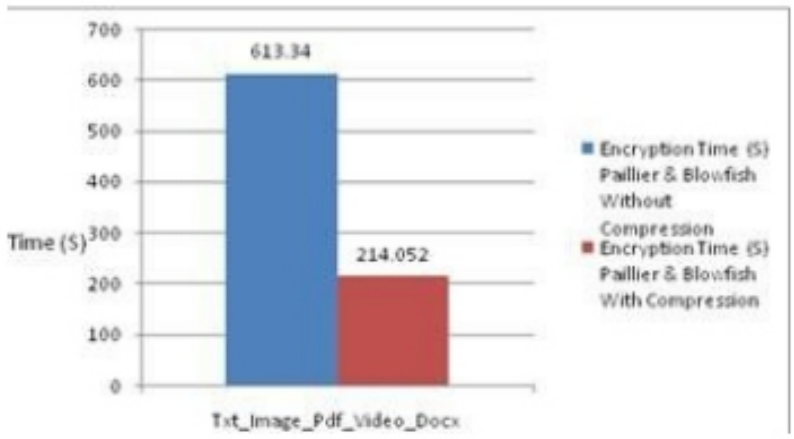

Figure 16. Encrypted text file size using Paillier and Blowfish (with and without compression)

Figure17 and Figure18 represent transfer rate and delay with memory bank enable and disable for varied number of files.

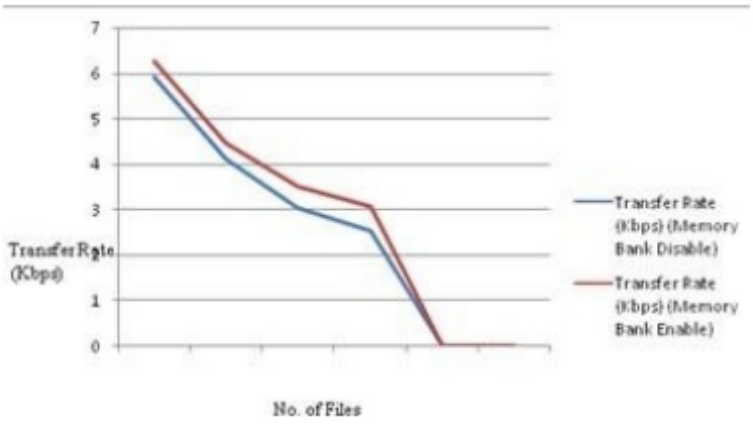

Figure 17. Transfer rate (memory bank enable and disable)

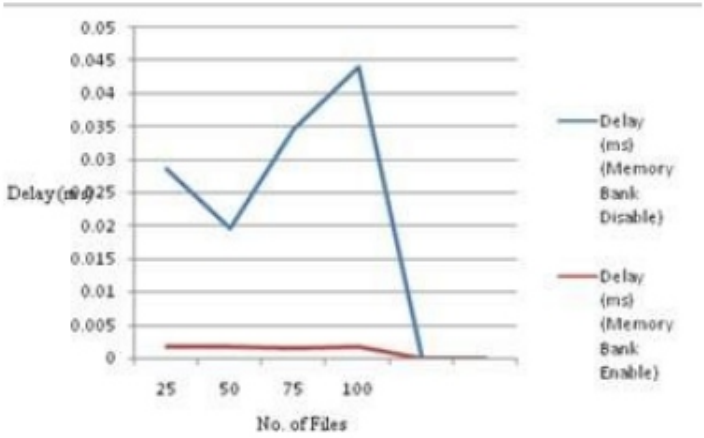

Figure 18. Delay (memory bank enable and disable)

4. CONCLUSION

Cloud computing is a concept shifting in the approach how computing resources are deployed and purchased. Even though the cloud has a capable, elastic, and consistent design, several security

concerns restrain customers to completely accept this novel technology and move from traditional computing to cloud computing. In the article, we aspire to present a form of a novel architectural model for offering protection to numerous cloud service providers with the intention to devise and extend security means for cloud computing. In this work, we presented a two-tier architecture for security in multiclouds; one at the client side, and other at the server side. The article presented a security domination outline for multi-clouds and supports security needs like Confidentiality, Integrity, Availability, Authorization, and Non-repudiation for cloud storage. Through this document we have anticipated, HBDaSeC, a securecomputation protocol to ease the chal- lenges of enforcing the protection of data for information security in the cloud. To the paramount of our acquaintance, it is the foremost effort that together utilizes two encryption techniques for data storage security and computation in the cloud. Our execution and assessment by numerous experiments suggest the convenient viability and ease of use of the system. By the extensive security analysis and performance simulation in our developed SecHDFS prototype, it is apparent that our procedure is effectual and competent for achieving a secure cloud computing. In addition, we intend to execute them in the real cloud platform such as NetCloud. Also, storage capacity improvements in case of pdf and video files are considered as future work.

CONFLICT OF INTEREST STATEMENT

The authors declared that they have no competing interest.

STATEMENT OF AUTHORSHIP

The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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