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Variance of Colour attributes of Kithul (*Caryotaurens*) flour from different growing areas in Sri Lanka

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Abstract

Kithul (Caryotaurens) flour has great gelling properties compared to other flour from plant sources. The colour of flour samples collected from five main Kithul growing districts, namely Rathnapura, Kegalle, Kandy, Matale and Kurunegala district, was analyzed by two methods as Universal Colour Language (UCL) colour chart and Colorimeter (Konica Minolta colorimeter, sensing, Japan). Pale yellow (UCL 89) was the most common colour while yellowish white colour (UCL 92) was not present in Sabaragamuwa province. According to the readings, there were significant differences ($p < 0.05$) among flour samples from five different growing areas for L(lightness), a*(redness) values and b* (yellowness) values. Kandy (71.56) and Kurunegala (70.18) flours presented higher L* values than those of other flour treatments. Kithul flour samples from Matale district has the lowest L* value (65.58). The lowest a* value (4.54) was observed in Kandy flour samples while the highest values were reported from Kegalle (5.34) and Rathnapura (5.29). In the case of b* (yellowness) values presented the highest value was observed in flour samples from Kegalle (17.90). The lowest b* value was reported from Matale (14.29).From the results the flour samples Matale ($\Delta E=34.77$) and Kegalle ($\Delta E=34.65$) had a greater deviation from the standard colour value than the other samples.*

Keywords: Kithul flour, *Caryotaurens,* colour evaluation, L* a* b* values, colorimeter

1. INTRODUCTION:

The Kithul is a majestic palm found in natural forests of both intermediate and wet zones (Rajyalakshmi P,2004) in India, Malaysia, Myanmar, Nepal, and Sri Lanka as native palms (Orwa C *et al*,2009). Distribution of Kithul in Sri Lankan lowland rainforests is found to be less than 2 trees/ha, which shows its rarity in the wild (Orwa C *et al*,2009). However, island-wide distribution of the Kithul palm was 2,977,261 in 2009 (Ministry of Traditional Insdustries,2009). Being a multipurpose tree, it provides both edible and non-edible products. Edible products from Kithul tree include sweet toddy, Kithul treacle, kitul toddy and kitul jaggery as well as kitul flour (Rajyalakshmi P,2004). Palms are a good source of food products and medicine (Rajyalakshmi P,2004), and starch is a major renewable resource beside cellulose which forms the chief source of carbohydrate in the human diet (Rajyalakshmi P,2005). So Kithul flour, which is equal in quality to industrial sago obtained from *MetroxylanSaguRottb*, plays a very important role as a food source(Rajyalakshmi P,2005).

But the main problem with the Kithul flour for the industrial food production is its pinkish colour (Rajyalakshmi P,2004). During thermal processing colour intensifies(Anilakumai B and Rajyalakshmi P,2000) to dark brown which is not preferable for industrial applications. According to previous studies on

Metroxylonsagu, brown colour of the flour is caused by enzymatic browning (Onsa*et al* ,1998). Mechanical and physiological injury during the flour extraction leads to interaction of polyphenols with polyphenol oxidase. Further, catechins and ephicatechins, when present, may act as substrates for the browning reaction (Onsa*et al* ,1998). As per the Indian scientists, total polyphenol content of crude Kithul flour ranged from 52% to 63% (Anilakumai B and Rajyalakshmi P,2000). Being very interactive with sensory properties, colour of the Kithul flour is a very important factor in food processing. The main objective of this study was to compare the colour of the Kithul flour samples which were collected from five main growing areas in Sri Lanka for identification of regional-based significant differences.

The study was based on two types of colour comparison: Universal Color Language (UCL) colour chart and CIELAB system. The UCL was defined by the Inter-Society Color Council - National Bureau of Standards in 1946. Each of the 267 UCL colour names gives an idea of the named color without reference to colour chips, by combining a very few standard and well known colour terms (Azelea society,2007). The International Commission on Illumination (CIE) serves to define the location of any colour in uniform space by correlating the L*,a* and b* or CIE LAB colour metric space (1976) (CIE ,2004) which can be measured using a Chromameter. This instrument enables users to directly determine the colour on the flour (Konica Instrument Manual) by generating L*, a* and b* values. This readings subjective for the sensorial are brightness, lightness, hue, saturation, Chroma and colourfulness(Macdougall D B,2002) , (Hutching J R and Luo W ,2002). *L** is a function of measure of the brightness from black (0) to white (100) while *a** presents a function of the red-green difference. It varies between -60 to +60 while -a* goes from green and +a* goes towards red. b* is functioning for the green-blue difference. Positive *b** indicates yellowness and varies from -60 to +60, with -b* and +b* go towards blue and yellow, respectively (Oliver *et al* ,1992). This measurements of the *L*,a*,b** system presents the same perception of colour difference (Konica Instrument Manual) by excluding human errors.

2. MATERIALS AND METHOD:

2.1 Sample Collection: Five districts, namely Kurunegala (North-western province), Matale and Kandy (Central province), and Kegalle and Rathnapura (Sabaragamuwa province), were selected for the study as the five main growing areas in Sri Lanka. Six Kithul flour samples were collected from each district from both household and commercial markets.

2.2 Sample preparation and Storage: Samples were sifted through a 355µm sieve and packed in air-tight containers, then stored in refrigerator (5 ºC) until further analysis.

2.3 UCL Colour Chart: Colour of the Kithul flour samples was analyzed using Universal Colour Language (UCL) colour chart. The UCL was defined by the Inter-Society Colour Council (ISCC) and the United States Department of Commerce's National Bureau of Standards (NSB) (present it is the National Institute of Standards and Technology) in 1946. Because of this reason this colour language is called ISCC-NBS Method of Designating Colours(Hutching J R and Luo W ,2002). Each of the 267 UCL colour names gives an idea of the named colour without reference to colour chips, by combining a very few standard and well known colour terms (CIE,2004).

2.4Chroma meter Minolta (CR 400) colourimeter:

The instrumental measurement of Kithul flour colour was carried out with a Chroma meter Minolta CR-400 (Konica Minolta colourimeter, sensing, Japan) and the results were expressed in accordance with the CIELAB system.

The meter was calibrated with white tile (L* = 93.30, a* = 0.32 and b* 0.33). The samples were poured into glass dish (6.4 mm diameter diaphragm with an optical glass), with the surface of the sample was manually made a flat and the measuring head of the meter was carefully placed on three different locations on the petri dish. The measurements were determined in triplicates and mean and standard deviations determined. The colour attributes were determined by colour coordinates of *L** (*L** = 0 [black] and *L** =

100 [white]), a^* ($-a^*$ = greenness and $+a^*$ = redness), and b^* ($-b^*$ = blueness and $+b^*$ = yellowness).ΔE value which defines the size of the total colour difference, but does not give information about how the colours differ was determined (Morrison W R and Laignelet B,1983).

ΔE is defined by the following equation:
$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$
(Morrison W R and Laignelet B,1983).

2.5 Statistical Analysis: Results were analyzed using one-way analysis of variance (ANOVA) at 0.05 probability level, pearson correlation and cluster analysis with MINITAB software package (version 17 for Windows).

3. RESULTS AND DISCUSSION:

3.1 Colour Variation of Kithul Flour by using UCL Color Chart:

The colour of the flour directly affects the colour of the finished product. Therefore colour specifications are required by manufacturers. Colour of Kithul flour samples was differentiated according to the graph (Figure 1). Pale yellow (UCL 89) was the most common colour among all studied samples with the highest contribution in Kegalle as 83.3%. Pale orangish yellow colour (UCL 73) was the second common Kithul colour and the highest percentage of 66.6% was recorded in flour samples obtained from Matale.

Yellowish white colour (UCL 92) was only present in samples from Central province and North-western province, but not in samples from Sabaragamuwa province. The crude Kithul flour has a considerable amount of phenols, 52.0 ±0.06 %, when compared to white coloured corn flour, which has no phenols(Anilakumai B and Rajyalakshmi P,2000).Variations of the phenolic content could be the main cause for these colours in Kithul flour samples.

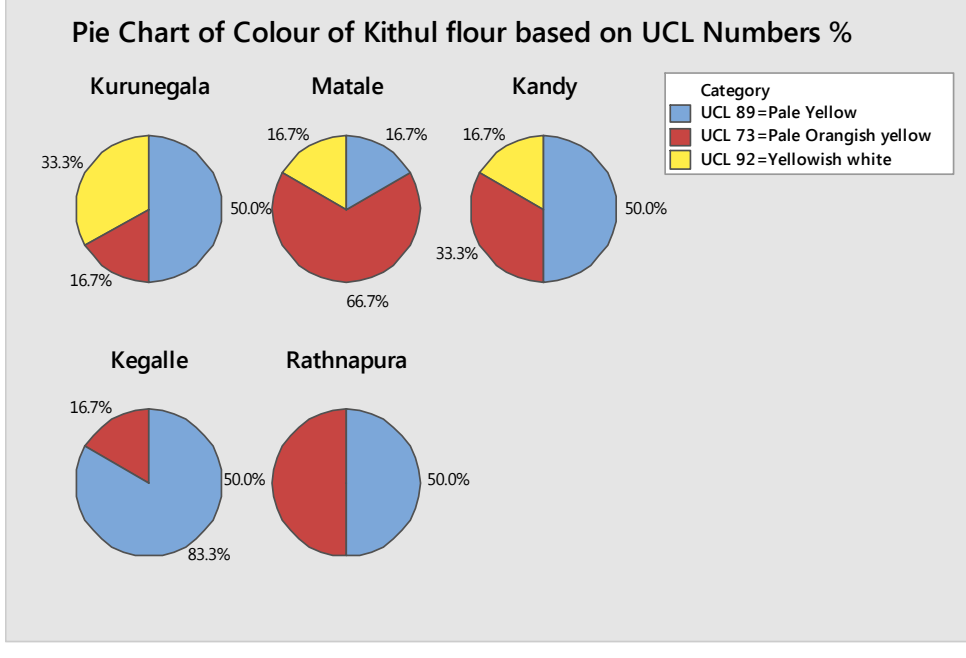

Figure 1.Pie chart for colour comparison of Kithul flour samples collected from five different districts by using UCL (Universal color language) colour codes (Graphed by Using MINITAB 17 Software).

3.2Comparison of Colour variations of the flour by using Chroma meter Minolta (CR 400) colorimeter:

Table 1:Variations in Colour properties of Kithul flour collected from five districts in Sri Lanka

Sampling Area	L*	a*	b*	ΔE
Kandy	71.56±3.07[a]	4.54±0.64[b]	16.50±0.82[ab]	30.24±2.71[c]
Kegalle	67.40±1.28[bc]	5.34±0.40[a]	17.90± 2.01[a]	34.65± 1.34[a]
Kurunegala	70.18±5.36[ab]	4.71±1.17[ab]	14.66± 1.58[cd]	30.72± 5.13[bc]
Matale	65.58±3.95[c]	5.16±0.89[ab]	14.29± 1.04[d]	34.77± 3.90[a]
Rathnapura	67.41±2.78[bc]	5.29±0.54[a]	15.93±1.97[bc]	33.81±2.33[ab]
Mean	**68.43±4.09**	**5.01± 0.82**	**15.85 ± 2.01**	**32.84 ± 3.82**

[a,b,c]Dissimilar letters indicate differences in treatment means within the same column ($p < 0.05$)

The colour attributes of the Kithul flour treatments from five different growing areas in Sri Lanka is shown in Table 1. According to the readings, there were significant differences($p < 0.05$) among flour samples from five different growing areas for L*(lightness), a*(redness) values and b* (yellowness)values.
Kandy (71.56) and Kurunegala (70.18) flours presented higher L* values than those of other flour treatments. Kithul flour samples from Matale district has the lowest L* value (65.58). The lowest a* value (4.54) was observed in Kandy flour samples while the highest values were reported from Kegalle (5.34) and Rathnapura (5.29).In the case of b* (yellowness) values presented the highest value was observed in flour samples from Kegalle (17.90). The lowest b* value was reported from Matale (14.29). The mean L* value for Kithul flour is 68.43 while means of a* and b* values were 5.01 and 15.85, respectively. Coordinates of these three colour attributes of Kithul flour among the sampling districts is shown in Figure 2.

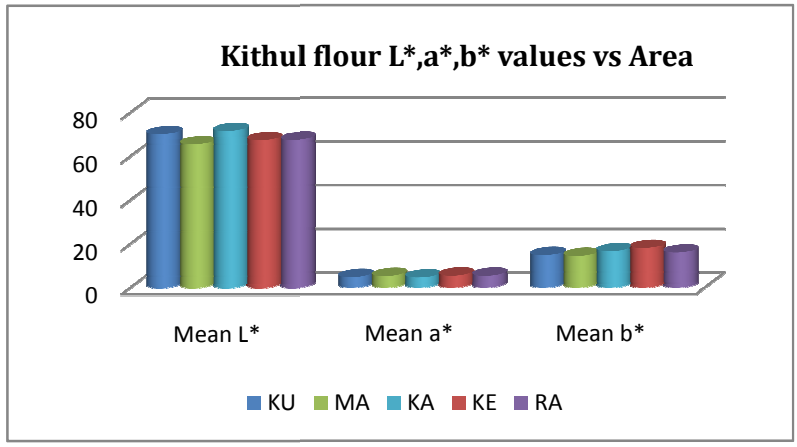

Figure2Variations in Colour attributes as means of L* a* and b* of Kithul flour collected from five districts in Sri Lanka.

The differences in colour could be characterized to the variety, age and also on different processing procedures for flour. The larger the **ΔE** value represents , the larger the colour difference(Morrison W R and Laignelet B,1983).The estimation of ΔE, indicate the extent of deviation of colour of samples from the standard tile colour used (L*=97.63, a*=- 0.48, and b*=+2.12). From the results the flour samplesMatale (ΔE=34.77) and Kegalle (ΔE=34.65) had a greater deviation from the standard colour value than the other

samples. Kandy area presented the least deviation from standard as ΔE=30.24 at the initial stage. Behaviour of Colour difference with area comparison according to the Figure 3.

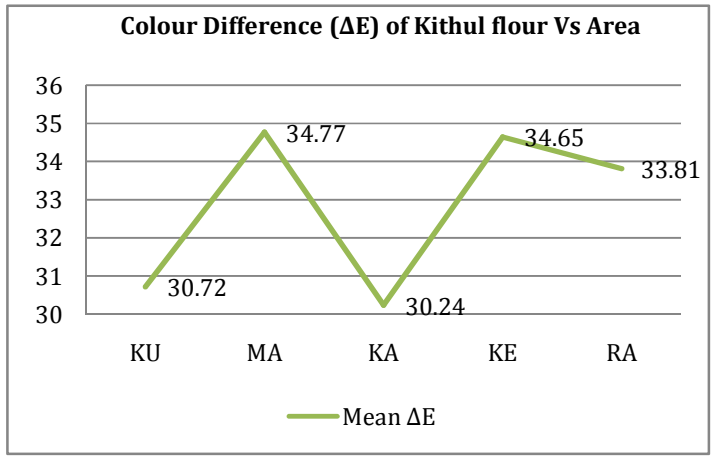

Figure 3 Variations in Colour difference (ΔE) of Kithul flour collected from five districts in Sri Lanka.

There was a strong,negative ,significantcorrelation ($r = -0.974$; $p < 0.05$) between L* and ΔEvalues, which indicates that, as L* increase, ΔE decreases.There were another two correlationswere identified as moderate relationships. There was another negative ,moderate correlation showed with significant difference($r = -0.721$; $p < 0.05$) among L* and a* values.And next correlation was positive as well as moderate with significant difference($r = 0.774$; $p < 0.05$) between ΔE vs a*.The positive a* value for Kithul flour samples showed its propensity towards pinkish colour as positive a* values represent the redness of samples (CIE,2004)

According to cluster analysis (Figure 4) (which is based on data in Table 1) it is clear that flour samples from Kegalle and Rathnapura represent the first cluster with highest similarity (Cluster 1.Similarity 64.37).As better observation this cluster was formed by the flour treatments from Sabaragamuwa province (Cluster 2 in Figure 3) as they belong to the same cluster among samples from other three districts.Similar observation has reported from UCL colour comparison in3.1 (Colour Variation of Kithul Flour by using UCL Color Chart) as flour samples from Sabaragamuwa province (Kegalle and Rathnapura) has not presented Yellowish white colour (UCL 92) (Figure 1). However second cluster was formed byKurunegala and Kandy area with 62.54 similarity level.

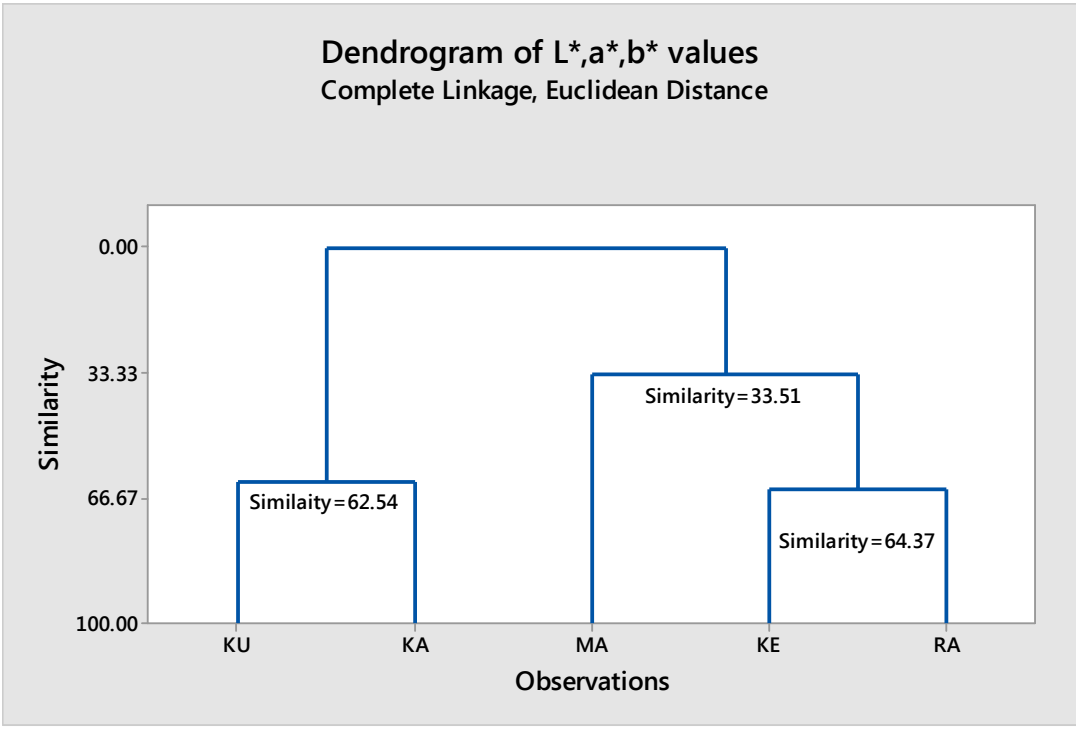

Figure 4.Cluster analysis of Colour variance of Kithul flour samples collected from five different districts by using L*a*b* values (Graphed by Using MINITAB 17 Software).

4.CONCLUSION AND FURTHER WORK: Kithul flour colour presented mainly three variations according to the UCL (Universal Colour Language) colour chart. Pale yellow (UCL 89) was the most common colour among all studied areas while pale orangish yellow colour (UCL 73) was the second common Kithul flour colour. Yellowish white colour (UCL 92) was not presented in Kithul flour samples from Sabaragamuwa province (Rathnapura and Kegalle). According to the instrumental measurements, there were significant differences($p< 0.05$) among flour samples from five different growing areas for all three colour attributes L* (lightness) value,a* (redness)and b* (yellowness)value. But the positive point is there were two strong similarity (> 50%) among five district's samples according to cluster analysis. It will be a good point for using flour samples from different growing areas to produce composite flours in food productions.

This study reveals that the colour attributes of Kithul flour influenced by the growing area ,although it could be the enzymatic browning though the flour processing steps. This can be a positive point for food applications in future as composite flours with similar colours can be produced using Kithul flour obtained from same growing areas. Flour colour often affects the colour of the finished product and therefore it will be one of a key flour specification which could be required keen attention of food technologists to empower the Kithul flour industry.

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Development of a Computer Software for Optimization of Packed Absorption Column

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Abstract

A Computer Aided-Design module was developed for the optimization of packed gas absorption column. The program was tested using a problem statement. The design parameters calculated agreed with those obtained from manual solution, with a correlation coefficient of 1.000. Optimization of the total cost of the absorber and its annual operation was also done by studying the trend in the operating parameters. The optimum total cost for the absorber and its operation was found to be $22,480.07 per year for temperature of 0^0C, pressure drop of 21 mm H_2O/ m of packing, flooding velocity of 0.7, gas flow rate of 0.126 Kg/s and 0.016 m polypropylene packing material.

Key Words: Packed column, gas absorption, optimization, CAD, visual BASIC

1.0 INTRODUCTION AND BRIEF LITERATURE

The chemical industry has undergone significant changes during the past 35 years due to the increased cost of energy, increasingly stringent environmental regulations and global competition. One of the most important engineering tools for addressing these issues is optimization (Edgar et al., 2001). Modifications in plant design and operating procedures have been implemented to reduce cost and meet constraints, with an emphasis on improving efficiency and increasing profitability. Optimization can therefore be defined as the use of specific methods to determine the most cost-effective and efficient solution to a problem or design for a process (Edgar et al., 2001). It involves the study of optimality criteria for problems, the determination of algorithmic methods of solution, the study of the structure of such methods both under trial conditions and on real life problems.

Optimization is used to improve the initial design of equipment and to enhance the operation of that equipment once it is installed so as to realize the largest production, the greatest profit, the minimum cost, the least energy usage, and so on. In plant operations, benefits arise from improved plant performance, such as improved yields of valuable products, or reduced yields of contaminants, reduced energy consumption, higher processing rates and longer times between shutdowns. Optimization can also lead to reduced maintenance costs, less equipment wear and better staff utilization (Edgar et al., 2001).

Generally, when setting out to optimize any system, the first step is to identify clearly the objective and the criterion to be used to judge the system performance. In engineering design, the objective will invariably be an economic one. For a chemical process, the overall objective for the operating company will be to maximize profits. This will give rise to sub-objectives with which the designer will work to achieve the main objective. The main sub-objective will usually be to minimize operating costs. Other sub-objectives may be to reduce investments, maximize yield, reduce labour requirements, reduce maintenance and operate safely (Richardson and Coulson, 2004).

When choosing his sub- objectives, the designer must keep in mind the overall objective. Minimizing cost per unit of production will not necessarily maximize profit per unit time; market factors, such as quality and delivery may determine the best overall strategy.

The second step is to determine the objective function, the system of equations and other relationships, which relate the objective with the variables to be manipulated to optimize the function. If the objective is economic, it will be necessary to express the objective function in economic terms (costs).

The third step is to find the values of the variables that give the optimum value of the objective function. The best techniques to be used for this step will depend on the complexity of the system and on the particular mathematical model used to represent the system.

A mathematical model represents the design as a set of equations (relationships) and it will only be possible to optimize the design if the number of variables exceeds the number of relationships, that is, there is some degree of freedom in the system.

A gas absorption column is a vertical cylinder in which liquid and gas are contacted. The packed columns are commonly used and the feed to the columns can be binary or multicomponent. The columns are characteristically operated with counter-flow of the gas and liquid. Gas absorbers are used extensively in industry for separation and purification of gas streams, as product recovery devices, and as pollution control devices. Gas absorbers are most widely used to remove water soluble inorganic contaminants from gas streams (Mclnnes et al., 1990)

Absorption is a process where one or more soluble components of a gas mixture are dissolved in a liquid (i.e. a solvent). The absorption process can be categorized as physical or chemical. Physical absorption occurs when the absorbed compound dissolves in the solvent; chemical absorption occurs when the absorbed compound and the solvent react. Liquids commonly used as solvents include water, mineral oils, nonvolatile hydrocarbon oils and aqueous solutions.

A comprehensive review of absorption and packed columns can be found in many units operations books (Richardson and Coulson, 2009, Brunazziet al., 2002, Perry and Green 1997,Mclnnes et al., 1990,Ayoade 1994, McCabe, Smit and Harriott1993, Coker 1991and Treybal 1981) and that of optimization techniques can be found in many optimization books (Edgar et al.,2001, Richardson and Coulson, 2004 and Peters and Timmerhaus, 1991).

Computer Aided Design (CAD) is a utility that exploits the capabilities provided computers for speedy processing of design procedures. It enables the engineers to solve large and complex design problems much morefaster and accurately than hitherto. The evolution, types structure, components and advantages of CAD are well detailed (Onifade 2000 and Oguntoyinbo 1993).

This work makes use of a CAD module, a high level language program of the procedure required for the optimization of a packed absorption column. Thus it is an assembly of a set of mathematical equations and

the techniques for solving them. The main program draws relevant information/data from a database of phase equilibria; and physical, chemical and thermodynamic properties.

The aim of this research work is to develop a computer software foroptimization of packed gas absorption column in terms of the overall cost of the absorber and its operation using a Computer Aided-Design module.

The overall aim will be achieved through the following:

1. Develop an objective function for the absorption column in terms of variables which relate the cost of the column to the design parameters of the column.
2. Solve the mathematical program obtained from (1) using a program developed in Visual Basic. The solution constitutes the CAD module.
3. Use the CAD module to optimize the design problem

2.0 METHODOLOGY

2.1 Design Module Source Code

The design and optimization procedures implemented in the CAD module are based on the following assumptions:

(a) The gas is assumed to comprise a two-component gas mixture (solute/air), where the solute consists of a single compound present in dilute quantities.

(b) The gas is assumed to behave as an ideal gas and the solvent is assumed to behave as an ideal solution.

(c) Heat effects associated with absorption are considered to be minimal for the solute concentrations encountered.

(d) Chemical reaction does not occur.

(e) The system is assumed to be isothermal.

(f) The equilibrium curve is assumed to be linear since the process fluid are dilute.

(e) The molar flow rate of the solute-free gas is assumed to be constant to be constant throughout the column.

The flowchart for implementing CAD module for absorption column design parameters is shown in Figure 1 and the flowchart for implementing the solution of the optimization program is shown in Figure 2. The program was developed using Visual Basic language because of its

user friendliness, easier comprehension, and faster application development.

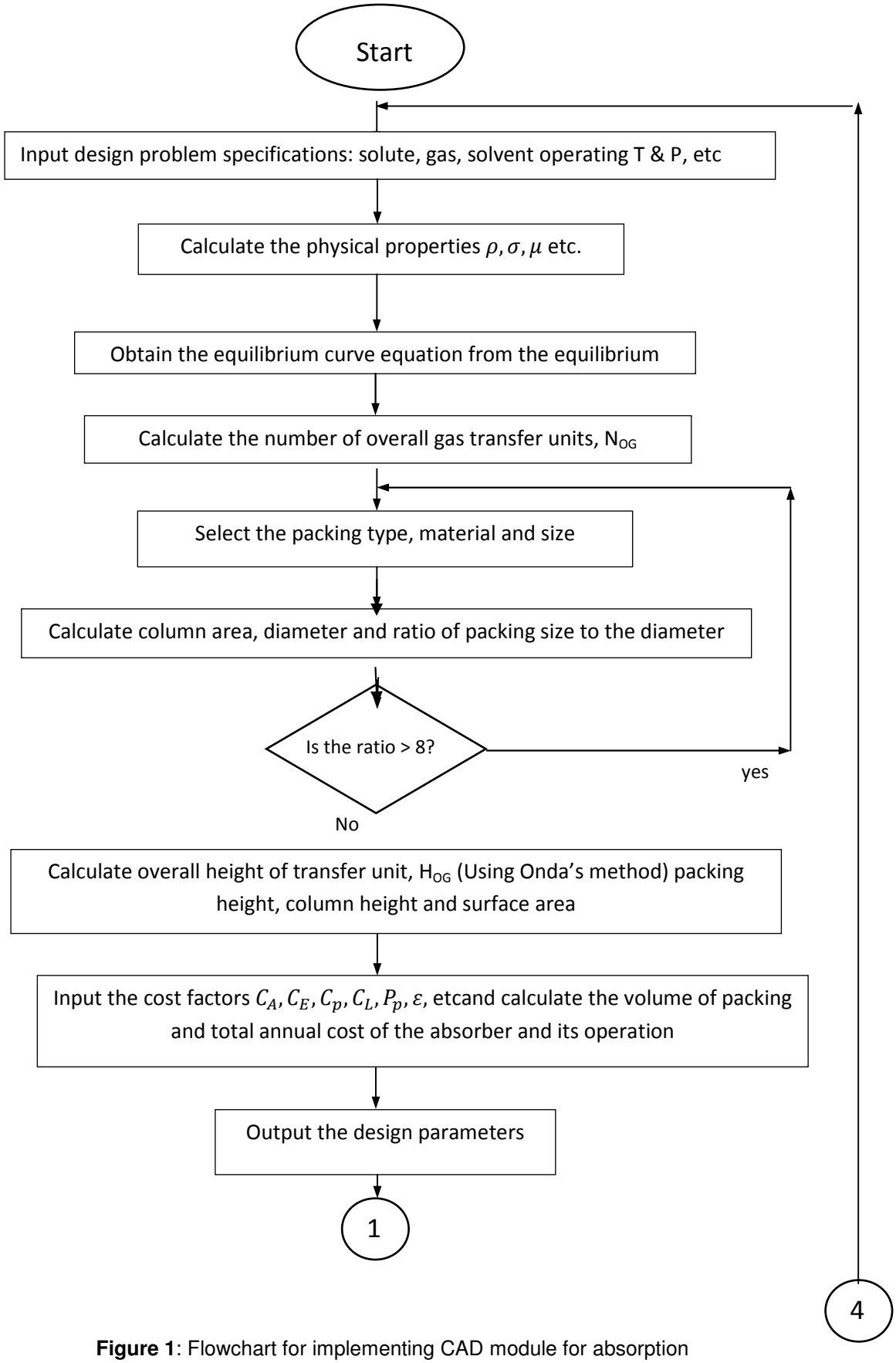

Figure 1: Flowchart for implementing CAD module for absorption

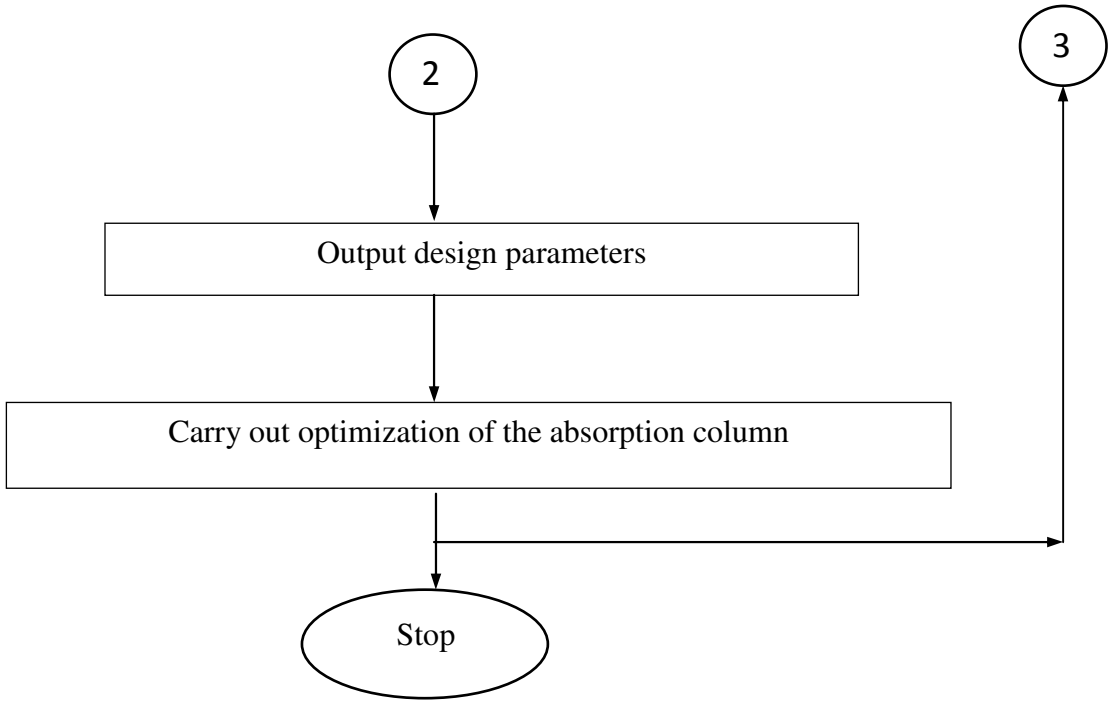

Figure 2: Flowchart for implementing the solution of the optimization program

The Visual Basic 6.0 program Icon was double clicked to open new forms. Text boxes and combo boxes were laid out on the screens for imputing and selecting the design specifications and were labeled appropriately. Command buttons were also placed on the forms for giving appropriate commands for calculating the pertinent design parameters of the packed column, the total annual cost of the absorber and its operation, generating report, updating record, adding record to data base and for exiting the application. All the equations, data and correlations for obtaining the design parameters of the packed column and the total annual cost of the absorber and its operation were then coded in the code window. The codes for generating report, updating record, adding record to data base and for exiting the application were also codedin the code window.A typical graphical user interface (GUI) and output screen are shown below.

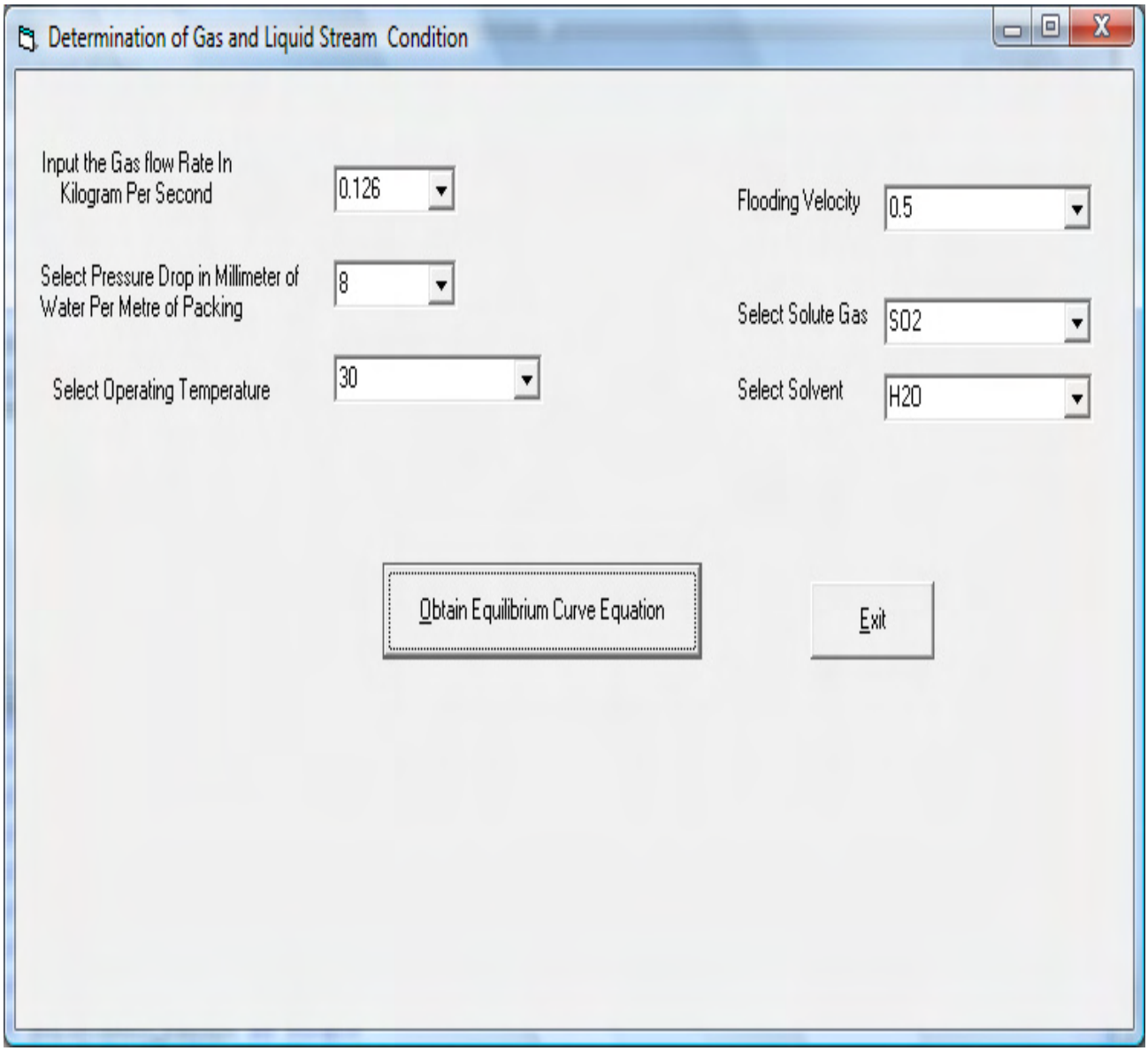

Figure 3: Graphical User Interface for Obtaining Equilibrium Curve Equation.

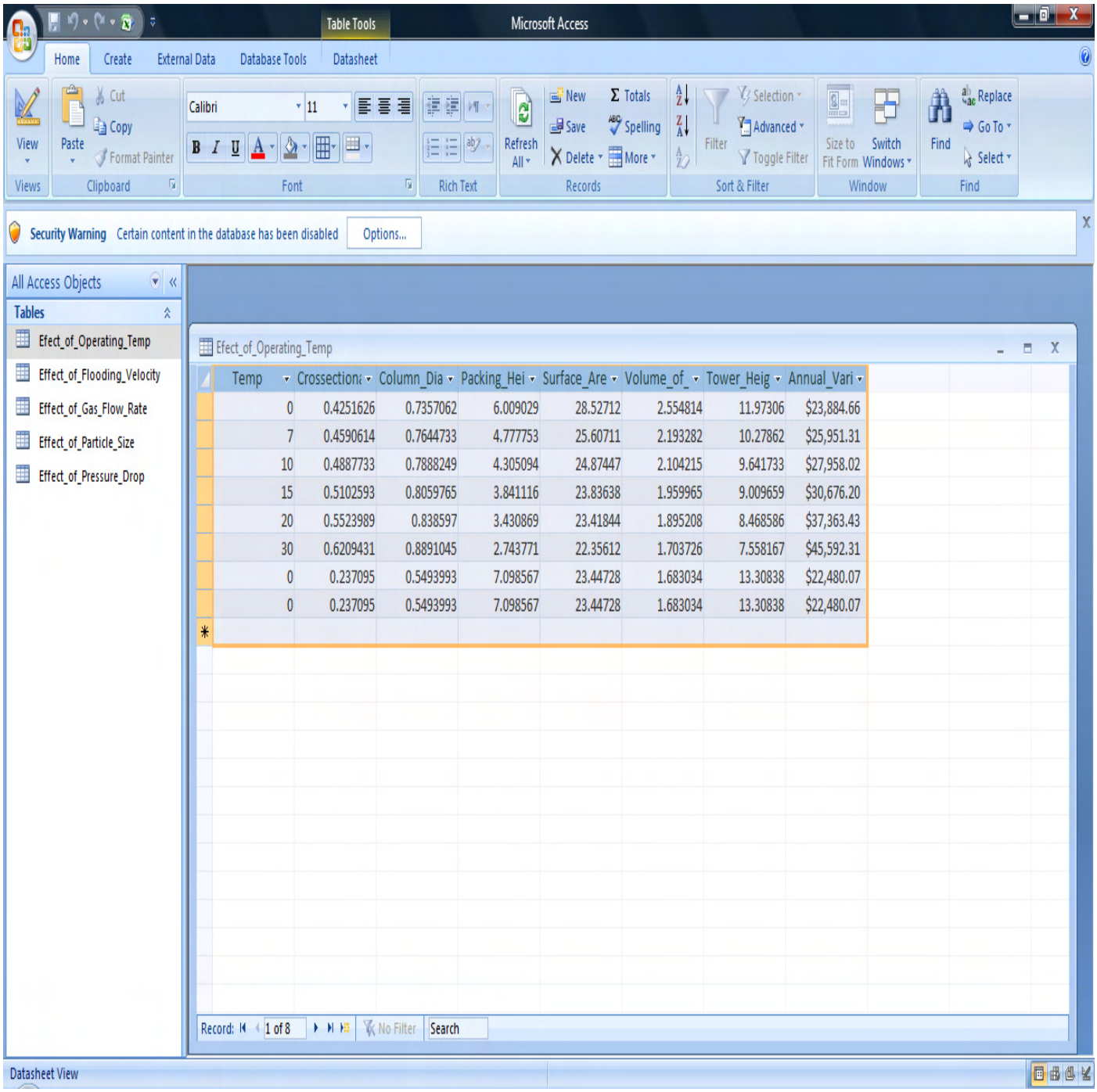

Figure 4: A Typical Output Screen

The CAD module was tested using the following problems.

2.1 The Test Problem 1

A gas mixture containing 6% SO_2 and 94% dry air is to be scrubbed with fresh water in a tower packed with 0.025m ceramic rasching rings to remove the SO_2 so that the exit will contain no more than 0.1 mole percent SO_2,that is, recovery of about 98.333%. The tower must treat 0.126kg/s of gas and is to be designed using 50% of flooding velocity. The water flow is to be twice the minimum required to achieve this separation in a tower operating at 30^0C and 760mmHg or 1 atm. Determine the tower diameter, cross-sectional area, packing height and surface area.

2.2 The Test Problem 2

Variable operating charges for the absorber including maintenance, solvent, fan power, and pumping power are included in the objective function.

The problem is to optimize the equation (objective function) with respect to gas flow rate, packing size, operating temperature, pressure drop, and percent flooding velocity.

2.3 Program run

The following important set of screens was used.

1. Design specification screens
   These series of screens are used for inputting the following information:
   a. Solute gas
   b. Solvent
   c. Pressure drop (mmH_2O/m of packing)
   d. Percentage of flooding rate (50-75 %)
   e. Gas flow rate (0.126-0.504 Kg/s)
   f. Operating temperature (0^0C-30^0C)
   g. Mole fraction of the solute in the gas entering the column
   h. Mole fraction of the solute in the gas exiting the column
   i. Mole fraction of the solute in the liquid entering the column
   j. Adjustment factor

   At this point the module displays the operating line equation

2. A screen comes up for inputting the packing type, packing material and size. The module calculates the pertinent design parameters (diameter, cross-sectional area, packing height, surface area, and height) of the absorption column.
3. Another screen comes up for inputting the following information:
   a. cost of absorber per unit surface area ($\$/m^2$)
   b. Solvent make up fraction
   c. Unit cost of electricity (\$/KW-hr)
   d. Cost of packing per unit volume packing ($\$/m^3$)
   e. Solvent unit cost ($\$/m^3$)
   f. Pump operating pressure (m of H_2O)
   g. Combined pump and fan motor efficiency (%)
   h. Operating hour per year (hr)

At this point the module calculates the total annual cost of the absorber and its operation.

After a series of screens which include one for generating the result, updating record and adding record, the final output screen is displayed. A typical output screen is shown in figure 4

3.0 RESULTS AND DISCUSSION

3.1 CAD Module Output.

The results of the manual calculations and those from CAD module are shown in Table 2 while the operating variables for obtaining the design parameters are shown in Table 1.Tables 3-8 summarize the various outputs obtained from the program using different specifications.

Table 1: Operating variables for obtaining the design parameters.

Operating Variable	Value
Temperature (^{0}C)	30
Pressure Drop (mm H_2O/m of Packing)	21
Flooding Velocity (%)	0.5
Gas Flow Rate (Kg/s)	0.126
Packing Type and Size(m)	Rachig Ring Ceramic (0.025)

Table 2:Results from manual calculations and CAD program for the problem statement**s.**

Design parameters	Manual calculations	CAD output
Cross sectional area (m^2)	0.621	0.621
column diameter (m)	0.89	0.889
Packing height (m)	2.73	2.74
Surface area (m^2)	22.3	22.36
Volume of packing (m^3)	1.7	1.7
Tower height (m)	7.54	7.56
Annual Variable Cost($/year)	45,436.91	45,592.31
Correlation coefficient	1.000	1.000

Table 3:Output from the program using operating pressure of 760 mmHg, gas flow rate of 0.126kg/s, flooding velocity of 50%, pressure drop of 21mm H_2O/m of Packing, 0.025m raschig ring ceramic packing with varying operating temperature.

operating variable varied	Design Parameters						
Temp (^{0}C)	Cross-sectional Area (m^2)	Column Diameter (m)	Packing Height (m)	Surface Area (m^2)	Volume of Packing (m^3)	Tower Height (m)	Total Annual Cost ($/year)
0	0.4251626	0.7357062	6.009029	28.52712	2.554814	11.97306	23,884.66
7	0.4590614	0.7644733	4.777753	25.60711	2.193282	10.27862	25,951.31
10	0.4887733	0.7888249	4.305094	24.87447	2.104215	9.641733	27,958.02
15	0.5102593	0.8059765	3.841116	23.83638	1.959965	9.009659	30,676.20
20	0.5523989	0.838597	3.430869	23.41844	1.895208	8.468586	37,363.43
30	0.6209431	0.8891045	2.743771	22.35612	1.703726	7.558167	45,592.31

Table 4: Output from the program using operating pressure of 760 mmHg, gas flow rate of 0.126kg/s, flooding velocity of 50%, operating temperature of 30^{0}C, 0.025m raschig ring ceramic packing with varying pressure drop

operating variable varied	Design Parameters						
Pressure Drop (mm H_2O/m of Packing)	Cross-sectional Area (m^2)	Column Diameter (m)	Packing Height (m)	Surface Area (m^2)	Volume of Packing (m^3)	Tower Height (m)	Total Annual Cost ($/year)
4	0.8781461	1.057329	2.577494	26.66218	2.263416	7.496967	45,554.30
8	0.7271741	0.9621574	2.665361	24.19683	1.938181	7.522906	45,034.12
21	0.6209431	0.8891045	2.743771	22.35612	1.703726	7.558167	45,592.31
42	0.5420035	0.8306689	2.815053	20.91543	1.525769	7.598356	47,109.74
83	0.5141897	0.8090746	2.843654	20.39005	1.462178	7.616372	50,853.83
125	0.4809804	0.7825113	2.880718	19.74892	1.385569	7.641166	54,768.35

Table 5: Output from the program using operating pressure of 760 mmHg, gas flow rate of 0.126kg/s, pressure drop of 21mm H_2O/m of Packing, operating temperature of 30^0C, 0.025m raschig ring ceramic packing with varying flooding velocity.

operating variable varied	Design Parameters						
Flooding velocity (%)	Cross-sectional Area (m^2)	Column Diameter (m)	Packing Height (m)	Surface Area (m^2)	Volume of Packing (m^3)	Tower Height (m)	Total Annual Cost ($/year)
0.5	0.6209431	0.8891045	2.743771	22.35612	1.703726	7.558167	45,592.31
0.6	0.5174525	0.8116376	3.007907	21.051	1.556449	7.84894	45,340.04
0.65	0.4776486	0.7797962	3.148938	20.59033	1.504086	8.013906	45,283.95
0.7	0.4435308	0.7514305	3.297352	20.2301	1.462477	8.192751	45,265.91

Table 6: Output from the program using operating pressure of 760 mmHg, operating temperature of 30^0C, flooding velocity of 50%, pressure drop of 21mm H_2O/m of Packing, 0.025m raschig ring ceramic packing with varying gas flow rate.

operating variable varied	Design Parameters						
Gas Flow Rate (Kg/s)	Cross-sectional Area (m^2)	Column Diameter (m)	Packing Height (m)	Surface Area (m^2)	Volume of Packing (m^3)	Tower Height (m)	Total Annual Cost ($/year)
0.126	0.6209431	0.8891045	2.743771	22.35612	1.703726	7.558167	45,592.31
0.252	1.241886	1.257384	2.743771	33.82787	3.407451	7.933811	88,421.97
0.378	1.862829	1.539974	2.743771	43.50887	5.111176	8.222054	131,277.13
0.504	2.483772	1.778209	2.743771	52.26292	6.814903	8.465053	173,958.54

Table 7: Output from the program using operating pressure of 760 mmHg, operating temperature of 30^0C, gas flow rate of 0.126kg/s, flooding velocity of 50%, pressure drop of 21mm H_2O/m of Packing, with varying packing type and size.

Operating variable varied		Design Parameters						
Packing Type	Packing Size (m)	Cross-sectional Area (m^2)	Column Diameter (m)	Packing Height (m)	Surface Area (m^2)	Volume of Packing (m^3)	Tower Height (m)	Total Annual Cost ($/year)
Rachig Ring	0.013	1.241886	1.257384	2.450342	32.20492	3.043046	7.52301	48,338.47
Ceramic	0.025	0.6209431	0.8891045	2.743771	22.35612	1.703726	7.558167	45,592.31
	0.038	0.4771479	0.7793875	3.59763	22.11629	1.716601	8.641657	46,161.78
Intallox saddle	0.016	0.4847827	0.7855982	2.68203	19.15181	1.300202	7.366153	42,721.68
Plastic	0.025	0.3533431	0.6706952	3.549105	18.54067	1.254051	8.462855	43,213.97
	0.038	0.3089896	0.6271895	4.585599	20.06725	1.416902	9.869572	44,225.55
Intallox Saddle	0.013	0.6962162	0.9414537	2.709471	23.76575	1.886378	7.563542	43,605.77
Ceramic	0.025	0.4693888	0.7730246	2.786514	19.15414	1.307959	7.499605	42,795.24
	0.038	0.3533431	0.6706952	3.833309	19.37914	1.354473	8.860742	$43,570.05

Table 8: Optimum Design parameters.

Design Parameters						
Cross-sectional Area (m^2)	Column Diameter (m)	Packing Height (m)	Surface Area (m^2)	Volume of Packing (m^3)	Tower Height (m)	Total Annual Cost ($/year)
0.237095	0.5493993	7.098567	23.44728	1.683034	13.30838	22,480.07

3.2 Discussion

Table 2 shows that the correlation coefficient between the results obtained from manual calculations and the CAD program is 1.000. This implies that that there is reasonable agreement between the two results, which confirms that the programming of the tables, charts, graphs and correlations using appropriate numerical methods and software are accurate.

The design parameters considered in the optimization of this design were cross sectional area of the packed column, column diameter, surface area of the packed column, column (tower) height, packing height and the total annual cost of the packed column.

In Table 3, the variable changed for the purpose of optimization is the operating temperature. Comparison of the values show that increase in the operating temperature increase the column diameter and cross-sectional area while tower height, height of packing, volume of packing, and surface area decrease . This could be due to the effect of temperature on the physical properties of the solute gas and solvent such as solubility of the solute gas in the solvent, diffusivity of the solute both phases, density, viscosity and surface tension. For instance, the higher the gas temperature, the lower the absorption rate and vice-versa (Treybal, 1981). This leads to higher solvent requirement. Column diameter and cross-sectional area are directly proportional solvent flow rate. The density of the solvent (water) is inversely proportional to temperature and the height of transfer unit is directly proportional to liquid density. That is, increase in temperature decreases the height of transfer unit and consequently decreases the tower height, height of packing, volume of packing, and surface area. The total annual cost also increases as the operating temperature increases. This is because increasing the column diameter will increase the capital cost (Coulson and Richardson, 2004) and the cost of pumping the solvent through the column increases due to increased solvent flow rate. The overall effect is increase in operating temperature leads to increase in the total annual cost of the absorber and its operation. 0^0C gives the minimum total annual cost for the absorber and its operation.

In Table 4, the variable changed for the purpose of optimization is the pressure drop. Increase in pressure drop increase the tower height and height of packing and decrease volume of packing, surface area, column diameter and cross-sectional area. This is attributed to the effect of the properties of the packing elements, such as surface area and free volume in the column. A high pressure drop results in high fan power to drive the gas through the packed column, and consequently high costs. The total annual cost decreases as the pressure drop is increased from 4 mmH_2O/mof packing to 8 mmH_2O/m of packing and then increases as the pressure drop is increased from 8 mmH_2O/mof packing to 125mmH_2O/mof packing. This is because the decrease in the capital cost as a result of decrease in column diameter and surface area outweighed the increase in cost of compressing the gas through the column as a result of increase in pressure drop from 4 mmH_2O/mof packing to 8 mmH_2O/m of packing. Normally, the column will be designed to operate at the highest economical pressure drop, to ensure good liquid and gas distribution(Coulson and Richardson, 2004). Though the results show that pressure drop of 8 mmH_2O/m of packing gives the lowest total annual cost, recommended design values for absorbers and strippers is 15-50 mmH_2O/m packing(Coulson and Richardson, 2004). This is because it is advantageous to have a reasonable hold-up in the column as this promotes interphase contact(Coulson and Richardson, 2009). Based on this argument, 21 mmH_2O/m packing gives the best result.

In Table 5, the variable changed for the purpose of optimization is percentage flooding velocity. Increase in percent flooding velocity decreases the column diameter, cross-sectional area, volume of packing, and surface area while tower height and height of packing increase. The results obtained agreed with the theory that higher flooding velocity leads to more efficient separation (Onifade, 2000), interpreted in terms of size of the column. Decrease in the column diameter,volume of packing, and surface area decrease the capital cost of the column hence, decrease in total annual cost of the absorber and its operation. 70 percent flooding velocity gives the best result.

In Table 6, the variable changed for the purpose of optimization is gas flow rate. The table shows that when the gas flow rate is increased, the packing height does not change. This is due to the fact that the height of gas transfer unit, $H_{G,}$ does not vary with gas flow rate (except at very low gas flow rate, where H_G approaches zero as the gas rate approaches zero). The cross sectional area of the packed column, column diameter, surface area of the packed column and column (tower) height increase as the gas rate increases. This is expected because the cross sectional area of the packed column and column diameter are proportional to gas flow rate. The surface area of the packed column,and column (tower) height, were similarly affected.The total annual cost also increases as the operating gas flow rate increases.This is because increasing cross sectional area of the packed column, column diameter, surface area of the packed column, column (tower) height will increase the

capital cost of the column (Coulson and Richardson, 2009). Gas flow rate of 0.126 kg/s gives the minimum total annual cost for the absorber and its operation.

In Table 7, the variable changed for the purpose of optimization is packing type and size.Increase in packing size decreases the column diameter and increase tower height. This expected because as the packing size increases, the gas flow rate per unit area decreases. The column diameter is proportional to gas flow rate. Generally, as the packing size is increased, the pressure drop per unit height of packing is reduced and the mass transfer efficiency is reduced. Reduced mass transfer efficiency results in a taller column being needed, so that the overall column cost is not always reduced by increasing the packing size (Coulson and Richardson, 2004). Normally, in a column in which the packing is randomly arranged, the packing size should not exceed one-eight of the column diameter (Coulson and Richardson, 2004). This is because the packing density, that is, the number of packing pieces per unit volume, is ordinarily less in the immediate vicinity of the tower walls, and this leads to a tendency of the liquid to segregate toward the walls and the gas to flow in the centre of the tower (Treybal, 1981).This leads to poor liquid distribution and hence reduced mass transfer efficiency. Above this size, this tendency is much more pronounced, that is, liquid distribution and hence the mass transfer efficiency, deteriorates rapidly. It is recommended that, if possible, the ratio d_p/D_c equals 1:15 (Treybal, 1981). For raschig rings ceramic,andintalox saddle ceramic, 0.025 m packing size gives the minimum total annual cost for the absorber and its operation while for polypropylene packing, 0.016 m packing size gives the best results. This may be due to the differences in the properties and costs of the various forms of the packing materials. Of all the packing materials, 0.016 m polypropylene packing gives the minimum total annual cost for the absorber and its operation followed by 0.025m intalox saddle ceramic packing. 0.016 m polypropylene packing, therefore, gives the best result. Metal packing materials cannot be used for this system because it involves highly corrosive solute (SO_2) (Coker, 1991).

Table 8 shows the optimum design parameters obtained at the optimum operating variables (temperature of 0^0C, pressure drop of 8 mm H_2O/ m of packing, flooding velocity of 0.7, gas flow rate of 0.126 Kg/s and 0.016 m polypropylene packing material).

4.0 CONCLUSIONS

A CAD module was developed for implementing the optimization of a packed absorption column. The program was tested with a design problem and the results of the manual calculations and CAD program agree reasonably well with a correlation coefficient of 1.000, which is a very good validation of the module. The CAD program was also used in optimizing the design by varying the values of certain operating parameters such as gas flow rate, packing type and size, operating temperature, pressure drop, and percentage flooding velocity.The optimum operating parameters are temperature of 0^0C, pressure drop of 21 mm H_2O/ m of packing, flooding velocity of 0.7, gas flow rate of 0.126 Kg/s and 0.016 m polypropylene packing material and the optimum total annual cost for the absorber and its operation is $22,480.07 per year.

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STABILIZATION OF BLACK COTTON SOILS FROM NORTH-EASTERN NIGERIA WITH SODIUM SILICATE

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Abstract

This work involves stabilization of black cotton soils from North-Eastern Nigeria with sodium silicate. Black cotton soil samples were collected from three locations within the studied area and their natural geotechnical properties determined in the laboratory. Sodium silicate was mixed with the soils in varied percentages of 2,4,6,8, and 10% and their responses monitored by testing in the laboratory. The test carried out on both the natural and treated samples are classification which includes Atterberg limits, particle size distribution; and strength characteristics through compaction and California Bearing ratio determination. The three soil materials tested were classified as A-7-6 with natural California Bearing Ratio (CBR) values ranging from 28.7% to 32.5%, giving weak subgrade to fair subbase materials. On stabilization, the plasticity indices of the soils were reduced considerably with remarkable improvement on the compaction characteristics. The CBR values increased to between 88% to 95%, and with percentage increase in strength of the stabilized soil samples over the natural soils up to 214%. The unsuitable materials were thus improved to suitable base materials.

Keywords: Stabilization, Laterite, Black Cotton Soils, Sodium Silicate, California Bearing Ratio

INTRODUCTION

Road construction in most developing countries involves the use of soil materials for the subbase and base of the roads. Some of these soil materials when encountered on site may not be directly suitable for use due to their poor strength characteristics, and when such occurs, the engineer is left with the choice of borrowing suitable materials from other sites or improves on the strength of the available ones (Oluyemi and Owolabi, 2003). When materials are imported to the site, the cost of construction becomes high due to delay in construction, increased haulage cost and time wastage, so the engineer with the choice of adding stabilizing agents to improve the properties of the available soil on site using various means of soil improvement techniques (Megan *et al.*, 1999, Allan *et al.*, 2003).

Black cotton soils are tropical expansive clay deposits which are particularly troublesome due to their high swelling and shrinkage potentials. They occur principally in semi arid tropics with marked alternating wet and dry seasons (Madedor and Lal, 1985, 1991). They are found in Australia, India, South Africa, Ethiopia, Tanzania, Asia and some other Africa countries especially in North Eastern Nigeria. Ola (1977, 1978, 1983, 1987, 1988) in his work described black cotton soils as being highly plastic silty clays formed by the weathering of basalt rock, shale and clay sediments. The soil contained a high proportion of montmorrilonite, with kaolinite and quartz making up the remainder (Ibrahim, 1983). The high shrinkage and swelling of these soils has caused a lot of problems with the use of the soils for engineering construction works due to excessive cracking which results on use especially for road works (Nigerian Building and Road research Institute, 1983).

Cement has been used with great success to stabilize naturally unsuitable soils, but the chemical conditions of some of the soils can inhibit the normal hardening of cement or lead ultimately to loss of durability or high construction cost for the highly plastic clay soils (Local Highway Technical News, 2007). Bituminous stabilization is also used for road surfacing all over the world, but has its own disadvantage in terms of energy loss during heating, it's dependent on machines to ensure maximum production and quality and negative effect on the environment and human exposed to the hazardous emissions produced in the industry (TRRL, 1986).

In view of these, there has been increasing need for sustainable development of roads all over the world, which has encouraged research into the use of alternative road materials to complement the conventional one. There are some nontraditional chemical stabilizers now in the market which may offer viable alternatives for stabilizing weak soils at reduced construction cost (Eyo, 2006).

It is against this background that this research work is brought up to assess the suitability or otherwise of using sodium silicate to improve the natural geotechnical characteristics of black cotton soils for road construction works.

Naturally occurring silicate minerals make up major portion of the earth's crust. Studies in the 1920s pointed out that prior to 1828, sodium silicate solutions were thought to be composed of products of hydrolysis, colloidal silicic acid, hydroxide ion, and sodium ion. The silicate solutions also contain crystalloidal silica which was thought to be the components of the known crystalline sodium silicates, charged aggregates of these unit structures and silica, or definite complex silica ions (Encyclopedia of Chemical Technology, 1982). They are produced by charging good quality and pure sand and sodium carbonate (soda ash) in selected proportions into a furnace resembling that

used for glass manufacture at a temperature between 1200-1425^{o}C. The material has been used as adhesives and binder applications after the turn of the century. These applications are generally based on the ability of silicates to form gels or react with multivalent metal ions or oxide surfaces in solution. Currently, the primary use of soluble silicate are as sources of silica (40%) for detergency (32%), in paper and board adhesives (6%) and miscellaneous (22%). They can also be used to manufacture synthetic pigments and filers, silica gels and solutions and synthetic clays. Other uses include cement manufacture, bleaching, water treatment, ore beneficiation and soil stabilization.

AIM AND OBJECTIVES OF THE RESEARCH.

The aim of this research is to evaluate the use of sodium silicate to stabilize and improve the geotechnical properties of black cotton soils for road construction and maintenance purposes.

The specific objectives are to:

(i) determine the physical and chemical properties of the chemical stabilizer in the laboratory,

(ii) collect some representative black cotton soil samples from North-Eastern Nigeria and evaluate their natural geotechnical characteristics,

(iii) stabilize the black cotton soils with sodium silicate in varied percentages and monitor performance, and

(iv) evaluate the effectiveness or otherwise of the chemical stabilizer for soil strength improvement.

STATEMENT OF THE PROBLEM

Black cotton soils are tropical expansive clay deposits, which occur principally in semiarid tropics with marked alternating wet and dry seasons (Madedor and Lal, 1985). They are highly plastic silty clays formed by the weathering of basalt rock, shale and clay sediments with a high proportion of expansive montmorrilonite, kaolinite and quartz making up the remainder (Ola, 1983). They appear firm in their dry state, swell up while wet and become highly unstable. They possess clay minerals of the smectite group which typically have a high swell and shrink potential and possess contraction cracks (Ibrahim, 1983).

According to Ola (1978, 1987), they have a black upper (20cm) horizon due to the presence of a black colored humus-clay complex with relatively low organic content and free calcium carbonate concretions with heavy texture. Massive expansion and contraction of the clay minerals takes place leading to the formation of wide and deep cracks, low permeability, high plasticity, expansiveness and shrinkage of the soils when used (Madedor and Lar, 1991). They are vastly available in North Eastern Nigeria lying within the Chad basin and the upper Benue trough (Adesunloye, 1987). Due to the negative characteristics of black cotton soils, they have become problem soils in the areas where they exist and their use has thus been limited.

This work is brought up to evaluate the performance characteristics of black cotton soils when stabilized with sodium silicate for possible improvement on their geotechnical characteristics.

LIMITATION OF THE RESEARCH

The research involved collection of representative samples of black cotton soils from North-Eastern Nigeria, their characterization in the laboratory to assess their natural geotechnical properties, and stabilization with sodium silicate to evaluate the effectiveness of the chemical to improve the soil's strength for construction purposes.

MATERIALS AND METHOD

Representative black cotton soils were collected from different locations in North-Eastern Nigeria and their geotechnical properties determined in the laboratory. The soil samples collected from Numan – Jalingo road, Numan – Yola road, and Numan - Gombe road in North – Eastern Nigeria.

The effectiveness of the stabilizer for soil strength improvement was studied by mixing sodium silicate with the collected soil samples in percentages of 2, 4, 6, 8, and 10, and performance tested in the laboratory. The laboratory tests carried out include determination of the Atterberg limits (liquid limit, plastic limit, and plasticity index), particle size characteristics, compaction characteristics, California Bearing Ratio (CBR) using standard ASTM specifications.

Figure 1shows the study locations.

LABORATORY TEST RESULTS AND DISCUSSIONS

Chemical Characteristics of Sodium Silicate

Soluble silicate glasses are manufactured usually in oil, electric or gas-fired open-hearth regenerative furnaces. The glass is obtained by reaction of quartz sand and sodium carbonate (soda ash) at a temperature sufficient to provide a reasonable quartz dissolution rate in the molten batch and a manageable melt viscosity. The reaction rate of quartz with Na_2CO_3 is controlled by silica diffusion and varies inversely with the square of the radius of the quartz particle). As Na_2CO_3 melts and envelops the sand grains, the slow process of quartz network breakdown and diffusion into the melt occurs.

The melts produced are very corrosive toward refractory materials and care is required in furnace design. Where electric power is available and costs are low, electric melting furnaces can be used satisfactorily. The sand and soda ash required for the manufacture of the soluble silicate must be of high purity. Typically, a no. 1 grade of glass sand containing no more than 300 ppm iron and a medium density soda ash, which is obtained from mined Trona ore is used.

The fused melt is drawn from the furnace continuously in a thin steam and solidified by passing onto a moving chilled conveyor of steel modes where it cools to a semi-transparent solid. The hot melt could be sprayed with a stream of

cold water to break them into small fragments which on grinding yields solid granular sodium silicates or it may be passed into a rotary dissolver, where the material is dissolved by superheated steam.

The minerals are slightly soluble and are generally in dynamic chemical equilibrium with the mineral components of the aqua sphere in the process of mineral breakdown and re-formation. Silicate solutions do not contain very large particles; however, aggregation of particles was indicated in high ratio solutions at high solids levels. The material is a colourless and odourless liquid. Laboratory test result shows that the chemical has a pH of 9.5, specific gravity and density of 0.96 and 1.172g/cm^3 respectively and also contain 23% of copolymer. The material used is a diluted solution of sodium silicate, a whitish odourless alkaline salt of a strong base and weak acid. The result of the chemical analysis of the imported and local stabilizers is as shown on Table 1.

Characteristic of Natural and Tested Soil Samples

Table 2 is the summary of the particle size distribution of the black cotton soil samples tested; Table 3 shows the summary results of the Atterberg's limits; while Table 4 shows the compaction and strength characteristics of the with the particle size curves shown in Figure 2.

(i) Black cotton soil from Yola-Gombe Road

The particle sizes are 0.1% gravel, 10.2% sand fractions and 32% of silt and 57.7% clay fractions (Table 2) with LL of 58.4%, PL of 32.5% and PI of 25.9% and LS of 9.8% indicating a soil with high shrinkage characteristics (Table 3). The soil is classified as A-7-6. The MDD and OMC are 18.9kN/m^3 and 15.5% respectively with a CBR value of 28.7% (Table 4). The soil is not recommended for either the subbase or base layers due to the high clay content, which will result in high swelling and eventual failure of the pavement if used.

Treatment with the sodium silicate led to reduction in the plasticity from the natural value to 21% at 2% mix and to 8.8% at 10% mix (Table 5). Also the LS reduced considerably. This is shown on Figure 3. Treating this soil sample with this stabilizer will definitely reduce the swelling and cracking which is generally associated with black cotton soils especially for road works. As shown on Figure 4 and Table 6, the sample had improvement on the MDD from natural value of 18.9kN/m^3 to 20.6kN/m^3 with 4% mix of sodium silicate.

Also in Table 6 and on Figure 5, the CBR also increased from 28.7% natural value to a maximum of 90.1% with sodium silicate at 4% mix. This shows a percentage increase of 214% of using sodium silicate over the strength of the natural soil.

(ii) Black cotton soil from Numan-Jalingo Road

This contains 0.2% gravel, 13.0% of sand fraction 30% of silt and 56.8% clay fractions (Table 2). The Atterberg limits are 53.3% liquid limit, 31.7% plastic limit and 21.6% plasticity index and linear shrinkage of 9.2% (Table 3). The soil is also classified as A-7-6. The strength characteristics gave a CBR of 28.7% (Table 4), which also confirms an unsuitable subbase and base materials with high shrinkage and swelling characteristics.

Addition of sodium silicate reduced the plasticity of the soil at all the mix ratios with increasing stabilizer content with minimum values of 8.8% PI and 3.0% LS at 10% mix (Table 5). This is also shown on Figure 6. Stabilizing this soil sample also improved the compaction and strength characteristics. The MDD increased from 21.4kN/m^3 natural value to 21.8kN/m^3 upon treatment with 4% sodium silicate. In Table 6, the CBR also increased from a natural value of 28.7% to maximum values of 88% with sodium silicate. In Table 7, stabilizing the soil with the sodium silicate gave percentage increase of 207% over the CBR value for the natural soil.

(vi) Black cotton soil from Numan-Yola Road

The particle size analysis of the black cotton soil from this location indicates a silty clay sand with 0.2% gravel fraction, 16.0% sand, 27% silt and 56.8% of clay fractions (Table 2) having PI of 19% and LS of 8.9% (Table 3) The sample is also classified as A-7-6. The MDD and OMC are 18.2 kN/m^3 and 14.9 % respectively while the CBR value is also 32.5% (Table 4). It is a fair subgrade material but naturally unsuitable for the subbase or base layers of roads.

With the addition of sodium silicate to this soil sample, there is also reduction in the plasticity of the soil from 2% to 10% and improvement on the compaction and strength characteristics. With 4% sodium silicate, the plasticity index reduced to 10.1% from the natural value of 19.0% with the linear shrinkage reducing from the natural value of 8.9% to 6.0%. The results are shown in Table 5 and on Figure 6. For the compaction characteristics, there was increase in the MDD at 4% sodium silicate from 18.2kN/m^3 to 21.8kN/m^3. The CBR value also increased from 32.5% natural value to 95% at 4% sodium silicate. Treatment with sodium silicate gave percentage increase of 192% over the natural soil strength.

Conclusions

The black cotton soil from Yola – Gombe and Numan – Jalingo roads contain high proportions of clay and silt fractions. They will be susceptible to swelling and cracking of road pavements. They are classified as A-7-6 and thus unsuitable for road construction without improvement.

Test results have shown that local stabilizer 3, acrylic copolymer is best suited to improve the strength of all tested soils especially the black cotton soils by reducing their plasticity, swelling

and shrinkage characteristics. With these stabilizers, some of the unsuitable widely available soil materials could be improved and used for road construction works. This will definitely help in the provision of good road networks in the areas where they exist.

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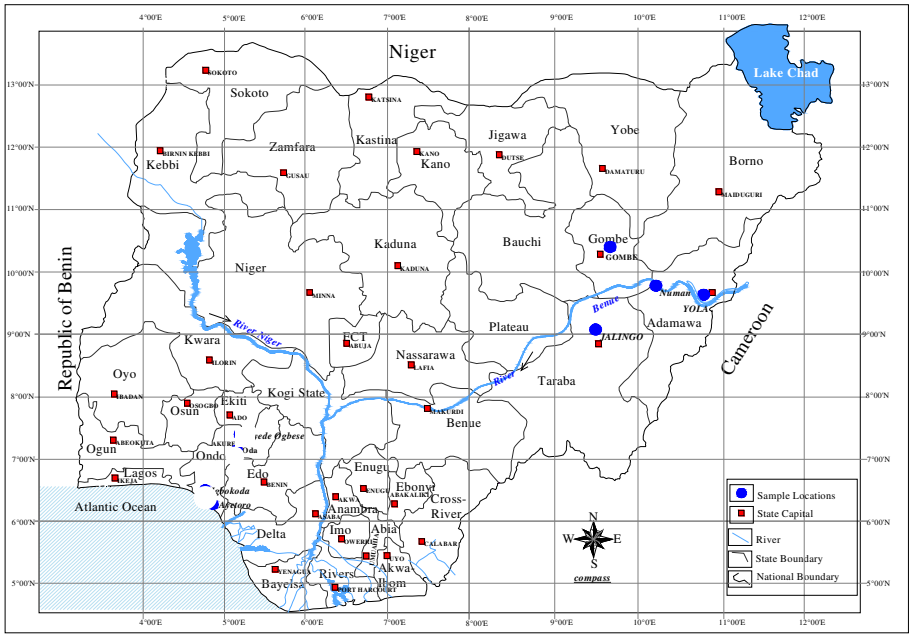


Fig. 1: Map of Nigeria Showing the Soil Sample Locations

Table 1: Summary Result of Physical and Chemical Analysis of Sodium Silicate used

Parameter	**Sodium Silicate**
Physical form	Liquid
Appearance	Colourless
Odour	Odourless
PH	9.5
Specific gravity	0.96
Volatility	-
Density	1.172g/cm^3
SCopolymer	23%
Vinyl acetate (Total solids)	-
Other Ingredients:	Al_2O_3 = 0.14%
	MgO = 0.02%
	SiO_2 = 70.3%
	CaO = 0.52%
	Na_2O = 29%
	TiO_2 = 0.02
Water	77%

Table 2: Summary of Particle Size Distribution of Soil samples

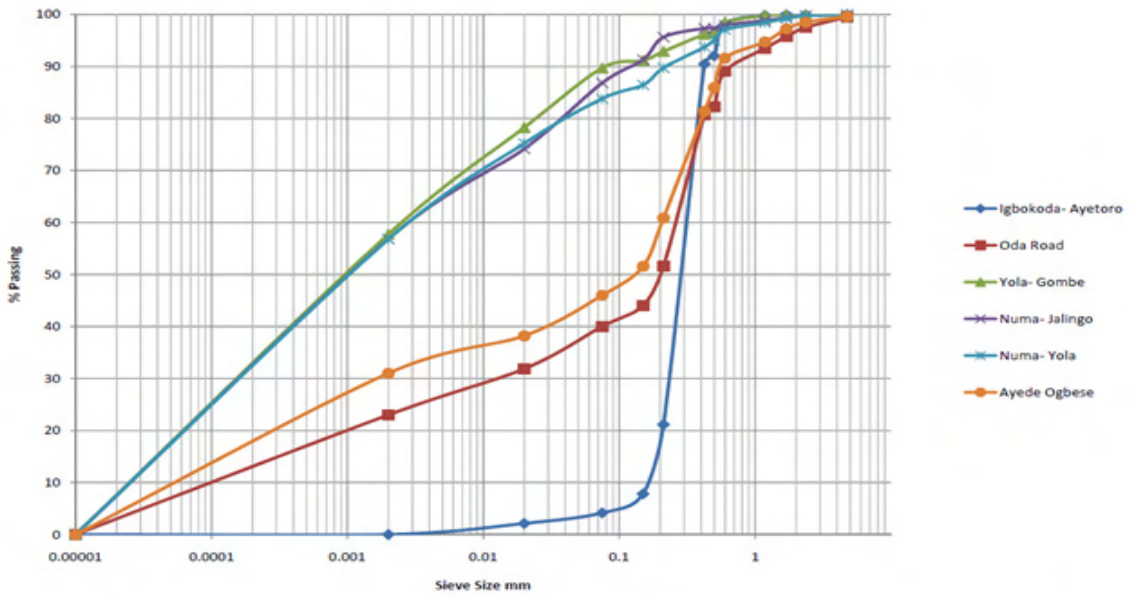
Sample location	Gravel Fractions, %	Sand Fractions, %	Silt fractions, %	Clay Fractions, %
A. Yola – Gombe road	0.07	10.22	32.0	57.74
B. Numan – Jalingo road	0.16	12.98	30.0	56.86
C. Numan – Yola road	0.22	15.98	27.0	56.8

Table 3: Summary Results of the Atterberg's Limits of Natural Soil Samples

Samples/ Location	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	Linear Shrinkage, %
A. Yola – Gombe road	38.4	12.5	25.9	9.8
B. Numan-Jalingo Road	33.3	11.7	21.6	9.2
C. Nurman – Yola Road	31.5	12.5	19.0	8.9

Table 4: Summary of Compaction Characteristics and California Bearing Ratio of Natural Soil Samples

Samples/ Location	Optimum Moisture Content, OMC %	Maximum Dry Density, MDD, KN/m^3	California Bearing Ratio, % (unsoaked)
A. Yola – Gombe Road	15.1	18.9	22.5
B. Numan-Jahingo Road	15.5	21.4	28.7
C. Nurman – Yola road	14.9	18.2	32.5



Clay	Silt			Sand			Gravel		
	Fine	Medium	coarse	Fine	Medium	Coarse	fine	medium	coarse

Fig. 2: Particle Distribution Curves of the Collected Soil Samples

TABLE 5: EFFECT OF SODIUM SILICATE ON PLASTICITY OF SOIL SAMPLES

SAMPLE	LL%	MEAN LL%	PL%	MEAN PL%	PI%	MEAN PI%	LS%	MEAN LS%
Yola Gombe, 0%	51.6		37		28.0		10.5	
	60.5	58.4	33	32.5	27.1	25.9	11.1	9.8
	63.1		27.5		22.6		7.8	
2% additive	50.9		31		19.9		5.9	
	46.1	48.5	21	25.8	25.1	21.0	8.5	6.9
	48.5		25.5		23		6.3	
4% additive	41.8		25.1		18.7		6.5	
	39.1	40.8	20.5	22.8	18.6	18.4	5.6	5.8
	41.5		22.8		18		5.3	
6% additive	35.0		22		13		5.1	
	32	35.0	18	19.9	14	15.1	4.6	4.5
	38		19.7		18.3		3.8	
8% additive	33.4		19		14.4		4	
	30	32.1	16.5	17.9	13.5	12.2	3.5	3.7
	32.9		18.2		14.7		3.6	
10% additive	26.1		16.8		9.3		3.5	
	23.5	25.3	16.6	16.5	6.9	8.8	2.7	3.0
	26.3		16.1		10.2		2.8	
Numan-Jalingo, 0%	48.5		35.7		21.4		12.5	

	51.3	53.3	26.2	31.7	22.5	21.6	7.6	9.2
	60.1		33.2		20.9		7.5	
2% additive	52.5		23.2		29.3		9.8	
	35.2	41.5	24.9	25.0	10.3	16.5	4.7	6.5
	36.8		26.9		9.9		5.0	
4% additive	35.2		18.5		16.7		7.1	
	33.8	33.0	20.0	20.5	13.8	12.5	5.3	6.0
	30.0		23.0		7.0		5.6	
6% additive	30.5		13.6		17.0		5.5	
	28.7	29.4	18.3	17.4	10.4	12.0	3.8	4.5
	29.0		20.3		8.7		4.2	
8% additive	26.8		15.3		11.5		4.2	
	24.8	25.5	12.9	13.7	11.9	11.8	3.7	3.8
	24.9		12.9		12.0		3.5	
10% additive	25.9		13.5		12.4		3.2	
	24.2	24.8	11.2	12.7	13.0	12.1	3.0	3.0
	24.3		13.4		10.9		2.8	
Numan-Yola, 0%	52.9		28.8		20.1		9.0	
	48.8	51.5	35.6	32.5	16.6	19.0	9.0	8.9
	52.8		33.1		20.3		8.7	
2% additive	40.2		24.1		16.1		7.5	
	36.1	37.3	25.8	23.8	10.3	13.5	5.6	6.3
	35.6		21.5		14.1		5.8	
4% additive	33.0		18.6		14.4		6.1	
	29.6	30.4	22.8	20.3	6.8	10.1	5.8	6.0
	28.6		19.5		9.1		6.1	
6% additive	29.5		18.9		10.6		5.3	
	28.0	28.1	19.5	19.6	8.5	8.5	5.0	5.1
	26.8		20.4		6.4		5.0	
8% additive	25.1		15.6		9.5		5.3	
	22.3	23.1	16.0	16.1	6.3	7.0	4.1	4.5
	21.9		16.7		5.2		4.1	
10% additive	21.8		13.5		8.3		4.0	
	19.5	20.5	14.0	14.5	5.5	6.0	2.8	3.0
	20.2		16.0		4.2		2.2	

TABLE 6: STRENGTH CHARACTERISTICS OF STABILIZED SOIL SAMPLES WITH SODIUM SILICATE (LOCAL STABILIZER I)

SAMPLE	OMC %	MEAN OMC %	MDD, kN/m^3	MEAN MDD kN/m^3	CBR %	MEAN CBR %
Yola-Gombe, 0%	16.0		19.5		30.9	
	15.6	15.5	19.1	18.9	27.7	28.7
	14.9		18.1		27.5	
2% additive	15.5		19.0		75.6	
	15.0	15.0	19.1	19.2	66.8	70.5
	14.5		19.5		69.1	
4% additive	15.1		22.0		93.0	

	16.1	15.1	20.7	20.6	90.3	90.1
	14.1		19.1		87.0	
6% additive	14.5		18.9		85.1	
	14.0	13.9	18.8	18.6	84.8	82
	13.2		18.1		76.1	
8% additive	14.1		18.1		75.0	
	12.6	13.2	17.1	17.4	70.6	71.2
	12.9		17.0		68.0	
Numan-Jalingo, 0%	16.1		21.8		30.5	
	15.6	15.5	21.6	21.4	30.4	28.7
	14.8		20.8		25.2	
2% additive	15.1		20.5		75	
	14.2	14.5	20.4	19.8	71	72
	14.2		18.5		70	
4% additive	15.2		21.6		93	
	13.6	14.0	21.5	21.8	86	88
	13.2		22.3		85	
6% additive	14.1		18.5		74	
	14.2	13.8	17.7	17.8	84	80
	13.1		17.2		82	
8% additive	12.8		14.5		75	
	13.1	13.1	16.1	15.6	69	69
	13.4		16.2		63	
10% additive	12.7		16.1		65	
	13.0	13.0	14.7	15.2	60	61
	13.3		14.8		58	
Numan-Yola, 0%	15.3		18.0		30.1	
	14.9	14.9	18.1	18.2	32.9	32.5
	14.5		18.5		34.5	
2% additive	15.0		21.1		80.0	
	14.8	14.7	20.6	20.0	81.8	82
	14.3		18.3		84.2	
4% additive	14.3		21.9		98	
	14.3	14.2	20.4	21.8	95	95
	14.0		23.1		92	
6% additive	12.9		19.6		92	
	12.9	13.1	18.5	18.8	89	88
	13.5		18.3		83	
8% additive	13.2		18.1		85	
	13.0	12.9	16.3	17.1	81	82
	12.5		16.9		80	
10% additive	13.1		18.0		77.5	
	11.7	12.0	14.9	16.0	78.7	76.1
	11.2		15.1		72.1	

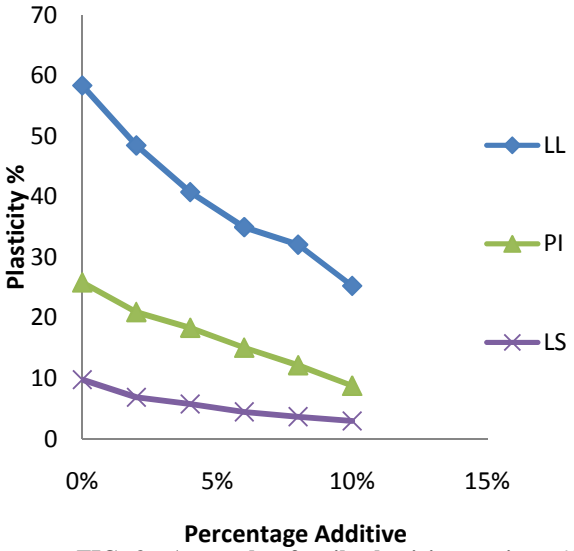


FIG 3: A graph of soil plasticity against % Additive using Sodium silicate for Yola-Gombe soil samples

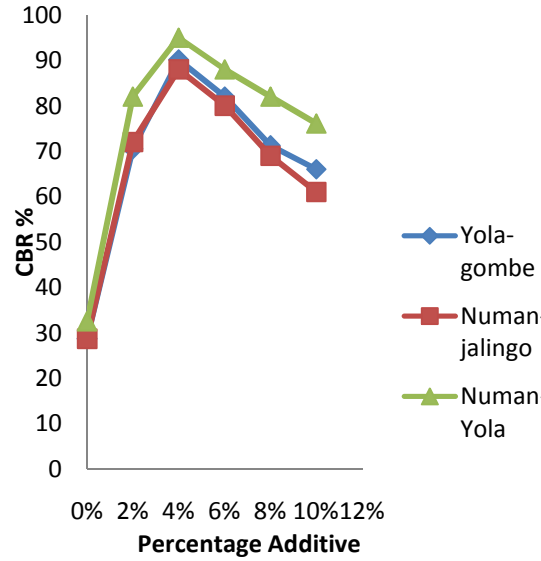


FIG 5: Variation of CBR with Sodium silicate for Yola-Gombe, Numan-Jalingo and Numan-Yola soil samples.

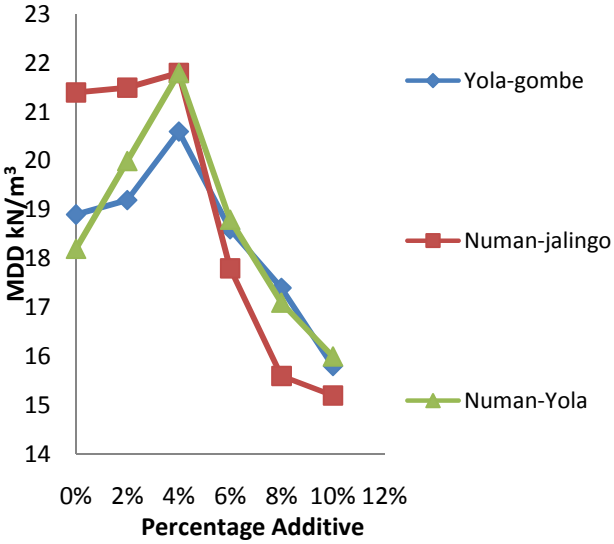


FIG 4: Variation of MDD with % Additive for Yola-Gombe, Numan-Jalingo and Numan-Yola soil samples using Sodium silicate

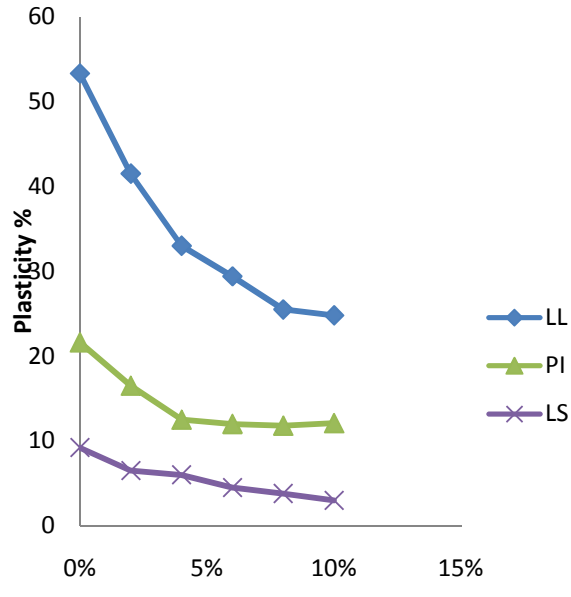


FIG 6: A graph of soil plasticity against % Additive with Sodium silicate for Numan-Jalingo soil samples

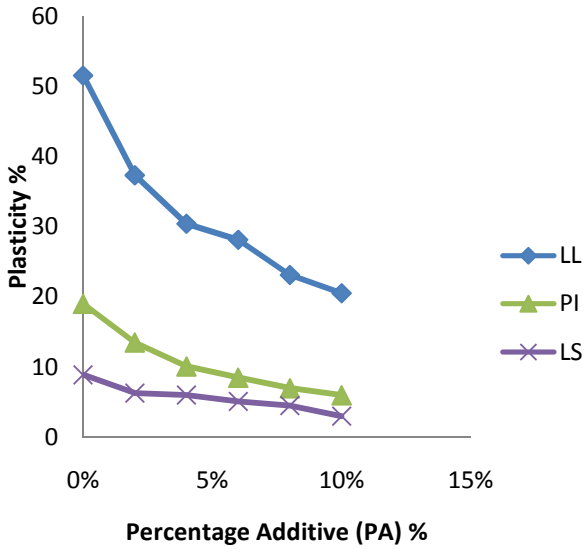


FIG 7: A graph of soil plasticity against % Additive using sodium

What the Buddha thought about Superstitions

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Avoid from wrong views

A suggestion can be made due to the research on occultism. It is accepted that superstitions exist in every religion[1]. Similarly Beliefs and wish fulfillment are common elements in all religions at the ideological level. All religions are led to practice them for the accomplishment of ambitions of the followers. But there are diverse rituals among Buddhists .The foregoing definition is inapplicableto the Buddha's teaching. As K . Sri Dhammananda denotes superstitions could not be found in the original teaching of the Buddha[2]. There are no invisible forces like magic based on occultism beside the five orders or processes " *niyāma*" operating surrounding us[3].

1 seasonal laws (*utuniyāma*)
2 the biological laws (*bijaniyāma*)
3 the kammic law (*kammaniyāma*)
4 natural phenomena laws (*dhammaniyāma*)
5 psychological laws (*cittaniyāma*)

Buddhism remarks that man can manage and control those processes with his spiritual power and intellectual methods but not with magical power. Oneself indeed, is one's own savior, for what other purpose savior would there be?[3]. Comprehensively,the Buddha's discourses rejected the superstitions of the contemporary people in India and guided them to avoid from wrong views. As the Buddha denoted worldliness is ignorance (andhabhutoayamloko)[4]. APalitechnical term ***Micchā-diṭṭhi*** also mean that magical beliefs and customs which are intrinsically operating on human mind that hindrance on the path of liberation. Another aspect, wrong view (Micchādiṭṭhi) indicates similarity with the ignorance in meaning.

It is the greatest teaching of Buddhism given to avoid from superstitions and guidance to observe the reality of what our beliefs are. In the kālamasutta Buddha emphasizes that one should not come to judgment upon doubt criteria. The *sutta*indicates that eight criteria which people cling to strongly may cause to close the truth we expect.

1. Do not accept anything based upon mere reports, tradition or hearsay,.
2. Norupon the authority of religious texts,
3. Norupon mere reasons and arguments,
4. Norupon one's own inference,
5. Norupon anything which appears to be true,
6. Norupon one's own speculative, opinions,
7. Norupon another's seeming ability,
8. Norupon the consideration " this is our Teaching, it should not be taken as"[5].

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[1]*Encyclopedia of Social Sciences*.Vol.111.1935.New York. Macmillan company.p.618.
[2]Dhammananda.K.Sri. 1998.*What the Buddha Believe*. Malaysia. Buddhist Missionary Society.p.57
[3] Jayawardena R.G.D 1996. *Niyama Dharma Wivaranaya*. Kandy.Sri Lanka. Buddhist Publication Society.p.2.
[4]Dhammananda.K.Sri.1998.p.372
[5]*Majjhima Nikāya*.vol.1.1954. London.PTS.Vimansaka Sutta.p.379

In this matter the problem is that there are no scientific techniques which can be applied to a method of verification and more reliable to our beliefs. There is a few endeavors of man involved in the investigation and observing the reality of belief that they have acknowledged without experience[6].***Bhayabheravasutta*** describes how the ascetic Gautama was moved from superstitions which were deeply rooted in his mind by investigating belief of horrible spirits which was held by people during his time in India.

Right view, the first step of the noble eight path direct us that we should not judge or reject without perusing the information obtained through our sense organs. It may be a challenge to one who has habitual practice of the superstitions. Similarly Buddhism directsus to avoid indiscriminate imitation as mentioned in the ***cankisutta[7].***

Wrong view is a cause of all nuisances and calamities. ***AlagaddupamSutta***describes how the wrong grasp lead us for a long time to woe and sorrow. For example, take a water – snake held by coil or by its tail, may bite him or his hand or arm or another part of his body, wrong view lead to sorrow. Buddha denoted that even we should not grasp the Dhamma without examining same. On the other hand wrong view is a demeritoriousdeed. So that is one of the ten meritorious deeds that we call straightening one's own views. Micchā ditthi, wrong view is abandoned by realizing what we see with the eye, objects, seeing etc.[8]

The whole teaching of the Buddha was based on the fundamental of ***pat.iccasamuppäda*** or dependent origination discovered and revealed by himself. Theoretically, the first chain of dependent origination - ignorance is a root cause of all mass of suffering. For one who follows superstitions who achieved his wishes this discovery indicates that he must first eradicate ignorance which is the root cause of the origin of suffering[9]. So bearing and grasping the views is more dangerous as catching a snake by hand in the wrong way[10].Dhammapada states thatthe established mind with wrong view does harm to him; likewise an enemy does harm to an enemy.

The path to realization exposed by the Buddha realized the truth who said to himself as pointing out the path to ignorance one who became a destitute (***mulhassavamaggamacikkheyya***) or who is in darkness like getting an oil lamp (***andhakarevatelapajjotam***) like one who sees the picture by one who has eyes ***cakkhumantorupanidakkhinti***)[11]. This means that the Buddha's teaching is a key to open the door to search for the truth and reject mysticism, fortune – telling, charms, talismans, mantras and prayers. In accordance with Ariyapariyesanasutta, the duty of the Buddha and his first sixty Arahants correspond to preaching the Dhamma to purified beings form the lust of the eye and ignorance. To convert the people from wrong views to right views was the first step of missionary service of the Buddha and his disciples. But many Buddhists use the term "embrace" when people accept the Buddha's teaching or entered to the Buddhist society, in the Pali texts we find another name which the Buddha gave a Buddhist as a stream enterer (***sotapanna).*** Stream enterer or one who embraced Buddhism could not believe superstitions. The Buddha named two kind of Buddhists based on their beliefs, namely Upasaka*Pundarika* and *UpāsakaCandāla* or real Buddhist and ordinary Buddhist. If a beliver by curious ceremonies (kotūhala - man˙galika) he believes in luck (man˙galanpacceti no kamman. man˙galanoloketi), not deeds he seeks outside for a gift – worthy person and there first he offers service[12].

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[6]*Majjhima Nikāya*.1954.Bahyabherava Sutta.p.21
[7]*Majjhima Nikāya*.Vol.11. London.PTS.1951.Canki Sutta.p.164
[8]Malalasekera.G.P.1960.*Dictionary of Pali Proper Name*.Vol.11.London.PTS.p.630
[9]*The Book of the Dscipline*.Vol.iv. 1951.London.PTS. "***evametassakevalassadukkhakkhandassanirodohoti***" p.2
[10]*Majjhima Nikāya*.1954. Alaguddupama Sutta.p.167.
[11] Saddhatissa.H.1985. Kasibharadvaja Sutta.p.10
[12]*Anguttara Nikāya*.Vol.111.1961.Great Britain. p.151

Many of those who practice Buddhist rituals,very oftendo not presumethe idea behind it. It is important to reveal the cause and effect between wish and fulfillment and sacrificial performance. Buddha's investigation and teaching of ritual practice theoretically presents a new interpretation and that leads to free will, wisdom and to moral conduct. The Buddha directed that one should not accept even his words without a critical examination of them. Also one should not ignore
his faith towards the Buddha. The Buddha expected to develop penetrative vision and independent thinking in both laity and Bhikkhu. As the first step of the noble eight fold path, right view aims at the culmination of philosophical free will of ordinary Buddhist and to concern the meaning of our religious sacrifice.

Buddha's view of some beliefs

Many accounts of discourses which addressed the ordinary men aimed at removing their fanciful thoughts. Expecting safety from super human beings people in India during the Buddha's time day and night made offeringsto the Yakkas(***divacarattocaharantiyebalim – tasmahinerakkhata , ratanasutta***)[13]. This convinced that offerings, made expecting safety is inconvenient for a Buddhist. For a Buddhist his safety is made by his own actions. Engage in good conduct of body, speech and mind,will protect themselves either internally or externally [14].

Under the Brahmanic influence there was a strong belief that giving birth to a baby girl first may be unlucky. Queen Mallika has given birth to a daughter. King Pasenadi was displeased hearing that his queen had given birth to a baby girl while he had expected a boy. The Buddha disclosed the fault of superstitions confirming that such beliefs are meaningless.

" A Woman, o lord of the people
May turn out better than a man:
She may be wise and virtuous;
A devoted wife, revering her mother –in – law,

" The son to whom she gives birth
May become a hero ' O lord of the land
The son of such a blessed woman
May even rule the realm[15].

Ever lasting superstitious, no one can solve problems arising daily. The Buddha said, a female child, O Lord of men, may prove even to be a better offspring than a male. For she may grow up wise and virtuous, her husband's other reverencing, true wife, the boy that she may bear may do great deeds, and rule a great realm, yes, such a son of a noble wife becomes his country's guide[16].

There is no alternative guidance to be achieved like welfare and happiness of life excepting well management of human resource. The four things that lead to the welfare and happiness of a family man in this very life are very close to the human resource management[17] .

1. The accomplishment of persistent effort.
2. The accomplishment of protection.
3. Good friendship.
4. Balanced living.

[13]*The Sutta Nipāta.*1985. Printed in Great Britain. ratanaSutta. "diva carattocaharanti ye balim-tasmahinerakkhata.p.24
[14] Acharya Buddharakkhita.trans.1985.*Dhammapada*. Kandy. Sri Lanka. Buddhist Publication Society.p.3
[15]*Samyutta Nikāya*.part.1.1960.London.PTS.Kosala Samyutta.p.68.
[16] ibid
[17]Hardy.E. ed. 1899. The A guttaraNikāya..part iv. London.PTS.p.281.

Everlasting superstitions, no one can solve problems arising day- to-day. In the Buddhist view, a common character of peoples' behaviour is practice and follow the myths to achieve secular benefits though they are no always reliable. A lot of people are ignorant taking decisions or in track to reach their goal until they have heretical habitations. If we concentrate the natural operative of our mind we are able to justify that we are living on imaginative concepts and in a hallucinationworld .Most of our definitions are autosuggestions.

Once incapable gods and men who created a dispute about three fold signs(Dittha – suta – muta - man˙galenasamannāgato), in justifying the signs of auspicious and ominous they asked the Buddha to explained the meaning of this belief. Excepting the traditional beliefs Buddha presented those education, arts, highly trained, discipline such as socio ethical and self skillful as auspicious signs pertaining to this very life [18]. Also well practiced archery will bring comfort (dhammos*ucinnosukhamavahati*)[19].

Apart from this, many ancient Indians learned and practiced metaphysics those prohibited by Buddha for his disciples. The Buddha prescribed that "monks should not practice metaphysics. Whenever they practice them, there is an offence of wrong – doing ". Sometimes the Buddha permitted learning of metaphysics for the laity at the same time. When several monks were living in a forest they did not know the position of the lunar mensuration, they did not know the divisions of the quarters. Thieves, having gone there, asked what is the day today according to a conjunction with the moon?. Which quarter is this?. The monks did not know. Then thieves decided they are not monks and started to harm them. Then the lord on this occasion, permitted a monk who is a forest dweller to learn the positions of lunar mensuration, either in whole or in part, he may also become skilled in the quarters[20]. Generally people follow superstitions even on some particular occasion such as a sneeze. On one occasion when the lord surrounded by a long assembly, sneezed while he was preaching the Dhamma, the monks, exclaimed : " lord , may the lord live long, may the welfare live (long) " thus making a loud noise, a great noise; preaching Dhamma was interrupted by this noise. Then the lord addressed the monks, saying : Now, monks, when (thephrases); long life; is spoken to one who has sneezed, can he for this reason live or die?. Monks, householders like lucky signs[21]. This indicates that such belief of the people are of no consequence.

People believed and engaged in astrology tofulfill their secure life, With regard to such engagement the Buddha questioned " what can stars do?(nakkattanikimkarissati) ".

" The fool may watch for lucky days;
Yet luk shall always miss.
"This luck itself is luck's own star
What can mere stars achieve ?"[22] .

The NakkhattaJatakaya indicates that fool misses luck believing superstations. The story presents an example, having fixed a day to come and fetch the bride, whether the stars were favorable for holding the festivities that day. Do the stars matter, is not the lucky thing to get the girl, meanwhile the fool was waiting for an auspicious day, in the meantime another one married the girl.

Even Buddhistsare engaged in astrology on special occasions of life such as examination, marriage proposals and for comparing horoscopes of the bride and groom for future luck before the ceremony. The story of *UmmaggaJataka*explains how a Buddhist should select a lucky spouse. The

[18]*The Sutta Nipāta.*1985.printed in Great Britain.p.29
[19] Saddhatissa.H.Trans.1985.*The SuttaNipāta.*printed in Great Britain. "***dhammosucinno sukhamavahati***"p.19
[20] Horner I.B.1963.*The Book of the Dscipline.* Vol.v. Great Britain.p.303
[21] ibid
[22] Robert Chalmers.Trans.1957.*The Jataka or Stories of the Buddha's former births* .London. Luzac& company LTD.Nakkhattajatakaya

BodhisattaMahoushadhatestedAmaravathi's intelligence. Finally Bodhisatta understood that Amaravathi is the suitable spouse for him[23]. Ordinary people who expect both happiness in this world and the other world are unable to understand immediate consequences of this procedure. But they follow traditional customs. They accept what is seen, heard or thought in the morning as auspicious. It is good, it means prosperous life for the day. The Buddha's interpretation on this aspect of auspicious belief is to reject the superstitions. If one develops socio – ethical qualities one will achieve his luck.

Sacrifice (Yāga)

The yāga which was performed by old Brahmanas to achieve both secular and transcendental wishes was excepted by the Buddha himself. The word " *yajamāna"* of the Sanskrit texts, which is the present participle middle voice of the verb *yaj* meaning to sacrifice. For the Hindu writers, sacrificer is a person who expects the effect of his acts to react on himself. Therefore prayers have been encouraged by priests to perform a particular sacrifice. We give the name
" sacrificer" to the subject to whom the benefits of sacrifice accrue or who undergoes its effects[24]. Sacrificial performances obviously assist the existence of religion and it is important to modify the family society and the individual life. The aim of some organized rituals is to offer solutions to problems of human life. Although rituals have a cultural value as in dancing, singing and music and concretizing the society yet they have no intellectual dimension. Distinction between culture and intellect is remarkable. Obviously rituals have been a necessary part of religion but they do not guide to intellectual dimension. Followers who practice rituals show deep faith and artificial behavior without empirical knowledge. Such specific behavior of people and their wish and fulfillment of it are unexplainable subjects. In the Brahmanic religion, sacrifice is called *yāga*and it means one who goes or moves. This implies asking,begging entreating and soliciting[25]. A technical name for these sacrificial ceremonies is called *Yāga* Vedic sacrificial rites simply include offering fruit,seeds, milk and so forth[26]. One aspect of this ritual is prosperity and another is purification[27]. Brahmanic rituals include animal offerings too.All rituals are based on the concept of god. Indeed, it may be questioned whether there is avery clear apprehension of these rituals.

According to the Master's critique and explanation, wish and fulfillment shows itself a reciprocity in the ritual performance, devotee's perceptions towards the means of ritual is dull because he is not aware of the cause and effects of what he is doing. All of us have enormous wishes for our secular benefit and for transcendental life. Aspects of many ritual performances have been related to individual and common needs. The vow made offering fruits, rice, milk, animals, target wishes of some daily needs such as being free from sickness, healing, prosperity, peace and good luck. Expecting good luck or prosperity devotees lost large amount of his assets in the form of sacrifice. *Kutadantasutta* consist of a description of requisites refer to a great *yāga* of killing a number of domesticated animals for sacrifice and destroying the flora and fauna in the ritual performance was rejected by the Buddha. There is distinction of the ethical element in the ritual structure of the Brahmana rite. Once Buddha questioned that if one can achieve his wishes with praying and rituals, why is it hard to find in this world one who has perfected some wishes with everything he desired. This critique expresses what the Buddha's teaching directed towards the sacrificial deity and faith of the people. In the early rites of Brahmana period the ultimate objective of sacrifice was to join with Brahma or attain emancipation of the soul. Rites have been accepted by Brahmanas as a ladder to heaven.

The pray, wish towards integration with Brahma is an unachievable task. In the Brahmana tradition, it is strongly believed that this is only a way for liberation. Brahmanas present that it is the straight path to

[23]Robert Chalmers.1957.Ummagga Jatakaya
[24] Alfred Hillebrandt.1897.*Ritual Literature*. Starsbourg.p.1
[25] Shiveram.Apte.1998.*The Practical Sanskrit English Dictionary*. Delhi. Printed in India.p.776
[26] ibid
[27] Maxmuller.F.ed.1885.*The Sacred Books of the East*. Vol .xxvi. Oxford University press.p.13

and is the affirmative direct way to make salvation. It leads to him who acts accordingly, into a state of union with Brahma[28]. One young BrahmanaVāsettha and young BrahmanaBhāradvāja visited the Buddha and questioned him about the true path, and straight path to join withchief Brahma .The Buddha questioned, as to whether there is a single Brahmana versed in the three Vedas who has ever seen the chief Brahma?.

Is there, a single one of the teachers of the Brahmanas versed in the three Vedas who has seen Brahma face to face?.

Is there a single one out of the pupils of the teachers of the Brahmanas versed in the three Vedas who has seen Brahma face to face?.

Is there then, a single Brahmana up to the seventh generation who has seen Brahma face to face?.

None of them had seen Brahma personally. Then this talk about Brahma is foolish. As a string of blind men are clinging on one to another, the first cannot foremost see, nor can the middle one nor can the one behind. Then the teaching of the way of unity with Brahma is ridiculous, mere words are vain and empty.

The Buddha compared the Brahmanas' way of unity with brahma in several fables. One is that as a man say he long for, and love the most beautiful woman in the land, yet he did not know her physical appearance or her name and the caste. His wish is to have such a beautiful woman. His talk of women was foolish. The Buddha compared that story toBrahmanas' path to liberation.Most critiques of the Buddha pointed out to rejecting those contemporary teaching of the Brahmanaswhich instruct us to search for the truth and not to accept hearsay.

When if a man makes a staircase in a place where four roads are crossing, to mount up into a mansion, other people will tell him, well good friend this mansion to which you are making the staircase, do you know whether it is in the east or the south or the west, or the north, whether it is high or low or of medium size?. If the river Aciravati is full of water even to the brim, and overflowing, a man with business on the other side, making his way for the other side come to cross over, he was standing on the bank, he starts invoking the God to send the other bank to his side, and, says; come hither. With the man's invoking praying and praising, will it ever come over to this side?[29].

In Buddhist practice, if one wishes to corporate with Brahma he should cultivate inner qualities of compassion, loving kindness, be soft spoken and equanimity. Parents are the visible Brahma who protects children and they should be worshipped. Sigalovadasutta compares one's parents with teachers and they are called first teachers[30].

If one practiced and perfected his own knowledge resulted to be of value and benefit than sacrifice done in a forest for a thousand years.

" Though for a hundred years one should tend
The sacrificial fire in the forest, yet if
Only for a moment one should worship those
Of developed mind, that worship is indeed
Better than a century of sacrifice"[31].

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[28]Somaratne.G.A. ed.*TheSamyuttaNikāya*.Volume 1.1998. Oxford .PTS. YajamanaSutta. p.500.
[29]*The DīghaNikāya*. Vol. 1.T.W.Rhys Davids.ed.1949. London. LUZC & Company LTD.Tevijja Sutta..p.235
[30]*DīghaNikāya*.Part 111.Stede. W. ed.London.PTS.S gālovāda Sutta.p.941.
[31] Acharya Buddharakkhita. 1985.*TheDhammapada*.Kandy. Sri Lanka.Buddhist publication Society.P21

Though month by month or hundred years one should offer sacrifices by thousand times, yet, if only for a moment one should worship those of developed mind, that honour is indeed better than a century of sacrifice[32]. Although many religions do not consider how the mental culture bring happiness, Buddhism recognizes thoroughly that wonderfully, indeed, it is to subdue the mind, which is difficult to subdue, ever swift, and seizing whatever it desires. A tamed mind brings happiness, also let the discerning man guard his mind, so difficult to detect and extremely subtle, seizing whatever it desire. Also a guarded mind brings happiness. And developing one's mental culture will bring happiness than *yāga* .

Once Bodhisatta accepted ritual performance when he was a ruler in the Benares. In those days Benares folk have given much to festivals of Gods, and used to show honour to Gods. It was their desire to massacre numbers of sheep ,goats, poultry, swine and other living creatures and perform their rites not merely with flowers and perfumes but with gory carcasses.

After Bodhisatta succeeded as viceroy and succeed to his inheritance after his father's death, he devised some clever strategies whereby evil shall be stopped without harming a single human being. People gathered together at a holy Banyan – tree praying to the fairy who had been reborn in that tree, to grant them sons and daughters, honour and wealth, each according to his heart's desire.

During his rule Bodhisatta expected to shunning the four evil courses and practicing the ten royal virtues, he ruled his people in righteousness, that was his vow[33]. But people are addicted to the fire since, to wit the slaughter of living creatures and so forth.

Throughout the Bodhisatta's reign not a man was convicted of transgressing. Bodhisatta made them observe the commandments and at the close of a life of alms – giving and other good work he passed away with his followers to throng the city of Devas[34]. We have further evidence of Lord Buddha rejecting *Yāga*and God cannot protect the donor' while God cannot protect thing which offered to him[35].

" Once on a time when Brahmadatta was reigning in Benares, the Bodhisatta was born a Brahmin in the North country, and on the day of his birth his parents lit a birth – fire.In his sixteenth year they addressed him thus, " Son , on the day of your birth we lit a birth – fire for you. Now therefore choose. If you wish to lead a family life, learn the three Vedas; but if you wish to attain to the Brahma Realm, take your fire with you into the forest and there tend it, so as to win Mahā – Brahmā'sfavour and hereafter to enter into the Brahma Realm".

Telling his parents that a family life had no charms for him, he went into the forest and dwelt in a hermitage tending his fire. An ox was given him as a fee one day in a border – village, and when he had driven it home to his hermitage, the thought came to him to sacrifice a cow to the Lord of Fire. But finding that he had no salt, and feeling that the Lord of Fire could not eat his meat – offering without it, he resolved to go back and bring a supply from the village for the purpose. So he tied up the ox and set off again to the village.

While he was gone, a band of hunters came up and, seeing the ox, killed it and cooked themselves a dinner. And what they did not eat they arried off, leaving only the tail and hide and the shanks. Finding only these sorry remains on his return ,the Brahmin exclaimed, " As this Lord of Fire cannot so much as look after his own, how shall he look after me? . It is a waste of time to serve him, bringing neither good nor profit." Having thus lost all desire to worship Fire, he said – " My Lord of Fire, if you cannot manage to protect yourself, how shall you protect me? The meat being gone, you must make shift to fare on this offal." So saying, he threw on the fire the tail and the rest of the robbers' leavings and uttered this stanza:-

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[32]Ibid .p.21
[33]Robert Chalmers.1957. DummedhaJatakaya
[34] -do- Kulavakajatakaya
[35] -do- NanguttaJatakaya

Vile Jātaveda, here's the tail for you;
And think yourself in luck to get so much!
The prime meat's gone; put up with tail to –day.

So saying the Great Being put the fire out with water and departed to become a recluse . And he won the Knowledge and Attainments' and ensured his re – birth in the Brahma Realm [36]."

It is better to include another instance regarding how Lord Buddha wanted to reject sacrifices which were unethical.

" Once on a time when Brahmadatta was reigning in Benares, the Bodhisatta was reborn in the womb of the Queen Consort. When he was born, he was named Prince Brahmadatta on his name – day. By sixteen years of age he had been well educated at Takkasilā, had learned the Three Vedas by heart, and was versed in the Eighteen Branches of Knowledge. And his father made him a Viceroy.

Now in those days the Benares folk were much given to festivals to 'gods, and used to show honour to 'gods,. It was their wont to massacre numbers of sheep, goats, poultry, swine, and other living creatures, and perform their rites not merely with flowers and perfumes but with gory carcasses. Thought the destined Lord of Mercy to himself, "Led astray by superstition, men now wantonly sacrifice life; the multitude are for the most part given up to irreligion: but when at my father's death I succeed to my inheritance, I will find means to end such destruction of life. I will devise some clever stratagem whereby the evil shall be stopped without harming a single human beign." In this mood the prince one day mounted his chariot and drove out of the city. On the way he saw a crowed gathered together at a holy banyan – tree, praying to the fairy who had been reborn in that tree, to grant them sons and daughters, honour and wealth, each according to his heart's desire. Alighting from his chariot the Bodhisatta drew near to the tree and behaved as a worshipper so far as to make offerings of perfumes and flowers, sprinkling the tree with water and pacing reverently round its trunk. Then mounting his chariot again, he went his way back into the city.

Thenceforth the prince made like journeys from time to time to the tree, and worshipped it like a true believer in 'gods'.

In due course, when his father died, the Bodhisatta ruled in his stead. Shunning the four evil courses, and practicing the ten royal virtues, he ruled his people in righteousness. And now hat his desire had come to pass and he was king, the Bodhisatta set himself to fulfil his former resolve. So he called together his ministers, the Brahmins, the gentry, and the other orders of the people, and asked the assembly whether they knew how he had made himself king. But no man could tell.

" Have you ever seen me reverently worshipping a banyan- tree with perfumes and the like, and bowing down before it?"
" Sir, we have," said they.

" Well, I was making a vow; and the vow was that, if ever I became king, I would offer a sacrifice to that tree. And now that by help of the god I have come to be king, I will offer my promised sacrifice. So prepare it with all speed".

" But what are we to make it of?"

" My vow," said the king ," was this:- All such as are addicted to the Five Sins, to wit the slaughter of living creature and so forth, and all such as walk in the Ten Paths of Unrighteousness, them will I slay, and with their flesh and their blood, with their entrails and their vitals, I will make my offering. So proclaim by

[36] Robert chalmers.1957. NanguttaJatakaya.

beat of drum that our lord the king in the days of his viceroyalty vowed that if ever he became king he would slay, and offer up in a sacrifice, all such of his subjects as break the Commandments. And now the king wills to slay one thousand of such as are addicted to the Five Sins or walk in the Ten Paths of Unrighteousness; with the hearts and the flesh of the thousand shall a sacrifice be made in the god's honour. Proclaim this that all may know throughout the city. Of those that transgress after this date," added the king, " will I slay a thousand, and offer them as a sacrifice to the god in discharge of my vow. However, obedient to the king's commands, the ministers observed five precepts and were aside in sacrifice[37] .

In the Yaññasutta Buddha reflected reduction ad absurdum of animal sacrifice supposed by kingPasenadi to act on the advice of Brahmins in order to avert the effects of his evil dreams[38]. The Buddha hearing of it, declared that such sacrifices never produce good results. There are other sacrifices " which harm no one and by which the celebrant are blessed and the Gods pleased. Very often Buddhists express alternative sacrifice for the benefit of human life. A poem of twenty-one stanzas which Bhuridatta describes to his brother Arittha have rejected various kinds of sacrifices and described their futility. Another important point in the KutadantaSutta criticized fruitless ritual performance, describes what the Buddha's attitude towards wish and fulfillment. At that time Brahman Kutadanta was staying at the village Khānumata, a place teeming with life, with life, with much grassland and woodland and water and corn. On a royal domain presented him by SeniyaBimbisara the king of Magadha, as a royal gift, with power over it as if he were the king. As gratitude to king, Brahman Kutadanta organized a great sacrifice with hundred bulls, hundred steers, hundred heifers, hundred goats, and a hundred rams. They had been brought to the post for sacrifice. Listening this ritual Buddha expressed alternative successful performance of sacrifice for the benefit of the king and the public.

The king asked KutadantaBrahmanato give instruction to him to welfare for a long time. Then kutadanta mentioned that King's country is harassed and harried so there are dacoits abroad who should pillage the villages and townships' and that made the roads unsafe. The king's opted to levy fresh tax, verily his majesty acted wrongly. But perchance his majesty might think according to this advise, that I'll soon put a stop to these scoundrels' game by degradation and banishment, and fines and bonds and death! But their license cannot be satisfactorily put to a stop. The remnant left unpunished would still go on harassing the realm. Now there is one method to adopt to put a thorough end to this disorder.

1. Whosever there be in the king's realm who devote themselves to keeping cattle and the farm, to them let his majesty the king give food and seed-corn.

2. Whosoever there be in the king's realm who devote themselves to trade, to them let his majesty the king give capital.

3. Whosoever there be in the king's realm who devote themselves to government service, to them let his majesty the king give wages and food[39].

Then those men, following each his own business, will no longer harass the realm; the king's revenue will go up; the country will be quiet and at peace; and the populace' pleased one with another and happy, dancing their children in their arms, will dwell with open doors[40].

[37]Robert chalmers.1957.Dummedha Jatakaya
[38]*DīhaNikāya* .Vol.1.1949. Kutadanta Sutta.p.127
[39]*DīghaNikāya*.vol.1.1949. Kutadanta Sutta.p.127.
[40]*DīghaNikāya*.Vol.1.1949. KutadantaSutta

Then the king's wide-realm accepted the word of his chaplain and did as he said. And those men, following each his business, harassed the realm no more. And the king's revenue went up. And the populace, pleased one with another and happy, dancing their arms, dwelt with open doors.

Avoiding Brahamanicyāga System Lord Buddha expresses other sacrifices step by step with more fruits and more advantage than this.

There is another sacrifice less difficult and less troublesome with more fruit and more advantageous than this. The perpetual gifts kept up in a family where they are given specifically to virtuous recluses.

1. The putting up a dwelling place (Vihāra) on behalf of the order in all the four directions. There is another sacrifice better than putting up a dwelling place, as he who with trusting heart takes Buddha his guide once and the truth, and the other.

2. If someone observes the precepts-abstinence from destroying life; abstinence from taking what has not been given to him, abstinence from evil conduct in respect of lust; abstinence from lying; abstinence from strong intoxicating, maddening drinks, and the root of carelessness.

The next step of sacrifice is to train morals step, mercy and kindness to all living beings. Advantages are visible in this life. Honesty, charity, truthfulness, peacefulness courtesy, good sense in speech. Abstinence from luxury of twelve different kinds, freedom from trickery, non violence, not injuring plants is the next step of sacrifice.

In such sacrifice one can develop his own mind step by step to first, second, third, fourth, and fifth concentrations. In the steps of concentrations, the five hindrances will vanish and eradicated by concentration of mind putting away the hankering after the world, he remains with a heart that hankers not, and purifies his mind of lust putting away corruption of the wish to injure. He remains with that free from ill temper, and purifies his mind of malevolence. Putting away proper heart and mind, keeping his ideas alight, mindful and self-possessed, he purifies his mind of sloth, putting away flurry and worry. He remains free from fretfulness, and with heart serenity within. He purifies himself of irritability and vexation of spirit putting away wavering, he remains as one passed beyond perplexity, purifies his mind of doubt. His psychological experiences himself, to be fruitful to use as identification of his own mind.

1. The passionate mind to be passionate and calm.
2. The angry mind to be angry, and the peaceful mind to be peaceful.
3. The dull mind to be dull, and alert mind alert.
4. Attentive mind to be attentive, and the wandering mind to be wandering.
5. The broad mind to be broad, and the narrow mind to be narrow.
6. The mean mind to be mean and lofty mind lofty.
7. The steadfast mind to be steadfast and the wavering mind to be wavering.
8. The free mind to be free and the enslaved mind enslaved.

The way he gains spiritual power as the heavenly ear-hearing heavenly sounds, seen with the heavenly eye. He recognizes the passing away from one form of existence and taking shape in another. The immediate fruit of the *Yāga*which the Buddha recommended are knowledge of others thoughts, memory of his own previous birth, and knowledge of other people's previous births. He knows as it really is: this is the path that leads to the cessation of pain. He knows these are the deadly floods and this is the origin of the deadly floods. Finally he perceived that this is the cessation of the deadly floods.

By the above perception there rises the knowledge of his emancipation, and he knows rebirth has been ceased. The realization of the inclinations, and attaintoArahant is the ultimate gain of Buddhist sacrifice .

Accordingly Buddha's interpretation led to the sacrifice, though some rituals of Buddhists performed today are rituals of white – magic. This was not similar in the Historic – rite and ceremony of Buddhism in India. With the concept of commemoration early pilgrims visited and worshipped the three sacrificial places where the Buddha was: place of birth, attained enlightenment and delivered the first sermon, and attained *nibbana*[41]. when commemorating such places Buddhists gradually developed the symbolical monuments Bo tree, Stupa, Image to represent the Buddha. All these symbols have been created with the mean of social aspects as well as ethical concepts. This was understood by emperor Asoka. There is a definite puritanical streak in Asoka's character suggested by his disapproval of festivals and of religious rituals many of which while being of little value were nonetheless harmless . He adopted this view to inform the people of Asoka's reforms and to encourage them to avoid useless religious festivals. The fourteenth rock edict notices " beloved – of –the – God , king Piyadassi, has caused this Dhamma edict to be written . Here (in my domain) no living beings are to be slaughtered or offered in sacrifice. Nor should festivals be held. For beloved – of – the Gods, king Piayadassi, sees much objection to in such festivals, although there are some festivals that loved – of –the Gods: king Piyadassi does approve of. Rather fourteenth rock edict declares that " Beloved –of – the – lords, king Piyadassi, speaks thus: in times of sickness, for the marriage of sons and daughters, at the birth of children, before embarking on a journey, on these and other occasions, people perform divers ceremonies. Women in particular perform many vulgar and worthless ceremonies. This type of ceremonies can be performed by all means, but they bear little fruit: what does bear great fruit, however, is the ceremony of the Dhamma. Dhamma ceremony involves proper behavior towards servants and employees, respect for teachers, restraint towards living beings, and generosity towards ascetics and Brahmanas. These and other things constitute the ceremony of the Dhamma. Therefore a father, a son a brother, a master, a friend , a companion, and even a neighbor should say: This is good, this is the ceremony that should be performed until its purpose is fulfilled, this I should do, other ceremonies are of doubtful results for they may achieve their purpose, or they may not, and even if they do, it is only in this world. But the ceremony of the Dhamma is timeless. Even if it does achieve its purpose in this world, it produces great merit in the next, where as if it does achieve its purpose in this world, through the ceremony of Dhamma one gets great merit both here and there. Rock edict of Asoka indicates that necessity of rendering the Dhamma ceremony introduced by the Buddha when overlap superstitions with Buddhism during his time[42].

The prospect of Buddhist ritual and ceremony are not intricate accounts as other religions. Buddha indicated that conduct (pratipatti) is more fruitful than offering thing in a sacrifice (āmisa). Objective of Buddhist rituals relate to socio cultural aspects; primarily support and control of immoral conduct of the ordinary men. In the Buddhist culture the ritual appears as a norm regarding social identity as well as existence itself. All rituals and ceremonies of Buddhism are performed around the sacred symbols like Bo tree, statue, Stupa and relics. Buddhist ritual was originated with the Buddha showing his gratitude to Bo tree spending a week gazing at it called *animisalocanapūja* and his advice to the devoted Buddhists as mentioned in the Parinibbanasutta. Devoted Buddhists should memorize and salute Lord Buddha visiting the four places where the Buddha was born, attained enlightenment and the place where Hi passed away. When the body of the Exalted one had been burnt up, the Mallas of Kusinārā brought water scented with all kinds of perfumes, and extinguished the funeral pyre of the Exalted one. Then the Mallas of Kusinārā surrounded the remains of the Exalted One in their council hall with a lattice work of spears, and with a rampart of bows, and there for seven days they paid honour, and reverence, respect and homage to them

[41] *DīghaNikāya*. Vol.111.T.W Rhys Davids.ed.1910. Oxford University press..Parinibbana Sutta.p.79

[42] RadhakumudMookerji. 1928.*ASOKA*. London. Macmillan AND Company Limited.Kalsi.ix.p.229.

with dance, song, music with garlands and perfumes[43]. It's remarkable that Buddhist rituals are not based on the myth and are based on the socio and psychological meaning. We have enough evidence from the Buddha's last deliverance. At the four cross roads Stupa should be erected to the Thatāgata. And whosoever shall there place garlands, perfumes or paint, or make salutation there, or became in its presence calm in heart that shall long be to them for a profit and a joy.

Alternative teaching for superstitions

The auspicious or *maṅgala* concepts explained in Buddhism as socio ethical practices devoted to human welfare: activity not to associate with fools, but to associate the wise, to honour those who are worthy of honour to reside in a suitable locality, to have done meritorious deeds in the past, to set oneself in the right course, much understanding of wife and abstain from evil, to abstain from intoxicants, and steadfastness in virtue, reverence, humility, contentment, gratitude and opportunity hearing of Dhamma, patience, obedience, sight of the Samanas and timely religious discussions and self – control, holy life, perception of the noble truths and realization of liberation, sorrowless, stainless , and secure – these are the highest blessings and they will bring luck to man[44] .

According to Buddhists, the concept of merit, which results in behavior giving clothes, food, medicine and dwellings is the way or ladder to heaven. It is
expected to distribute things which benefit others. Such socio – ethical affairs are considered to be good conduct and wholesome action which will result in rebirth in the heaven. Cultivating inner qualities compassion, love, sympathy, right speech, avoiding harsh words and slander is a ladder to heaven was what the Buddha thought to himself. Advantage of good character and welfare work give results rather than rites. Lord Buddha rejected traditional yāga system which was offered to the fire God, which was converted to beayāga of non violence. Once, God Sakka asked the Buddha how best it is to offer gifts, so as to gain great rewards. The Buddha replied that gifts should be offered to the monks. In Buddhism it is the right way to heaven. Once the Master explained that how social service will result after death. The Boddhisatta fulfilled these seven injunctions – to cherish ones mother, to cherish ones father, to honour ones elders and speak the truth, and avoid harsh speech, slander, and shun niggardliness.

Whosoever supports his parents, honours, age.
Is gentle, friendly – spoken, slandering not.
Chaste, truthful, lord – not slave – of wrath.
He earns the thirty three heaven as God[45].

Such was the praise which explains the worthy state to which he grew, and at the end of his life he passes away to be reborn in the realm of the thirty three as Sakka, king of Deva. His friends are also reborn in that realm. Having cultivated merit the result was to be reborn as a God. They kept the five commandments. Young noble Boddhisatta known as Maghawas reborn as Sakka[46].

For secular prospect, one who was vocationally trained, well experienced competent and strained every way will perfect his wishes himself. Buddha's answer to the questions of goblin Alawakawhat practice will bring happiness for, is well trained will bring him happiness[47]. Determination and training of one will make a path to produce wealth. Reflecting his previous life Lord Buddha showed how determined perfect one's wishes. Boddhisatta drove in a caravan with brother merchants on a long trading way in a horrendous desert. They found it difficult to replenish the pots of water in the desert. Looking a tuft

[43]Dīgha Nikāya.Vol.111.1910.p.79.
[44] Saddhatissa.1985.p.28
[45] Robert Chalmers.1957. Kulavakajatakaya
[46]Robert Chalmers.1957. Kulavakajatakaya

[47]Dines Andersen and Helmer smith. Ed.*Sutta-Nipāta*. 1965.London.PTS.Alavaka Sutta.p.31.

Boddhisatta began to dig the ground and met with a rock. Their enthusiasm with right endeavor lead to drill the rock and obtained underground water[48]. This story disapproves that human requirements will not fulfill in ritual performance but it can only fulfil in effort and determination. Best management and mindfulness of a person in an industry will advance his industry. The story of small millionaire (ChullaSetti) reveals that one who wishes to be a millionaire, should earn and save property step by step with the help of his knowledge of economic[49].

Laymen who enjoy worldly pleasure, lead a life encumbered by wife and children, they use sandal wood of Kasi, they deck themselves with garlands, perfume. and unguents, they suffer due to the use of gold and silver. To such people, Buddha preached the doctrine about things that lead to wealth and happiness, in this life and to the happiness of the other world. In Buddhism cause of worldly progress depends on people's themselves but not on rites. Buddha taught these four things to Vyagghapajja, conducive to the good and happiness of a clansman in this very life.

1. The achievement of persistent effort.
2. Refrain from wariness.
3. Finding suitable companionship.
4. Balanced livelihood.

By achievement of persistent effort one can acquire much property with whatsoever activity, a clansman earns his living, whether by the plough, by trading, by watching cattle, by archery, by ministering to the king, or by any other kind of craft that he becomes skillful and not lazy. He is endowed with reasoning the ways and means thereof. he is able to manage (his job) – collected by the strength of his arms, and by the sweat of his brow[50].

The treasuresobtained by dint of effort, collected by strength of arms, by sweat of his brow just acquired by right means. Such husbands who guard and watch such treasure so that kings would not seize them, thieves would not steal, fire would not burn, water not affect, nor ill- disposal takes place.

In whatever society, a clansman dwells, stands together, converses, engages in discussions with householders' sons, cultured, full of faith, full of virtue full of charity, full of wisdom will achieve social acceptance. He acts in accordance with faith of those full of virtue. These full of virtue, with the charity to those full of charity, and wisdom based on conduct.

A clansman knowing his income and expenses leads a steady life, being neither too extravagant nor too sordid, thinking that thus his earning will stand in excess of his income. " Just as the goldsmith, or his apprentice, knows on holding up a balance, that by so much of it as little expenses A clansman knowing his income and expenses, leads a steady life, being neither too extravagant nor too sordid, thinking that thus his income will stand in excess of his expenses, but not his expenses in excess of his income. This way a clansman can expect a luxurious life, even with a little income. But a clansman cannot expect a luxurious life with a little income to lead a wretched life. There are four sources of destruction of his earning in following ways.

1. Debauchery
2. Drunkenness
3. Indulgence in gambling
4. Friendship, companionship and intimacy with evil-doers.

[48]Robert Chalmers.1957. ApannakaJatakaya
[49]Robert Chalmers.1957.ChullasettiJatakaya
[50]DīghaNikāya. .ByagghapajjaSutta

These four decisions define whether one can achieve or decline his prosperity. This expresses through an instance as, in the case of a great tank with four inlets and one outlet. If a man closes the inlets and open the outlets there should be no adequate rainfall, decrease of water is to be expected in that tank; such as there are four sources for the destruction of accumulated wealth debauchery, drunkenness, indulgence in gambling, and friendship, companionship and intimacy with evil – doers and vice versa – there are four sources for the development of mass wealth abstain from those sources. For instance, in the case of a great tank itself with four inlets and four outlets, if a person to open the inlets and close the outlets is employed. Then there would be adequate rainfall, increase of water is certain. So the four above – mentioned are the sources of development of amassed wealth. This explanation determines sacrifice make impossible to conduct the good and happiness of a noble son in this life itself. But the responsibility of developing wealth is in his own hands.

In the traditional societies, very often people believe in occult science which came through their mysterious culture .At the Buddha's time when Singala householder's father was dying, he said to his dear son, that you should worship the quarters of earth as sky. In Buddhism, six quarters should not be worshipped as such but advices to conduct them do as much, avoid these fourteen evil things as a cover of the six quarters , he has practiced so as to conquer both worlds; he tastes success both in this world and in the next[51]. At the dissolution of the body, after death, he is reborn to a happy destination in heaven. These are the four vices of conduct that should be put away.

1. The destruction of life
2. Taking what is not given
3. Licentiousness
4. Lying in speech

Who avoids from motives of partiality, enmity, stupidity and a fear made him as perfect moon and full good name and fame became to brighter as the waxing moon.The six channels for dissipating wealth should be moved. They are;

1. Being addicted to intoxicating liquor
2. Frequenting the streets at unseemly hours
3. Haunting fairs
4. Being infatuated by gambling
5. Associating evil companions

6 The habit of idleness.

Habit of idleness leads to many impede advancement. Usually we postponed our daily work thinking it is too cold, it is too hot, it is too early, and too late. Also too hungry and sleepy leads to delays in work not completed. In those cases the work remains undone not accumulating more wealth and such wealth he has, dwindles away.

However with secular aspects many people wish their luck addressing and seeking assistance from the unknown Gods. It is believed that omnipotence is able to fill all their wishes. Buddhism indicates that one's Master and his onus will be himself no other than himself.

[51]Dīgha Kikāya.Part.111. London.PTS.Si□gālovāda Sutta.p.941.

ECONOMIC VIABILITY OF ORGANIC BROILER FEEDING IN SRI LANKA

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ABSTRACT: *Broiler is highly propagated livestock subsector in Sri Lanka. Aim of the present study was to evaluate the economic performance of organic broiler feeding in Sri Lanka. Ninety of Cobb 500 strain chicks were randomly divided into 3 equal treatment groups and each treatment had 10 replicates with three chicks for each replicate. Treatment A was Conventional diet. Treatment B and C were semi organic diets. Feeding was done for 45 days. Treatment A showed higher average body weight, feed intake, body weight gain, feed to gain ratio, live weight and carcass weight than semi organic dietary treatment groups. However, Dressing percentages (76%) of all treatment groups were equal. Highest liver weight was recorded by treatment A while the highest gizzard weight recorded by treatment B. Conventional broiler feeding was profitable than organic broiler feeding and which confirmed by critical factor analysis and return on investment analysis. Under the prevailing conditions, organic broiler feeding was not economically viable in Sri Lanka.*

Key words: *Broiler, Economic, Feeding, Organic, Viability*

INTRODUCTION

Broiler is highly propagated livestock subsector in Sri Lanka (Samarasingha, 2007). Chicken meat export was recorded as 1812.025 Metric Ton (MT) in the year 2011; a remarkable increase of 173.81% previous year volume of 661.71 MT (DAPH, 2011). Export is one of the major breakthroughs to expandsion of the broiler production. The per capita chicken meat availability had recorded as 4.86 kg/person/year and it has been increased up to 4.99 kg /person /year (DAPH, 2011). The anticipated per capita availability of chicken meat will be 10 kg/ person/year at year 2016 (MLRCD, 2011). In Sri Lanka, mostly consume meat type was chicken meat recorded as 259.11 g/person/month in 2010 (DAPH, 2011). Therefore, huge expansion of local broiler industry is on course.

To promote the exportation of value added poultry products is essential to improve the quality standard of the poultry products in conformity with the global standard (DAPH, 2011). Organic feed is intended to ensure the quality of production rather than maximizing the production (Pedersen *et al.,* 2003). In recent years, there has been a rapid increased in organic animal production in many European countries (Nizam, 2011, Fatico *et al.,* 2009). This development is response to increase consumer demand for that has perceived to be fresh, wholesome and flavorsome, free of hormones, antibiotics and harmful chemicals, and produced in a way that is suitable environmentally and without the use of gene modified (GM) crops (Blair, 2008, Buchanan,2007). United States of America (USA), Canada, is having rapidly growing Organic Food market reporting around 20% annual growth rate (Ranaweera, 2008). In addition, European Union rate of growth on Organic Food market is averaging 7.8% per year (Ranaweera, 2008). Organic broiler concept is not fully developed in Sri Lanka despite higher potential for export market and especially higher demand from hotel industries to cater

rapidly developing tourism industry. Anticipated tourist arrival in year 2016 is 2.5 million (SLTBP, 2011). Therefore, promote and enhance organic broiler production in Sri Lanka has a great significance.

Organic feed is generally more expensive than conventional feed often resulting in egg and meat being twice as costly as the conventional products (Blair, 2008). One of the major issues of the poultry sector in Sri Lanka is fluctuation of feed cost and high cost of feed and chicks which is over 70% in of cost of production (DAPH, 2011). Therefore, the cost of organic feed is a key factor influencing the financial performance of organic broiler enterprise (Castellini *et al.,* 2006). Therefore, the objective of the present study was to evaluate the organic broiler feeding could be commercially viable in Sri Lanka.

METHODOLOGY

Feed Formulation

Basal diet (A) was prepared by adding conventional feed ingredients and two semi-organic (B and C) diets were prepared by using some conventional feed ingredients and organic trace minerals (Bioplex), brewer's yeast and germinated rice by using Linear programming software package. Treatment B and C was known as semi organic because some ingredients which used for feed formulation were not organic. Organic feeds were formulated based on some guidelines of Codex Alimentareous Commission (1999), International Federation of Organic Agriculture Movement (IFOAM, 2005) and accordance with some conditions of United Kingdom Register of Food Standers (UKROFS, 2000) and European Union (European Commission, 2005) regulations (Table 1). Feed mixing was done manually in the Feed Mill at Veterinary Research Institute, Sri Lanka. Feed samples were analyzed for proximate composition by following the AOAC procedure (2005).

Management of Experimental Birds

The experiment was conducted with 90 day old Cobb 700 broiler chicks for a period of 45 days. Chicks were weighted and randomly divided in to 3 equal treatment groups (A, B and C) each having 30 chicks. Each treatment was included in to 10 equal replications of 3 chicks for each. The birds were housed in metabolism cages of 36"×20". Dry mash feed was supplied on adlibitum basis and first 3 days fed with control diet (Basal diet) in the same pen together. At the fourth day birds were weighed and put into the labeled metal cages accordance with treatment and replicates. Treatment diets were introduced to the animals at 4^{th} day. Starter diet was given up to 22^{nd} day and Finisher diet up to 45^{th} day relevant to the different treatments. Fresh clean drinking water was made at all the time and adequate sanitary measures were taken during entire experimental period.

Slaughtering process

Two birds of 45 day old in each replicate were randomly selected, fasted over night, live weight was measured and slaughtered by severing a jugular vein. After scalding in warm water for about few minutes, defeathering was done. Each and every bird was manually eviscerated.

Data collection

To evaluate the treatment effect, feed intake and body weight were recorded and from which body weight gain and feed to gain ratio were calculated in week basis. After slaughtering process, weights of the carcass, heart, liver, gizzard, pancreas and length of the small intestine were recorded. Mortality rate was calculated by recording the number of dead animals weekly. Economical performance was evaluated by determining total feed cost, total chick cost, management cost, total production cost, total sale price and net profit which

relevant to each dietary treatment. It was assumed that apart from the feed cost rest of the cost components were similar in all the treatment groups. In addition, Critical Factor Analysis and Return on Investment (ROI) analysis were done to further clarify the economic performances of three treatments.

Table 1. Content of Different Dietary Treatments

Ingredients		**Starter**			**Finisher**	
	Diet A	Diet B	Diet C	Diet A	Diet B	Diet C
Maize	57.22	70.44	60.1	62.04	76.57	61.84
Organic Soyabean meal (expeller)		9.62	9.78		12.24	9.68
Soyabean meal (dehulled)	36.52			30.69		
Plant protein		14.46	14.40		9.12	10.25
Coconut oil			0.7			3
Palm Oil	2.33			3.5		
DCP	1.7	1.21	1.25	1.49	1.17	1.2
NaHCO3		0.1			0.05	0.11
Shell powder	1.26	0.78	0.73	1.18	0.32	0.51
Salt	0.35			0.35		
Herbal methionone		0.29	0.29		0.28	0.31
Herbal choline		0.1	0.1		0.1	0.1
Choline Chloride	0.1			0.1		
D-L methionine	0.23			0.23		
L- lysine	0.12			0.19		
L- Threonine	0.02			0.08		
Mineral premixes	0.1	0.1		0.1	0.1	
Vitamin premixes	0.05	00.5		0.05	00.5	
Bioplex			0.05			0.1
Dried brewery yeast			2.5			2
Germinated rice flour			10			10
Coconut Poonac		2.7				

Statistical Analysis

Complete Randomized Design (CRD) was applied as an experimental design. Differences among three treatments were analyzed by using one way ANOVA (Analysis of Variance) and means separated by performing Least Significant Deference (LSD). Data were statistically analyzed by using Minitab 16 software package.

RESULT AND DISCUSSION

Proximate composition of the dietary treatment is shown in Table 2 and values are quite similar except treatment diet C. Metabolized energy of starter and finisher was 2950 Kcal/kg and 3075 Kcal/kg respectively. Metabolized energy and proximate composition values were approximately similar to the Buchanan *et al.,* (2007) and Castellini *et al.,* (2002) values. Average body weight of the different treatments is presented in Table 3. Statistically significant ($P < 0.05$) differences in average body weights among the treatments were observed at all the ages.

Table 2. Proximate Composition of Dietary Treatments

Parameter	Starter			Finisher		
	Diet A	Diet B	Diet C	Diet A	Diet B	Diet C
Moisture	13.1%	12.9	14.3	10.4	11.9	11.0
Crude protein	20.4	21.9	21.5	18.7	18.0	18.4
Crude fat	4.8	4.0	3.6	6.4	4.0	6.3
Crude fiber	3.4	3.1	2.6	3.0	4.4	2.3
Ash	6.3	6.5	5.0	5.2	4.2	3.8

Source: Laboratory records of Veterinary Research Institute

Birds on treatment B and C was showed lower ($P< 0.05$) average body weight than treatment A. There was not statistically significant difference in between treatment B and C during first 4 weeks.

Table 3. Average body weights at different ages in different treatments

Age (Days)	Dietary Treatments			SED	Level of Sig:
	A	B	C		
1 Day	46.6 ± 1.430	45.9 ± 0.876	46.1 ± 1.449	0.572	N.S
4 Day	86.0 ± 5.907	86.5 ± 4.143	85.7 ± 5.334	2.317	N.S
10 Day	241.8 ± 13.74 [a]	222.0 ± 10.01 [b]	224.2 ± 13.8 [b]	5.65	*
17 Day	520.27 ± 29.39 [a]	499.87 ± 23.43 [b]	447.13 ± 26.19 [b]	11.83	*
24 Day	941.93 ± 36.77 [a]	735.60 ± 58.76 [b]	708.00 ± 70.62 [b]	25.5	*
31 Day	1444.3 ± 94.9 [a]	1080.7 ± 76.7 [b]	1029.6 ± 119.6 [b]	44.1	*
38 Day	2010.6 ± 84.2 [a]	1672 ± 125.1 [b]	1482 ± 175.2 [c]	59.7	*
45 Day	2507.7 ± 159.4 [a]	2151.8 ± 158.1 [b]	1827.0 ± 282.5 [c]	93.2	*

A= Conventional diet; B= Semi organic diet option 01; C= Semi organic diet option 02; ± = Standard deviation; SEM= Standard Error of Mean difference; Figure having different superscript in the same row differ significantly ($P < 0.05$); * = 5 % level of significance; NS= non significant. Note: Dietary treatments were started at 4 th day onwards

The results were agreement with the Bunyamin *et al.,* (2011) who described that the average bogy weight of conventional bird was higher than the organic control group. Bunyamin *et al.,* (2011) stated that average body weight of conventional group was higher (2307.4g) than organic control group (14435.3g). Furthermore, Bunyamin *et al.,* (2011) emphasized that the mean body weight of the organic broiler based on pastures was recorded as 1702 g of average body weight at the 6th week. National Research Council (1994) was mentioned that the expected typical body weight at the different ages as at the 4,5,6 weeks expected 1085g, 1576g, and 2088g respectively. According to the results of the experiment (Table 3) conventional group (A) and semi organic diet B were compatible with those expected values but semi organic diet option C far behind than expected values. Therefore, at the extreme organic conditions, it was difficult to maintain expected performance without extra cost for prolong the slaughtering period until they reached to the accepted market weight.

Average feed intake of the birds fed on different diet is shown in Table 4. Feed intakes of birds were not significantly different ($p<0.05$) at the first week. It was evident that average feed intake higher in treatment A and lower in treatment C and statistically differed except for day 4-10. There was an evidence that treatment B and C had not expressed statistically significant difference $p<0.05$) up to day 21-31. At the last two weeks statistically significant difference ($p<0.05$) was existed in between treatment B and C.

Table 4. Feed intake (g) at different ages of experimental birds in different treatments

Age (Days)	Dietary Treatments			SED	Level of Sig:
	A	B	C		
4-10 Day	206.53 ± 18.97	199.67 ± 18.01	208.97 ± 12.89	7.53	N.S
10-17 Day	439.37 ± 19.76 ^{a}	418.00 ±26.82 ^{ab}	397.43 ± 34.16 ^{b}	12.32	*
17-24 Day	608.60 ± 101.64 ^{a}	567.47 ± 75.70 ^{ab}	515.13 ± 59.06 ^{b}	36.1	*
24-31 Day	815.10 ± 84.10 ^{a}	679.93 ± 87.30 ^{b}	635.77 ± 81.48 ^{b}	37.7	*
31-38 Day	968.6 ± 65.4 ^{a}	875.0 ± 65.3 ^{b}	776.3 ± 106.6 ^{c}	36.4	*
38-45 Day	1277.9 ±84.7 ^{a}	1258.4 ± 98.7 ^{a}	1042.3 ± 173.0 ^{b}	55.9	*

A= Conventional diet; B= Semi organic diet option 01; C= Semi organic diet option 02; ± = Standard deviation; SEM= Standard Error of Mean difference; Figure having different superscript in the same row differ significantly ($P < 0.05$); * = 5 % level of significance; NS= non significant. Note: Dietary treatments were started at 4 th day onwards

Feed intake of the semi organic diet option C was considerably reduced because of the leg outstretched of growing birds, which difficult to access to the feed and therefore reduced the growth rate of the animals and use of yeast slurry instead of Dried Brewer's Yeast as a feed ingredients of semi organic diet option C was significantly reduce the feed intake due to the low palatability. Previous research of Blair (2008) indicated that the feed intake of starter period was lower with yeast slurry at the grower stage of animals. Paryad and Mahmoudi (2008) indicated that more than 1.5% yeast inclusion level was reduced the growth rate, feed intake, and feed conversion ratio. In the treatment C, mineral premix was completely replaced by Bioplex and according to the Nollet *et al.,* (2008) there was not significant performance difference between 100% Bioplex included broilers diet and 100% mineral premix included broilers diet.

Cumulative feed consumption also expressed a similar pattern as feed intake is shown in Table 5. Highest cumulative feed intake was recorded by treatment A and lowest in treatment C which statistically different ($p<0.05$) at all the ages. There was not statistically significant difference ($p<005$) in between treatment B and C at starter period and statistically significant difference ($p<005$) was expressed at latter part of the finisher period. The highest feed consumption was shown at treatment A and the lowest in treatment C. The results were compatible with findings of Bunyamin *et al.,* (2011) who reported that the highest cumulative feed intake of the conventional group (1131.3g at starter period, 3825g at finisher period) and organic control group consumed 942.9g and 3496.8 g during the starter and finisher periods respectively.

However, Bulmyumin *et al.,* (2011) was prolong the experimental period up to 10 weeks only in the organic control group recorded 1935.5g total feed intake and organic pasture group double the feed consumption at last 4 weeks (3211.6). Fanttica *et al.,* (2009) was reported that the feed intake of faster growing indoor organic birds was 7402g at the 63rd day and Cobanoglu *et al.,* (2012) was reported that the cumulative feed intake of organic broilers as 8041g for 81 days. Those values were higher than present study because they extended the experimental periods.

Table 5. Cumulative feed consumption (g/bird) of the birds in different ages

Age (Days)	Dietary Treatments			SED	Level of Sig:
	A	B	C		
4-10 Day	206.53 ± 18.97	199.67 ± 18.01	208.97 ± 12.89	7.53	N.S
4-17 Day	645.90 ± 18.42 [a]	617.67 ± 17.57 [b]	606.40 ± 30.08 [b]	10.19	*
4-24 Day	1254.5 ± 113.0 [a]	1185.1 ± 75.7 [b]	1124.5 ± 52.7 [b]	37.7	*
4-31 Day	2069.6 ± 175.2 [a]	1865.1 ± 154.8 [b]	1757.3 ±116.3 [b]	67.4	*
4-38 Day	2633.1 ±189.7 [a]	2197.5 ± 250.7 [b]	1979.7 ± 117.8 [c]	86.7	*
4-45 Day	3910.9 ± 115.0 [a]	3455.9 ± 213.0 [b]	3022.0 ± 223.8 [c]	85.6	*

A= Conventional diet; B= Semi organic diet option 01; C= Semi organic diet option 02; ± = Standard deviation; SEM= Standard Error of Mean difference; Figure having different superscript in the same row differ significantly (P < 0.05); *= 5 % level of significance; NS= non significant. Note: Dietary treatments were started at 4 thday onwards

Effect of different dietary treatments on live weight gain is presented in Table 6. Highest average body weight gain was recorded in treatment A and which significantly higher (p<0.05) at 4-10 days to 24-31 days than diet B and C. Lowest average body weight gain was recorded by treatment C which had significant difference (p<0.05) while compared with treatment A .Treatment B was shown high average body weight gain relative to the treatment C but not significantly differed (p<0.05) up to day 24-31. At the day 31-38 highest average body weight gain was recorded by treatment B but not significantly different with treatment A. At the last week, average body weight gains of all treatments were reached to the same level and there was no significant difference (p<0.05) exist among the treatments.

Table 6. Live weight gain of birds in different treatments

Age (Days)	Dietary Treatments			SED	Level of Sig:
	A	B	C		
4 Day	86.00 ± 5.907	86.50 ± 4.143	85.70 ± 5.334	2.317	N.S
4-10 Day	154.53 ± 16.09 [a]	135.50 ± 7.81 [b]	138.50 ± 13.24 [b]	5.75	*
10-17 Day	281.73 ± 21.66 [a]	227.87 ± 16.88 [b]	222.93 ± 25.41 [b]	9.66	*
17-24 Day	416.73 ± 23.59 [a]	285.73 ± 55.28 [b]	260.87 ± 62.55 [b]	22.40	*
24-31 Day	494.73 ± 92.67 [a]	345.07 ± 53.02 [b]	321.60 ± 82.43 [b]	34.8	*
31-38 Day	567.93 ± 33.25 [a]	591.53 ± 75.08 [a]	453.20 ± 107.14 [b]	34.9	*
38-45 Day	483.10 ± 104.0	479.6 ± 45.9	425.9 ± 257.6	72.7	N.S

A= Conventional diet; B= Semi organic diet option 01; C= Semi organic diet option 02; ± = Standard deviation; SEM= Standard Error of Mean difference; Figure having different superscript in the same row differ significantly (P < 0.05); *= 5 % level of significance; NS= non significant. Note: Dietary treatments were started at 4 thday onwards

The result was contradicted with findings of Pedersen *et al.,* (2003) who indicated that the average body weight gains at day 01-24, day 25-35, and day 34-50 as 297, 200, and 115 respectively. At the same ages the

results of semi organic diet option B and C (Table 6) were than previous research findings. Fanttica *et al.,* (2005) reported that overall weight gain of the fast growing indoor organic birds was 2,506 at the day 53, and those values approximately compatible with semi organic diet C because it was shown higher cumulative live weight gain. The results of the cumulative weight gain was contradicted with the findings of Fanttica *et al.,* (2009) who reported body weight gain of indoor rearing organic broiler as 3389g at the 63 day.

The effect of the different dietary treatments on the feed to gain ratio is presented in Table 7. It was evident that the feed to gain ratio was statistically significant ($p<0.05$) and better feed to gain ratio was recorded by treatment A during the initial 4 weeks. There was an enough evidence that different between treatment A and B was statistically significant ($p<0.05$) and difference in between B and C was non-significant. At the last 2 weeks feed to gain ratio of the different treatments were reached to equal level and statistically non-significant. Feed to gain ratios of treatment B and C were considerably decreased (0.5000, 0.3145) when increasing (0.0286) the corresponding value of treatment A while moving from day 24-30 to 31-38.

Table 7. Feed to gain ratios of the birds in different treatment groups

Age (Days)	Dietary Treatments			SED	Level of Sig:
	A	B	C		
4-10 Day	1.3446 ± 0.134^{b}	1.4786 ± 0.168^{a}	1.5150 ± 0.087^{a}	0.06	*
10-17 Day	1.5663 ± 0.119^{b}	1.8396 ± 0.130^{a}	1.7921 ± 0.139^{a}	0.058	*
17-24 Day	1.4597 ± 0.235^{b}	2.0244 ± 0.287^{a}	2.0522 ± 0.407^{a}	0.1423	*
24-31 Day	1.6816 ± 0.219^{b}	2.0035 ± 0.360^{ab}	2.0933 ± 0.550^{a}	0.1789	*
31-38 Day	1.7102 ± 0.142	1.5035 ± 0.250	1.7888 ± 0.459	0.1407	N.S
38-45 Day	2.791 ± 0.795	2.658 ± 0.455	3.242 ± 2.0490	0.580	N.S

A= Conventional diet; B= Semi organic diet option 01; C= Semi organic diet option 02; ± = Standard deviation; SEM= Standard Error of Mean difference; Figure having different superscript in the same row differ significantly ($P < 0.05$); *= 5 % level of significance; NS= non significant. Note: Dietary treatments were started at 4 thday onwards

At the last week, treatment effect is non-significant and showed considerably higher feed to gain ratio than all other weeks and highest feed to gain ratio was recorded by treatment C. The results were agreement with previous findings of Bulmyumin *et al.,* (2011) that higher feed to gain ratio was observed in organic control and organic pasture group that 2.21 and 2.11 respectively compared with conventional group as 1.66 at the age 0-6 weeks.

The results of the feed to gain ratios of both semi-organic treatment groups were contradicted with the previous research of Fanattica *et al.,* (2009) who found that overall feed to gain ratio of fast growing indoor organic broilers were recorded as 2.9 at 63 day. But the present value of the results (Table 7) much higher even in 45 days experimental period. The results of the feed to gain ratio was agreement with the findings of Pedersen *et al.,* (2003) who reported average feed to gain ratio at different organic farms in Denmark that 2.1, 2.8, and 3.3 at the starting growing and finishing periods respectively. Most of those values were compatible with present experimental results (Table 7) which recorded 2.024 and 2.05 in semi organic diet option 01 and 02 respectively. At the last week (day38-45) feed to gain ratio was recorded as 2.658 and 3.242 in the semi organic diet option B and C (Table 7). Castellini *et al.,* (2002) was reported that the average feeding efficiency as 2.75 and 3.29 at the day 53 and day 81 respectively and those values were approximately comparable with present study. Average feed to gain ratio of the present study was approximately compatible with Cobanoglu *et al.,* (2012) who reported that the feed to gain ratio of organic and conventional groups as 1.93 and 2.93 respectively.

Effect of different dietary treatments on carcass yield is presented in Table 8. It was evident that dressing percentages for treatment A, B and C have not differ significantly ($p<0.05$). Higher live weight and carcass weight was shown by treatment A and lower in treatment C which showed statistically significant difference ($p<0.05$) among the three dietary treatment groups.

Bulmyumin *et al.,* (2011) stated that the slaughtering weight of conventional group was 2,588g and carcass weight 1,948g and organic control group recorded 2,381g slaughtering weight and 1,758g of carcass weight. Those values were approximately compatibles with present experimental results in Table 8. In contrast, the mean carcass weight of organic pasture group was higher than conventional group (Bulmyumin *et al.,* 2011). Slaughtering weight of the organic broilers were lowered in present study compared with the Castellini *et al.,* (2002) who recorded 2861g slaughtering weight at 56 day. Fanttica *et al.,* (2005) findings was also agreement with the results of the carcass characteristics, those organic indoor rearing birds yield 2630g of carcass with 76.3% dressing percentage. Castellini *et al.,* (2002) was reported that the carcass weight and dressing percentage as 2011g and 70.3% respectively and carcass weights were higher and dressing percentages were lowered than present study (Table 8).

Table 8. Carcass weights of broilers in different treatment groups

Parameters	Dietary Treatments			SED	Level of Sig:
	A	B	C		
Live weight (g)	2476.6 ± 108.2 [a]	2262.2 ± 157.8 [b]	2041.9 ± 353.3 [c]	98.53	*
Carcass weight (g)	1899.8 ± 107.4 [a]	1736.2 ± 173.7 [b]	1552.8 ± 269.3 [c]	86.0	*
Dressing %	76.789 ± 4.394	76.782 ± 5.835	76.587 ± 8.970	2.99	N.S

A= Conventional diet; B= Semi organic diet option 01; C= Semi organic diet option 02; ± = Standard deviation; SEM= Standard Error of Mean difference; Figure having different superscript in the same row differ significantly ($P < 0.05$); *= 5 % level of significance; NS= non significant. Note: Dietary treatments were started at 4 thday onwards.

Castellini *et al.,* (2002) also stated that the carcass weights were higher in conventional production system than organic system and dressing percentages were similar in both systems. Those results were agreement with present study (Table 8). In contrast, slaughtering weights and carcass weights of the organic group was higher than conventional group (Cobanoglu *et al.,* 2012.). Cobanoglu *et al.,* (2012) was reported that the carcass weights of organic and conventional groups as 2045g and 1735g respectively and slaughtering weights organic and conventional groups as 2778g and 2250g respectively.

Effect of different dietary treatments on the different organs which associated with carcass and some parts of digestive system is presented in Table 9. Heart weight, percentage of heart and liver weight in relation to the carcass weight and length of small intestine was not expressed statistically significant difference ($p<0.05$) among different dietary treatments. Highest heart weight, (non- significant at $p<0.05$) liver weight shown in treatment A and lowest weights in treatment C which had statistically significant difference ($p<0.05$). Higher gizzard weight percentage to carcass weight was shown by treatment B which had not expressed statistically significant difference ($p<0.05$) with any other dietary treatments. The highest pancreas weight was recorded in treatment A and the lowest in treatment C which had statistically significant difference ($p<0.05$) in between treatment A and treatment C. Statistically significant difference ($p<0.05$) had not exist among the length of small intestine in different dietary treatment groups. Adil *et al.,* (2010) was recorded the gizzard , heart and liver weight by feeding diet which similar to the conventional diet of present study and values were compatible with present study.

Weights of the some organs and percentage weight relative to the carcass weights were recorded. Gizzard weight was quite higher in semi organic diet B and considerably small in semi organic diet option C. It may be consequences of low feed intake of birds in semi organic diet option C. Pancreas weight was also lower in semi organic diet C might be due to the mal functioning of digestive process. Length of the small intestine was also smaller in semi organic diet C. It may be due to the suppression of immunity since lack of adequate well balance vitamins in the diet. In contrast, Geo *et al.,* (2008) stated that supplementation of 2.5g/kg of yeast was improved the immune function.

Table 9. Weights and length of some organs in different treatment group

Parameters	Dietary Treatments			SED	Level of Sig:
	A	B	C		
Organ weights (g)					
Heart	8.7 ± 1.457	7.4 ± 0.843	7.7 ± 1.513	0.584	N.S
Liver	47.6 ± 4.440 ^{a}	44.2 ± 3.545 ^{ab}	40.550 ± 6.84 ^{b}	2.296	*
Gizzard	31.600 ± 4.095 ^{a}	34.300 ± 4.097^{ab}	28.350 ± 4.928 ^{b}	1.964	*
Organ weights (% of carcass weight)					
Heart	0.4557 ± 0.075	0.4305 ± 0.063	0.5119 ± 0.133	0.1395	N.S
Liver	2.4885 ± 0.251	2.5617 ± 0.206	2.6562 ± 0.432	0.0427	N.S
Gizzard	1.6543 ± 0.221 ^{a}	1.9877 ± 0.196^{ab}	1.8393 ± 0.321 ^{a}	0.1129	*
Associated organs					
Pancreas (g)	4.70 ± 0.4830 ^{a}	4.50 ± 0.4714 ^{a}	3.90 ± 0.7746 ^{b}	0.265	*
Small intestine(cm)	173.50 ± 8.71	171.10 ± 10.2	162.23 ± 15.57	5.31	N.S

A= Conventional diet; B= Semi organic diet option 01; C= Semi organic diet option 02; ± = Standard deviation; SEM= Standard Error of Mean difference; Figure having different superscript in the same row differ significantly ($P < 0.05$); *= 5 % level of significance; NS= non significant. Note: Dietary treatments were started at 4 thday onwards

None of the single bird was dying during the experimental period in treatment A and B. In treatment C, mortality percentage was 3.33%, recorded at the finisher period. The results of mortality percentages were agreement with Bunyamin *et al.,* (2011) that recorded 3% in organic control group and 1% of organic pasture based group. The result was contradicted with the findings of Lampkin (1997) who reported 10% mortality level current organic forming in United Kingdom (UK) and European Union (EU) region. Mortality rate of the of the present study was contradicted with the Cobanoglu et al., 2012 findings who reported that the mortality rates of the organic and conventional group as 1.00% and 2.83% respectively.

The production cost of broiler in different dietary treatments is shown in Table 10. The feed cost was highest in treatment C and the lower in treatment B. Most of the other expenditures were equal among the treatments because uniform conditions were maintained during experimental period. Higher total net profit and the net profit per kg of carcass weights were recorded in treatment A and approximately two times higher than treatment C. Cobanoglu *et al.,* 2012 stated that organic broiler production was profitable relative to conventional boiler production because market price of the organic broilers were twice than conventional broilers. The increment of feed prices resulted from the proposed EU organic livestock regulation could be resulted in a significant loss (Lampkin, 1997). As Table 10 present that the net profit of semi organic diet option C was drastically reduced because of the higher feed cost.

Organic regulations were banned most of the cheap synthetic raw materials. Therefore, additional cost is added to total production cost. In consequently, profit margin would be reduced. The results of the cost evaluation in Table 10 were derived by selling 1kg of broiler meat on LKR 350.00. Major factor which affected to the profitability of organic broiler production was feed cost (Castellini *et al.,* 2006). In present study, Critical factor was the feed cost element which critically affected to the revenue/profit of the each treatment groups whereas other cost elements were remaining constant as equal cost has incurred separately for each treatment.

Table 10. Cost of production and net profit of different dietary treatments

Parameter	Dietary Treatments		
	A	B	C
Total feed cost (LKR.)	3,127.07	2,789.00	4,066.88
Total chick cost (LKR)	2,100.00	2,100.00	2,100.00
Electricity cost (LKR)	1,950.00	1,950.00	1,950.00
Slaughtering cost (LKR)	600.00	600.00	600.00
Other management cost (LKR) [1]	1,750.00	1,750.00	1,750.00
Total production cost (LKR)	9527.09	9,189.00	10,466.88
Total production cost (LKR)/ kg carcass weight	167.16	176.50	224.68
Total sale price (LKR)	19,947.90	1,8230.10	16,304.40
Total net profit (LKR)	10,420.00	9,041.10	5,837.51
Net profit (LKR) /kg carcass weight	182.84	173.66	125.31

A= Conventional diet; B= Semi organic diet option 01; C= Semi organic diet option 02;

Critical factor analysis (Table 11) indicated that the conventional feed was highly productive than both semi organic diets. Return on Investment (ROI) analysis is a performance measure used to evaluate the efficiency of an investment or to compare the efficiency of the number of different investments (Dowan, 2012). ROI analysis of present study (Table 12) indicated that the conventional broiler feeding was given higher return than both semi organic diet options.

Table 1. Calculation of Net Profit to the Critical Factor

Project	**A**	**B**	**C**
Net Profit	10,420.00	9,041.10	5,837.52
Critical Factor (Feed Cost)	3,127.07	2,789.00	4,066.88
Thus,			
Net Profit/Feed Cost	**3.33**	**3.24**	**1.43**
Rank	(1)	(2)	(3)

A= Conventional diet; B= Semi organic diet option 01; C= Semi organic diet option 02

Lampkin (1997) stated that when net margin of conventional broilers were 0.04£ EU and organic broiler production recorded -15£ in UK. The overall profitability of organic table bird production is highly dependent on scale in order to spread fixed costs. The extension of the finishing period from 70 to 81 days, which would be required to meet the current EU proposals, reduces the number of batches which can be finished each year in an individual house from 5 to 4, resulting in a 20% increase in housing costs (Lampkin, 1997). Castellini *et al.,* (2006) findings also proved that production performances of organic broiler production much lower than conventional broiler production and whereby lower the profitability of organic broiler production than

conventional production. Cobanoglu *et al.,* (2012) suggested that twice the selling price of organic broiler product than conventional broilers to maintain the profit margin.

Table 2. Calculation of Return on Investment

Project	**A**	**B**	**C**
Investment	12,000.00	12,000.00	12,000.00
Net Profit (a)	10,420.00	9,041.10	5,837.52
Interest income from temporary investment of exceeds funds			
Initial invested funds	12,000.00	12,000.00	12,000.00
Expenses incurred at the beginning of the Research	(9,527.09)	(9,189.00)	(10,466.88)
Excess funds	**2,472.91**	**3,061.00**	**1,533.12**
Period of Research (days)	45	45	45
Interest rate (Savings account)	4.5%	4.5%	4.5%
Thus,			
Interest income (b)	13.71	16.98	8.51
Total Net Profit (a+b)	10,433.71	9,058.08	5,846.03
Thus,			
ROI (Total Net Profit/ Investment)*100%	**86.94%**	**75.48%**	**48.72%**
Rank	(1)	(2)	(3)

A= Conventional diet; B= Semi organic diet option 01; C= Semi organic diet option 02, It is assumed that the excess funds are invested in a savings account at a prevailing interest rate during the research period and all expenses are incurred exactly at the beginning of the research.

CONCLUSION

Organic broiler feeding was not economically viable under local conditions in term of profitability when compared to commercial poultry feeding system in Sri Lanka. For sustain the business it is essential to increase the premium price of organic broiler meat. Organic broiler production with fast growing strains will be profitable. Further research is needed to identify the cheap feed ingredients which capable to use in organic ration formulation. Alternative antibiotics, natural amino acids sources, more vitamin sources, and natural growth promoters, would have to identify. Traditional herbal medicines, spices, and non conventional feedstuff in Sri Lanka would have to direct on the further investigation.

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DOES THE MODERN APPLICATION OF THE ISLAMIC FINANCIAL SYSTEM IS THE NEW RECOMMENDED ARCHITECTURE TO PROMOTE GROWTH AND PREVENT THE OUTBREAK AND SPREAD OF FUTURE CRISES?

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Abstract

Purpose - *There are sufficient theoretical and empirical studies on the nexus between conventional financial system and economic growth. However, only few theoretical and empirical studies have examined the relationship between Islamic financial system, in terms of banking sector and financial market, and economic development, in terms of economic growth and financial crisis. To fill this gap in literature, this study investigates importance of the modern application of the Islamic financial system in promoting growth and prevents the outbreak and spread of future crises, especially in Islamic countries.*

Design/methodology/approach *- This work reviews the importance of Islamic finance on economic development, examines the real effect of conventional financial system on economic growth and compares it with Islamic financial system.*

Findings *- The paper has three main results.*

First, Islamic finance system is the appropriate system to promoting economic development process, especially in Islamic countries. The second result, the international financial system has failed miserably in its mission to promote economic growth without creating financial crises. The third result, there are insufficient studies to provide theoretical and empirical evidences to support the modern applications of the Islamic financial system as the good alternative of conventional financial system in promoting economic growth without creating financial and economic crises.

Research limitations/implications – *There are insufficient empirical and theoretical studies that support the view of Islamic financial system as a good alternative for the conventional financial system. Moreover, the empirical analysis has strong impact on the role evaluation process of the Islamic financial development on the economic growth process especially in Islamic countries.*

Practical implications - *This study is helpful for the researchers and policy makers for formulating the future policy.*

Originality/value - *This paper explore the relationship between Islamic financial development and economic growth without ignoring the potential causal link between Islamic financial development and financial crisis.*

Keywords: Islamic Finance, Islamic Banking, Islamic Financial Market, Conventional financial system, Economic Growth, Economic Development, Financial Crisis.

1. Introduction

Economic development is actually comprised of economic thought and in this context economic development has been addressed by economic thinkers for centuries, where mainstream economists have often predominantly taken the lead over development theorists. Nevertheless, the recent increasing concern for the environment, societal culture, religion and institutions and their interrelationship with economic activities have led to the formation of a novel dimension to the development economics concept (Biswas, 2009).

In the 1940s and 1950s, a period known as the pioneering period, majority of economists viewed economic development as being growth per capita real income in the context of under-developed countries, whereas in other contexts, it is growth with change (in values and institutions)(Meier & Baldwin, 1957).

In relation to this, Krause (1961) stated that economic growth and economic development are synonymous and other authors were convinced that per capita output/per capita income is the appropriate measure to be used for the development index. Other studies, like Flammang (1979) and Hosseini (1999) stated that growth and development are complementary concepts, where economic growth refers to the process of simple increase indicating more of the same, and economic development refers to the process of structural change indicating something different rather than something more of the same. Moreover, Hosseini (1999) explained that economists often speak of economic growth when they are considering a quantitative and measurable increase in the economy, where GDP is concerned. On the other hand, the term economic development is often used to describe qualitative change. Nevertheless, growth and development complement each other, with each contributing to the achievement of the other.

More importantly, modern development economics should exert more effort into shedding an insight into the different growth objectives and paths where it could relate economic paradigms to the changes in the world brought about by globalization and regionalism, and uniformity and national identity. Also, economic development subject is increasingly becoming a valid social science, where the study of traditional institutions, community life, religious and ethnic aspects is not only significant but they form the core to the development of a novel social objective of economic growth and models dedicated to it (Piasecki & Wolnicki, 2004).

2. What happens for the conventional financial system?

The financial sector refers to a part of the economy providing financial services to other economic sectors although the general concept is that it is the supply-demand interaction in terms of providing capital and other financial services (Schmidt & Tyrell, 2003). In this regard, according to him, some economists view financial development as a growth driver, whereas others insisted that it is not a cause but the effect/outcome and it represents real economic development, while others contended that the financial markets and institutions development is a part and parcel of the process of growth, and that the financial systems play a key role in the countries' economies.

Based on the above, economists are of the consensus that the financial system has been playing an active role in the precipitated world economic development, especially following the World War II. This marked the birth of a continuous stream of financial innovations, with the inclusion of the ICT revolution that largely contributed to the development (Alam, 2010). Aligned with this, Levine (1997) explained the financial system and institution's role with the inclusion of loan and credit provisions for the process of production. He categorized the fundamental financial function of the economy into five namely facilitation of trade, hedging, diversification, risk pooling, resources allocation, monitoring of management and exerting corporate control, savings mobilization, and exchange of goods and services. According to him, the five functions indirectly impact economic growth via capital accumulation and technological innovation undergone by financial entities.

Along the same line of argument, owing to the integral position of the financial system in the country's economy, it is logical to state that a weak and ineffective financial system doesn't bode well for long-term economic sustainability and may even ultimately result in a financial crisis (Vaithilingam, Nair, & Samudram, 2006).

Current economic scholars expound on the reasons behind the international financial system today and they attributed it to interest rate, debts, inflation rate, and unemployment rate. They are of the consensus that the international financial system has failed to bring about stability in the financial flow around the globe, and thus worsening the situation. This begs to question as to what is going on in the conventional financial system.

In this day and age of unexpected economic changes, it has become a common occurrence for a country to suffer from economic crisis and as a consequence, there have been 100 crises in the past decade and a half, where the entire geographical area around the globe has been affected at one point or another by them. Even the countries who are safeguarded against them with their fiscal and monetary policies did not escape their wrath. It is thus evident that the international financial system has failed in its objective to bring about stability in the international financial flow and instead made matters worse (Alam, 2010; Stiglitz, 2003).

In an attempt to resolve financial crises, Chang and Velasco (1998) proposed a simple model to elaborate on the recent financial crises features in the emerging markets, with the international illiquidity in the context of the domestic financial system being the core of the problem. Such illiquidity is one of the primary reasons behind the financial crises – more elaborately, domestic financial liberalization and capital flows from abroad (particularly short-term) can add to the adverse effect on the banks' illiquidity and thus, leaving the banks exposed to exogenous expectations in terms of shocks and shifts.

More importantly, the most recent financial crises that began in 2007, appears the most severe crises compared to those in the past and it is still permeating the globe despite the bail of around three to four billion dollars forked out by the U.S., U.K. and Europe along with several other countries. It has debilitated money

markets and results in the considerable decline in property and stock values, failures of banks and anxiety over the global economic fate and the financial system (Chapra, 2008).

In other words, the recent financial crisis negatively affected the whole world and the effects are increasingly being experienced in the real sector and ultimately causing economic recession. In this regard, the most broadly acknowledged and significant cause behind the crisis is excessive and irresponsible lending of banks. This has led to an unsustainable boom in the prices of assets and what appears to be a rise in consumption and speculative investment, and in this case, the greater the leverage, the more challenging to unwind in the downturn. Such unwinding resulted in an ending cycle of selling that consumes itself and ultimately forces asset prices to decline and financial crisis to occur.

The recent financial crisis is so pervasive and serious that even the considerable amounts spent to stave it off have left it unresolved as mentioned. Majority has attributed it to the defaulting of mortgages although this is just a symptom of a more serious problem, which is the erroneous pricing in the market of credit default swaps (Murphy, 2008).

Along the same line of explanation, the monetary policy and fiscal policy effectiveness both depend on the rate of interest and the inflation target to motivate the economy have now become a controversial debate among concerned researchers and authors (Barth & Bradley, 1988; Chong & Liu, 2009; Grier & Tullock, 1989; Kia, 2002; Subbarao, 2009) as most of them are attempting to determine solutions through the use of financial instruments that are better than interest rate, inflation and unemployment rate due to their ineffective role.

More importantly, the role of financial development towards bringing about growth in the economy and the relationship between the two has been examined in literature dedicated to development economics, but with mixed results. While some of the authors (King & Levine, 1993; Kunt & Maksimovi, 1998; Roja & Valev, 2003; Dimitris & Efthymios, 2004; Eita & Jordaan, 2007) found a significant positive effect of conventional financial development on economic growth, other studies, found a significant negative effect (e.g. Hermes & Lensink, 2013; Al-Malkawi, Arashdeh & Abdullah, 2012; Samargandi Fidrmuc & Ghosh, 2013).

Among the many research attempts conducted in this field, four kinds of causality relationships were found between financial development and economic growth that contrasts with the premise that financial development causes economic growth in long and short run;

The first causality relationship is supply-leading, where the financial development leads to economic growth as evidenced by Gregorio and Guidotti (1995) and Calderon and Liu (2003). The second one is demand-following where economic growth results in financial development as advocated by Robinson (1952), Odhiambo (2010), and Ang & Kibbin (2007). The next causality relationship is the bi-directional one where financial development results in economic growth and this relationship holds true the way around. This relationship is supported by Demetriades and Hussein (1996) and Abu-Bader and Abu-Qarn (2008).

The fourth and last causality relationship is the absence of causality between financial development and economic growth as advocated by Deidda and Fattouh (2002), Rioja and Valev (2004), Graff (1999), Lucas (1988) and Stern (1989).

In the quest of establishing what is primarily wrong with the international financial system, the need for a new architecture is highlighted where innovation can assist in preventing the crisis outbreak and the proliferation of future crises, or to lessen it in terms of severity and frequency. Such new architecture should guarantee that significant positive effect of financial development on economic growth with regards to growth and crisis in

both short and long run. Added to this surface changes in the present system will not suffice as what is needed is a wholly innovative architecture that is effective (Alam, 2010).

3. Islamic Economic Development-Growth Approach

In some Islamic discussions, important economic principles have been provided, particularly from an Islamic perspective where it is believed that every resource is provided by God and is entrusted to people. This shows the importance of making efficient use of resource to in order to bring about the most superior outcome, and that human beings should achieve God's aim and facilitate the dissemination of good fortune and earth as well as the hereafter. This notion significantly affects wealth ownership and its generation and it motivates every Muslim to get involved in economic activity and to enhance their confidence with the goal accomplishment. Metwally (1997) stated that moral law may be difficult to use but the trusteeship it carries goes against the principle of self-interest that exists in free market economy.

The distinction between Islamic and convention economics is the notion that Islamic economics is Shariah-based where the overall conditions and rules for human living are enumerated as revealed to the Prophet Muhammed. Despite his state of being illiterate, the Prophet Mohammed was the person that God chose to reveal the Shariah to him and destine such law to the whole of mankind, not just the Muslims.

The importance of differentiating Islamic economics from traditional economics as the former is being examined as the latter's replacement. From the pioneering authors of Islamic economics, like Maududi to the current authors, the aspect of Islamic economic that have been emphasized is interest (riba), zakat in light of the Islamic economic distribution system and some Islamic economic norms (Kuran, 1995). These aspects are discussed in detail in the next paragraphs;

Prohibition of Interest Rate

In Islamic business, the beginning argument brought forward in Islamic economics and finance advocates is injustice/exploitation (zulm). In relation to this, Islamic laws and regulations do not allow any charges to be incurred on business dealings and it regards the practice as one that is repugnant because of the many injustices and exploitations attributed to it (Farooq, 2012).

Moreover, Islamic banks do not permit to distribute a portion of returns on deposits and to charge loans with interests. Theoretically, Islamic economics is interest-free and Islamic banking is not based on interest rate just as the conventional banking is. Added to this, PLS paradigm is among the primary characteristics of Islamic finance system products, specifically Mudarabah and Musharakah, what is respectively referred to as profit and joint ventures that are Islamic contracting products. Such a paradigm allows Islamic banks to share both profit and loss with the investors as well as the depositors (Khan & Mirakhor, 1990).

The Intelligent and Gentle Financial System

Zakat, referred widely as Islamic redistribution, is the second feature of the Islamic economy set up by the Islamic economic advocates. In Zakat, the system levies a tax on well-off Muslims in order to financially assist eight causes namely, the emancipation of slaves, poor relief and assistance to Muslims who serve Islam. However, the collection and distribution of Zakat are full of controversial opinions (Afzal-ur-Rahman, 1979; Ahmed, Iqbal & Khan, 1983).

Added to the above, zakat forms the core of the Islamic economy and it advocates the notion that every individual earning wealth is higher in level (nissab) and thus, every one of them should offer a portion of his/her wealth to those who are poor and needy. Literally, Zakat means purification while technically; it means that 2.5% of the wealthy individual's wealth is distributed to the poor every year. Meanwhile, modern terminology describes the underlying purpose of zakat as the tax collection from the well-off individuals and its distribution to poor Muslims. Zakat is different from progressive taxation based on different reasons (Metwally, 1997).

Islamic Economic Norms

Several methods of acknowledged production products are accepted in Islamic and these include private property. More specifically, Islam does not stress on strict private ownership right as the whole community has to gain some benefit from it. In other words, individuals cannot privately own a property if the government is inclined to own it for the public interests. To this end, community interest generally takes precedence over personal interests as elaborated by Shariah. Thus, in cases where the personal interest of an individual contradicts the state or community interests, the latter community's interest are satisfied and as such, the individual has to forego his.

Additionally, Islam does not permit the receiving of money from the manufacture and sale of alcoholic substances and pork products, gambling, usury money, litigation, black market, speculative buying, from businesses that bring about harm to other human beings, and it does not permit hoarding. In this context several researchers such as Kuran (1995), Maali, Casson and Napier (2006) showed if the profits are gained through the above prohibited ways, no individual can legitimately own them.

In Islam, public ownership management is ensured whereas in the free market economy of the West, greater control is exerted by private market over the market and the industry. This is because Islam has it basis on the Prophet's saying clarifying that people have common rights when it comes to water, pasturage and fire. Stated differently, extracting industries that are concerned with the production of water, mining and food should be undergone for the whole society's interests but at the same time, it should not be considered as a government-owned business. Added to this, domestic industries and fuels should not be privately owned as this could result in extensive private sector as exemplified by the Arab Gulf economies (Metwally, 1997). Moreover, a balance can be established between different sectors via the cooperative forces and not contrasting methods. Muslim entrepreneurs like buyers, sellers, wage-earners, profit makers and others, are urged to be vigilant of the words in the Quran that states, "Let there be amongst you traffic and trade, my mutual goodwill" (The Quran, 4: 29).

Furthermore, non-Islamic economies allow the adoption of several speculation methods as part of the economy and these include races, games of cards, gambling activities and forward business transactions. In this regard, Prophet Mohammed stated, "He who accumulates stocks of grain during shortages of it (with a view to profiteering later) is a great sinner (Qureshi, 1974).

Several decades following the collapse of the Islamic Caliphate in 1927, Islamic economy was exclusively practiced in an intellectual level. But currently, several changes have been experienced that make it suitable to practice these intellectual ideas. Most countries around the globe establish Islamic financial institutions based on interest-free loan and they are displaying better performance in comparison to their convention counterparts. Moreover, Islamic banking has achieved a distinctive status with regards to security after the financial crises in 2008. In fact, several Islamic banks have developed in terms of their profitability and they have proliferated around the globe.

In relation to this, the Prime Minister of the U.K., David Cameron declared on October 2013 that the U.K. will be the first non-Muslim country to deal with Islamic bonds. It is also notable that the Islamic investments in the country have undergone a 150% increase in the past 7 years and is expected to reach to 1.3 trillion in the coming year. The Prime Minister explained that this move may benefit the financial services in the U.K. (BBC, October, 2013).

In the context of Islamic economy, scholars, governments and financial institutions in the Islamic world have been attempting to explain economics and finance in such a way that it's divergence from the interest-bearing procedures and its basis on Islamic norms and guidelines are highlighted. This is particularly significant as Muslims make up one billion of the global population, with countries in the Arab and Asian region as predominantly Muslims and with Muslims being a large minority in Africa and Europe. For instance, in Malaysia and Nigeria, Muslims make up most of the total population, while in India, Philippines, South Africa and the U.K., Muslims are a large minority – despite of this fact, no country strictly adopts Shariah in its economy (Metwally, 1997).

Presently, a strict Islamic economy is difficult to adopt in the absence of a real Muslim society. The collapse of the Muslim Caliphate and the acceptance of non-Muslim ideologies have been related to the Muslims leaving the practice of Islam and adopting communism and capitalism as their ideologies. According to several scholars, Shariah is the only recourse as it is able to solve any and all economic and societal issues (Ali, 2001). Added to this, Muslims who are inclined towards adopting Islamic laws and teachings and modeling their way according to Islamic values are increasing, particularly those in Iran, Pakistan, Malaysia and Saudi Arabia (Metwally, 1997). Some other authors like Saleem (2007) and Tabelsi (2011) are convinced that Islamic economics is the future solution to the problems that are faced by traditional economy and the conventional financial system that have adopted in Islamic nations.

4. Does Islamic finance be the good alternative for conventional financial system?

Islamic finance refers to a financial system that primarily aims to achieve the Holy Quran's teachings rather than obtaining the highest returns on financial assets. The fundamental principle laid down by the Shariah is the notion that exploitative contracts that are based on interest/usury (riba) or unfair contracts involving risks/speculation (gharar) are not permissible to be enforced (Zaher & Hassan, 2001). Moreover, the Holy Quran does not condemn morally acceptable investments that provide fair-legitimate profit and economic/social value.

Added to the above, there are two other fundamental Islamic finance principles with the first being that the Islamic law represents the totality of God's commands that regulate all the life aspects of a Muslim and second, Islamic finance is directly related to spiritual values and social justice (Yahya, Muhammad & Hadi, 2012).

Another distinctive feature of Islamic finance is its prohibition of the creation of debt via direct lending and borrowing of money or other financial assets as explained by Alam (2010). In other words, debts can only be formed via the sale/lease of real assets through schemes developed for lease-based financing (i.e. Murabaha, Ijara and Sukuk). In this regard, it is important to ensure that the assets that are leased or sold should be real like building, property or physical infrastructure, and the transaction should be real and approved by both government regulators and religious experts of the Shariah board. The intention should be giving and taking charge in a way that the related risk or debt is non-transferable.

Furthermore, Islamic bank was described by Dusuki (2008) as a financial institution that functions by gathering financial resources and directing them towards effective use in order to achieve the general public's interests through the offered range of products and services. Along a similar line of contention, Khan and Bhatti (2008) contended that Islamic financing system concentrates on investment projects like industries, agriculture and services. Hence, it includes economic initiatives that add to the activities of production and development. More importantly, Islamic finance was developed to eradicate the interest rate system, particularly in the Islamic nations as interest violates the Shariah principles and as such it is illegal in the perspective of Islam (Meera & Larbani, 2009).

In relation to this, not all interest-free banking is known as Islamic financing as the latter should adhere to the Shariah principles (Chong & Liu, 2009; Goaied & Sassi, 2010). Therefore, Islamic financing should be free from interest and it should operate by adhering to some Islamic precepts and values namely honesty, integrity, benevolence, kindness and charity.

The above values attributed to Islamic principles is what facilitated its progress throughout the globe. According to the International Monetary Fund (IMF) report, Islamic banking is among the fastest growing segments in the financial industry as it had a 10-15% growth rate in the past ten years, with an estimated Islamic banking assets growth of approximately 15% yearly and is expected to reach $1 trillion by 2016 (Abduh & Omar, 2012).

Aligned with the above contentions, Hasan and Dridi (2011) stated that several factors have facilitated the considerable growth of Islamic finance and some of these factors are strong demand in several Islamic countries for Shariah-compliant products, reinforcement developments of the legal and regulatory framework for Islamic finance, increasing demand from conventional investors (e.g. diversification), development of several financial instruments to achieve the corporate and individual investors' needs.

To this end, all the financial systems in Iran and Sudan adhere to Islamic Shariah as described by the countries' local authorities. Such nations also own banking authorities governing the general system charges and returns level. In other nations, Islamic transactions and institutions constitute a minimal portion of the total financial institutions and they are in competition with their conventional counterparts (Hassan, 2006).

Majority of economists are of the consensus that in theory, Islamic finance appears to be a good alternative for conventional finance as it has a direct contribution to the economic recovery. Generally, economists are convinced that this current generated financial system does result in financial development and growth compared to the conventional system. Also, the Islamic financial system does not lead to financial crises and it is not vulnerable to the effects of the international financial crisis (Abduh & Chowdhury, 2012; Alam, 2010; Grais & Pellegrini, 2006; Khan, 2009; Khan & Bhatti, 2008; Warde, 2010; Ahmed, 2010).

Other authors like Al-Qardawi (1995) described Islamic economics to be ethical (akhlaqi), Godly (rabbani), humane (insani) and balanced (wasati). In a related study, Khan and Bhatti (2008) and Yahya, Muhammad & Hadi (2012) stressed on the fact that Islamic banking and financial system are not established merely to achieve profit-oriented goals but also to create societal wealth and ultimately enhance the country's economic growth. This is why it is important that Islamic banks should only mimic the practices and aims of conventional banks but instead embark on a more important role of enhancing the country's economic performance.

It is becoming clearer that conventional financial system is not appropriate to be adopted in an Islamic economy as it is based on interest rate and Islam prohibits interest. Also, Islam stresses moral values and promotes justice in every societal aspect with the inclusion of finance and thus, it comes to reason that the Islamic economy calls for institutional arrangements that are supported by the Islamic law objectives and in

this regard, a financial system sans interest is one of the many distinctions of Islamic financial system (Saleem, 2007).

On the basis of the above argument, Ali (2011) stated that Islamic countries with their constitutions cannot develop unless they apply the Shariah principles in their economic development process. Majority of the Muslims attributed the humiliating collapse of the Islamic caliphate to the Arabs turning away from Islam and adopting foreign ideologies like communism and capitalism, whose principles go against those of Islamic principles and thus, their problems persist. As such, majority of Muslims urge the return to Shariah compliance financial institutions that are considered as solutions to all types of economies. In the words of Umar Ibn Al-Khattab (Radia-Allahu Anhu);

"We are the most humiliated people on earth and Allah gave use honor through Islam. If we ever seek honor through anything else, Allah will humiliate us again".

However, literature dedicated to studying the impact of Islamic financial development and economic growth, and the relationship between the two reported mixed findings. For instance, some authors (Furqani & Mulyany, 2009; Majid & Kassim, 2010; Abduh & Omar, 2012; Yusof & Bahlous (2013) reported for a significant positive effect of Islamic banking upon the economic growth whereas Goaied and Sassi (2010) found a negative effect of financial development on the growth in the context of the MENA countries, and that Islamic banks has a weak relationship with growth.

Other empirical studies that focused on the relationship between Islamic financial development and growth revealed mixed proposed causality hypotheses; on one hand, Majid and Kassim (2010) supported a supply-leading hypothesis, Furqani and Mulyany (2009) supported a demand-following hypothesis, while other authors (Abduh & Omar, 2012; Abduh & Chowdhury, 2012; Yusof & Bahlous, 2013; Farahani & Dastan, 2013) supported a bi-directional causality hypothesis and Goaid and Sassi (2010) advocated no causality existence.

Other related empirical studies include Hasan and Dridi (2010), and Kassim and AbdMajid (2010) examined the impact of financial crisis on Islamic financial development and revealed that Islamic as well as conventional banking systems are susceptible to the negative effects of the financial shocks and this goes against the extensively acknowledged notion that the former system is not vulnerable to it owing to its prohibition of interest.

It is clear from the above contentions that a contradiction exists between the theoretical and empirical findings relating to the relationship between Islamic financial development, economic growth and financial crisis. For further elaboration, some theoretical studies indicated the positive effect of Islamic financial development on growth indicating that Islamic financial development is safe from the effects of financial crisis while others showed a negative effect of Islamic financial development on economic growth. Some other studies reported that financial crisis significantly and negatively affects the development of Islamic finance.

It is therefore reasonable to assume that owing to these contradictory findings between theory and empirical studies, the success/failure of modern Islamic financial system in the economic development process is unclear, particularly in light of the promotion of economic growth and the eradication of the negative impact of the financial crisis in the economic growth due to several reasons;

1. Lack of empirical studies dedicated to studying the effect of Islamic banking development on the economic growth as explained by Furqani and Mulyany (2009) and Farahani and Dastan (2013).

2. The rarity of empirical studies that addressed the relationship between Islamic financial market development, economic growth and financial crisis.

3. Majority of the studies regarding the relationship between Islamic financial development and financial crisis are based solely on theory.

4. Three decades of experience undergone by the Islamic finance system is not sufficient to consider whether it would be successful or not.

5. Although over 57 countries in the world adopted constitutions that declared Islam as the state religion, only Sudan and Iran have an actual overall Islamic financial system, with the financial transactions conducted according to the Islamic principles, whereas other countries like Malaysia and Jordan have certain Islamic banking laws and Islamic banks that are established along with conventional banks. In some other countries (e.g. Bangladesh) Islamic banks are operated based on conventional banks' laws through promulgations or through circulars of central banks (Hassan, 2006).

6. The assets of Islamic finance are only around USD1.6 trillion of the global assets, constituting a mere 1.6% of the global financial assets (Najeeb & Vejzagic, 2013).

7. Majority of the empirical works done on the field are unable to clarify the actual effect of the activities of Islamic banking on economic growth because of the single-country sample (Gudarzi, Farahani & Sadr, 2012).

Conclusion

Hence, the information regarding the application of the modern Islamic financial system on the promotion of economic development, particularly in Islamic countries, is still insufficient. Thus, this calls for further evaluation through empirical analysis to determine whether or not the Islamic financial system can replace the conventional system in the promotion of economic growth while staving off financial crisis and its adverse impacts. It is therefore recommended that future studies in this field empirically examine the short and long run causality and relationship between financial development, in terms of banking sector and financial market activity and size, and economic growth while considering the potential causal relationship between Islamic financial development and financial crisis that has been largely ignored in the extant analytical studies dedicated to the topic.

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EFFECTS OF BLAST-HOLE DEVIATION ON DRILLING AND MUCK-PILE LOADING COST

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Abstract

Effect of blast-hole deviation on drilling and muck-pile loading cost at Hwange Colliery Mine, Zimbabwe was investigated. Samples were obtained from the mine and tested for point load strength index using point load tester. Uniaxial compressive strength was estimated from the result obtained from point load strength index of the samples. Blast-hole depth and deviation were measured on the field. Blasting parameter, volume of blast, drilling cost and excavation cost were determined using empirical equations developed by researchers. Six scenarios were to analyze excavation cost for bucket capacity of 4 m^3 and 5.5 m^3 respectively. The results of point load strength index varied from 1.43 – 2.10 MPa and 34.27 – 89.49 MPa respectively. The drilling cost varied from $0.13/m for operator's cost to $7.35/m for total operating and ownership cost. Extra cost of drilling varied from $1,728 for 7.07% blast-hole deviation to $4, 218 for 21.58% blast-hole deviation. Excavation cost varied from $3.47/$m^3$ - $4.25/$m^3$, $3.55/$m^3$ - $4.35/$m^3$, $3.57/$m^3$ – $4.41/$m^3$, $3.49/$m^3$ - $4.25/$m^3$ and $3.50/$m^3$ – $4.28/$m^3$. The correlation between extra cost and blast-hole deviation produce high value of coefficient of determination and it varies from 0.9941 – 0.9952.

Keywords: Effect, blast-hole, muck-pile, strength, excavation, loading, mine

Introduction

Drilling is one of the critical elements in the process of rock breakage. A blast hole is merely a cylindrical vehicle drilled and strategically situated to hold and contain an explosive charge. When detonated in the most efficient and optimum manner possible, it can give good rock fragmentation which can be measured for evaluation of blasting performance (Muhammad, 2009). Many researchers have established significant relationship between blast-hole deviation and cost of drilling and blasting in surface mines. On the other hand, rock fragmentation is arguably the most important process in mineral exploitation as it has direct effect on the costs the extraction-loading and ore dressing. Adebayo and Aladejare (2013) researched on the effect of the rock properties on excavation loading operation and establish the relationship between excavation -loading and rock properties. Rock fragmentation is dependent on two main factors; (i) the rock properties which are uncontrollable and (ii) the blasting parameters that can be changed to give maximum efficiency (Muhammad, 2009). Bondai (2013) investigated the effects of rock properties and blasting parameters on blasting performance and he found out that there is a strong correlation between blasting parameters and blasting performance. It means that if blast-hole deviation is experienced, this will alter the blasting parameters and consequently affect the blasting performance. The blasting parameters can be adjusted in an attempt to increase blasting efficiency, it mostly depends on the execution of the drilling process. Fewer studies have been done that correlate the cost incurred by inaccurate drilling and the blast-hole deviations (Sarma *et al.,* 2001). Better setup and selection of drilling method and equipment will help minimize deviation, improving the whole rock breaking operation (Atlas Copco, 2008).

Kangwa (2001) stated that many operators do not have a good grasp of their actual drilling costs per metre, most do not capture all costs, and do not consider pattern deviation to be a major issue. The impact of blast-hole deviations can be felt throughout the production cycle, such as excavating, hauling and mineral processing. The consequences of blast-hole deviation include build-ups, hang-ups and poor rock fragmentation and will normally lead to extra drilling, loss of drill strings, ore dilution, ore loss, increased explosive consumption, time wastage and delays in the chain of production operations. Rock drilling deviation is usually divided into four different classes as follows: Collaring deviation, alignment deviation (horizontal direction and vertical inclination), drilling deflection and depth. In case of feed with indicator the error is reduced to 0.5 – 1.0% and further to 0.2 – 0.5% with careful working and this error is more related to operating personnel (Atlas Copco, 2002). Penetrating structured rock with strong foliation and bedding properties can cause deviations of up to 5-10% (Oslen, 2009). In view of this many mines avoid drilling holes deeper than 20 m, unless guide rods are added directly behind the bit, or drill tubes are used. In these cases, the deviation can be expected to decrease to 3-5% Atlas (Copco, 2000) and top hammer holes are normally restricted to 30 m. According to Zvonimir (2005) "Blasting of explosive charge in blasting hole creates significant amount of energy released, shock-wave of great force in explosive and surrounding rock-formation and gases of high temperature and pressure. Crushing process in blasting affects the average size of the fragmented rock and the discharge affects the muck-pile geometry which is crucial to the loading process (Akande, 2014). Digability is the ease at which at a loader bucket is filled. Fill factor refers to how well a container such as a loader bucket or truck tray is filled. Fill factor is directly related to the size distribution of the rock being loaded (Cottee, 2001). The objectives of this paper therefore are to determine the rock strength parameters, deviations of blast-holes from the designed blast pattern and evaluate drilling and muck pile loading cost at different blast-hole deviations.

MATERIALS AND METHOD

Scenarios Adopted in the Study

This study was conducted at Hwange Colliery Mine. Coal production is carried out after the supplementary stripping and overburden removal at JKL and CHABA and the scenarios used are presented in Table1.

Table 1: Scenarios used

Scenario	Design Burden	Design Spacing	Explosive	Bit diameter
1	4	4.6	ANFO	191
2	4	4.6	ANFO	311
3	4	4.6	Heavy ANFO	191
4	4	4.6	Heavy ANFO	311
5	4	4.6	Emulsion	191
6	4	4.6	Emulsion	311

Blast-hole depth measurement

Blast-hole depth was measured by lowering a metal ball tied to a string down the blast hole. The ball was let to reach the bottom of the hole and the string collar position was marked. The ball would then be taken out and the length of the string measured to the collar position.

Determination of Point load strength index and uniaxial compressive strength

The Point Load Strength Index $I_s(50)$ was determined in accordance with standard method suggested by the International Society of Rock Mechanics (ISRM, 1989). The point load was evaluated using Equations 1 and 2.

$$f = \left(\frac{D}{50}\right)^{0.45} \quad \text{..... (1)}$$

$$I_{s50} = f\left(\frac{P}{D^2}\right) \quad \text{..... . (2)}$$

Where; I_{s50} is Point load index, P is failure load (N) and D is the distance between the plates

The UCS was derived from the results of the point load strength index. This was done using the calculated point load strength index of the rock and the correlation factor C, in accordance with ISRM (1981) and the value of the correlation factor C used is 24.

$$UCS = CI_{s(50)} \quad \text{..... (3)}$$

Where, UCS is Uniaxial Compressive Strength, $I_{s(50)}$ is the correlated point load index and

C is the correlation factor between UCS and $I_{s\,(50)}$

Measuring of blasting parameters

The blasting parameters which are the burden and spacing were measured after drilling using a tape measure. The burden and spacing for each hole measured to come up with the collar deviations.

Determination of planned and Actual volume of blast

Planned volume of blast was determined using Equation 4.

$$Volume\ of\ Blast = L_{avg} \times b \times s \quad \text{..... (4)}$$

Where; L_{avg} = Average hole length, b is burden, s is spacing and n is number of holes

The Area to be blasted was measured using a GPS device and the volume of blast was then obtained using Equation 5.

$$Volume\ of\ Blast = A \times L_{avg} \quad \text{..... (5)}$$

Where; A is the area (m^2) and L_{avg} is average hole length

Determination of cost of drilling

Atlas Copco DM 45 900 was the drilling machine used. Drilling cost per meter was determined using Equation 6 proposed by Jimeno *et al.* (1995). All the parameters in the equation where obtained from the mine planning department and from the drill manual.

$$C_{TD} = \frac{C_A + C_I + C_M + C_O + C_E + C_L + C_B}{P_r} \left(\frac{\$}{m}\right) \quad \text{..... (6)}$$

C_A Is depreciation ($/h), C_I is interest rate and insurance ($/h), (indirect costs), C_M is maintenance cost ($/h), C_O is labour ($/h), C_E is fuel or energy, C_L is cost of lubrication and filters ($/h), C_B cost of bits, rods and shanks ($/h) (direct costs) and P_r is drilling productivity (m/h)

Determination of excavation cost

Precise stopwatch was used to determine the cycle time. The bucket filling rate was determined from equation (4).The bucket filling rate was determined using Equation 7.

$$Bucket\ filling\ rate = \frac{Bucket\ capacity}{Cycle\ time}\left(\frac{m^3}{s}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Excavation cost was determined using Equation 8.

$$C_{EX} = \left[\frac{C_A + C_I + C_M + C_{FE} + C_{LUB} + C_{LAB}}{B_{FR}\left(\frac{m^3}{h}\right)}\right] + C_{BA} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Where C_{EX} is cost of excavation ($/m^3), C_A Is depreciation ($/h), C_I is interest rate and insurance ($/h), (indirect costs), C_M is maintenance cost ($/h), C_{LAB} is labour ($/h), C_{FE} is fuel or energy, C_{LUB} is cost of lubrication and filters ($/h), C_{BA} cost of bucket teeth and hydraulic consumables ($/h) (direct costs)

Determination of extra costs

The cost of extra cost was determined using Equations 9-11.

$$Hole\ per\ 100\ 000\ bcm = \frac{100\ 000\ bcm}{Burden \times Spacing \times Hole\ length\ (m)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

$$Drilling\ Shifts\ per\ 100000\ bcm = \frac{Holes\ per\ 100000\ bcm}{Drilling\ metre\ per\ shift} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

$$Extra\ cost = Extra\ Shift \times Labour/shift + Extraholes \times D\&B\ cost\ per\ hole \ldots (11)$$

Results and Discussion

The results were obtained from the Hwange Colliery Company JKL and Chaba open cast mines. An excel model was used to model the changes in costs due to hole deviation. Six scenarios were developed, and each scenario`s blasting patterns were varied from the designed.

Analysis of Strength Parameter

Table 2 shows the results of the strength parameter for Chaba and JKL Pits. The point strength index varied from 1.49 - 3.73 MPa while the uniaxial compressive strength varied from 34.27 -89.49 MPa.

Table 2 Strength Parameters Chaba and JKL Pits $I_{s(50)}$

Specimen	Diameter mm	Failure Load (kN)	D^2 (mm^2)	Point Load Strength ($I_{s(50)}$) MPa	UCS (MPa)
1	45	4.48	2025	2.10	56.19
2	45	4.15	2025	2.02	48.47
3	45	3.05	2025	1.43	34.27
4	45	7.97	2025	3.73	89.49
5	45	3.85	2025	1.80	45.62
6	45	3.81	2025	1.79	43.01
7	45	3.18	2025	1.49	35.85

Drilling cost per metre

Table 3 presents summary of the estimate of the drilling cost per meter of a 191mm hole using Atlas Copco MD 45 900. The total operating cost of $5.97/m was estimated for the drilling rig. Also, total operating and ownership cost was calculated to $7.35/m. The cost variables varied from $0.13/m for operator's cost to $3.14/m for fuelling.

Table 3 Drilling Costs per Metre

Summary of Costs Per Metre	Cost ($/m)
Fuel Cost per metre	3.14
Operator Cost per metre	0.13
Maintenance Cost per metre	1.72
Consumable Cost per metre	0.98
Total Operating Cost per metre	5.97
Total Owning Cost per metre	1.38
Total Operating and Owning Costs	7.35

Table 4 presents extra cost incurred due to collar deviation for three different blasts. The percentage deviation recorded varied from 7.07% for blast 2 to 21.58%. The incurred for blasts 1, 2and 3 are $3,456:00, $1,728:00 and $4, 218:00. The third blast with highest collar percentage deviation of 21.58% incurred highest extra cost for drilling and blasting (D & B). This confirmed that cost drilling and blasting increases and collar hole deviation increases.

Table 4 Extra cost due to collar deviation from observed three blasting cycles

Blast-hole No.	**No.of drilled holes**	**Average depth (m)**	**Average Actual Burden (m)**	**Average Actual Spacing (m)**	**% Deviation**	**Extra Costs (D&B) ($)**	**Volume of Blast (m^3)**
1	94	11.4	3.7	4.1	17.55	3,456.00	16250
2	76	11.7	3.8	4.5	7.07	1,728.00	15205
3	88	12.3	3.7	3.9	21.58	4,218.00	15619

Analysis of Cost Drilling, Blasting and Excavation from Six Scenarios formulated.

Tables 5-7 present cost of drilling, blasting and excavation-loading for the six scenarios. Scenarios 1 and 2 use design pattern of 4 x 4.6 m, ANFO, deviation (0 to – 0.5) with bit diameter of 191 mm for scenario 1 and 311 mm for scenario 2. The size of fragments (X 50) varied from 122 – 149 mm and 117 – 142 mm for scenario 1 and 2 respectively. This reveal that as the deviation increases the size of fragment increases. The cost of drilling and blasting increase from \$1.58/m^3 – 2.02/m^3 as the deviation increases form (0 - 0.5). The excavation cost varied from \$4.20 - 4.25/m^3 and \$4.30 – 4.35/m^3 for scenario 1 and 2 using bucket capacity 4 m^3. In addition, excavation cost varied from \$3.47 – 3.50 4/m^3 and \$3.55 – 3.59/m^3 for scenario 1 and 2 respectively using bucket capacity of 5.5 m^3. It could be deduced with lager diameter blast-holes could lead smaller fragment size.

Table 5: Cost Drilling, Blasting and Excavation for Scenarios 1 and 2

Description	**Scenario 1 – Design Pattern (4 X 4.6), 191 mm bit and ANFO**						**Scenario 2 – Design Pattern (4 X 4.6), 311 mm bit and ANFO**					
Deviation	0	-0.1	-0.2	-0.3	-0.4	-0.5	0	-0.1	-0.2	-0.3	-0.4	-0.5
Burden (m)	4.0	3.9	3.8	3.7	3.6	3.5	4.0	3.9	3.8	3.7	3.6	3.5
Spacing (m)	4.6	4.5	4.4	4.3	4.2	4.1	4.6	4.5	4.4	4.3	4.2	4.1
X 50 (mm)	149	144	138	133	128	122	142	137	132	`127	122	117
P. F (kg/m^3	1.69	1.77	1.86	1.95	2.15	2.16	2.86	3.00	3.15	3.31	3.48	3.67
D& B. Cost (\$/m^3)	1.58	1.66	1.74	1.83	1.92	2.02	2.23	2.34	2.45	2.58	2.71	2.84
Exca Cost 4 m^3 (\$/m^3)	4.25	4.24	4.23	4.22	4.21	4.20	4.35	4.34	4.33	4.32	4.31	4.30
Exca Cost 5.5 m^3 (\$/m^3)	3.50	3.49	3.49	3.48	3.47	3.47	3.59	3.58	3.58	3.57	3.56	3.55

From Table 6 the cost of drilling and blasting varied from \$1.09 – 2.33 /m^3 and \$3.66 – 4.69/m^3 for scenario 3 and 4 respectively. The excavation varied from \$4.33 – 4.41/m^3 and 4.22 – 4.25 \$/m^3 using bucket capacity of 4 m^3 for scenarios 3 and4. Using the bucket capacity of 5.5 m^3 the excavation ranged from \$3.57 – 3.62/m^3 and \$3.49 – 3.51/m^3 for scenarios 3 and 4 respectively. It could be observed using excavator with larger bucket capacity is capable of reducing cost of excavation as could be observed in Tables 5-7.

Table 6: Cost Drilling, Blasting and Excavation for Scenarios 3 and 4

Description	**Scenario 3 – Design Pattern (4 X 4.6), 191 mm bit and Heavy ANFO**						**Scenario 4 – Design Pattern (4 X 4.6), 311 mm bit and Heavy ANFO**					
Deviation	0	-0.1	-0.2	-0.3	-0.4	-0.5	0	-0.1	-0.2	-0.3	-0.4	-0.5
Burden (m)	4.0	3.9	3.8	3.7	3.6	3.5	4.0	3.9	3.8	3.7	3.6	3.5
Spacing (m)	4.6	4.5	4.4	4.3	4.2	4.1	4.6	4.5	4.4	4.3	4.2	4.1
X 50 (mm)	207	200	192	185	177	170	102	99	95	91	87	84
P. F (kg/m^3	1.09	1.15	1.20	1.26	1.33	2.16	4.47	4.49	4.92	5.17	5.44	5.73
D& B. Cost (\$/m^3)	1.04	1.09	1.15	1.20	1.27	2.33	3.66	3.86	4.03	4.23	4.45	4.69
Exca Cost 4 m^3 (\$/m^3)	4.41	4.39	4.37	4.36	4.34	4.33	4.25	4.24	4.23	4.23	4.22	4.22
Exca Cost 5.5 m^3 (\$/m^3)	3.62	3.61	3.60	3.59	3.57	3.56	3.51	3.51	3.50	3.50	3.49	3.49

Comparing the performance the explosive used ANFO performance was the best with blast-hole diameter of 191 mm having the maximum fragment size of 144 mm in the distribution while heavy ANFO recoded the best performance with blast-hole diameter of 311 mm having maximum fragment size of 102 mm in the distribution.

Table 7: Cost Drilling, Blasting and Excavation for Scenarios 5 and 6

Description	**Scenario 5 – Design Pattern (4 X 4.6), 191 mm bit and Emulsion**						**Scenario 5 – Design Pattern (4 X 4.6), 311 mm bit and Emulsion**					
Deviation	0	-0.1	-0.2	-0.3	-0.4	-0.5	0	-0.1	-0.2	-0.3	-0.4	-0.5
Burden (m)	4.0	3.9	3.8	3.7	3.6	3.5	4.0	3.9	3.8	3.7	3.6	3.5
Spacing (m)	4.6	4.5	4.4	4.3	4.2	4.1	4.6	4.5	4.4	4.3	4.2	4.1
X 50 (mm)	167	161	154	148	142	137	114	110	106	102	98	94
P. F (kg/m^3	1.66	1.74	1.83	1.92	2.06	2.13	4.46	4.61	4.84	5.09	5.36	5.64
D& B. Cost ($/m^3$)	1.60	1.68	1.76	1.85	1.95	2.05	3.72	3.90	4.09	4.30	4.52	4.77
Exca Cost 4 m^3 ($/m^3$)	4.28	4.28	4.27	4.26	4.25	4.24	4.28	4.27	4.26	4.25	4.25	4.25
Exca Cost 5.5 m^3 ($/m^3$)	3.53	3.53	3.52	3.51	3.50	3.45	3.53	3.53	3.52	3.52	3.51	3.51

From Figures 1 to 6, the correlation equations between blast-hole deviations and extra costs, it is evident that the blast-hole deviation has strong correlation with extra cost incurred. This is consistent with hypothesis and the findings of (Kangwa, 2001).

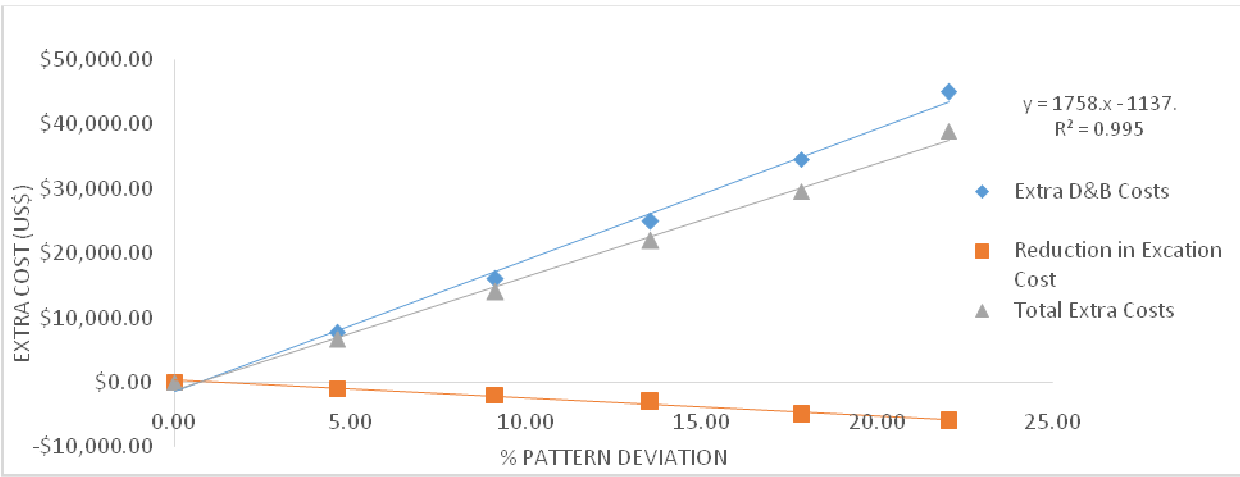

Figure 1: Total extra cost, extra D&B cost and Reduction in excavation cost against % pattern deviation for Scenario 1

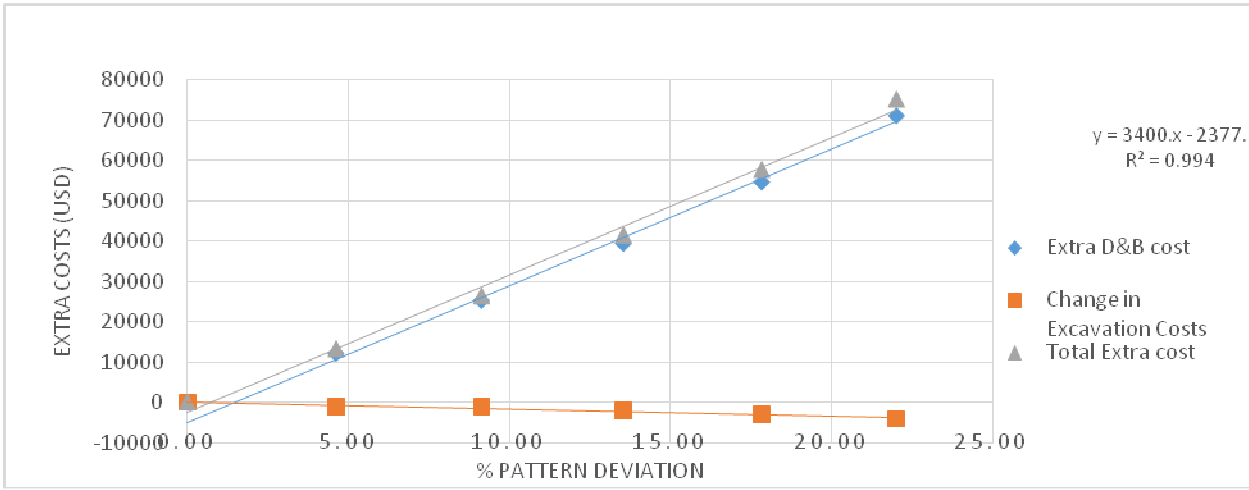

Figure 2: Total extra cost, extra D&B cost and Reduction in excavation cost against %o pattern deviation for Scenario 2

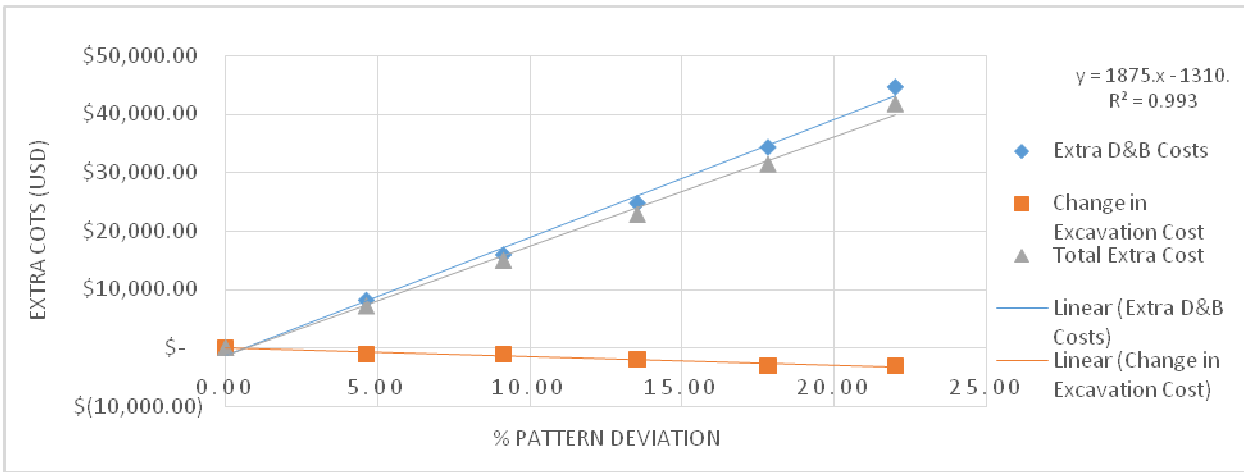

Figure 3: Total extra cost, extra D&B cost and Reduction in excavation cost against % pattern deviation for scenario 3

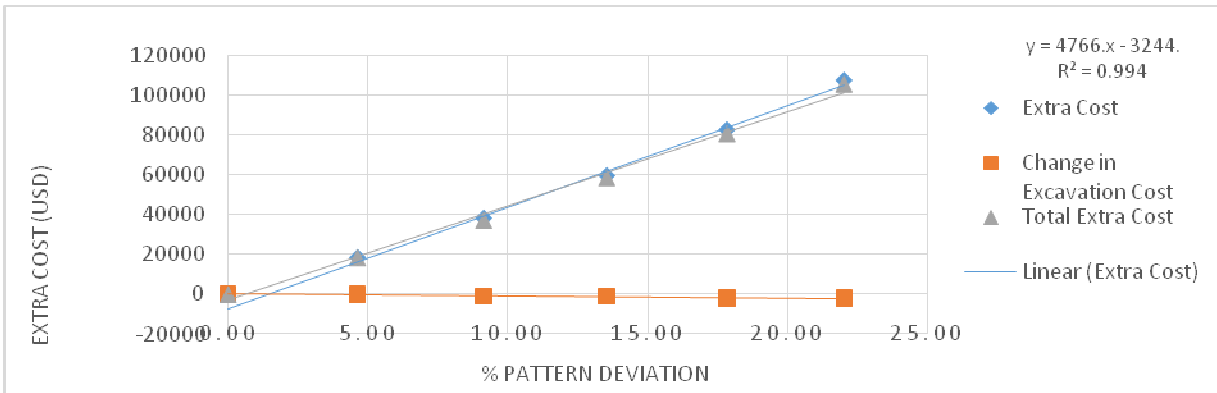

Figure 4: Total extra cost, extra D&B cost and Reduction in excavation cost against % pattern deviation for scenario 4

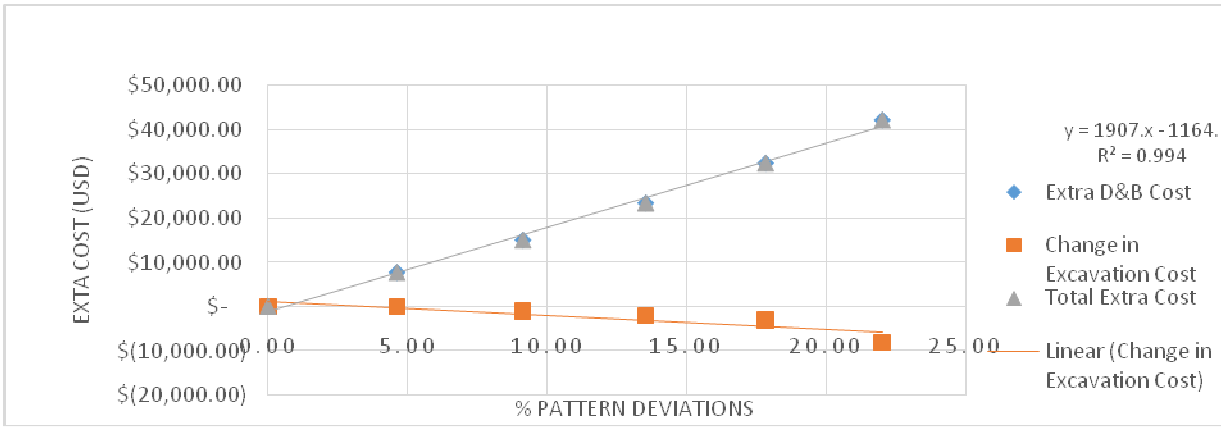

Figure .5: Total extra cost, extra D&B cost and Reduction in excavation cost against % pattern deviation for Scenario 5

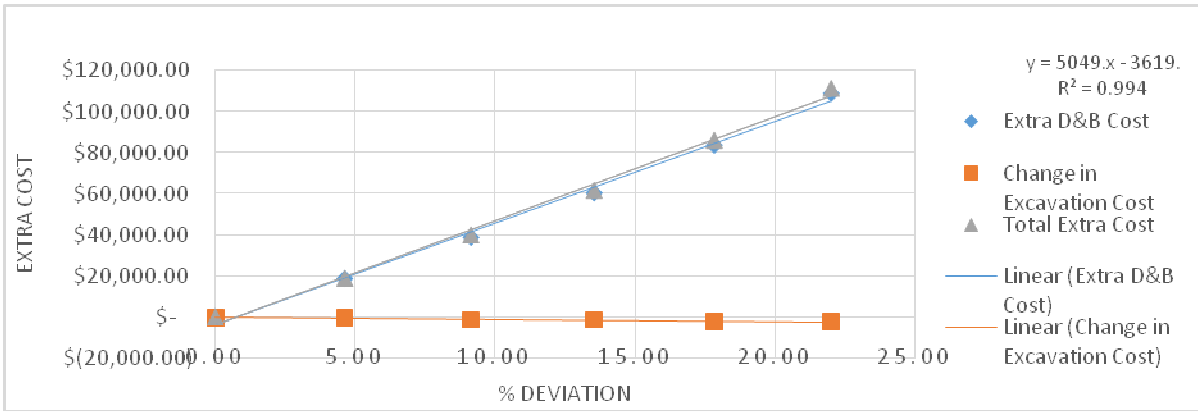

Figure 6: Total extra cost, extra D&B cost and Reduction in excavation cost against % pattern deviation for Scenario 6

Conclusion

A clear quantification of the extra costs as a result of the consequences is useful in targeting the unit operations (drilling and charging and excavation-loading) for improvement. Elimination or reducing the casual effects of uneven toe of bench platform and blast-hole inclination would make significant savings in the overall mining operational cost. The results obtained agree with the research of Muhammad [1]. He found out that when there is a change in drillhole diameter or fragmentation specification, changes in the blast design parameters are required affecting the cost of a drilling and blasting operations. The correlation equations generated from each scenario may be used as a quick or on the spot estimates of the extra cost due to the hole-deviation. This will enable prompt decision towards minimizing operational costs. ANFO performance was the best with blast-hole diameter of 191 mm while heavy ANFO recoded the best performance with blast-hole diameter of 311 mm.

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Analyzing the Diversification in the Optimal Portfolio Choice: an empirical study of the Moroccan Stock Market

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Abstract

The Financial markets in the emerging countries in Asia, Latin America and Eastern Europe have sparked an important literature aimed at understanding how they work, their organization and future prospects, and the different techniques and methods of allocation of their portfolios. However, few studies have been devoted to the Moroccan financial market; especially those concerned with the problem of diversification in the optimal portfolio choice.

In this study, we will try to understand the portfolios wide diversification strategy that is based on the correlation of financial assets in the Moroccan financial market. Similarly, this paper seeks to present a critical analysis of this strategy of the optimal diversification and implement the mixed linear program with absolute deviation model of Konno & Yamazaki Simplified by Hamza & Janssen. This program will reduce the size of the portfolio to be optimized in order to avoid the management and transaction expenses of the financial assets generated by this strategy.

Key Words: diversification, costs of transactions, absolute mean-deviation model simplified, mixed linear program, Casablanca Stock market.

Classification (JEL): G11, G17, C61

1. Introduction

The choice of an optimal portfolio of the financial assets has been, for a long time, a topic of a primary interest in the financial field. The basic idea is to maximize the return of the portfolio while minimizing its risk. In this context, several theoretical models of the assets allocation have been studied since the early 1950s with the aim of resolving this problem of the portfolio choice.

The article of the economist Harry Markowitz to the United States published in 'The Journal of Finance' in 1952 launched the early developments of the modern theory of portfolio management. After it had been limited to the academic field for a long time, this theory was eventually imposed on the professionals of the financial world. Markowitz suggested expressing a security's interest by the expectation of its returns and the risk by its variance. The investor, for the construction of his portfolio, will seek to make a full return with a minimum risk. This approach, called the mean-variance approach, led him to win the Nobel Prize in 1990.

He has also introduced the concept of the efficient border deducted from the minimum variance portfolio for a given expectation of return, which represents the optimal combination of risk and return. The optimization is done by defining a function of utility that represent the investors' preference taking into

account their aversion to the risk and maximizing the one, which is given the constraint represented by the efficient border.

The works of Harry Markowitz helped, as well, in establishing a theory of the optimal diversification of the stock market portfolio. In fact, Markowitz has established the strategy of diversifying his portfolio and reducing its risk level while maintaining a satisfactory return. Furthermore, among his proposals, he suggests the use of all types of assets to achieve a good diversification.

The diversification can occur at several levels: not only securities, sectors, countries, regions and investment types, but also styles and strategies. It can reduce the risk of a portfolio except when the investment components are weakly correlated.

The standard theory of the choice of the financial portfolio postulates that the investor arbitrates among all the assets that exist in the market so as to maximize the relation return/risk. Thus, it determines a well-diversified and efficient portfolio. This configuration involves transactions costs[1]. Nevertheless, these transaction costs are not taken into consideration; whereas they cannot be ignored in reality.

In this context, Pogue showed in 1970 that the transaction costs could sometimes exceed, and even further, the expected profitability of the investor, especially for the large portfolios.

Similarly, Leland showed in 1985 that some frequent adjustments of the portfolio to keep the assets close to their target proportions, led to very high transaction costs.

Consequently, the reduction in portfolio size before even carrying out its optimization is very useful to avoid heavy expenses due to the transaction costs.

To achieve our goal and deal with our problem, we must give answers to the following derived questions: *What is the necessary threshold of diversification to eliminate the specific risk? How many assets will be sufficient to diversify significantly a portfolio of financial assets? How should we select them so as to optimize the diversification to reach a fixed threshold of assets?*

In this regard, this work will focus mainly on the presence of a constraint that makes the diversification of our portfolio more efficient within the Moroccan financial market. In the financial discipline, it is called the constraint of the minimum threshold of investment. It aims at reducing the rate of assets, which make the optimal portfolio.

This work is organized as follows. After a general introduction. The second section is devoted to the review of literature mainly the principle of diversification and optimal portfolio choice. Indeed it presents a critical analysis of diversification and a program of resolution, namely the mixed linear program formulated by Hamza & Janssen (*simplifying the model of Konno & Yamazaki),* which takes into consideration the constraints of the purchase threshold. In the third one, we illustrate our approach through a digital application using the historic weekly returns of 74 financial securities that build the Moroccan stock market from January 2, 2013 - June 08, 2014. We will rely also on the econometric software E-views 7 for the tests of the different statistical parameters and Matlab software for the simulation of our resolution program. In the last section, we conclude this work with a discussion about the results and a conclusion.

2. Literature Review

2.1. Diversification and optimal choice of a financial assets portfolio.

As illustrated by Clauss (2011), the principle of diversification is based on an old saying: "*Do not put all one's eggs in one basket*." To diversify means to compose a portfolio of securities from different sectors in order to distribute the overall risk between these different securities. An investor, who cannot take risk, will build a well-diversified portfolio by investing in different assets**.**

2.1.1. The Formulation of diversification and the mean-variance approach.

The pioneer of the modern finance, Markowitz has demonstrated mathematically the reality of diversification. He established that the total risk of a group of securities is less than the sum of risks of

[1] The theory of transactions' costs, founded by Coase in 1937 and particularly elaborated by Williamson since 1975, resulted in a very important empirical development since 1985. In 1991, the Royal Academy in Sweden gave the Nobel Prize of Economy to Ronald H.Coase for the discovery and clarification of the role of the costs of transactions

these individual securities[2]. In other words, investing in a group of securities reduces the rate of risk without losing the return of the portfolios.

The diversification consists in combining several instruments of investment within the same portfolio. According to Harry Markowitz, *"an investor can reduce the risk of his portfolio simply by holding assets that are not or can be positively correlated, thus, diversifying his investment."* Diversification is efficient when the risk is decreased to the maximum, either absolutely or for a given level of return. Thus, the quality of diversification depends on two parameters:

- The number of securities included in the portfolio.
- The level of correlation between the returns of securities.

The selection of a security to include it in a portfolio is not made according to its individual characteristics, but according to its behavior within the portfolio.

$$\sigma_p^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} x_i x_j \sigma_{ij} = \sum_{i=1}^{N} x_i \left[\sum_{j=1}^{N} x_j \sigma_{ij} \right]$$

Thus, the overall risk of the portfolio is the weighted sum of contributions to the risk of each asset. Considering that a uniform weighted portfolio consists of N securities.

The proportion invested in any security is $(x_i = {}^1/_N)$. Thus the total risk of a portfolio can be calculated by the variance or standard deviation of its returns:

$$\sigma_p^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} x_i x_j \sigma_{ij} \Leftrightarrow \sigma_p^2 = \frac{1}{N^2} \sum_{i=1}^{N} \sum_{j=1}^{N} \sigma_{ij}$$

That is $\sigma_p^2 = \frac{1}{N^2} \sum_{i=1}^{N} \sigma_{ii} + \frac{1}{N^2} \sum_{i=1}^{N} \sum_{\substack{j=1 \\ j \neq i}}^{N} \sigma_{ij}$

Noting that V is the largest variance. Thus, we shall have $\frac{1}{N^2} \sum_{i=1}^{N} \sigma_{ii} \leq \frac{VN}{N^2} = \frac{V}{N}$

This ratio tends to zero when N strives for the infinity (it is the effect of non-correlation).

So, $\overline{\sigma}_{ij}$ is the average covariance between the securities, thus, the weighted sum of covariance will be:

$$\frac{1}{N^2} \sum_{i=1}^{N} \sum_{\substack{j=1 \\ j \neq i}}^{N} \sigma_{ij} = \frac{1}{N^2} (N^2 - N) \overline{\sigma}_{ij} = (1 - \frac{1}{N}) \overline{\sigma}_{ij}$$

The weighted sum of the covariance tends to the average covariance when the number of securities in the portfolio increases[3]. When increasing the number of securities, the decrease of risk is at first rapid, and then it slows down sharply. Beyond a certain number, it becomes useless to keep diversifying because the marginal benefits of diversification decrease when the portfolio is diversified, while the marginal costs remain high due to transaction costs. The following figure illustrates this result:

[2] H. Markowitz (1959), *Portfolio Selection*: efficient diversification of investment. Yale University Press.

[3] Jacquillat and Solnik '*Les marchés financiers et la gestion de portefeuille'*, p.66, Dunod. 1986

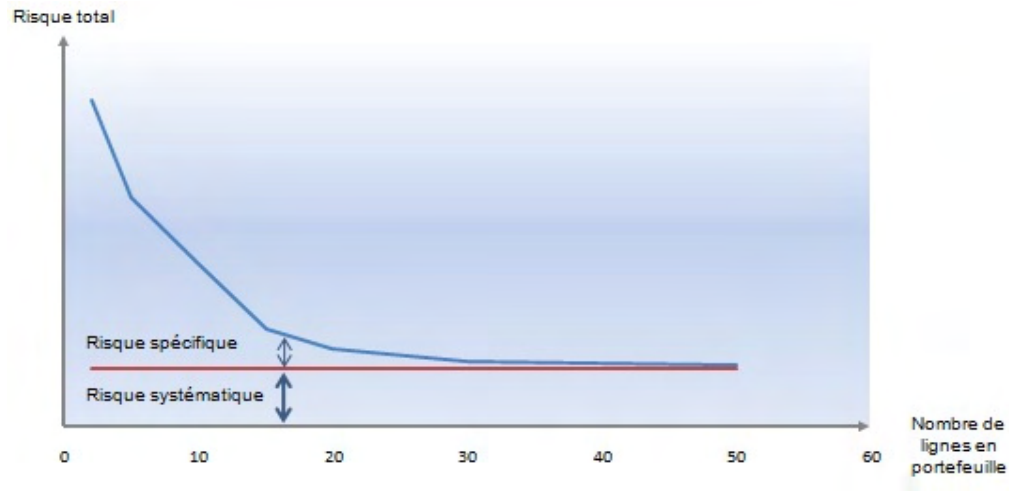

Figure 1: Risk and diversification

Thus, the total risk, which affects the expected return of a value, consists of the systematic and specific risks.

- Systematic or non-diversifiable risk: Systematic risk is attributable to the general movements of the market and economy[4]. This risk cannot be eliminated by diversification.
- Specific or diversifiable risk[5]: The peculiarity of the specific risk is that it can be diversified within one portfolio. It strives for zero when the number of securities in a portfolio is important enough (This is the effect of diversification). That is why it is not remunerated.

In addition, all the empirical studies that have been conducted in some financial markets showed that the return of diversification depends on the structure of covariance[6] and correlation[7] between the securities.
Indeed, the specific risk of the portfolio decreases when the number of securities constituting the portfolio increases; by decreasing well as the total risk of the portfolio, until it no longer supports the market risk. The number of securities to hold in its portfolio to achieve a total diversification depends heavily on the correlations between the returns of securities.

2.1.2. The mean absolute deviation approach and diversification

We will explain in the following pages the effect of diversification using the risk function $K(x)$ defined through the function Piece Wise Linear (PWL), instead of the Quadratic function. This is the mean absolute difference of the portfolio return compared with its average. Thus, we consider a uniform weighting portfolio consisting of securities. The proportion invested in any security j ($j = 1, \ldots . N$) is $x_j = 1/N$ **.** We have:

$$K(x) = E\left[\left|R(x) - E(R(x))\right|\right] = E\left[\left|\sum_{j=1}^{N} R_j x_j - E(\sum_{j=1}^{N} R_j x_j\right|\right] = \frac{1}{N} E\left|\sum_{j=1}^{N} R_j - E(\sum_{j=1}^{N} R_j)\right|$$

Konno & Yamazaki showed that their risk measurement and the standard deviation of portfolio returns (the function of risk based Markowitz) are equivalent to a constant if asset returns follow a multivariate normal distribution.

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[4] This type of risk is generated from some unexpected macro-economic events like inflation, shock over the rate of interest, higher rate of unemployment, recessions, the change of governments,…, affecting the securities.

[5] The specific risk or micro-risk is linked to the factors which its influence receives on it firm or the group of firms, especially the strikes, changes in the taste of the consumers, errors of management and judicial proceedings.

[6] $\sigma_{ij} = \text{cov}(R_i, R_j) = E[(R_i - E(R_i))(R_j - E(R_j)]$

[7] $\sigma_{ij} = \text{cov}(R_i, R_j) = E[(R_i - E(R_i))(R_j - E(R_j)]$

If the vector of the securities returns $(R_1.....R_n)$ is distributed according to a multivariate normal law, $N(\mu) = (\mu_1,....., \mu_n), \Sigma = (\sigma_{ij})_{1\le i.\, j\le n}$

Then $R(x) = N(\mu(x) = \sum_{j=1}^{N} \mu_j x_j, \sigma(x) = \sqrt{\sum_{i=1}^{N}\sum_{j=1}^{N} \sigma_{ij} x_i x_j})$

$K(x) = \sqrt{\frac{2}{\pi}}\sigma(x)$, thus $\lim_{N\to\infty} K(x) = \lim_{N\to\infty}\sqrt{\frac{2}{\pi}\sigma^2(x)} = \sqrt{\frac{2}{\pi}\bar{\sigma}}$

Therefore, the diversification has a limit and the risk, which is measured by the absolute deviation of the portfolio average return not fully diversifiable.

2.2. Critical analysis of diversification

The diversification of a portfolio, if properly conducted, is of real interest. But it also has its own limitations. Diversification helps to reduce the specific risk of the assets, but by no means systematic risk that comes from the market and on which diversification will have no influence.

Similarly, the total diversification is not very realistic for a portfolio manager, especially when the results include minimal amounts of investment. Therefore, this prevents the manager from investing the very low optimal sum provided by the optimization model.

To remedy the presence of small amounts in the optimal diversified portfolio, investors can eliminate securities with a lower proportion of fixed capital at a minimum level, and be content with a portfolio theoretically resulting suboptimal. This is unfortunately one of the major difficulties encountered in practice by managers' portfolios.

To account for these practical aspects, it is interesting to study whether risk diversification can be achieved by adding a purchase threshold constraint to the model of Konno & Yamazaki Simplified by Hamza & Janssen (2000). This amounts to solving a linear mixed program in the case of using the measure of mean-absolute risk.

2.2.1. The Disjunctive Programming and the Problem Modeling

We propose thus a linear disjunctive program as a new modeling of this problem.

Using the linear programming, several criteria can be used for the optimum choice of a portfolio. Young (1998) proposed the norm L_∞ to measure the portfolio risk. It is the "minimax" criterion for the portfolio choice.

Another criterion using the norm L_1 can be used. It is the model of Konno and Yamazaki (1991), which measures the risk through the absolute deviation of portfolio returns compared to its average: $K(x) = E[|R(x) - \mu(x)|]$, where $\mu(x)$ represents the mathematical expectation of the random variable $R(x)$.

Using the historic estimator of $K(x)$[8]:

$$\hat{K}(x) = \frac{1}{T\text{-}1}\sum_{t=1}^{T}\left|\sum_{j=1}^{n}\left(r_{jt} - \hat{r}_j\right)x_j\right| \qquad \hat{r}_j = \frac{1}{T}\sum_{t=1}^{T} r_{jt} \quad j=1,..., n,$$

And $y_t = \left|\sum_{j=1}^{n}(r_{jt} - \hat{r}_j)\, x_j\right|$

[8] Konno H & Yamazaki H. (1991), *A mean Absolute Deviation investment Portfolio optimization Model and its applications to Tokyo stock Market*, Management Science.

The optimization program (P) of the portfolio of Konno and Yamazaki, obtained by the simplified formulation of Hamza and Janssen (1998)[9], is written as follows:

$$Min \ \frac{\sum_{t=1}^{T} y_t}{T-1} \qquad \textit{subject to}$$

$$\begin{cases} y_t + \sum_{1\le j\le n}\left(r_{jt}-\hat{r}_j\right)x_j \ge 0 & t=1,.....,T \\ \sum_{1\le j\le n}\hat{r}_j x_j \ge \rho & \\ \sum_{1\le j\le n} x_j = 1 & \\ x_j \ge 0 & 1\le j\le n \\ y_t \ge 0 & t=1,.....,T. \end{cases}$$

In the following, the criterion of absolute deviation is retained. For each security

j $(j = 1 \dots n)$, we impose the following condition: $x_j < n_j \Rightarrow x_j = 0$, where the constant x_j represents the minimum percentage to invest in the asset j $(j = 1,\dots,n)$. This is a disjunctive constraint.
So if we introduce the disjunctive constraint which corresponds to a purchase limit in the optimization program, it becomes as follows

$$\text{Min } \frac{\sum_{t=1}^{T} y_t}{T-1}$$

Subject to

$$\begin{cases} y_t + \sum_{1\le j\le n}\left(r_{jt}-\hat{r}_j\right)x_j \ge 0 & t=1,...,T \\ \sum_{1\le j\le n}\hat{r}_j x_j \ge \rho & \\ \sum_{1\le j\le n} x_j = 1 & \\ x_j < n_j \Rightarrow x_j = 0 & j=1,...,n \\ x_j \ge 0 & j=1,...,n \\ y_t \ge 0 & t=1,...,T. \end{cases} \qquad [P_D]$$

Unfortunately, the optimal solution cannot be calculated with conventional variants of the Simplex algorithm for bounded variables.

2.2.2. Diversification and Mixed linear programming

The program of optimization $[P_D]$ is equivalent to the following linear mixed program[10]:

$$Min \ \frac{\sum_{t=1}^{T} y_t}{T-1} \qquad [P_{LM}]$$

[9] Konno H & Yamazaki H (1991), *A mean Absolute Deviation Portofolio optimization Model and its applications to Tokyo stock Market,* Management Science.
[9] Faris HAMZA & Jaqcues Janssen *'Choix Optimal des Actifs Financiers et Gestion de Portefeuille', Hermes-Lavoisier, 2009*

[10] Faris HAMZA & Jaques Janssen *'Choix Optimal des Actifs Financiers et Gestion de Portefeuille', Hermes-Lavoisier, 2009*

$$
\begin{cases}
y_t + \sum_{1\le j\le n} \left(r_{jt} - \hat{r}_j\right) x_j \ge 0 & t = 1,.....,T \\
\sum_{1\le j\le n} \hat{r}_j x_j \ge \rho & \\
\sum_{1\le j\le n} x_j = 1 & \\
x_j - q_j + u_j = 0 & 1 \le j \le n \\
n_j q_j - x_j + v_j = 0 & 1 \le j \le n \\
q_j = 0 \text{ ou } 1 & \\
x_j \ge 0, u_j \ge 0, v_j \ge 0 & 1 \le j \le n \\
y_t \ge 0 & t = 1,.....,T.
\end{cases}
$$

Consequently, solving the disjunctive program $[P_D]$ amounts to solving the mixed linear program $[P_{LM}]$.

3. Methodology

3.1. Hypotheses

From the above-mentioned literary review, we adopt the following hypotheses:

Hypothesis 1: The transaction costs sometimes can be very high compared with the expected profitability of the investor, especially for the large portfolios.

Hypothesis 2: the manager of a portfolio cannot anymore fulfill the full diversification, especially when the optimal solutions include very small amounts of investment.

Hypothesis 3: The linear mixed program applied to the mean- absolute-deviation model (Konno & Yamazaki) simplified by Hamza & Janssen ensure the reduction of the size of the portfolio to be optimized and in order to avoid the transaction costs of the financial assets.

3.2. Sample

Our study sample includes data corresponding to the weekly historical returns of 74 financial securities coming from the Casablanca stock market (it makes the totality of the market). The stock market data cover the period of January 2, 2013- June 4, 2014.

For the simulation of the program, an expected rate of return of 0.05% per unit of time (one week) and an accepted minimum threshold of investment of 5% for all j = 1, ..., 74 are planned. Our work is mainly achieved by using *MATLAB* software.

The normality tests are performed on Eviews7.

The distribution of the weekly returns of our portfolio moves far from the distribution of the normal law (see appendix 1).

4. Discussion

The tables below provide us with the optimal compositions of the portfolios obtained by the compared models. The optimal values of the objective function and the time of calculation are referred to in the bottom of the tables.

The first table provides us with the optimal composition of the portfolio obtained by the mean linear model - absolute deviation given by the program (see the theoretical part).

Our optimal portfolio consists of 31 shares distributed according to the different sectors.

Share	Proportion
STOKVIS NORD AFRIQUE	0,16690567
CENTRALE LAITIERE	0,101744341
BMCE BANK	0,085212237
CIMENTS DU MAROC	0,055008352
REBAB COMPANY	0,054966941
TASLIF	0,050693868
DIAC SALAF	0,05038586
HPS	0,046965827
UNIMER	0,040054146
OULMES	0,040049405
DISWAY	0,030701422
AGMA LAHLOU-TAZI	0,028975371
S.M MONETIQUE	0,028220873
ENNAKL	0,023811427
ZELLIDJA S.A	0,022815781
EQDOM	0,021366356
DELATTRE LEVIVIER MAROC	0,021249731
NEXANS MAROC	0,018959653
MAROC LEASING	0,018091
LESIEUR CRISTAL	0,015909345
AFRIC INDUSTRIES SA	0,011971573
REALIS. MECANIQUES	0,01180508
MINIERE TOUISSIT	0,010671625
COLORADO	0,008619764
STROC INDUSTRIE	0,008581833
AFRIQUIA GAZ	0,005485647
FERTIMA	0,00542108
CDM	0,004174023
PROMOPHARM S.A.	0,003929899
INVOLYS	0,003813851
AUTO NEJMA	0,003437894
Objective Function	**0,000265**
Time calculation (min)	**1,32**

Table 1- the portfolio composition aims at a weekly return of 0.05% according to the (P) program.

The second table gives us the optimal composition of the portfolio obtained by the mean linear model - absolute deviation eliminating all the shares, which have a fraction of the order less than 0.0065, from the initial portfolio (that are: AFRIQUIA GAS FERTIMA, CDM, PROMOPHARM **A.C**., INVOLYS, AUTO NEJMA). The optimization leads to an optimal portfolio consisting of 28 securities**.**

In this table related to the constraint that cancels the securities whose rates are below 0.0065, we note that the securities CTM COLORADO, EQDOM and LYDEC, which did not take part in the optimal portfolio resulting from the first optimization program, have come out with lower percentages. So the program is still running and it does not solve the problem.

Share	Proportion
STOKVIS NORD AFRIQUE	0,149337031
CENTRALE LAITIERE	0,092085944
BMCE BANK	0,086006279
REBAB COMPANY	0,073598364
DIAC SALAF	0,055970124
LESIEUR CRISTAL	0,055346167
CIMENTS DU MAROC	0,047779175
OULMES	0,047228567
HPS	0,045244513
S.M MONETIQUE	0,042083581
AFRIC INDUSTRIES SA	0,038411733
TASLIF	0,035913954
AGMA LAHLOU-TAZI	0,028470993
ZELLIDJA S.A	0,028378256
UNIMER	0,026896157
DISWAY	0,023738356
DELATTRE LEVIVIER MAROC	0,023730842
ENNAKL	0,023223734
NEXANS MAROC	0,020157892
MAROC LEASING	0,01388468
MINIERE TOUISSIT	0,010207557
CTM	0,00813781
CARTIER SAADA	0,006965368
STROC INDUSTRIE	0,006174949
MICRODATA	0,005925493
COLORADO	0,002015849
EQDOM	0,001681701
LYDEC	0,001404931
Objective Function	**0,00028**
Time calculation (min)	**1,14**

Table 2- the Composition of the portfolio aims at a weekly return of 0.05% taking into account the constraint according to the (P) program

The results obtained by the optimization program with and without additional constraint are directly compared with those obtained by the linear mixed program in the table below:

Share	Proportion
UNIMER	0,149897
STOKVIS NORD AFRIQUE	0,095441
LESIEUR CRISTAL	0,063806
EQDOM	0,061367
CENTRALE LAITIERE	0,059032
OULMES	0,058744
AGMA LAHLOU-TAZI	0,05698
ENNAKL	0,052154

SALAFIN	0,051414
BMCE BANK	0,05114
TIMAR	0,05012
TASLIF	0,05006
NEXANS MAROC	0,05
RISMA	0,05
CIMENTS DU MAROC	0,05
MAROC LEASING	0,05
Objective Function	**0,001305**
Time calculation (min)	**15,24**

Table 3- the Portfolio Composition aims at a weekly return of 0.05% based on the linear mixed program (P_{LM})

By imposing a minimum threshold of the securities purchase of 5%, the obtained optimal portfolio consists of 16 shares with a rate above or equal to 5%.

To solve this linear mixed problem, we used an algorithm of separation and evaluation (SE)[11] or Branch and Bound (B & B).

5. Conclusion

The problem of reducing the size of the financial assets portfolio that need to be optimized in order to avoid transaction expenses requires more interest from the researchers. Thus, it has become a major concern for the countries that are aware of the important role of the financial markets in the growth of their economies.

Like most developing countries, Morocco has made radical changes concerning the organization and functioning of the financial markets. The reforms adopted since 1993 have been instrumental in the development of its financial market, but this has not led to a significant improvement in the management of the portfolios of financial assets; particularly the principle of diversification.

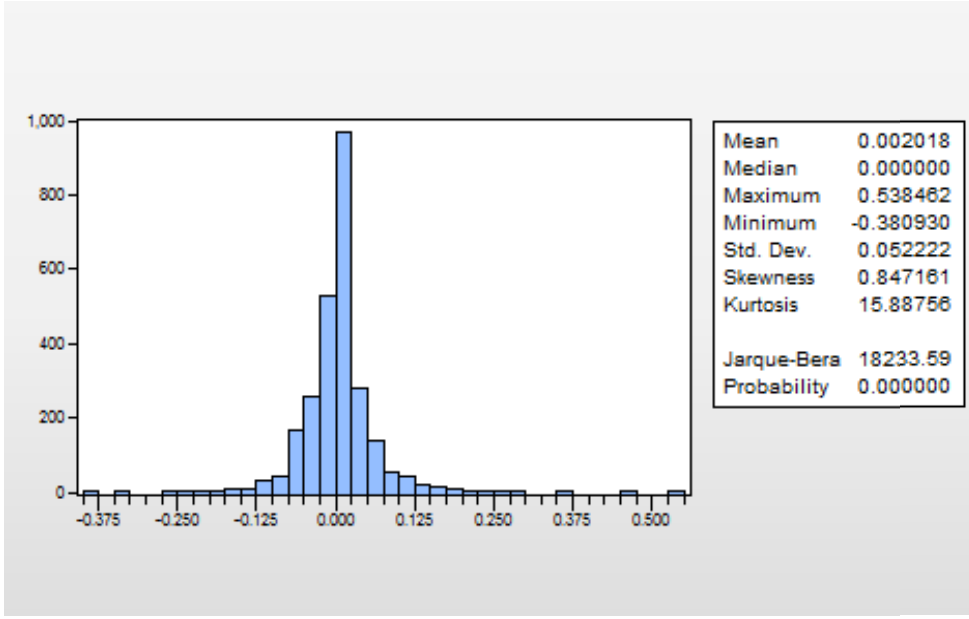
Thus, any rational investor within our financial market hopes to own the "right" portfolio; that is to say, a portfolio that offers solely a non-diversifiable risk that he will be paid for. The investor must eliminate the diversifiable risk by optimizing it in any possible way to build a well-diversified portfolio. Nevertheless, he will be left with heavy expenses due to this strategy of diversification.

The advantage of the used method in our stock market is that it ensures an optimal portfolio of a lower number of shares by eliminating all securities with a rate of invested capital less than a minimum percentage of investment.

Appendix

Appendix 1: Graphic 1: Distribution of the weekly returns of the studied sample

[11] Noting that this algorithm is a generic method to solve the problem of optimization, particularly the combinatorial or discreet non-convex optimization. In the methods of separation and evaluation, the separation ensures the obtainment of a generic method to localize all the optimal solutions; whereas, the evaluation avoids the systematic enumeration of all the solutions.



Appendix 2: **The code under Matlab according to the $[P_D]$ program**

```
functionoptimisation()
[S, txt, tab] = xlsread('price.xls');
[T0,N]= size(S);
for j=1:N,
for t=1:T0-1,
      r(t,j)=(S(t+1,j)-S(t,j))/S(t,j);
end,
end;

disp(r);
[T,n] = size(r);
for i=1:n,
rm(i)= mean(r(:,i));
end;

Y(1:T,1)=1/(T-1);
Y(T+1:T+n,1)=0;
for t=1:T
for j=1:n,
y(t,j) = r(t,j)-rm(j);
end;
end
for i=1:T
for j=1:T
if(i==j)
A(i,j) = 1;
else
A(i,j) =0;
end
```

```
end
for j=1:n
A(i,T+j)=y(i,j);
end
end;
A(T+1,:) =0 ;
for j=1:n
A(T+1,T+j) =rm(j);
end
for j=1:T+n
if(j<=T)
aeq(1,j)=0;
else
aeq(1,j)=1;
end
end
beq=1;

for i=1:T
b(i,1)=0;
end
b(T+1,1) = 0.0005;

Aa=-A;
bb=-b;

m = max(size(Y));

L = zeros(m,1);
[x,fval] = LINPROG(Y,Aa,bb,aeq,beq,L);

for j=1:n
xi(j)=x(j+T);
end
ind=find(xi<=10^-4);
ind2=find(xi>=0.0065);
xi(ind)=0;
xlswrite('Rest_stage1.xls',[txt'  num2cell(xi')]);
ind=find(xi<=0.0065);
ind3=find(xi(ind)>0);
ind2=find(xi>=0.0065);
xlswrite('eli_stage1.xls',[txt(ind(ind3))'  num2cell(xi(ind(ind3))')]);
xlswrite('ind.xls',ind(ind3)+T )
                    xlswrite('Value_objective_C_Y1.xls',fval)
```

<u>Appendix 3</u>: The code under Matlab according to the program (P) with an additional constraint

```
function optimisation2()
[S, txt, tab] = xlsread('price.xls');
ind=xlsread('ind.xls');
[T0,N]= size(S);
for j=1:N,
```

```
for t=1:T0-1,
      r(t,j)=(S(t+1,j)-S(t,j))/S(t,j);  %r(i)=ds/s0
end,
end;

disp(r);
[T,n] = size(r);
%rm is the average of return
for i=1:n,
rm(i)= mean(r(:,i));
end;
%disp(rm);
for t=1:T
   Y(t,1)=1/(T-1);
end
for j=T+1:T+n
Y(j,1)=0;
end

for t=1:T
for j=1:n,
y(t,j) = r(t,j)-rm(j);
end;
end

for i=1:T
for j=1:T
if(i==j)
A(i,j) = 1;
else
A(i,j) =0;
end
end
for j=1:n
A(i,T+j)=y(i,j);
end
end;
A(T+1,:) =0 ;
for j=1:n
A(T+1,T+j) =rm(j);
end
for j=1:T+n
if(j<=T)
aeq(1,j)=0;
else
aeq(1,j)=1;
end
end
[k,h]=size(ind);
for i=1:h
aeq(i+1,:)=0;
```

```
aeq(i+1,ind(i))=1;
end
beq(1)=1;
beq(2:h+1)=0;
%IN = eye(n);
%for j=1:n,
% A((T+3+j),:) = IN(j,:);
%end;
%disp(y3);

%U = ones(1,n);
%disp(U);
for i=1:T
b(i,1)=0;
end
b(T+1,1) = 0.0005;
[k,h]=size(A);
%for j=1:n,
%   b(T+3+j,1) = 0.0;
%end;

%disp(b);

%n = max(size(y));
%L = zeros(n,1);
%U = 10^10*ones(n,1);

%disp(size(y));
%disp(size(A));
%disp(size(b));

%X=LP(y,A,b)
Aa=-A;
bb=-b;

% Limites inf?rieures et sup?rieures de x :
m = max(size(Y));
%L = zeros(n,1);
L = zeros(m,1);
%disp(L);
U = ones(m,1);
%
% Optimisation :
[x,fval] = LINPROG(Y,Aa,bb,aeq,beq,L);

for j=1:n
xi(j)=x(j+T);
end
ind=find(xi<=10^-4);
ind2=find(xi>=0.0065);
xi(ind)=0;
```

```
xlswrite('Rest_stage2.xls',[txt'  num2cell(xi')]);
ind=find(xi<=0.0065);
ind3=find(xi(ind)>0);
ind2=find(xi>=0.0065);
xlswrite('eli_stage2.xls',[txt(ind(ind3))'  num2cell(xi(ind(ind3))')]);
xlswrite('ind2.xls',ind(ind3)+T )
xlswrite('Value_objective_C_Y2.xls',fval )
```

Appendix 4: The code under Matlab according to the linear mixed program or Bround & Brunch.

```
Function BB()

%date
[S, txt, tab] = xlsread('cours.xls');
[T0,N]= size(S);
%calculus of return of any share
for j=1:N,
for t=1:T0-1,
r(t,j)=(S(t+1,j)-S(t,j))/S(t,j);
end
end

disp(r);
[T,n] = size(r);
%rm is the of average of return
for i=1:n,
rm(i)= mean(r(:,i));
end;
Y(1:T)=1/(T-1);
Y(T+1:T+4*n)=0;
for t=1:T
for j=1:n,
R(t,j) = r(t,j)-rm(j);
end
end
A(1:T,1:T)=eye(T);
A(1:T,T+1:T+n)=-R;
A(1:T,T+n+1:T+4*n)=0;
A(T+1,1:T)=0;
A(T+1,T+1:T+n)=rm;
A(1+T,T+n+1:T+4*n)=0;

b(1:T)=0;
b(T+1) = 0.0005;
nj=0.05;
Aeq(1:1+2*n,1:T+4*n)=0;
Aeq(1,T+1:T+n)=1;
Aeq(2:1+n,T+1:T+n)=eye(n);
Aeq(2:1+n,T+n+1:T+2*n)=-eye(n);
Aeq(2:1+n,T+2*n+1:T+3*n)=eye(n);
Aeq(2+n:2*n+1,T+1:T+n)=-eye(n);
```

```
Aeq(2+n:2*n+1,T+n+1:T+2*n)=nj*eye(n);
Aeq(2+n:2*n+1,T+3*n+1:T+4*n)=eye(n);
beq(1)=1;
beq(2:2*n+1)=0;
A=-A;
b=-b;
m = max(size(Y));
L = zeros(m,1);

for i=1:n
beq1=beq;
Aeq(1+i,T+n+i)=0;
Aeq(1+i+n,T+n+i)=0;
beq1(1+i)=1;
beq1(1+n+i)=-nj;
[x1,v1,exitflag1] = LINPROG(Y,A,b,Aeq,beq,L);
[x2,v2,exitflag2] = LINPROG(Y,A,b,Aeq,beq1,L);
if(v2<v1)
beq=beq1;
   x=x2;
fval=v2;
else
   x=x1;
fval=v1;
end
end
for j=1:n
xi(j)=x(j+T);
end

for j=1:n
q(j)=x(j+T+n);
end

for j=1:n
xi(j)=x(j+T);
end

for j=1:n
q(j)=x(j+T+n);
end
ind=find(xi>10^-10);
[txt(ind)'  num2cell(xi(ind)')]
sum(xi(ind))
xlswrite('BB.xls',[txt(ind)'  num2cell(xi(ind)')]);
xlswrite('Value_objective_BB.xls',fval )
```

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