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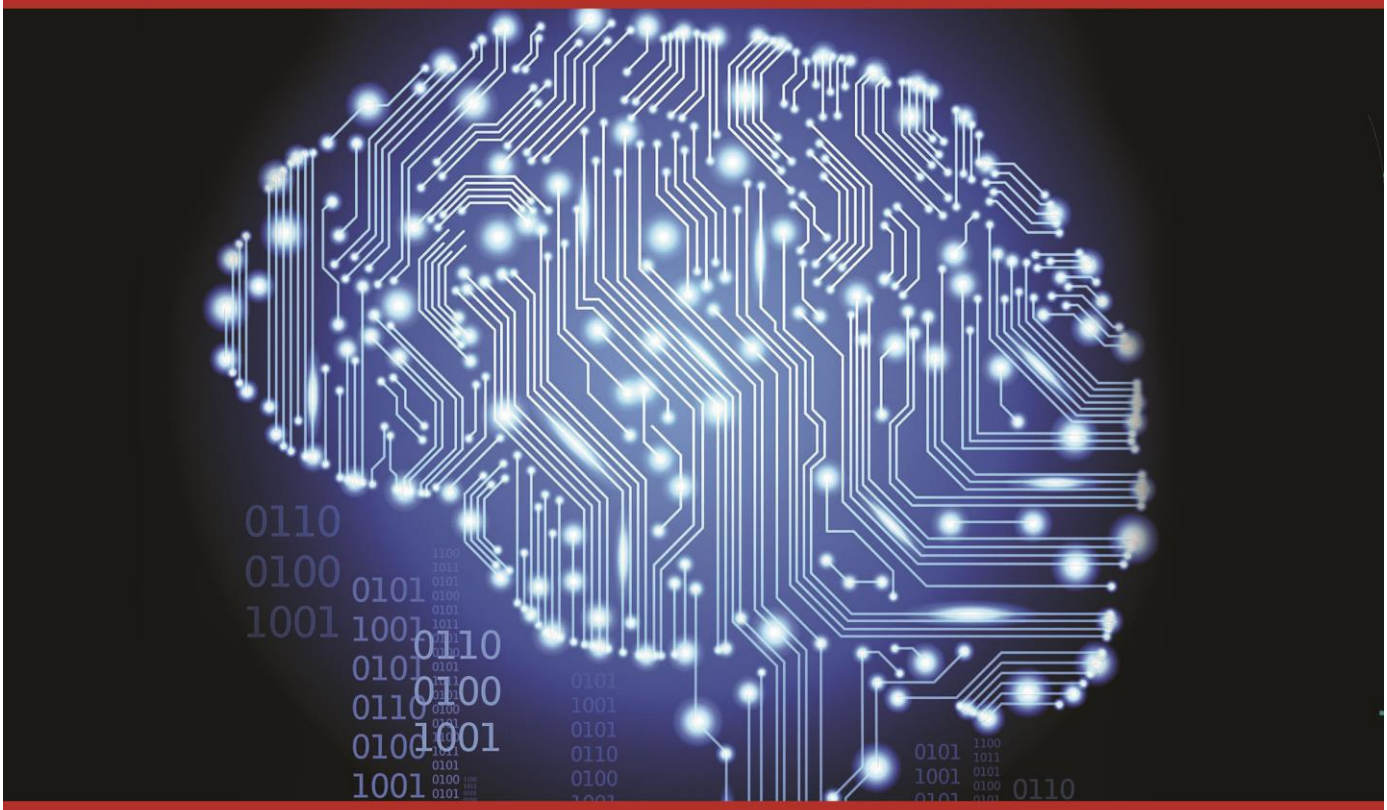

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Editorial Board

FOREWORD

I am pleased to put into the hands of readers Volume-3; Issue-11: Nov, 2017 of **"International Journal of Advanced Engineering, Management and Science (IJAEMS) (ISSN: 2354-1311)" ,** an international journal which publishes peer reviewed quality research papers on a wide variety of topics related to Science, Technology, Management and Humanities. Looking to the keen interest shown by the authors and readers, the editorial board has decided to release print issue also, but this decision the journal issue will be available in various library also in print and online version. This will motivate authors for quick publication of their research papers. Even with these changes our objective remains the same, that is, to encourage young researchers and academicians to think innovatively and share their research findings with others for the betterment of mankind. This journal has DOI (Digital Object Identifier) also, this will improve citation of research papers.

I thank all the authors of the research papers for contributing their scholarly articles. Despite many challenges, the entire editorial board has worked tirelessly and helped me to bring out this issue of the journal well in time. They all deserve my heartfelt thanks.

Finally, I hope the readers will make good use of this valuable research material and continue to contribute their research finding for publication in this journal. Constructive comments and suggestions from our readers are welcome for further improvement of the quality and usefulness of the journal.

With warm regards.

Dr. Uma Choudhary
Editor-in-Chief
Date: Dec, 2017

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Institutional and Program Self-Evaluation (IPSE): Towards Institutional Sustainability Assessment (ISA)

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Abstract*—Over the past years, quality assurance processes in education have become increasingly common and are steadily gaining in importance in all public and private higher education institutions. This, in turn, has brought about calls for greater accountability on the part of educational providers in measuring outputs or outcomes through quality assurance processes. Presently, the NONESCOST is continuously pursuing its quest for quality education as manifested by its International Certification on ISO 9001 and AACCUP Accreditation. With the recent challenge for all private and public HEIs on Institutional Sustainability Assessment (ISA), NONESCOST is taking its first step. Hence, this study was undertaken to ascertain the extent of compliance of the College to the Key Result Areas (KRAs) of ISA and its significant difference and relationship. Descriptive method was used in the study using the Self-Evaluation Document (SED) of the CHED-ISA administered to the College Officials and employees using purposive sampling technique. The study revealed that NONESCOST is greatly compliant as a whole and as to the five KRAs but the indicators were not fully met at a level of excellence that can be a model for others. A significant difference exist at 0.05 level for KRA1-Governance and Management, KRA2-Quality of Teaching and Learning, KRA3-Quality of Professional Exposure, Research and Creative Work, and KRA5-Relations with the Community. Further, no significant relationship exists between Governance and Management to; KRA2, KRA3 and KRA5 while a significant relationship exist between Governance and Management and KRA4: Support for Students.*

Keywords*—*Quality Assurance, Institutional Sustainability Assessment, Internal Quality Assurance, Key Result Areas.

I. INTRODUCTION

Quality Assurance has been gauged as a way higher education system, university or discipline monitors and assures the development of graduate attributes as one of the most influential drivers of effective implementation. The development, by graduates, of the types of abilities described as graduate attributes (GA), is perceived by many in universities and government agencies to be an important and useful outcome indicator of quality education.

With the exception of some disciplines which have already moved towards outcomes-based accreditation requirements, a relatively narrow range of quality assurance strategies is used about gradate attributes in some universities or colleges. Central to many institutional Quality Assurance (QA) strategies is the conduct of regular curriculum audit or mapping. This typically includes checking and verifying the provision of core "generic attributes" subjects or the mapping, based on the inclusion of GA in the teaching and assessment of subjects in the course curriculum. Hence, the focus of report QA strategies can range from claims of inclusion in subject learning outcomes, claims of inclusion in the curriculum, and claims of inclusion in assessment criteria or tasks.

According to Church [1] quality assurance is not about specifying the standards or specifications against which to measure or control quality. Rather, QA is about ensuring that there are mechanisms, procedures, and processes in place to ensure that the desired quality, however, defined and measured, is delivered.

Ruiz and Sabio [2] recognize quality assurance as the process of verifying whether products or services meet or exceed customer expectations. It is a process driven approach with specific steps to help define and attain goals. A quality assurance system in the case of university/college is said to increase student confidence and the university/college's credibility as provider of quality services to improve processes and efficiency and to enable a university/college to better compete with others. Quality assurance must become essential part of institutional management and planning. Higher education is changing

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and quality assurance processes must change with it, or become irrelevant. It is a process that takes time. Lemaitre [3] cited that quality assurance must be done with HEIs, learning to trust them and to help them improve themselves.

Higher education exerts considerable influence on the larger society. The concern for quality in the Philippine Higher Education is enunciated in the Section 1 of Article 14 of the 1987 Philippine Constitution [4] which provides that "the State shall protect and promote the right of all citizens to quality education at all levels". The enactment of Republic Act 7722 [5], otherwise known as the Higher Education Act of 1994 created the Commission on Higher Education (CHED) and directed it to promote and support higher education in the country. It further mandates CHED to monitor and evaluate performance of programs and institutions of higher learning.

According to Lagrada [6] it is the declared policy of the Commission to support and value the significant role of higher education institutions, academic community, and other stakeholders in establishing a quality assurance system for higher education sector. Institutional monitoring and evaluation for quality assurance is deemed complementary to accreditation.

The CHED 2009 Annual Report [7]mentioned that the Institutional Quality Assurance through Monitoring and Evaluation (IQuAME) which was issued through CHED Memorandum Order Nos. 15 and 16 [8], series of 2005 is a mechanism for monitoring and evaluating the outcomes of the programs, processes and services of higher education institution in the key area of quality of teaching and learning as supported by the governance and management, support students, relations with community and management of resources [2].

According to Castañeda [9] the IQuAME looks at the effectiveness of the institution in its entirety, particularly, the development of an institutional system that ensures the quality and standards of programs. IQuAME is a flagship program of CHED aimed at enhancing educational institution's capacity in designing, delivering and managing its programs and services, identify its areas for reform and intervention and ensure that quality learning outcomes are responsive to changing domestic needs and comparable to international standards.

In the Philippines, the Commission on Higher Education Strategic Plan 2011-2016 [10] highlights a program for quality and standards whose projects include setting and enforcement of Policies, Standards and Guidelines (PSGs) for academic programs, monitoring of compliance and phase out/closure of non-compliant programs, IQuAME, and accreditation. Likewise, CHED Memorandum Order No. 46, series of 2012 [11] on "Policy-Standard to Enhance Quality Assurance (QA) in Philippine Higher Education through an Outcomes-Based and Typology Based QA" was issued and implemented to private and public HEIs in the country to enhance quality assurance system of Philippine higher education through learning competency-based system of quality assurance that is differentiated by type of HEI.

It should be noted, however, that any internal QA system begins with the HEI's identity and commitment to enter a quality cycle of planning, implementing, reviewing, and enhancing programs, projects, and activities. The plan-do-check-act cycle or the Dehming Cycle is applied to the HEI's capacity to; 1)translate vision, mission, and goals into desired learning outcomes, 2) establish the proper learning environment (implementation of teaching-learning systems as well as support processes and procedures), 3) review against performance indicators and standards defined in the assessment system, and 4) enhance programs and systems.

Withthe challenge on Institutional Sustainability Assessment (ISA) to higher education institutions, NONESCOST is on the go and ready to embrace change. Hence, this study was undertaken to ascertain the extent of compliance of NONESCOST to the indicators or parameters of ISA.

II. STATEMENT OF THE PROBLEM

The purpose of the study was to ascertain the extent of compliance of NONESCOST to Institutional Sustainability Assessment parameters and indicators.

Specifically, the following problems were pursued by the study;what is the extent of compliance of NONESCOST to horizontal typology based QA when taken as a whole and when categorized as to Key Results Areas (KRAs) as;Governance and Management,Quality of Teaching and Learning,Quality of Professional Exposure, Research and Creative Work,Support for Students, and Relations with the Community; is there a significant difference on the extent of compliance categorized as to KRAs;is there a significant relationship on the extent of compliance between Governance and Management to; Quality of Teaching and Learning, Quality of Professional Exposure, Research and Creative Work, Support for Students, and Relations with the Community, and based on the findings of the study, what intervention is recommended.

HYPOTHESIS OF THE STUDY

There is no significant difference on the extent of compliance of NONESCOST to horizontal typology based QA when taken as a whole and when categorized as to Key

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Results Areas (KRAs) and there is no significant relationship on the extent of compliance between Governance and Management to; Quality of Teaching and Learning, Quality of Professional Exposure, Research and Creative Work,Support for Students, and Relations with the Community, at 0.05 level of significance.

III. METHODOLOGY

The descriptive method was used in the study since this primarily aims to ascertain the extent of compliance of NONESCOST to CHED-ISA's Horizontal Topology Framework using the standardized Self-Evaluation Document (SED) questionnaire.

Desk research was also used to hunt out information published by entities that are relevant to the study. The data available in published form were accessed from the Internet, Public Library, Foreign and Local Journals, Researches and other compiled sources. Similarly, field research was also used in the study because it involves fieldwork in collecting primary data.

Evaluation and Respondents of the Study

The respondents of the study were the vice presidents, directors, deans and chairpersons, internal accreditation body/members, internal quality auditors, program or academic coordinators, research coordinators, extension coordinators, unit heads and the support to operation personnel. These respondents were selected since they have the good grasp of the operations of the college in relation to systems and processes or mechanisms in the performance of their functions, duties and responsibilities to the school. Table 1 below is the summary of respondents.

Table.1. Summary of Respondents of the Study

Categories	Population	Sample Size	%age
VPAA	1	1	2
Directors	5	5	7
Deans/Chairpersons	9	9	16
IAB	11	11	19
IQA	1	1	2
Program/Academic Coordinators	3		5
Research Coordinators	9	9	16
Extension Coordinators	9	9	16
Unit Heads/Support to Operations	10	10	17
Total	58	58	100

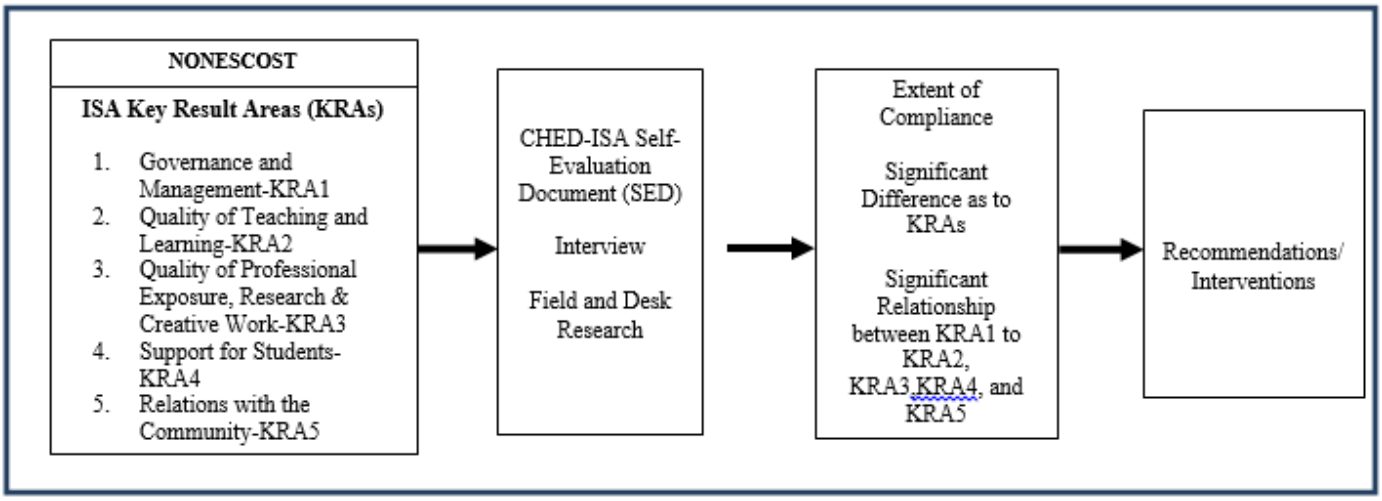

Fig.1: Schematic Diagram Illustrating the Conceptual Framework of the Study

The researcher used purposive sampling technique in determining the sample size of the study. This sampling was used since it has direct and substantial bearing to the KRAs, parameters and indicators of the ISA. To achieve the objectives set forth under the statement of the problems, the researcher adopted the following instruments and/or strategies in the collection of data; CHED-ISA SED, interview, field and desk research and observation.

The Self-Evaluation Documents (SED) questionnaire has five (5) key result areas such as; KRA1-Governance and Management; KRA2-Quality of Teaching and Learning; KRA3-Quality of Professional Exposure, Research and Creative Work; KRA4-Support for Students; and KRA5-Relations with the Community. Core, required, and optional indicators in all KRAs including parameters of evaluation are also provided. Each item is rated in a scale of

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0, 1, 2, 3, and 4 where 0-means the criterion/criteria is/are not met, 1- the criterion/criteria for the indicator is/are met in some respects, but much improvement is needed to overcome weaknesses, 2- the criterion/criteria for the indicator is/are met in most respects, but improvement is needed to overcome weaknesses in some elements, 3- the criterion/criteria for the indicator is/are met, with most elements demonstrating good practice, and 4- the criterion/criteria for the indicator is/are fully met, and its elements are achieved at a level of excellence that provides a model for others.

The SED questionnaire was personally distributed and administered by the researcher to the respondents. These respondents were given adequate time to answer the questionnaire. Instructions are stated in the questionnaire for the respondents to completely and thoroughly answer each item. Since the respondents are all professionals, it is deemed that all items are answered. After a week or two the researcher personally retrieved the accomplished questionnaires and have it ready for tabulation and analysis.

An interview with the administrators of the four-fold functions of the college and observation of the school system, processes and mechanismswere also done to assess the schools' operations and implementation. The actual observation also validated the responses of the respondents on the items stipulated in the questionnaire.

After the data were collected the researcher processed it into an order and form that allows statistical tabulation and facilitates analysis and interpretation. The hypotheses postulated for the problems formulated in the study were tested in the following manner.

Data Processing and Statistical Treatment

To determine the extent of compliance of NONESCOST to horizontal typology based QA when taken as a whole and when categorized as to Key Results Areas (KRAs), the mean was used.On the other hand, to determine the significant difference on the extent of compliance categorized as to Key Results Areas (KRAs), the ANOVA was used.Likewise, to determine the significant relationship on the extent of compliance between Governance and Management to; Quality of Teaching and Learning, Quality of ProfessionalExposure, Research and Creative Work, Support for Students, and Relations with the Community, the Pearson R Correlation Coefficient was used.

IV. RESULTS AND DISCUSSION

The implementation of QA mechanisms are geared towards addressing the needs of the stakeholders for quality services towards the delivery of academic and non-academic services. That while educational institutions implement QA system and processes it should also ensure that these system and processes lead to the attainment of the organizational outcomes, in particular and the attainment of the national development goals, in general. Table 2 shows the mean and verbal interpretation on the extent of compliance of NONESCOST to horizontal typology-based QA when taken as a whole and when categorized as to KRAs.

Table.2: Mean and Verbal Interpretation on the Extent of Compliance of NONESCOST to Horizontal Typology-Based QA when taken as a whole and when categorized as to KRAs.

CHED-ISA KRAs	Mean	Std. Deviation	Verbal Interpretation
Governance and Management	2.70	.16180	**Greatly Compliant** The criterion/criteria for the indicator is/are met, with most elements demonstrating good practice.
Quality of Teaching and Learning	2.64	.17676	
Quality of Professional Exposure, Research and Creative Work	2.59	.14193	
Support for Students	2.65	.24531	
Relations with the Community	2.71	.13414	
As a Whole	2.66		

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Table.3: Significant Difference on the Extent of Compliance of NONESCOST to the Key Results Areas (KRAs) of Horizontal Typology-Based QA.

(I) KRA's	(J) KRA's	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Governance and management	quality of teaching and learning	.05700*	.02687	.035	.0041	.1099
	quality of prof exposure research and creative work	.10787*	.03426	.002	.0404	.1753
	support for students	.04128	.03296	.211	-.0236	.1062
	relations with the community	-.01672	.03789	.659	-.0913	.0579
quality of teaching and lea rning	governance and management	-.05700*	.02687	.035	-.1099	-.0041
	quality of prof exposure research and creative work	.05087	.03346	.130	-.0150	.1167
	support for students	-.01572	.03213	.625	-.0790	.0475
	relations with the community	-.07372*	.03717	.048	-.1469	-.0006
quality of prof exposure research and creative work	governance and management	-.10787*	.03426	.002	-.1753	-.0404
	quality of teaching and learning	-.05087	.03346	.130	-.1167	.0150
	support for students	-.06658	.03852	.085	-.1424	.0092
	relations with the community	-.12458*	.04281	.004	-.2089	-.0403
support for students	governance and management	-.04128	.03296	.211	-.1062	.0236
	quality of teaching and learning	.01572	.03213	.625	-.0475	.0790
	quality of prof exposure research and creative work	.06658	.03852	.085	-.0092	.1424
	relations with the community	-.05800	.04178	.166	-.1402	.0242
relations with the community	governance and management	.01672	.03789	.659	-.0579	.0913
	quality of teaching and learning	.07372*	.03717	.048	.0006	.1469
	quality of prof exposure research and creative work	.12458*	.04281	.004	.0403	.2089
	support for students	.05800	.04178	.166	-.0242	.1402

*. The mean difference is significant at the 0.05 level.

The study revealed that NONESCOST is greatly compliant to horizontal typology-based QA as a whole and in the five KRAs. While it showed that it meets the criterion/criteria for the indicator it reflects that the criteria for the indicators are not fully met and that its elements at\re not achieved at a level of excellence that provides a model for others. Hence, QA mechanisms should be revisited, evaluated, and improved to ensure full compliance. Further, these QA mechanisms should be considered for convergence such that it cut across all levels of the organizational processes and units.

The QA mechanisms allow HEIs to streamline processes as it provides control to ensure that non-conforming processes or services are reviewed and evaluated for effectiveness.

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Table 3 showed the significant difference on the extent of compliance of NONESCOST to the five KRAs of horizontal typology-based QA. The study revealed that a significant difference exist at 0.05 level for the four key results areas, namely; Governance and Management, Quality of Teaching and Learning, Quality of Professional Exposure, Research and Creative Work, and Relations with the Community. It is at this instance where HEI should consider the intertwining mechanisms approach to ensure consistency of quality assurance systems or processes across different functions.

The success of the implementation of any Quality Assurance mechanisms is sometimes attributable to the kind of governance, management and support the educational institutions have to its academic and non-academic services and/or functions, if not often times.

Hence, it is necessary to underpin if indeed there is causal-effect relationship between governance and management to other KRAs.

Table 4-7 showed the significant relationship on the extent of compliance between Governance and Management to; Quality of Teaching and Learning, Quality of Professional Exposure, Research and Creative Work, Support for Students, and Relations with the Community.

The study revealed that no significant relationship exist between Governance and Management to; Quality of Teaching and Learning, Quality of Professional Exposure, Research and Creative Work, and Relations with the Community. While a significant relationship exist between Governance and Management and Support for Students at 0.05 level.

Table.4: Significant Relationship between Governance and Management and Quality of Teaching and Learning

		governance and management	quality of teaching and learning
governance and management	Pearson Correlation	1	-.090
	Sig. (2-tailed)		.424
	N	81	81
quality of teaching and learning	Pearson Correlation	-.090	1
	Sig. (2-tailed)	.424	
	N	81	94

Table.5: Significant Relationship between Governance and Management and Quality of Professional Exposure, Research and Creative Work

		governance and management	quality of professional exposure, research and creative work
governance and management	Pearson Correlation	1	-.197
	Sig. (2-tailed)		.223
	N	81	40
quality of professional exposure, research and creative work	Pearson Correlation	-.197	1
	Sig. (2-tailed)	.223	
	N	40	40

Table.6: Significant Relationship between Governance and Management and Support for Students

		governance and management	support for students
governance and management	Pearson Correlation	1	.296*
	Sig. (2-tailed)		.048
	N	81	45
support for students	Pearson Correlation	.296*	1
	Sig. (2-tailed)	.048	
	N	45	45
*. Correlation is significant at the 0.05 level (2-tailed).			

Table.7: Significant Relationship between Governance and Relations with the Community

		governance and management	relations with the community
governance and management	Pearson Correlation	1	.354
	Sig. (2-tailed)		.055
	N	81	30
relations with the community	Pearson Correlation	.354	1
	Sig. (2-tailed)	.055	
	N	30	30

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V. CONCLUSIONS AND RECOMMENDATIONS

Based on the aforementioned findings derived from the study, the following conclusions were drawn:

The extent of compliance of NONESCOST to the horizontal typology-based QA is greatly compliant when taken as a whole and as to key results areas. Hence, the College met the criterion/criteria for the indicators of the CHED ISA with most elements demonstrating good practice. However, while the criterion/criteria, the parameters and indicators of the five key results areas of the horizontal typology-based QA are met it provides evidence that these criteria, parameters and indicators of QA mechanisms are not fully met to achieve a level of excellence (quality) that can be modeled by other HEIs.

There is significant difference at 0.05 level on the extent of compliance of the four key results areas, namely; governance and management, quality of teaching and learning, quality of professional exposure, research and creative work, and relations with the community. The existence of the significant difference to the four key results areas is a strong evidence of inconsistency on the implementation of the Quality Assurance system and processes.

There is no significant relationship between governance and management to; quality of teaching and learning, quality of professional exposure, research and creative work, and relations with the community, while a significant relationship exist between governance and management and support for students at 0.05 level. This significant relationship showed that student supports and strong student governance is necessary and should be enliven.

Based on the findings and conclusions derived from this investigation, the following recommendations were set;

Centralized Quality Assurance structure may be established which shall include infrastructure, human resource and set up, budget prioritization, quality assurance plan and programs while considering the mapping of other QA frameworks and/or models.

QA mechanisms may be regularly revisited, reviewed, evaluated, and improved for effectiveness to ensure full compliance across QA frameworks/models. Further, these QA mechanisms may be considered for convergence such that it cut across all levels of the organizational processes and units.

Organizational Diagnosis (Preziosi) that covers the variables such as; purposes, structure, relationships, rewards, leadership, helpful mechanisms and attitude toward change may be undertaken to ensure organizational development.

NONESCOST may consider the intertwining mechanisms approach to ensure consistency of quality assurance system or mechanisms across different functions.

A more focus and functional student-related academic and non-academic programs may be provided for to ensure total growth and development of students. Further, very functional and dynamic student governance may be considered for planning and decision-making.

QA policy manual and QA job manuals may be considered as policy guidelines to ensure sustainability of quality processes.

Continuous capability-building program for all employees on QA mechanisms may be crafted, implemented, regularly reviewed, revised and evaluated to program employees on Quality Assurance as a way of life.

The development and installation of document tracking system and records management and keeping mechanisms may be considered for data banking and/or data mining.

Research-based or need-based extension Programs, Projects and Activities (PPAs) that provide entrepreneurial activities or income generation may be provided to create significant impact or dramatic change in the quality of life of the communities.

Impact assessment on the extension and on the student-related academic and non-academic PPAs of our SUC may be conducted to evaluate its effectiveness and suitability and improved, when necessary.

Quality Assurance research using other QA frameworks or models may be done to align other QA mechanisms.

Mock ISA visit assessment may be conducted to determine ensured compliance and shall include post hoc test to determine improvement of the different KRAs.

Mock ISA visit assessment results may be used as basis for CHED ISA visit application to determine the College's horizontal typology.

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Effect of Satisfaction on Customer Loyalty in Bimbel Tiki Taka Bekasi Indonesia

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Abstract**—** *This study aims to determine whether there is influence on customer loyalty limb bimbelTiki Taka Harapan Indah Bekasi and how much influence on loyalty customers.The research was conducted at the Tiki Taka Harapan Indah Bekasi. The method used is the library reseach and field reseach data collection using questionnaires with a population of 45 people from the total number of parents enrolled students, obtained a sample of 31 people.*

The result of linear regression test is a = 20,55, b = 0,57, y = 20,55 + 0,57x. The result of correlation coefficient is r = 0.57. The percentage of influence satisfaction on customer loyalty amounted to 32.49% while the rest of 67.51% influenced by other factors not involved in this study.Test t count 3.74 and t table for n = 31 with degrees of freedom (dk) is n-2 = 29 with error rate 5% (0.05) is 2.045. From the above value is known that t arithmetic 3.74> of t table 2.045 then Ha accepted and Ho rejected. It means that based on data research results then there is Influence between satisfaction with customer loyalty at BimbelTiki Taka Harapan Indah Bekasi.

Keywords— Customer Satisfaction and Loyalty.

I. INTRODUCTION

Increasing awareness of many parents to provide additional lessons to their sons and daughters outside of school hours makes learning guidance effort (bimbel) more promising. Many parents put their sons and daughters into learning counseling institutions in the hope that lessons learned in schools are increasingly overwhelmed by additional tutoring lessons.The rise of the current guidance counseling effort makes all the bimbel race to create strategies that can make customers satisfied and at the same time attract new customers. Business opportunities in the field of education outside the school is very promising this makes more and more peminatnya.Semakin high enthusiasts this business makes the similar business competition increasingly fierce. Customer satisfaction must be a priority in order to retain customers so that will bring a high loyalty to the business guidance learning.

loyalty is very important in maintaining and in an effort to attract new customers. Customers are expected to always be able to survive in one bimbel not move to other guidance and the loyal customers are expected to be able to recommend and voice their sense of satisfaction to others so that this would be a promotion of mouth mouth which has a high success rate in attracting new customers.One of the guardians who participated in the competition is the tutoring Tiki Taka Harapan Indah Bekasi.Seiring with the passage of time the number of students in the guidance Tiki Tiki Harapan Indah mengalamai instability. Whether the customer is satisfied or not so that customers can remain loyal in bimbel Tiki Taka Harapan Indah this need to be held research.

II. LITERATURE REVIEW

1. Customer Satisfaction

Offer will work well if it gives value and satisfaction to the customer. Therefore a business must be keen to see customer satisfaction because the more fierce level of competition in similar businesses. Quoting from Kotler and Keller's words that satisfaction reflects one's judgment about the product's perceived performance (or outcome) in relation to expectations. If the performance of the product does not meet expectations, the customer is dissatisfied and disappointed. If the product performance matches expectations, the customer is satisfied. If the product performance exceeds expectations, the customer is happy.

To survive and grow in an enterprise should be oriented to the customer not only the product because the customer is the main reason a business can still run. Whether a customer is satisfied after enrolling in a bimbel or disappointed depends on the performance of the offer in relation to customer expectations. Expectations come from past purchasing experience, friend and peer advice and marketing and competitors' information and promises. If the company sets expectations too low, the company will not attract enough buyers. If marketers raise high expectations, buyers will be disappointed (kotler and keller).

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Customer satisfaction is the best way to keep them from moving to other guides and loyal customers are expected to be able to recommend and voice their sense of satisfaction to others so it will be a mouth-to-mouth promotion that has a high level of success in attracting new customers.

Paul J. Peter and Jerry C. Olson revealed that: In theory, if consumers are satisfied with products, services, or brands, they are more likely to continue to buy and tell others about the experience that benefits them with the productGary Armstrong and Phillip Kotler also agree with Peter and Olson: Customers whose expectations of value and satisfaction about the various markets will order and buy directly. Satisfied customers will buy again and tell others about their good experiences.

So it can be interpreted that customer satisfaction here is the first key to make customers become loyal or loyal to keep using products / Services. Customer satisfaction lies in how a company provides maximum service and different from competitors in providing services or to customers as they wish.

In measuring customer satisfaction David L. Kurtz argues thatSatisfaction can be measured in terms of the gap between what customers expect and what they perceive they have receivedFrom the above theory can be concluded that the actual satisfaction can be measured, by looking at customer expectations of a product and how the company meets those expectations. According to John W. Mullins and Orville C. Walker, JR. also suggests that:

Measuring customer satisfaction should check

(1) customer expectations and preferences regarding the various dimensions of product and service quality (such as product performance, features, reliability, timely delivery, service competencies, etc.).

(2) their perception of how well the companies meet their expectations. any gaps in which customer expectations exceed their recent experience can indicate fruitful areas for the company to work to increase customer value and satisfaction)

According to Irawan (2002), one of the founders of Indonesia Customer Satisfaction Award (ICSA) and initiator of the idea of National Customer Day 2003, there are five driving factors that make customers feel satisfied:

1. Quality of product
2. Price
3. Quality of service (service quality)
4. Emotional factors (Emotional factor)
5. Related to the cost and ease to get the products and services

O.C Ferrell and Michael D. Hartline say that there are several things that marketers can do to manage customer satisfaction in their marketing efforts, including:

1. Understand what can go wrong
2. Focus on controlled issues
3. Manage customer expectations
4. Offer satisfaction guarantee
5. Make it easy for customers to complain
6. Create a relationship program
7. Make customer priority satisfaction measurement in progress

O.C Ferrell and Michael D. Hartline also revealed that fully satisfied customers include:

1. It is more likely to be a loyal customer or even advocate for a company
2. Lack of propensity to explore alternative suppliers
3. Less sensitive to price
4. Lack of tendency to switch to competitors
5. More likely to spread good word of mouth about the company and its products

From the above opinion it can be concluded that customer satisfaction is a feeling of pleasure that immediately felt by the customer when customer expectations of a product are met or even exceed customer expectations. When a customer feels satisfied then the customer can re-purchase again even the customer will share a pleasant experience to their relatives for the results that satisfy him after consuming the product.

2. Customer loyalty

2.1. Define customer loyalty

The decision of the customer to be loyal or loyal is the accumulation of the many small problems in the company. Creating a good and close relationship with customers will be the key to long-term marketing success. Gramer and Brown in Utomo say Loyalty (loytalitas services), ie the degree to which a consumer shows the repetitive buying behavior of a service provider, poses a positive attitude or attitude towards service providers, and only considers using these service providers when the need arises to use this service.

According to Revelation Nugroho (2005) consumer loyalty is defined as a measure of loyalty of customers in using a brand product or service brand at a certain time in situations where many choices of products or services that can meet their needs and customers have the ability to get it.

2.2. Factors Affecting Consumer Loyalty

Marconi (in Priyanto Doyo 1998) mentions that the factors that affect a product or service are as follows:

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1) Value (price and quality),
2) Image (both of the personality it possesses and the reputation of the brand)
3) Convenience and ease to get the product / service
4) Satisfaction felt by consumers
5) Services,
6) Warranty and guarantee

Furthermore Griffin (2003) suggests the benefits that will be obtained if the company has a loyal customer, among others:

1. Reduce marketing costs (because the cost to attract new customers is more expensive).
2. Reduce transaction costs (such as contract negotiation fees, order processing, etc.).
3. Reduce the cost of turn over customers (due to fewer customer turnover).
4. Increase cross selling that will enlarge the company's market share.
5. Word of mouth is more positive with the assumption that loyal customers also mean those who are satisfied.
6. Reduce the cost of failure (such as replacement cost)

According to Giddens (2002) consumers who are loyal to a product have characteristics:

1) Have a commitment to the product.
2) Dare to pay more on the product when compared with other products.
3) Will recommend the product to others.
4) In the purchase of the product does not make consideration.
5) Always follow the information related to the product.
6) They can be a kind of spokesperson of the product and they always aredevelop a relationship with the product.Here are four types of marketing activities that can be used to increase loyalty and referrals by Kotler and Keller:

1. Interacting with customers
2. Develop customer loyalty program
3. Personalize marketing
4. Creating institutional ties and winning back customers in a way.

Reactivate unsatisfied customers through a winning strategy.

III. RESEARCH METHODOLOGY

The method used is the method of Library Studies (library reseach) by way of mengumulkan data from various literature in the form of book books, diktat lectures etc. and field studies (field reserch) by way of interview and dissemination Quisioner. The population in the study were parents of students / customers who have registered in the guidance Tiki Taka amounted to 45 people and a sample of 31 people. Technique of data analysis from 2 variables that have known that free variable (x) is satisfaction and dependent variable (y) is customer loyalty calculated by using simple linear regression, correlation coefficient analysis, coefficient of determination and hypothesis test.

IV. RESULT

The results of the research are:

$\Sigma x = 1105$, $\Sigma y = 1278$, $\Sigma x2 = 39959$, $\Sigma y2 = 53266$, $\Sigma xy = 45885$, and $N = 31$.

Linear regression analysis is a = 20.55, b = 0,57, y = 20,55 + 0,57xThe result of correlation coefficient of r = 0.57 then the value of correlation coefficient between satisfaction with customer loyalty at Bimbel Tiki Taka of 0,57.Based on determination coefficient analysis of 32.49% note that the percentage of influence satisfaction on customer loyalty of 32.49% while the rest of 67.51% influenced by other factors not involved in this study.

Test t count 3.74 and t table for n = 31 with degrees of freedom (dk) is n-2 = 29 with error rate 5% (0.05) is 2.045. From the above value is known that t count 3.74> from table 2.045 then Ha accepted and Ho rejected. It means that based on the data of research results then there is influence between satisfaction with customer loyalty at Bimbel Tiki Taka Harapan Indah Bekasi.

V. CONCLUSION

1. Linear Regression Analysis Y = 20.55 + 0.57 X, which means that if customer satisfaction experienced an increase, then customer loyalty will also increase, on the contrary customer satisfaction decreased then customer loyalty also experienced a decline.
2. From the results of analysis conducted in know that satisfaction has a significant effect on customer loyalty with r = 0,573. In Determination coefficient test of 32.49%, satisfaction has an influence on customer loyalty of 32.49% while the rest is influenced by other factors factors4. Test T arithmetic is 3, 74 and T table for n = 31 is 2.045 then t arithmetic> t table then HO rejected and HA accepted, means there is influence satisfaction on customer loyalty

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Development of a Solar Drier for Domestic Applications

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Abstract— *The solar drying system utilizes solar energy to heat up air and to dry small scale domestic produce like grain, omena, vegetables etc. This is beneficial in reducing wastage and hence preservation of agricultural products as well as increasing affordability by the local population who naturally cannot afford the higher cost of mechanical driers. This study presents the design, construction and performance of solar grain dryer. In the dryer, the heated air from a separate solar collector is passed through a grain bed, and at the same time, the drying cabinet absorbs solar energy directly through the transparent walls and roof. Tests carried out on the drier showed that the temperatures inside the dryer and the solar collector were much higher than the ambient temperature during most hours of the daylight. The temperature rise inside drying cabinet was up to 24°C (74%) for about three hours immediately after 12.00h (noon). This indicates better performance compared to open sun drying.*

Keywords—Drier, grains, Solar, Temperature.

I. INTRODUCTION

The purpose of drying agricultural produce is to reduce moisture content so that it can be processed safely and stored for increased periods of time [1]. It is estimated that substantial amount of the world‘s grain production is lost after harvest because of inefficient handling and poor implementation of post-harvest technology. Most grains are sun-dried on the ground, but this process is slow and ineffective because it takes more time to achieve a desired results as well as being unhygienic due to general exposure to the environment.

Solar drying of agricultural produce by forced convection in enclosed structures is one of effective ways of reducing post-harvest losses as well as low quality of dried products associated with the normal traditional open sun drying methods [2]. In most developing nations and especially their rural locations, grid-connected electricity or supplies of any other non-renewable energy sources may be unavailable, too expensive or unreliable. In such circumstances, solar dryers become increasingly attractive as commercial alternatives [3]; [4].

Passive dryers can be applied better for drying small batches of grains as well as fruits and vegetables such as Mangoes, bananas, pineapple, potatoes, carrots etc. [5]

II. DESIGN AND CONSTRUCTION

The materials used for the construction of the solar dryer were obtained locally and cheaply. The essential materials included: *Well-seasoned wood, transparent glass, wire mesh, aluminium sheet, black paints, pairs of screws, welding rods, SHS metal (square hollow section) ordinary steel, nails and water proof glue*

AutoCAD and Civil 3D was used in initial design and analysis of the design. The final design was achieved by fabrication. The fabrication process entailed arc welding for solar grain dryer stand, screwing of the solar cabinet and solar collector. The main parts of the solar dryer included: *The drying cabinet, The solar collector. The stand, the drying trays for grain loading*

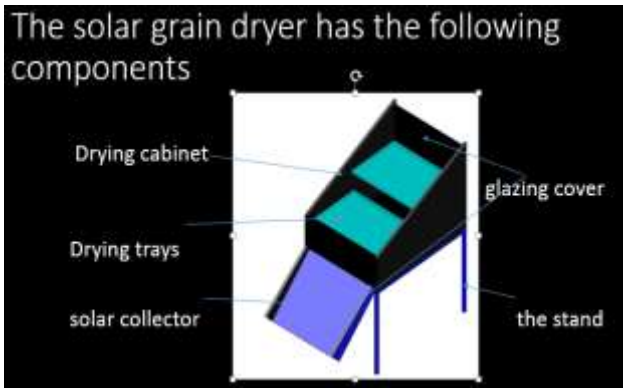

Fig. 3.1: isometric view solar grain drier

i. The drying cabinet

The drying cabinet was made of a well-seasoned wood well fitted by screws with a glazing cover plate.

Inside the cabinet are the drying trays. The cabinet was painted black from inside.

The drying cabinet together with the structural frame of the dryer was built from well-seasoned woods which could withstand termite and atmospheric attacks. An outlet vent was provided towards the upper end at the back of the cabinet to facilitate and control the convection flow of air through the dryer. Access door to the drying chamber was also provided at the back of the cabinet. The top of the cabinet was covered with glass for direct sunlight drying.

ii. The solar collector

It had a simple design, it entailed the cover glazing was made of glass, the absorber plate was made of aluminium

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sheet metal painted black. Also, it was insulated all round with wood. The solar collector had two openings, hence, $A_1V_1 = A_2V_2$ applying flow rate in a reducing bush in fluid mechanics.

The heat absorber (inner box) of the solar air heater/collector was constructed using 1mm thick aluminum plate, painted black, was mounted in an outer box built from well-seasoned woods. The solar collector assembly consists of air flow channel enclosed by transparent cover (glazing). An absorber mesh screen midway between the glass cover and the absorber back plate provides effective air heating because solar radiation that passes through the transparent cover is then absorbed by both the mesh and back-plate. The glazing is made of a single layer of 3 mm thick transparent glass sheet; it has a surface area of 0.2675 m^2 and transmittance above 0.7 for wave lengths in the rage 0.2 – 2.0 μm and opaque to wave lengths greater than 4.5 μm. The effective area of the collector glazing is 0.2675m^2. One end of the solar collector has an air inlet vent of area 0.056 m^2 which was covered by a wire mesh to prevent entrance of rodents.

iii. The stand

The stand of the grain dryer was made of ordinary steel tube (square hollow section) which had desired strength for that purpose.

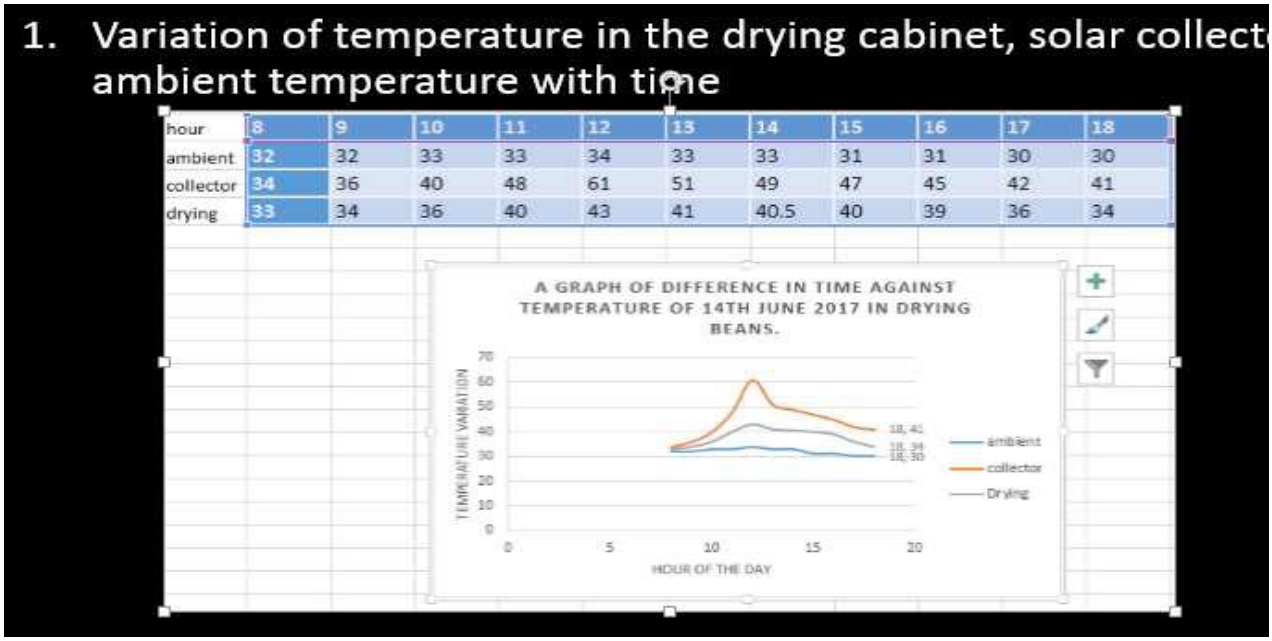
iv. Drying trays

The trays had a simple design. They were made of a layer of wire mesh mounted on a wooden framing.

The dryer is a passive system in the sense that it has no moving parts. It is energized by the sun‘s rays entering through the collector glazing. The trapping of the rays is enhanced by the inside surfaces of the collector that were painted black and the trapped energy heats the air inside the collector. The greenhouse effect achieved within the collector drives the air current through the drying chamber. If the vents are open, the hot air rises and escapes through the upper vent in the drying chamber while cooler air at ambient temperature enters through the lower vent in the collector. Therefore, an air current is maintained, as cooler air at a temperature T_{inlet} enters through the lower vents and hot air at a temperature T_{outlet} leaves through the upper vent.

III. RESULTS AND ANALYSIS

A solar drier was fabricated complete with required specifications before testing temperatures variations in solar collector and drying cabinet as compared to the ambient temperature. It was established that; The dryer is hottest about mid-day when the sun is usually overhead. The temperatures inside the dryer and the solar collector were much higher than the ambient temperature during most hours of the daylight. The temperature rise inside drying cabinet was up to 24ºC (74%) for about three hours immediately after 12.00h (noon). This indicates better performance compared to open sun drying.



hour	8	9	10	11	12	13	14	15	16	17	18
ambient	32	32	33	33	34	33	33	31	31	30	30
collector	34	36	40	48	61	51	49	47	45	42	41
drying	33	34	36	40	43	41	40.5	40	39	36	34

Fig. 3.1: Variations of Temp in the drying cabinet, solar collector and ambient temperature with time

IV. CONCLUSION

From the test done, it can concluded that the solar dryer can raise the ambient air temperature to a higher considerable value for drying agricultural crops. The hourly variation of the temperatures inside the cabinet and air-heater are much higher than the ambient temperature during the most hours of the day-light. The temperature rise inside the drying cabinet was up to 24ºC (74%) for about three hours immediately after 12.00h (noon). The dryer exhibited sufficient ability to dry agricultural

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produce reasonably rapidly to a safe moisture level and simultaneously it ensures a superior quality of the dried product. In addition the products inside the dryer required less attentions, like attack of the product by rain or pest (both human and animals), compared with those in the open sun drying. Although it was used to dry grain, the drier can also be used in other crops like yams, cassava and plantain and other food products e.g. Omena. There is ease in monitoring when compared to the natural sun drying technique. The capital cost involved in the construction of a solar dryer was much lower to that of a mechanical dryer because of use of locally available materials.

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Influence over the Dimensionality Reduction and Clustering for Air Quality Measurements using PCA and SOM

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Abstract—*The current trend in the industry is to analyze large data sets and apply data mining, machine learning techniques to identify a pattern. But the challenges with huge data sets are the high dimensions associated with it. Sometimes in data analytics applications, large amounts of data produce worse performance. Also, most of the data mining algorithms are implemented column wise and too many columns restrict the performance and make it slower. Therefore, dimensionality reduction is an important step in data analysis. Dimensionality reduction is a technique that converts high dimensional data into much lower dimension, such that maximum variance is explained within the first few dimensions.*

This paper focuses on multivariate statistical and artificial neural networks techniques for data reduction. Each method has a different rationale to preserve the relationship between input parameters during analysis. Principal Component Analysis which is a multivariate technique and Self Organising Map a neural network technique is presented in this paper. Also, a hierarchical clustering approach has been applied to the reduced data set. A case study of Air quality measurement has been considered to evaluate the performance of the proposed techniques.

Keywords *— **Air Quality Dimensionality reduction, Hierarchical Clustering,Principal Component Analysis, Self Organising Maps.***

I. INTRODUCTION

Multivariate Statistical Analysis is useful in the case where data is of high dimension. Since human vision is limited to 3 dimensions, all application above 2 or 3 dimension is an ideal case for data to be analyzed through Multivariate Statistical Analysis (MVA). This analysis provides joint analysis and easy visualization of the relationship between involved variables. As a result, knowledge that was unrevealed and hidden among vast amounts of data can be obtained. PCA is a powerful multivariate technique in reducing the dimension of data set and revealing the hidden relationship among the different variables without losing much of information [1].

Artificial Neural Network (ANN) is an information processing computational model based on biological neural networks and is composed of several interconnected processing elements (neurons) that work in parallel to solve a generic problem. In general ANN are used to identify complex relations between input and output or to find patterns in a given data set. ANN is an adaptive system that can change its structure based on the flow of information through the network during the training phase.

The two important learning paradigms in ANNs are supervised learning and unsupervised learning. In supervised learning, there exists a training data that helps in the construction of the model by specifying classes and by providing positive and negative objects that belong to those classes. In unsupervised learning, there is no preexisting taxonomy and the algorithm classifies the output into different classes. Kohonen's Self Organising Map is an unsupervised learning technique that reduces a high dimensional data into a 2 dimensional space. This reduction in dimensionality helps in understanding the relationship quickly and also SOM provides better visualization of components [2].

The rest of the paper is organized as follows. Section 2 discusses related work and their findings. Section 3 briefly explains the existing Principal Component Analysis and Self Organising Map techniques used in our work. Section 4 consists of a case study on air quality to evaluate the performance of the proposed techniques, along with expected results. Finally the concluding points are given in section 5.

II. RELATED WORK

Some of the related work pertaining to Principal Component Analysis and Self Organising Maps are discussed in this section. In [3] multivariate analysis used to analyze and interpret data from a large chemical process. PCA was used to identify correct correlations between the variables to reduce the dimensionality of

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process data. In [4] Multivariate Statistical Analysis is applied for Dermatological Disease Diagnosis. There are few diseases like psoriasis, seborrhoeic dermatitis, lichen planus, pityriasis, chronic dermatitis and pityriasis rubra piaris in dermatology that share the same clinical features. PCA is applied to identify the relationship between 12 clinical attributes and the circle of correlations depicts patterns of variable associations. Monitoring abnormal changes in the concentration of ozone in the troposphere is of great interest because of its negative influence on human health, vegetation and materials. Modeling ozone is very difficult because formation mechanisms in troposphere are very complex and adding to it is the uncertainty regarding the meteorological condition in urban areas. PCA is used as a data detection method for highly correlated variables in [5]. PCA was applied for the yeast sporulation data for simplification of analysis and visualization of gene expression data. Data was collected for 7 different gene expressions over time and it was observed that much of variability was explained within first two principal components in [6].

In [7] both principal component analysis and self-organizing has been applied to classify and visualize fire risks in forest regions. On application of PCA first two principal component has explained most of the variance but SOM was successful in effective visualization and clustering of nodes to depict fire risks. In [8] PCA, cluster analysis and SOM was applied to a large environmental data set to assess the quality of river water. The results indicated the power of classification of SOM when compared to other traditional methods. In [9] Forest Inventory (FI) contains useful information on forest conditions. To interpret such large data sets, SOM technique is applied that helps in fast and easy visualization, analysis of multidimensional data sets. In [10] PCA and SOM was applied in cellular manufacturing system for visual clustering of machine-part cell formation. PCA was used for reducing the dimensionality of data set and was projected on to 2 dimensional space. The unsupervised SOM technique was applied for data visualization and also to solve the problem of cell formation. In [11] SOM was applied to complex geospatial datasets for knowledge discovery and information visualization. The dataset consisted of socio economic indicators mapped to municipalities in Netherlands. By the application of SOM, structure and patterns of dataset was uncovered and graphical representation helped in discovery of knowledge and better understanding.

III. EXISTING TECHNIQUES

Multivariate Statistical Analysis is useful in the case where data is of high dimension. Since human vision is limited to 3 dimensions, all application above 2 or 3 dimensions is an ideal case for data to be analyzed through Multivariate Statistical Analysis (MVA). This analysis provides joint analysis and easy visualization of the relationship between involved variables. As a result, knowledge that was unrevealed and hidden among vast amounts of data can be obtained.

A. Principal Component Analysis (PCA)

PCA is a powerful multivariate technique in reducing the dimension of data set and revealing the hidden relationship among the different variables without losing much of information [12]. The steps involved are:

1. Calculate the covariance matrix

Covariance is the measure of how one variable varies with respect to other variable. If the variables are more than two, then the covariance matrix needs to be calculated. The covariance matrix can be obtained by calculating the covariance values for different dimensions. The formula for obtaining the covariance matrix is

$$C^{n\,X\,n} = (c_{i\,,j}\,, c_{i\,,j} = cov(Dim_i\,, Dim_j)\,)$$

where $C^{n\,x\,n}$ is a matrix with n rows and n columns

i, j is the row and column indices and covariance is calculated using below formula

$$cov(X,Y) = \sum_{i=1}^{n} [(X_i - \bar{X})(Y_i - \bar{Y})]/(n-1)$$

where X_i is the value of X at i^{th} position

Y_i is the value of Y at i^{th} position

$\bar{X}$, $\bar{Y}$ indicates the mean values of X and Y respectively.

2. Find Eigen Vectors for covariance matrix

Eigen vectors can be calculated only for square matrix and not all square matrix has eigen vectors. In case n x n matrix contains eigen vectors, then total number of eigen vectors is equal to n. Another important property is that the eigen vectors are always perpendicular to each other. Eigen values are associated with Eigen vector and describe the strength of the transformation.

3. Sort Eigen vectors in decreasing order of Eigen values

The highest eigen value corresponds to be the principal component which explains the maximum variance among the data points with minimum error. The first few principal components explain most of the variance and eigen values with lesser values can be neglected with very little loss of information.

4. Derive the new data set

The original data will be retained back but will be in terms of the selected eigen vectors without loss of data.

B. Self Organising Map (SOM)

Self Organising Map is a popular technique in Artificial Neural Network (ANN) under the category of unsupervised learning. In conventional ANN approach,

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the input vector is presented to a multilayer feed forward network and the generated output is compared with the target vector. When there exists a difference, the weights are altered to minimize the error in output. This phase is repeated many times with different sets, until the desired output is achieved. However, SOM does not require a target vector during the training phase. A SOM without any external supervision, learns to classify the training data.

The basic principle of SOM is when the weight of nodes matches the input vector, then that portion of lattice is selectively optimized to resemble the input vector. Each node receives every element of input or training data in vector format one at a time. A calculation is done between the element and weight of the node to determine the fit between them. The calculation performed is to determine the distance between the two and usually it is Euclidian distance or any other distance measure can be used. A winning node that best describes the training element can be obtained and it has the smallest distance between the input element and node's weight. The neighbors of winning node should be identified. Then, these neighbors and winning node is updated to represent the new training element. By this procedure, the map learns through individual elements [13].

SOM Algorithm

1. Initialize the weights for each node either randomly or by pre-computed values.
2. For every input element
   a) Get the input element and convert to a vector
   b) For every node in the map
      i) Compare the input vector with the node
   c) Every node weight is examined to see which one matches and is closest to the input vector. The node with the smallest distance is declared as the winning unit and is commonly referred as Best Matching Unit (BMU).
      Distance between the between input vector and node's weight is calculated using Euclidean Distance formula.

$$Dist = \sqrt{\sum_{i=0}^{i=n} (V_i - W_i)^2}$$

where V is the current input vector
W is the node's weight vector

   d) The radius of neighborhood of the BMU is calculated. All nodes within this radius range will be updated in the next iterations. Initially, the radius will be set to the radius of lattice and it decreases in each step.
   e) The weights of each neighboring nodes are adjusted according to the below equation

$$x(t+1) = x(t) + N(x,t)\,\alpha\,(t)\,(\partial(t) - x(t))$$

where x(t+1) is the next value of weight vector
x(t) is current value of weight vector
N(x, t) is the neighbourhood function, which decreases as a function of time
α(t) is the learning rate, which decreases as a function of time
∂(t) is the vector representing the input document

IV. CASE STUDY

A case study is considered to demonstrate the concept of dimensionality reduction on a data set using Principal Component Analysis and Self Organising Map. Later, hierarchical clustering is applied to the obtained SOM results. The case study considered determines the quality of air in regions of New York city. The data set consists of variables like Ozone, Solar radiation, Wind, Temperature for different regions. Ozone variable consists of numeric values in parts per billion, Solar radiation depicts the radiation in Langleys with a frequency band 4000-7700 Angstroms, Wind variable has numeric values in miles per hour, Temperature indicates in degrees the maximum daily temperature.

A. *PCA Application*

PCA reduces the dimension and explores the hidden information. The first few principal components explain most of the variance. Table 1 indicates the summary of principal component analysis which explains the standard deviation between the principal components, proportion of variance and cumulative proportion.

Table.1: indicates the standard deviation, variance and cumulative proportion associated with principal components

	PC1	**PC2**	**PC3**	**PC4**
Standard Deviation	1.5343	0.9529	0.6890	0.51441
Proportion of Variance	0.5886	0.2266	0.1187	0.06615
Cummulative Proportion	0.5886	0.8152	0.9338	1.00000

The important task in PCA is deciding the number of principal components to be considered for further analysis. Fig. 1. Indicates a scree plot for determining the number of PCs. The elbow point shows the number of components to be considered and beyond this the eigen values are small and indicates negligible data loss.

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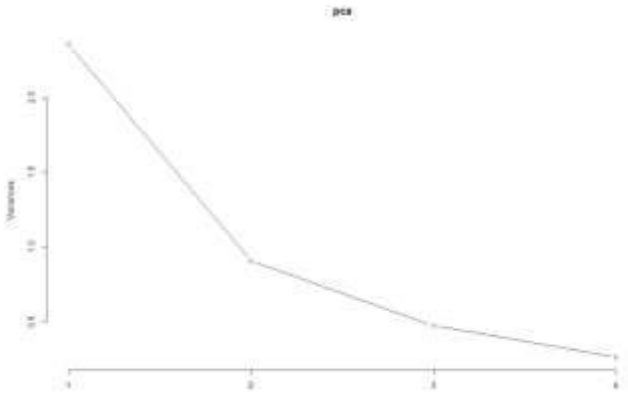

Fig. 1. indicates a scree plot for determining the number of PCs.

The relationship between variables can be identified using biplot. Fig. 2. represents variables and observation of multi-dimensional data. Fig.2 indicates the variables Temperature and Ozone are closely related to each other and Wind is negatively correlated with other variables. The angle between vectors represent an approximation of covariance. A small angle between vectors indicates the variables are highly correlated, an angle of 90 degrees indicates variables are not correlated and 180 degrees represents that the variables are negatively correlated.

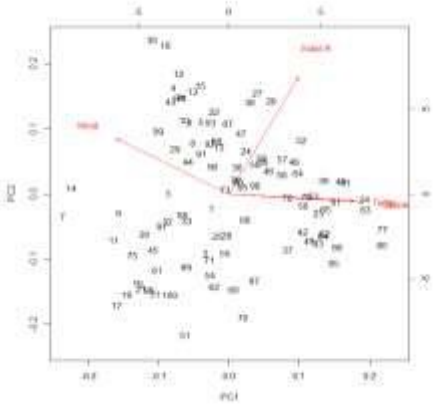

Fig. 2. Represents variables and observation of multi-dimensional data.

B. SOM Application

Before the application of SOM, the data was prepared for analysis by identifying the duplicates, removal of outliers, data conversion, removal of null values and the variables are scaled to provide equal importance during training phase. A SOM grid is created with a size of 10 x 10 and there is no explicit rule for selecting the number of nodes, except that it should allow easy visualization of the SOM. The SOM is trained with a learning rate of 0.05 that gradually declines to 0.01. The radius of neighbourhood can either be a vector or a single number. If it is a single number, the radius will vary from current value to the negative value of the current number. Once, the neighbourhood becomes small and radius is less than 1, only the winning node will be updated.

Fig.3. shows a plot of SOM during training phase after 100 iterations. In this experiment, 100 times the complete data set is presented to the network. The distance between the weight of the node and input sample reduces as the training iterations progress. This distance should ideally reach a minimum value and Fig. 3. shows training progress over time.

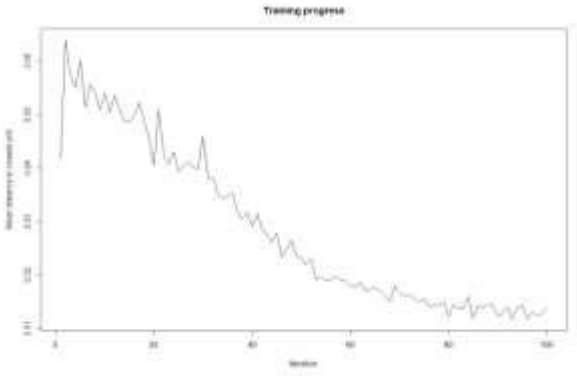

Fig.3. shows a plot of SOM during training phase after 100 iterations.

Unified Distance matrix (U –matrix) is a type of SOM visual representation in a map of 2 dimensional grid as shown in fig. 4. U-matrix indicates the distance between adjacent nodes and it is represented by different grey shades. A dark color indicates a larger distance between the neighboring nodes and represents a gap in input values.

A lighter shade indicates the vectors are close to each other and they indicate cluster themselves, high values represents borders among the clusters.

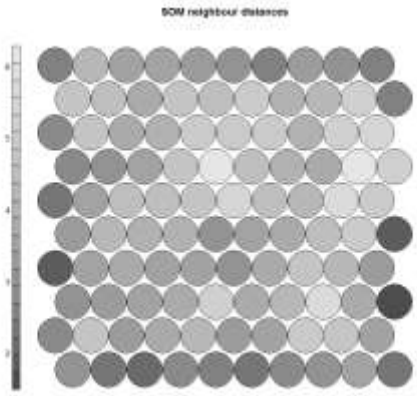

Fig. 4. Indicates the unified distance matrix visualization

Component Planes

Component planes represents clearly the visualization of individual input variables. They are represented in grey scale or a combination of different colors. Fig. 5.

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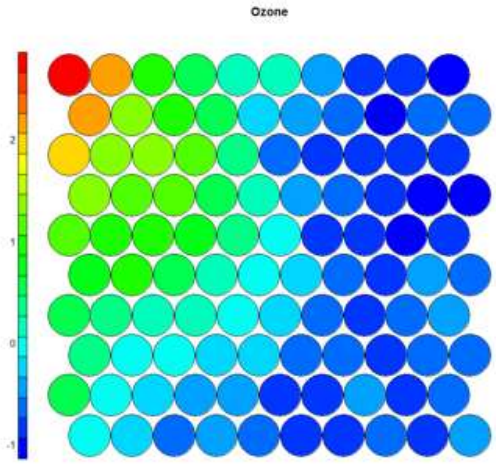
represents component planes for each variable. By inspecting component planes in Fig. 5. it is evident that the variables Ozone, Solar radiation and Temperature are positively correlated and variable Wind is negatively correlated with other variables. Fig. 5. represents component planes for each variable.

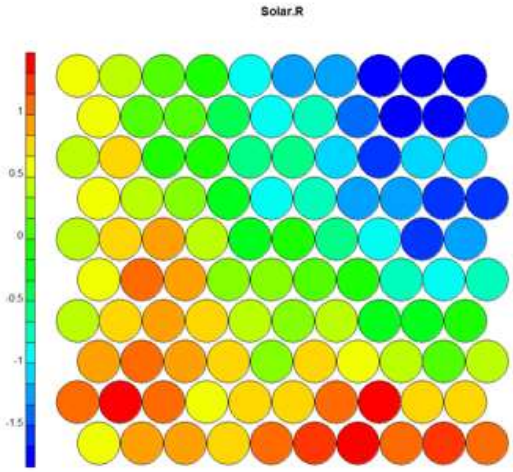
The rate of chemical reactions that produce ozone are affected by solar radiation and temperature. Therefore, an increase in these values increases the chemical reactions and leads to an increase in ozone levels. Wind speed is negatively related to all the variables. The concentration of ozone is high, when there is low wind speeds. The covariance matrix is generated for the input variables and it reflects the same relationship as the component planes.

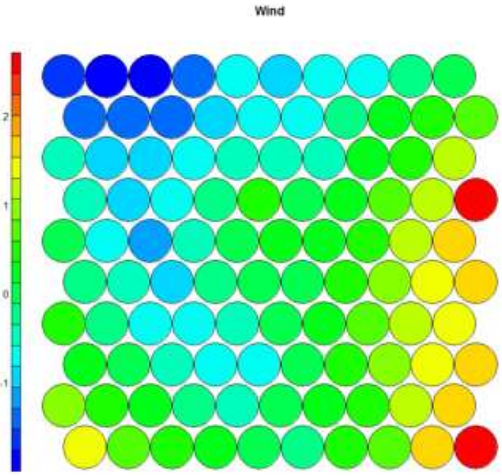
Table 1 represents the correlation coefficient values between the variables. It can be observed that maximum correlation exists between ozone and temperature. Wind is most negatively related with ozone. Component planes help in understanding this concept pictorially, therefore Self Organizing Map helps in easy visualization of relationship between variables.

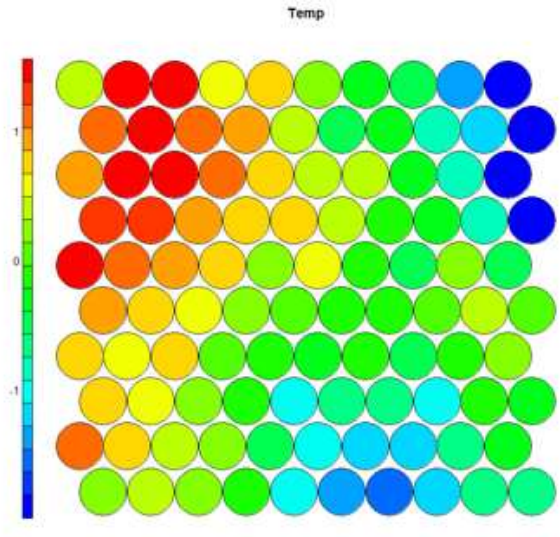
Table 1 represents the correlation coefficient values between the variables

Variables	Ozone	Solar.R	Wind	Temp
Ozone	1.0000			
Solar.R	0.3411	1.0000		
Wind	-0.6265	-0.1147	1.0000	
Temp	0.6938	0.2850	-0.4947	1.0000









Clustering of Self Organising Map

A U-matrix may be appropriate to identify the cluster boundaries. But this may not be effective and therefore, a hierarchical clustering technique is applied after the SOM is trained. Fig. 6. Shows the formation of clusters. Here,

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there is a formation of 3 clusters – High Ozone, Medium Ozone and Low Ozone.

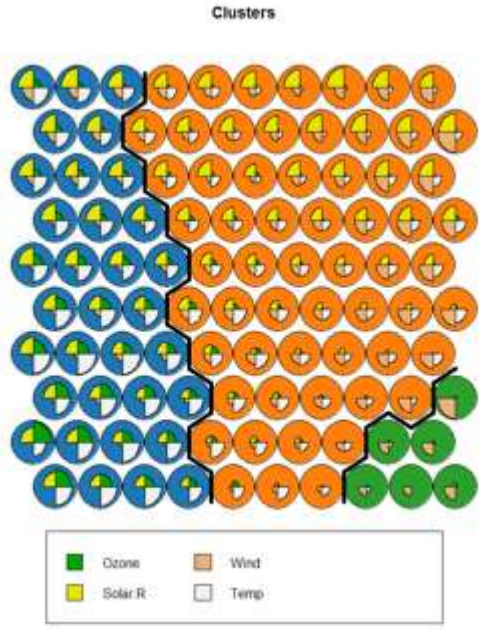

Fig. 6. Blue nodes indicate High Ozone, Orange colour nodes indicate Medium Ozone and Green color nodes indicate Low Ozone.

Fig. 6. shows the formation of clusters into low ozone, medium and high ozone that is depicted by green, orange and blue respectively.

In High Ozone class, the effect of solar radiation and temperature are above average and wind speed has very low effect. The effect of solar radiation and temperature is below average in Low Ozone class and wind speed has significant effect. In Medium Ozone cluster, solar radiation, temperature and wind have about average effect. The clustering results obtained are satisfactory and Self Organising Maps can be used to classify the quality of air.

V. CONCLUSION

In this paper, principal component analysis (PCA) and Self Organising Map (SOM) has been applied to demonstrate the dimensionality reduction of dataset. A case study was considered to visualize and classify air quality data. PCA explained most of the variance in data but it was difficult to interpret the data pattern. However, SOM appears to be the best fit to represent complex data. Especially, the component planes of SOM provides effective visualization and uncovers the correlation between the input variables.

U-matrix can be used for data classification, but may not be a good choice in all cases. Therefore, in this paper hierarchical clustering technique is applied to the SOM results obtained. The quality of air is partitioned into 3 clusters – low, medium and high ozone content. Therefore, it can be concluded that SOM has better resolving power of classification than traditional methods.

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Using Porous Media to Enhancement of Heat Transfer in Heat Exchangers

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Abstract— *According to increasing human needs for energy and to avoid energy waste, researchers are struggling to increase the efficiency of energy production and energy conversion. One of these methods is increasing heat transfer and reducing heat dissipation in heat exchangers. Using porous materials in the fluid flow is one of the passive methods to increase heat transfer in heat exchangers. The existence of porous media in the flow path, improve the matrix of thermal conductivity and effective flow thermal capacity and also matrix of porous-solid increase radiation heat transfer, especially in two phase flow (gas-water) systems. In this paper, recent studies on the effect of using porous media on enhancement the amount of heat transfer in heat exchangers has been investigated via using porous media with difference porosity percentage, material and geometric structure in the flow path in numerical simulations and laboratory studies.*

Keywords— Porous media, Heat transfer enhancement, Heat exchanger.

I. INTRODUCTION

Energy consumption is one of the most important issues that man has faced over the past decades. Providing clean and environmentally friendly energy is of great importance to developed countries. Among the various types of energy used today, more than 70% of it is exchanged as heat energy. In many industrial systems and processes, the heat must be given as input to the system or, ultimately, the energy must be exhaust from the system. By increasing the need for energy in the world, strengthening the process of heat transfer and reducing energy losses is of great importance [1].

Better design of heat exchangers and their wider application to retrieval of the far-off heat industry can have a significant effect on the preservation of fuel resources and the prevention of environmental pollution. The key to increasing heat transfer is to reduce thermal resistance. This results in smaller heat transfer systems with lower cost and better efficiency. Heat transfer and control are a very important issue in high-flux systems, including reactors and nuclear reactors, microelectronic systems and micro-chemical reactors, and many other applications. Today, porous materials are used in many industrial applications to control the heat transfer and insulating of the systems. The most important application of porous materials is the insulating of furnaces and boilers and the transfer of energy in the geothermal and oil industries.

II. HEAT TRANSFER ENHANCEMENT METHODS

In recent decades, many studies have been conducted to enhance heat transfer, focusing on finding methods that, in addition to increasing heat transfer, have more efficiency. Such methods lead to lower energy consumption and less costly and less expensive equipment, with higher thermal efficiency [2]. As increasing efficiency and improving energy consumption in the industry have always been a concern of the researchers, improving heat transfer in heating and cooling systems is no exception. Therefore, extensive research to enhance the transmission methods Heat is used to reduce heat dissipation in these systems. Bergles, In his book [3], introduced fourteen ways to increase heat transfer in heat exchangers. These methods can be divided into two active and passive categories. Passive methods do not require any external power source to increase heat transfer. But active methods require an external power source. Table 1 presents examples of these two methods.

Passive methods are preferable to active methods because of simple production, low cost, long life and convenient use [4]. One of the non-active methods that has been considered in recent decades to increase heat transfer in heat exchangers is the use of porous media. Porous media play an important role in the industry due to their unique properties. In the following, the porous environment and its application are discussed.

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Table.1: Methods of enhancement of heat transfer

Passive methods	Active methods
Surface coating	Mechanical method
Rough surfaces	Vibrate surface
Extended Surfaces	Fluid Vibration
Removable devices	Electrostatic fields
Surface tension devices	Injection
Additives for liquids	Suction
Rotational flow devices	Spraying devices

III. POROUS MEDIUM

When discussing the porous medium, it means a material that is composed of a network of solids and empty spaces, with the assumption that the solid network is completely rigid. The existence of this network is indispensable for porous media. This means that the solid is not a porous medium without a network of empty spaces. Empty spaces between solids allow fluid to move in porous matter. The fluid path inside the cavities is very complex, at small and comparable porosity measurements, flow quantities such as speed and pressure will be completely irregular, therefore, a study on a microscopic scale is not possible. Therefore, to analyze the porous medium, the continuous environment is used. Figure 1, shows the examples of natural porous material. Examining empirical results has shown that in areas with a large number of pores, the average of the behavioral flow rates with the base are relative to time and space, and theoretical discussions could be devised for them. It may depend on the porosity of the porous medium to be considered as an observer. If the observer's distance is small, the observer will see only one or two ducts; then, in the traditional methods of fluid mechanics, fluid behavior can be described. But if the environmental distance is high, there will be plenty of ducts and holes in the observer's eyes; then, volumetric modalities will be much more useful and efficient for describing fluid behavior and simplifying the problem. [5].

The expression unit is the ppi number of porous medium cavities. The larger the number, the more caverns and the smaller the cavities are smaller [6]. Most porous media are rigid and rigid, but can sometimes be slightly deformed. In continuous spaces, one or more streams flow. In single-phase mode, empty spaces are saturated only by a fluid, while in two-phase flows; liquid and gas saturate empty spaces. The nature of porosity and non-repetitive algorithms of these environments have many complications for the analysis of these environments. The fluid flows in porous layers and causes the transfer of mass and energy between these materials. The study of heat transfer in non-homogeneous porous media is not easy [7]; it is also important to analyze and design various catalysts and thermal insulators.

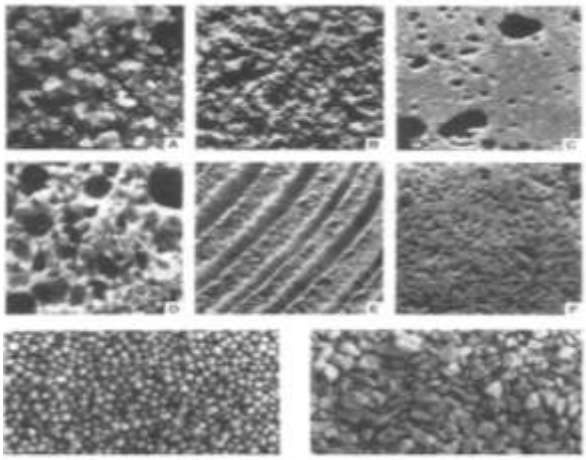

Fig. 1: Examples of natural porous material: (A) beach sand, (B) sandstone, (C) limestone, (D) rye bread, (E) wood, (F) human lung. Bottom: Granular porous materials used in the construction industry, 0.5-cm-diameter Liapor spheres (left), and 1-cm-size crushed limestone (right) [5]

IV. POROUS MEDIUM CHARACTERISTICS

In this section, the parameters that are used to identify the porous medium are introduced.

4.1 Porosity

The porosity (φ) of a material is the amount of storage capacity that can hold the fluid, in other words, it can be said to be the porosity of the blank volume ratio to the total volume. In another definition, the concept of effective porosity is used, which is the ratio of empty spaces interconnected to total volume [8]. In natural environments, porosity does not exceed 0.6%. In a bed of matched spheroid solids, porosity can vary from 0.2595 to 0.4644. If the particles do not match, porosity will be less. For some porous human materials such as metal foams, porosity is close to 1. If in the porous medium the cavities flow and the fluid contained within these cavities completely fill them, so to say, this porous medium is said to be a saturated porous medium. An unsaturated porous medium refers to an environment in which the fluid, in general, only fills part of the space in the cavities or does not have all the cavities, so the fluid cannot be in the entire cavity [9].

4.2 Infiltration Coefficient

The characteristic of other porous media is the permeability of η, which is the ability of the material to pass fluid through itself. The unit of this coefficient is equal to the length to the power of two (L^2). This characteristic has been used in the relationship between the velocity and the pressure drop in a porous medium as part of the proportional constant. The form of this relation, known as the Darcy's law [10], is:

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$$u = -\frac{k}{\mu}\frac{\partial P}{\partial x} \quad (1)$$

where u and p are the velocity and pressure drop in a porous medium respectively. k is independent of the flow specification and depends on the geometry of the porous medium. The porous medium with permeability 1 allows the flow of fluid to pass through the viscosity 1 Pa.s at a speed of 1 m / s and with a pressure difference of 1 Pa in a cross section of 1 m^2. This coefficient is called the specific permeability or intrinsic permeability of the porous medium. Researchers working in the field of geophysics often use a common penetration unit called Darcy, which is 987 × 1017 square meters. The porosity of porous materials in nature is very diverse. For example, the penetration coefficient of clay is lower than coal, and coal is less clean sand. The permeability coefficient of the clean gravel is higher than all of them [10]. The prediction of porosity coefficient of permeability is one of the issues that many scientists and researchers deal with. These studies are particularly complicated, especially for porous materials, with the internal structure of the pores irregular and unobtrusive. The researchers concluded that the infiltration coefficient was influenced by parameters such as the porous media bed structure, porosity coefficient, particle geometry of the substrate, homogeneity or non-homogeneity of the surface. Many theoretical and empirical studies have been carried out on a bed of spherical particles or fibers of various materials have been used to model porous media. The use of these artificial porous media, due to the network structure and repeating pattern, creates homogeneous bedding, making it easier to check the porous environment and make general rules simpler [11,12].

V. APPLICATION OF POROUS MEDIUM

The porous environment and the study of the phenomenon of heat transfer and flow in it, has a special place in technology and industry. Although studies on porous media have attracted scientists and researchers from recent decades, the importance of this has led researchers of recent years to consider parameters that affect heat transfer in porous media. Various applications have been made of porous media applications such as heat exchangers, porous blades, porous burners, solar collectors with porous adsorbents and many other cases [13].

VI. THE ROLE OF POROUS MEDIA IN INCREASING HEAT TRANSFER

Porous media have a large contact surface with fluids, which can enhance the heat transfer effect. The porous medium not only changes the flow field conditions and causes the frontal layer to thinner, but also the conduction heat transfer coefficient is usually higher than that of the fluid studied. As a result, the introduction of a porous medium into a fluid channel effectively improves the thermal transfer properties [14]. Also, for open cellular porous media, the presence of multiple paths that are intense heat conductors can increase heat transfer; another reason is the increase in heat transfer, the flow of the porous matrix and its high mixing. Applying the porous medium, depending on the permeability of the environment, forces the fluid to escape from the central region to the outer regions, which reduces the thickness of the boundary layer and increases the heat transfer rate. The porous medium also corrects effective thermal conductivity and effective heat capacity and fluid heat capacity, and, in a system that has a gas flow, the solid matrix also enhances the heat transfer rate. Heat transfer reinforcement occurs through three mechanisms: redistribution of current, thermal conduction modification, and correction of environmental radiation properties [15].

The study of the hydraulic properties of porous media is important because the transfer of heat can be considerably increased by adding a porous medium to a heat exchanger. But, on the other hand, the fluid passes through the porous matrix, with greatly reduced pressure. In order to achieve the maximum heat transfer in a heat exchanger, the porous medium parameters must be optimized during the design stage, due to the fluid pressure drop. Improvement of heat transfer in thermal systems (such as heat exchangers) using a porous medium results in a significant increase in the loss of fluid pressure and fluid pumping power. Therefore, a parameter is needed for simultaneous evaluation of thermal performance and pressure drop in these systems. Accordingly, Webb and Eckert presented a parameter called the Performance Evaluation Criteria (PEC), which takes into account the simultaneous effects of heat transfer and pressure drop and is defined in equation (2) in the heat exchanger [16.17].

$$PEC = \frac{Nu/Nu_s}{(f/f_s)^{1/3}} \quad (2)$$

where, Nu and f are the Nusselt numbers and the tube pressure drop coefficient in the presence of porous material, and Nu_s and f_s are the Nusselt number and the coefficient of pressure drop in the simple tube. Today, cellular microstructures are widely used in heat dissipation technologies, shock absorbers and compressed heat exchangers. Thermal properties such as high heat transfer rates allow the material to be cooled or put into a

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high performance heat exchanger.

VII. RESEARCH ON THE EFFECTS OF POROUS MEDIUM

The first studies on porous media began with Darcy studies on the soil environment and found a relationship between the fluctuations of fluid pressure flowing in it. In 1856, the Darcy introduced a legal environment for the flow of water through a porous medium as follows [18].

$$Q = -k.A.\frac{dH}{dL} \tag{3}$$

Another of the first studies on porous media was carried out by the Ergum, in 1952, in his study; he presented a relation to calculate the pressure drop in the channel [19]. These relations are given in the set of relations (4).

$$f_p = \frac{150}{Gr_p} + 1.75$$
$$f_p = \frac{\Delta p}{L}\frac{D_p}{\rho v_s^2}\left(\frac{\varepsilon^3}{1-\varepsilon}\right) \tag{4}$$
$$Gr_p = \frac{\rho v_s D_p}{(1-\varepsilon)\mu}$$

In these equations, Δp is the difference in pressure in the flow bed, L is the length of the bed of the current D_p, is the equivalent diameter and ε is the porosity permeability coefficient. Also, heat transfer enhancement has been widely studied in various equipment such as heat exchangers. Many scientists have worked in this direction. In 1994, the Webb discussed different methods and techniques for transfer of heat in single-phase and multi-phase fluids [20]. One of the ways to increase the speed of mass and heat transfer in different systems is to use porous media. Lauriat et al. [21] reported an increase of 50 percent in Nusselt numbers during the slow flow of porous canals over porous canals. Generally, the transfer coefficient of heat transfer is higher in systems consisting of porous media. One of the important reasons for this is the increase in the thermal conductivity of the porous matrix in different papers and papers, compared with the thermal conductivity of the fluids.

VIII. NUMERICAL STUDIES

In the field of flow modeling in porous media, a relatively large number of numerical and analytical works has been done. Examples include the following.

Mohamad [22] studies the numerical flow and heat transfer in a semi-porous tube. This research has been investigated for a completely filled pipe with porous material and a tube in which the porous material has been embedded in the tube center. In this research, the Nusselt number, the developed pressure gradient and the flow velocity profile have been calculated. In calculating the momentum and energy equations, simplifications are assumed with the assumption of a slow, two-dimensional, incommensurable, stable, thermodynamic equilibrium between porous matter and its fluid and insignificance of energy dissipation in the energy equation. In this work, the temperature of the pipe surface was assumed to be constant, the effect of increasing and decreasing the relative diameter of the porous material inside the tube, and the effect of the variation of the Darcy number on the pressure drop and Nusselt number were investigated. In figure 2, the geometry of Mohamad's problem is shown.

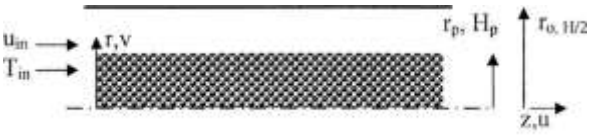

Fig. 2: The schematic of the pipe and plate, investigated by Mohamad [22]

Solving the flow and energy equations in this work is an integrated that simultaneously involves both environments. In the fluid environment without porous material its equations and in the porous medium are also solved for its equations, and for the boundary grains that are at the interface between the two environments and half of it inside the fluid and the other half The porous medium, the average harmonic value of fluid properties such as viscosity and conduction heat transfer coefficient are placed in equations. In this study, Mohamad obtained some results, including the fact that the inertial coefficient has an important effect on the Nusselt number, while the dependence of this coefficient on porous media with high permeability is not accurate. The effect of adding the inertial coefficient to the Navier-Stokes equations is to calculate the local drag force. The extended channel length is not a function of the Darcy number. The increase in the diameter of the porous material causes an increase in the pressure drop, but the Nusselt number first increases with increasing porosity of the porous material and, after reaching a certain value, is reduced again. However, the pressure drop is higher than that in which the tubes are empty and without a porous medium. For this reason, an optimal amount of porous material diameter should be found. Siavashi et al. [23] investigated the heat transfer in a tube containing aluminum metal foam with nanoparticles in the fluid. The operating fluid in this study is chosen with particles Al_2O_3, which are nanoparticles of nanoparticles. This research has been done in two modes. In the first case, the geometry is such that the porous material as well as the thermal flux is drawn from the inner wall to the tube. In the second case,

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the porous material and thermal flux are in the vicinity of the outer wall. In this study, the increase in entropy and nano-velocity effect on porous matrix has been investigated. The corresponding diagrams are plotted for the Nusselt number and the pressure over the channel. This research has been studied by assuming a slow flow for Reynolds numbers between 100 and 2000. Also, with the increase of the Darcy number of the profile, the speed is increased more rapidly. On the other hand, by increasing the porosity of the porous material, the nanofluid flows more easily and this reduces the thickness of the thermal boundary layer. In this study, the performance improvement, i.e., the ratio of heat transfer variations to pressure drop variations is shown by equation (5).

$$PN = \frac{Nu/Nu_s}{\Delta p/\Delta p_s} \quad (5)$$

where, Nu and Δp represent the Nusselt number and the pressure drop in the presence of porous matter, respectively. Similarly Nu_s and Δp_s represent the Nusselt number and the pressure drop in the internal flow without porous material. Siavashi has used two models of the Darcy Brinkman Forchimer and two-phase combination models. According to the results of this study, also taking into account the second law of thermodynamics, an optimum thickness for porous material has been proposed to reduce the entropy production rate. Shokouhmand and colleagues [24] examined the effect of porous matter on increasing the heat transfer of the channel, part of which has a porous medium. They were found to be in good agreement with the analytical solutions by placing the porous material at the side of the walls and in the core of the channel. By examining various parameters on the channel's thermal performance, such as Darcy number, porous material thickness and permeability, it was determined that the porous material position has a great effect on the thermal performance of the channel. Nazari et al. [25] investigated the heat transfer conductivity between two parallel plates containing different porous layers in an analytical study. They considered the boundary conditions in the upper and lower plates in the form of constant temperature with respect to the production of internal heat under thermal imbalance conditions. First, the heat transfer equation was extracted in each layer for solid and fluid phases, and then, considering the thermal boundary conditions in each layer, the heat transfer equations were compared to the analytical solution. The proposed analytical solution is general and valid for any number of porous layers of different thicknesses. The results of this study show the effects of the porosity ratios of each layer, the fluid and solid conductivity coefficients, and the displacement heat transfer coefficient on the cavity scale on the temperature distribution and temperature difference between the two fluid and solid phases. The results show that by increasing the ratio of solid and fluid thermal conductivity coefficients, the temperature difference between the two phase's increases. Increasing the transfer heat transfer coefficient causes the temperature rise of both solid and fluid phases. In the case where the porosity ratio of the two layers is different, at the joint location, the temperature distribution of each of the two phases is fractured. Changes in the porosity ratio in the layers can cause the maximum temperature of the two phases to be transferred from the center of the channel. The maximum temperature difference is directly proportional to the coefficient k. Maerefat et al. [26] investigated the heat transfer inside a dual-heat exchanger of metal porous material. The flow of fluid within the tubes is a turbulent heat exchanger, which is more in line with the actual operating conditions of these converters in the industry. Fluid flow and heat transfer equations have been decomposed using a finite volume method and using the Simplil algorithm on a localized network. By writing a numerical program in the Fortran language, the effect of the porous material specification and the Reynolds number of the fluid flow on heat transfer has been investigated. Figure 3 shows the geometry in this numerical study.

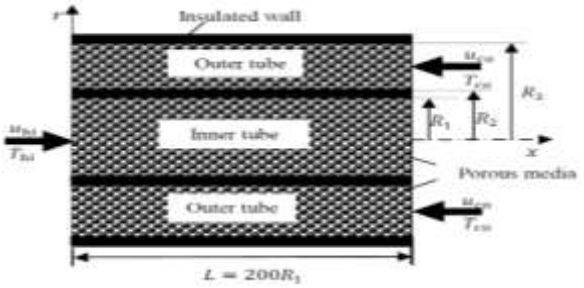

Fig. 3: Geometry investigated in Jamarani research [26]

The results of this study show that the use of porous material in the heat exchanger increases the total heat transfer coefficient of porous material and, in the best case, results in an improvement of about 7 times. Reducing porosity in the range of 0.95-0.8 increases the porosity of the porous material and the thermal conductivity coefficient, thus improving the heat transfer in the heat exchanger, although a reduction in porosity results in a significant drop in pressure. Investigating the changes in the diameter of the porous material cavity in the range of 1 to 6 mm shows that increasing the diameter of the cavity increases the permeability and dimensions of the turbulent flow vortices in the porous medium, thereby increasing the turbulence of the flow and heat transfer

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And the pressure drop also decreases. They also found that heat transfer in the heat exchanger increases in the case of a turbulent fluid, in contrast to the slow flow, in the low ratios of the thermal conductivity of the porous material to the fluid. This is due to the increase in the effect of disturbances of the current, which is not present in the calm flow. As the amount of this ratio increases, the total heat transfer coefficient of the heat exchanger increases and reaches the highest value for the porous material of copper. Another result was that changing the Reynolds number of the turbulent flow from 10,000 to 80,000 does not change the heat transfer efficiency. However, the results show that the ratio of improved heat transfer in the flow is more than confluent flow. Evaluation of the performance evaluation criterion shows that with increasing the diameter of the cavity and the thermal conductivity of the porous material, the system performance can be improved, while the porosity increase of the porous material does not have much effect on this parameter. In another study, Maerefat et al. [27] examined the numerical and analytical validity of two common definitions of the Nusselt number for the transfer of heat transfer in a pipe with porous porous material.

The first definition of $Nu_1(x) = 2R(\partial T/\partial r)_{r=R} / (T_w - T_m(x))$ is presented for many non-porous tubes. Different porous materials have been used in a tube.

The second definition of $Nu_2(x) = 2Rq''_{Cond.} / h_{ref}(T_w - T_m(x))$ is also provided by various authorities for the transfer of heat in a pipe or channel with a porous medium.

The analytical results showed that for a tube without a porous material or in a pipe with a central arrangement of porous matter, the Nusselt number is equal to the two definitions, but in the boundary arrangement of the porous material in the tube, the Nusselt number obtained from the two Each other is different. In the resulting relations it was found that in the first definition of the Nusselt number, the thermal value transmitted through the fluid flow from the porous material to the fluid is not taken into account, and therefore the calculated Nusselt number of this definition is not correct. However, in the second definition, the thermal flux of the input from the porous material is considered to be fluid, and thus the Nusselt number is appropriate for this definition. In this study, the boundary arrangement of the porous material was simulated numerically in a tubular tube with a turbulent flow and the Nasset number was calculated according to both definitions. The results showed that, in different thicknesses of porous material, the Nasset number decreases according to the first definition. By increasing the heat transfer coefficient of the porous material, the Nusselt number decreases from the first definition, which is quite non-physical. Therefore, the first definition is not suitable for calculating the Nusselt number. The results of the second definition of Nusselt number show the increase of heat transfer in the tube with the porous porcelain boundary arrangement. This is completely compatible with the physics of the problem, and as such, the use of this definition is appropriate for calculating the Nusselt number in the boundary arrangement of the porous material.

In another study, the numerical study of the effect of aluminum-oxide nanowire on the heat transfer in a tube containing porous material was investigated with a mixed flow of fluid [28]. Thermal tubes have been studied in four different structures without porous material, filled with porous material, boundary and central makeup of porous material. The results show that the use of nanofluidis improves the thermal conductivity of the entire nanofluid and porous material in the tube section. As the porous material is located in the central arrangement, the total conductivity coefficient at the adjacent wall of the pipe shows the most improvement, and thus the heat of entering the fluid in this case has the highest increase. As the porous material is placed adjacent to the wall of the pipe, ie the border arrangement and the state of the porous material, due to the thermal conductivity of the porous material, the effect of nanoparticles on the total thermal conductivity is lower and, as a result of heat transfer Moving is a better place for improvement. Hamidi-Moghadam et al. [29] have investigated an analysis of the fully developed forced displacement flow in a cylindrical homogeneous porous channel. The obtained equations have been solved for temperature distribution in transverse directions, considering frictional heat due to viscous loss, in which the Darcy number and the Brinkman number are variables. The effect of heat induced by friction on the temperature distribution is investigated and analyzed for two heating and cooling processes. The results indicate that Darcy's effect on the distribution of fluid temperature is insignificant in the absence of the effects of the viscous loss term, which includes the effects of internal and friction, while, taking into account the effects of viscous losses, the temperature distribution is a large nationalization of the Darcy number And Brinkman number. For both the cooling and heating processes, the contribution of friction heating term along the walls is high and as it moves away from the walls toward the center of the channel to zero, while the contribution of the internal heating term to the channel center It is maximized and decreases to near zero as it approaches the walls. Therefore, in general, the effect of the viscous heat loss on the walls is exclusively frictional heating, and in the

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vicinity of them, the combination of internal heat and frictional heating, and in the center of the channel is exclusively internal heating. Therefore, it can be concluded that frictional heating production is confined to the walls, while domestic heating produces a large part of the canal, originating from the center of the canal. Superior Shokouhmand and Ejlali [30] Transient heat transfer was studied in a bundle of two-dimensional porous Finns, which is under the influence of a smooth fluid flow. The governing equation governing the fluid was considered outside the porous medium of the Navier-Stokes equation and within the porous medium of the Brinkman-Forchheimer equation. The fins were placed horizontally, two-dimensionally, with a constant porosity ratio, and the two-dimensional flow of fluid was transmitted through a forced displacement from this set. In this study, it is assumed that the fins are homogeneous and the fluid flow is continuous and continuous, and the thermal equilibrium is established for this set. The flow rotation function has been used to solve the momentum equations in the fluid and fin fluid conditions. In examining the results after obtaining the flow and temperature field, it was determined that porous fines are more efficient than other types of fines, and this improvement in thermal efficiency increases with increasing porosity coefficient, but increasing the heat transfer coefficient Conductivity reduces the heat transfer efficiency of porous fins compared to conventional non-porous fines. Also, increasing the flow velocity is ineffective in improving the ratio of heat transfer, because in this case, the fluid particles leave the porous medium at a higher rate, and due to the geometry of the problem, which looks like a channel, there is not enough time to exchange heat. The variation of the Nusselt number is also increased by increasing the speed of the fluid injection at the beginning of the Finn, so that the Nusselt number increases to a point where, after a while, the injection rate is zero, in which case the Nusselt number remains unchanged. However, the heat transfer behavior of the porous and solid Finns is similar to each other. Rezaie and Maghrebi [31] investigated the numerical simulation of a smooth natural transfer of heat transfer in a porous square box with two solid walls using Boltzmann's method. The porous medium is modeled on a macroscopic scale, and the Darcy-Brinkman-Forchemer model has been used to model porous media in the Prandel number equal 1. Figure 4 shows the geometry examined.

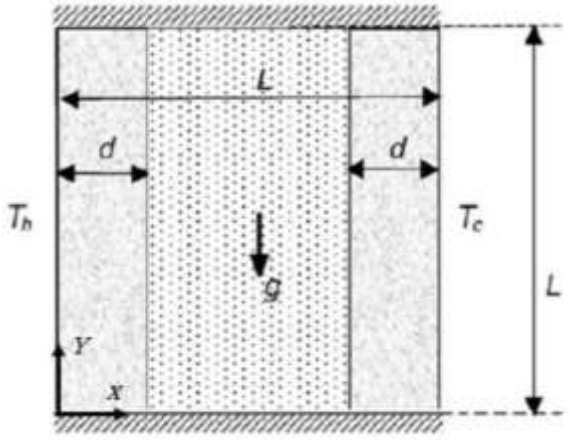

Fig. 4: Geometry studied by Rezaie and Maghrebi [31]

According to the results, it was observed that with increasing Riley number, the amount of heat transfer from the environment due to the change in the heat transfer regime from the conduction to the displacement increased, and by decreasing the Darcy number due to the decrease of the fluid permeability in the environment Porous, the amount of heat transfer decreases. By increasing the porosity coefficient due to the decrease of the resistance in the fluid path, the heat transfer rate increases in the environment, as well as by increasing the thickness of the solid walls due to the overlay of the transfer of heat transfer in the transfer The overall heat of the enclosure and the concentration of heat transfer to a thin layer in the middle of the enclosure, the amount of heat transfer from Hfzh decreases and finally, by increasing the permeability of the porous solid-wall temperature also increases the overall heat transfer from the chamber. Nazari et al. [32] examined the free heat transfer heat transfer from a vertical hot plate in a porous material. Thermal imbalance model was used to express energy equations in fluid and solid phases. The problem is analyzed for the state of the fluid source of the heat source. The equations governing the problem are extracted from the similarity method and analyzed by numerical method. The conceptual diagram of the porous medium and the coordinates of the problem are shown in figure. 5. According to the results, the increase in the suction / drop parameter reduces the thickness of the boundary layer of the temperature and leads to an increase in the local nsset number for both phases. Therefore, to achieve the thermal equilibrium between phases, the thickness of the boundary layer can be reduced. The increase in the thickness of the solid phase solid-state boundary layer will be proportional to the desire of the solid phase Nusselt number to zero. Also, in the absence of internal heat generation in the fluid phase, the Nusselt number is larger.

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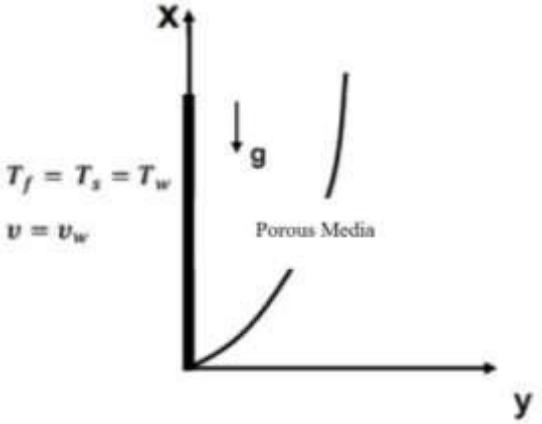

Fig. 5: Geometry examined by Nazari et al. [32]

In another study, the same people [33] have investigated numerical transfer of heat and mass transfer in porous matter in the presence of biochemical thermal flux. In this study, it is assumed that the desired environment is a homogeneous porous medium and that the Darcy model for the momentum equation is used. The porous material compartment contains two concentration components, one of the first biomass and the second component of the substance. The results show that the role of porosity in this biochemical process is significant. The porosity ratio affects the maximum temperature in the porous medium, the growth rate and consumption of the masses, and in particular the heat produced by the chemical reaction. Increasing porosity in the studied environment increases the biochemical production of heat in the compartment. Taeibi-Rahni et al. [34] A comparison and investigation of the flow and rate of forced convection heat transfer in a broadly-spaced tube were investigated numerically in a three-dimensional fashion. The porous material is partially or completely arranged in two distinct boundaries and central layers within a wider tube. The boundary condition governing the wall of the tube is constant temperature. The results show that using porous material in the central arrangement, increasing the thickness of the porous layer to about 0.75, increases the heat transfer and then decreases. Reducing the Darcy number is also one of the factors that increase heat transfer. Of course, the increase in heat transfer is accompanied by an increase in the pressure drop, which, given the economic cost, should be considered optimally. Contrary to the central arrangement, in the border arrangement, the heat transfer is first reduced and then increased to a maximum extent when the thickness of the porous layer reaches a certain value (thickness of about 0.5), until it is completely porous. Kayhani and Mohebi [35] studied the forced flow and heat transfer between two parallel planes, which were partially filled with porous media, numerically using Boltzmann's method. The porous medium is created using square barriers, with a regular arrangement that allows for the examination of cavity-scale complex flows. In the absence of a porous medium, the results are consistent with the corresponding analytical solutions. The results obtained in this case indicate that the flow and temperature distribution under the influence of the porous medium has changed and the existence of fixed obstacles in the computational range as a porous medium increases the thermal performance and the average Nusselt number.

Zehforoosh and Hosseinpoor [36] examined the natural displacement of a water-based nanofluid inside the package, partly filled with porous material with internal heat production. Maxwell and Brinkman models have been used to determine the solvent properties. The geometry examined in this study is shown in figure 6 the results show that increasing the nanosilver volume fraction will increase the Nusselt number in all porosities, which will increase in lower porosity. It also shows that changes in the porosity matrix conductivity ratio lead to two different modes of displacement and conduction within this environment. By increasing and decreasing the porosity, respectively, the displacement and guidance are amplified, which results in a minimum point in the porosity between 0.4 and 0.6 depending on the other parameters. The change in the high porosity conductivity ratio does not have an effect on the Nusselt number, but the increase in the conductivity ratio in the low porosity can increase the Nusselt number by as much as twice. Also, with Riley's increase in high porosity, penetration into the porous matrix increases, and in porosities below the outer wall of the porous matrix, the matrix is cooled, in both cases with the cooling of the matrix, the Nusselt number is greater in the entire domain Porosity is obtained. It was also concluded that using the lower porosity in the lower rillies and high porosity in the upper Riley, we can obtain the best Nusselt number factor. Nazari et al. [37] calculated the analytic and numerical value of the flow infiltration in a porous medium. In this research, a complete review of the modeling and calculating of the permeability coefficient in porous materials was first presented and then the porosity coefficient of a porous material with square geometry was calculated analytically and numerically. Selected geometry is for modeling a porous medium with a square section whose axis of fibers is vertically oriented to the flow.

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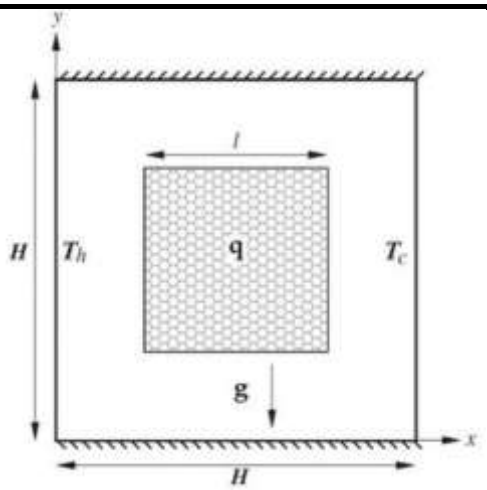

Fig. 6: Geometry examined by Zehforoosh and Hosseinpoor *[36]*

The governing flow equations are solved analytically after proper simplifications, and the explicit function for the coefficient of permeability is numerically analyzed. The predictions of numerical methods, analytical and analytical methods were compared with each other for the estimation of permeability of porous media with structural microfiber with square cross section. The results show that these methods are suitable for different porosities. Due to the Darcy equation in Reynolds number very low Re << 1 (called creeping current) decreases the amount of pressure drop by increasing the permeability. Nebbali and Bouhadef [38] investigated the effect of using porous barriers on increasing the heat transfer of non-nuclide fluids in horizontal channels. In their work, they used the Brinkman-Forchimer model, which extended the Darcy model for porous media, and used two geometric models for the porous medium. The first model of the channel is with a porous barrier and the second model consists of two porous barriers alternating up and down the channel. In the work of Nabali and Bohadef the effect of various parameters such as Darcy number, Reynolds number, power law index and thermal conductivity ratio on heat transfer and flow pattern were investigated. They observed that quasi-plastic fluids produce the highest heat transfer with the least pressure drop in both modes. The results show that it is more beneficial from the thermal point of the first state, but dynamically, the second state is better; also other interesting results were obtained, such that the thermal efficiency of the second model can be increased through the paths. Madera et al. [39] solved the equations for effective environments for momentum modeling and heat transfer in a channel with parallel plates that were summited with porous material. To solve the boundary conditions at the boundary of the porous fluid, they solved the equations including location-dependent coefficients and solved the momentum transfer problem by the implicit integral equation based on the Green's function. The simulations were carried out in terms of porosity, plaster number, porosity size and thermal conductivity ratio, and similar to the previous work, it was determined that the increase in the heat transfer was increased by increasing the size of the porous material or the amount of mixing inside the canal. Chen Yang et al. [40] investigated the performance of the forced heat transfer heat transfer in a semi-permeable channel with porous material. In the study, the porous material was once in the center of the tube and once on the wall. They performed thermal equilibrium and heat imbalance analyzes in both cases in order to ascertain the accuracy of the assumption of thermal equilibrium in these two cases. Finally, it was concluded that the assumption of thermal imbalance for porous matter on the wall is necessary and the assumption of the thermal equilibrium for the porous material in the center is appropriate. It was also found that in the low range of pumping power, the heat transfer function of the pipe with the porous material in the center is better than the porous material in the wall, whereas in the pump power above it is the opposite.

Various arrangements of the porous medium inside the tube or the canal have been investigated so far. Huang and Vafai [41] investigated the effects of the simultaneous use of intermittent porous barriers and cavities on controlling heat transfer and surface friction on the outer surface, and showed that the formulation of this problem leads to the conclusion that the flow and transfer of heat to Seven parameters are dependent on the following: Reynolds number, Darcy number, Prantel number, Inertia parameter, Geometric dimensional parameters and number of barriers and porous cavities. They performed a deep analysis of the interaction between the flow of the cavities and the external flow. They also showed that changing some of the parameters could have significant effects on the characteristics of the outer momentum and the thermal boundary layer. Nield et al. [42] examined the condition of thermal imbalance in the fluid in the channel filled with porous media. They noted that the boundary condition of the fixed wall temperature had less effect on the thermal imbalance than other conditions, such as the condition of constant flux in the wall. They also concluded that the Nusselt number is highly dependent on the Pecklet number and the ratio of the effective thermal conductivity coefficient of the solid to the fluid, and has less dependence on the shape parameter and the Darcy number. In their work, they increased the ratio of effective thermal conductivity of the porous medium to the fluid to 10. In 1999, in the context of the use of porous materials in a double-walled heat exchanger, Alkam and Al-Namir, they investigated the heat transfer

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in the heat exchanger of two flow tubes that are in line with the porous medium [43]. The porous medium is placed on both sides of the inner tube and the flow of fluid is considered to be gentle. The results of the study show that heat transfer improves in the presence of porous matter. The heat exchanger efficiency also shows a significant increase in the heat capacity ratio. In 2001 [44], the researchers investigated the heat transfer of the plate heat exchanger in the central arrangement between the plates and showed that the presence of porous material in the central makeup reduced the thickness of the boundary layer and consequently Increases heat transfer. Poulikakos and Kazmierczak's research [45] on compulsory displacement in a channel, which is partially occupied by porous material. The porous material is clinging to the channel wall. They have solved the problem for two situations between two parallel planes and a channel with a circular cross-section. Also, in his results, the effects of a number of parameters such as the thickness of porous area adhering to the wall, the Darcy number and the effective thermal conductivity coefficient of the porous region to the thermal conductivity of the fluid are investigated on the fluid flow and heat transfer in the channel. The effect of the above parameters on the flow characteristics of the fluid and the heat transfer were qualitatively investigated for the two geometries, for the boundary conditions, the temperature and constant thermal flux in the wall were similar. The other result is the linear dependence of the Nusselt number on the thickness of the porous region. In other words, there is a critical thickness for the porous region in which the Nusselt number reaches a minimal value. Xu et al. [46] in an analytic study examined the forced flow inside the filled pipe. The solution flow in this study was fully developed and assisted by a two-equation model, using the Brinkman model for flow analysis. The assumption of heat transfer between two fluid and solid phases is a local thermal imbalance and has been used to solve equations in the case of two fluid and solid phase assumptions. In this study, the temperature and velocity profiles are implicit equations for the coefficient of friction and Nusselt number. The effect of other variables on heat transfer has also been studied. Nimvari et al. [47] studied the flow and heat transfer in porosity channel channels in detail. In this study, where two layers were considered, the porous material was clamped to the surface of the tube in a state, and in the second case it was placed in the center of the tube. For both layers of different thicknesses and different Darcy numbers have been investigated. For placement of the fastening to the wall, the Nusselt number in the thicknesses between 0.6 and 0.7 for the minimum number of Darcy has been found to be minimal, also for laying in the center of the channel, the maximum Nsult number in the thicknesses of 0.83, 0 and 0.9 in Darcy numbers are 0.01, 0.001, and 0001/0. They concluded that as the amount of the Darcy number decreases, the thickness in which the minimum number of Nusselt numbers is decreasing. Aguilar-Madera et al. [48] investigated the effective equations of heat transfer and momentum in the channel filled with porous medium. The equations are solved using a location-dependent coefficient to avoid assuming certain conditions in the boundaries of fluid collision with the porous medium. Also, energy equations are solved by numerical solution using finite element method. This numerical simulation has been performed based on a number of data, such as porosity coefficient and Pecklet number. Rochette and Clain [49], in a study using a new microscopic model, sought to evaluate the local thermal heat load assumption in the solid phase of porous matter. To do this, they simulated the gas flow inside the porous material using the Euler model. In the geometry examined, the porous material completely fills inside the tube. They first used the classical method of local thermal imbalance, then introduced a new model in which the porosity depth is used.

Peng et al. [50] studied numerical parameters affecting the porous medium and its effect on the coefficient of performance improvement and heat transfer. In numerical simulation, they examined the thermal conductivity of the porous material for the porous material at the center of the tube. The flow inside the tube was calm and fully developed. The porosity of the porous medium was 0.9 and the Reynolds number range was 25-2000. Also, the thermal conductivity of the porous material varied from 0.1 to 200 W/m.C. This simulation was carried out in four different modes: in the two fluid states of the air and in a fluid state of water, in the fourth state the fluid had a density of one fourth of the water, while the other properties were all similar to water. According to the results of this simulation, Nusselt number and coefficient of improvement have a uniform increase in yield with porosity conductivity coefficient and Reynolds number.

IX. EXPERIMENTAL STUDIES

Pavel and Mohamad [51] have investigated the effects of insertion of metal porous material in the form of a grid in the center of the pipe, on numerically and experimentally examining the heat transfer of a pipe that is subject to constant and uniform flux. They investigated the porosity, porous diameter and conduction heat transfer coefficient plus the Reynolds number. Results for Reynolds numbers ranging from 1,000 to 4,500 including both relaxed and turbulent regimes. The results showed that this placement, which in the case where the diameter of the porous material is close to the diameter of the pipe, increases the

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heat transfer rate by the cost of the logical pressure drop. The maximum increase in the mean value of the Nusselt number is reported to be 2.5 times as much as the non-porous medium. This condition is achieved when the entire tube is filled with porous medium and has porosity equal to 98.1% and a Reynolds number of 4500. The porous material used in this experiment was aluminum commercial lace (k = 177 w / m ^ 2.k). Nazari et al. [52] investigated the experimental forced displacement of nanofluids in a horizontal tube containing porous material. In this experiment, they placed a tube containing porous material under constant temperature conditions and carried out 700 to 5000 experiments in the range of Reynolds numbers. The results show that the addition of nano powder to base fluid leads to a significant increase in heat transfer in the tube. It was also concluded that the tube containing porous material with a porosity of 50% and 63% would increase the heat transfer significantly (about twice) compared with the empty tube. In another experimental study, Nazari et al. [53] performed a test for forced heat transfer in a cylindrical duct channel with internal heat production. Dry air has been used as an agent fluid in the process of cooled hot spherical beads. The internal temperature with electromagnetic induction heating method is uniformly produced in the spherical metal particles used in the test. The study is in constant flow mode and in the turbulent flow regime in the range of 4500 to 9500 Reynolds number. Various parameters due to changes in grain diameter, fluid velocity and amount of heat generated on forced transfer heat transfer in porous channel have been studied. The results of the present work indicate an increase in the forced heat transfer coefficient of the air in the porous channel by increasing the Reynolds number, as well as the porous channel of the pressure drop. On the other hand, by reducing the diameter of the grains, the forced heat transfer and the pressure drop in the canal have increased and the fluid temperature has decreased. Compared to the work done with water, the forced heat transfer coefficient for air fluid is lower and the pressure drop is lower than the water fluid. Angirasa [54] performed experiments to increase the amount of heat transfer by placing metal fibrous materials with two porosities of 97 and 93 percent in the canal. The output of Reynolds number changes from 17000 to 29000 and the input power of the pump is 7/3 and 9/2 watts. An increase of 3 to 6 times the Nusselt number compared to a non-porous channel has been reported. Hetsroni et al. [55] investigated the heat transfer and pressure drop in a rectangular channel with a porous material in the bed by laboratory method. In this experiment, low porosity was investigated for heat dissipation in small-sized devices with high power, and the results showed that the wells would be very efficient, although the heat transfer increased as the heat pump increased. Pamuk, and Ozdemir [56] experimentally investigated the heat transfer in a porous medium under fluctuating water flow. A total of 54 experiments performed with frequency, fluid displacement length and different incoming heat. They used two steel bullet models to form a porous medium in the tube. They provided a model for calculating Nusselt numbers in their work. Wang and Guo [57] investigated numerically and experimentally the effect of inserting metal fibers into a square channel and without contact with the channel wall. The results showed that the temperature profile of the fluid passing through the fibers would be more uniform and the temperature of the liquid near the wall would be more severe, thereby increasing the heat transfer. Their geometry is shown in figure 7.

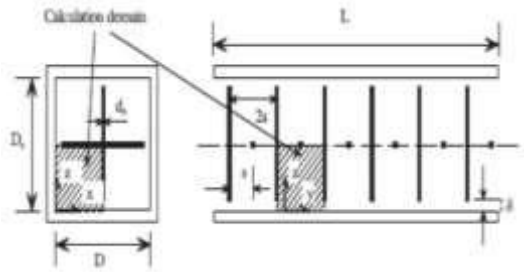

Fig. 7: Schematic research of Wang and Guo [57]

Huang et al. [58] examined the increase in heat transfer by embedding the porous medium at the center of a tube numerically and experimentally. In their work, they used diameters of copper with different diameters, which were inserted at different intervals, and used the boundary condition of constant flux. They used air as a fluid in a wide range of Reynolds number (1000 <Re <19000). It also used three different porosity of 0.951, 0.966, and 0.975 in experiments. The effect of radius on the function of the system was numerically investigated. Experimental and numerical results showed that the transfer heat transfer substantially increased in porous medium placements close to the pipe diameter, and the flow resistance also increased at a reasonable rate, especially in a slow flow. In sum, they introduced this method, an effective solution to increase heat transfer. Jiang et al. [59] investigated the empirical and numerical research of forced heat transfer in a canal filled with porous media. The schematic geometry used is shown in figure. 8. They studied the effects of temperature distribution, variable properties due to pressure variation, porosity particle diameter, thermal conductivity of particles and fluid velocity. The experimental and numerical results obtained for the coefficient of friction in the porous medium were in good agreement with the value obtained from the formula. The porous medium also significantly increased

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the pressure drop across the canal, compared with the empty channel. Heat transfer has decreased with decreasing the diameter of the porous particles and increased with increasing the conductivity of the particles.

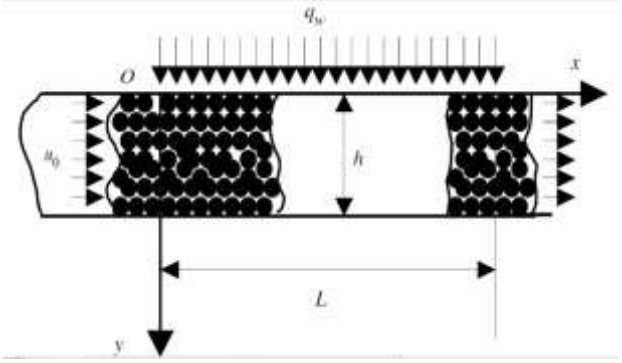

Fig. 8: Geometry examined by Jiang et al. [59]

Sarada et al. [60] investigated numerically and experimentally the effect of mesh insertion in a horizontal tube on increasing the heat transfer of the flow of turbulent fluid by air. They observed the most Nusselt number, equal to 2.51 times the simple tube, at a mesh radius of 0.8 and a distance of 50 mm. Also, the highest drop in pressure drop that is 1. 23 times of the simple tube was in the mesh radius of 0.945.

X. CONCLUSION

Placement of porous materials in the fluid path is one of the passive ways of increasing heat transfer in heat exchangers. In this paper, recent studies on the effect of using porous media on increasing the amount of heat transfer in heat exchangers by applying porous environments with porosity percentage, gender and geometric structure in the flow path, using numerical simulations and studies Laboratory was studied. However, each of the results is related to the particular case and its conditions, but studies have shown that the presence of porous media in the flow path improves the thermal conductivity matrix and effective heat capacity of the flow. A porous solid-state environment also increases the heat transfer velocity especially in systems where gas is flowing. It seems that, given the increasing human need for energy and the needs to prevent its loss, many researchers are working to increase the efficiency and efficiency of energy production or conversion systems using porous media.

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Effect of Displacement on Pressure Distribution in Cake Expression

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Abstract— *The principle underlying expression basically involves the separation of a solid from the liquid in which it is suspended by passing the mixture through a porous medium with pore sizes too small to allow the passage of the solid particles at an applied pressure. The analytical method of the finite element method has been used to determine the relationship between pressure distribution and displacement distribution along sludge cake height in a filter press expression process. The finite element formulation basically involves the properties of the sludge in question as distinguished from other solution. The solution domain was idealized as a one-dimensional quadratic shape function for the purpose of this analysis and the displacement function formulation method were employed in solving the pressure distribution. It was discovered that pressure increases with an increase in displacement of the cake at different time of expression. It was also discovered that pressure increases simultaneously with displacement as the time of expression increases. The ranges of displacement in a sludge cake height with increase time of expression increases with a decrease in sludge depth, hence impacting positively of the effective pressure. The displacement increases continuously with increase time of expression.*

Keywords— Expression, Sludge cake, Compressive pressure.

I. INTRODUCTION

Cake filtration is an important and widely used separation process in many areas in which the objectives may be to either recover a clear filtrate, or to recover the suspended solids, or both. The aforementioned areas include the chemical and petrochemical, mineral, food, pharmaceutical and water treatment industries. In the process industries, separation and purification of the product stream is probably the stage where most value is added. Also, increasing environmental awareness has resulted in ever more stringent legislations to control liquid discharge compositions. These two factors have led to separation science and technology playing a pivotal role in the relationship between product quality, competitiveness and the environment (Tien, 2002).

The handling and disposal of this sludge is one of the greatest challenges facing the environmental engineer. The sludge has high water content and compressibility attribute and as such it is expedient to dewater it to reduce its volume and prevent environmental health hazard. The dewatering of sludge using the filter press method has been in existence far back as in the 1920s. Since then, a number of equations have been presented by various contributors aimed at improving the performance of the sludge filtration/expression process, Carman, (1934), (1938); Grace, (1953); Coackley, (1956); Ademiluyi and others, (1983), (1987); Gale, (1975); Anazodo, (1974); Ademiluyi, (1986). However, their research was limited to experimental work which could not provide an insight into the interactive nature of sludge filterability. As previously sighted in literature (Anazodo, 1974; Ademiluyi, 1986) the inapplicability of Darcy's law of fluid flow to the dewatering process stems from the fact that Darcy's law is only applicable to rigid materials where porosity is constant. This uniformity in porosity implies a corresponding uniformity in pressure throughout the cake height. This is not true with compressible or deformable materials in for sludge cake. Porosity decreases from sludge to the cake height closest to the septum (Hemant, 1981; Bear et al, 1991; Lee et al, 2000; Svarosky, 2000; Challeppah et al, 2009; Challeppah et al, 2010). In the course of this porosity variation, pressure also varies as a result of solid compaction displacement along the sludge height. Even though the direction of porosity and pressure variation will be intuitively assessed, there is still the need to provide a theoretical base for such assessment. It is in the light of the foregoing that finite element method of analysis was used in this study to evaluate the effect of displacement distribution on effective pressure along the expressed cake height. It is hoped that the study will find practical application in the evaluation of models necessary to describe cake expression phenomenon.

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II. RESULTS AND DISCUSSION

As presented in previous publications, the finite element model equation for pressure distribution using a displacement formulation matrix has been developed. The quadratic shape function model was used on a cake expression generated data and the results are as presented below.

A graphical representation of pressure and displacement at particular heights of sludge cake versus time as shown in Figures (1, 2, 3 and 4) indicates that pressure increases with time. This is attributed to the continuous dissipation of excess pore water pressure with increased filtration time.

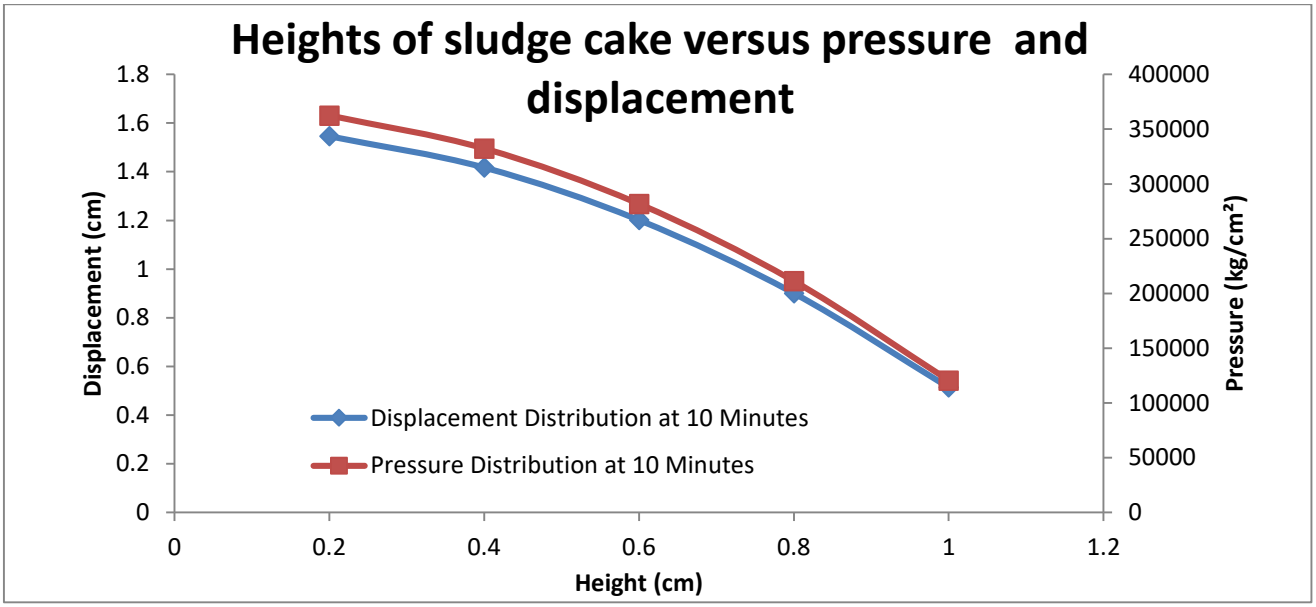

Fig.1: Plot of Heights of sludge cake versus pressure and displacement at 10 minutes

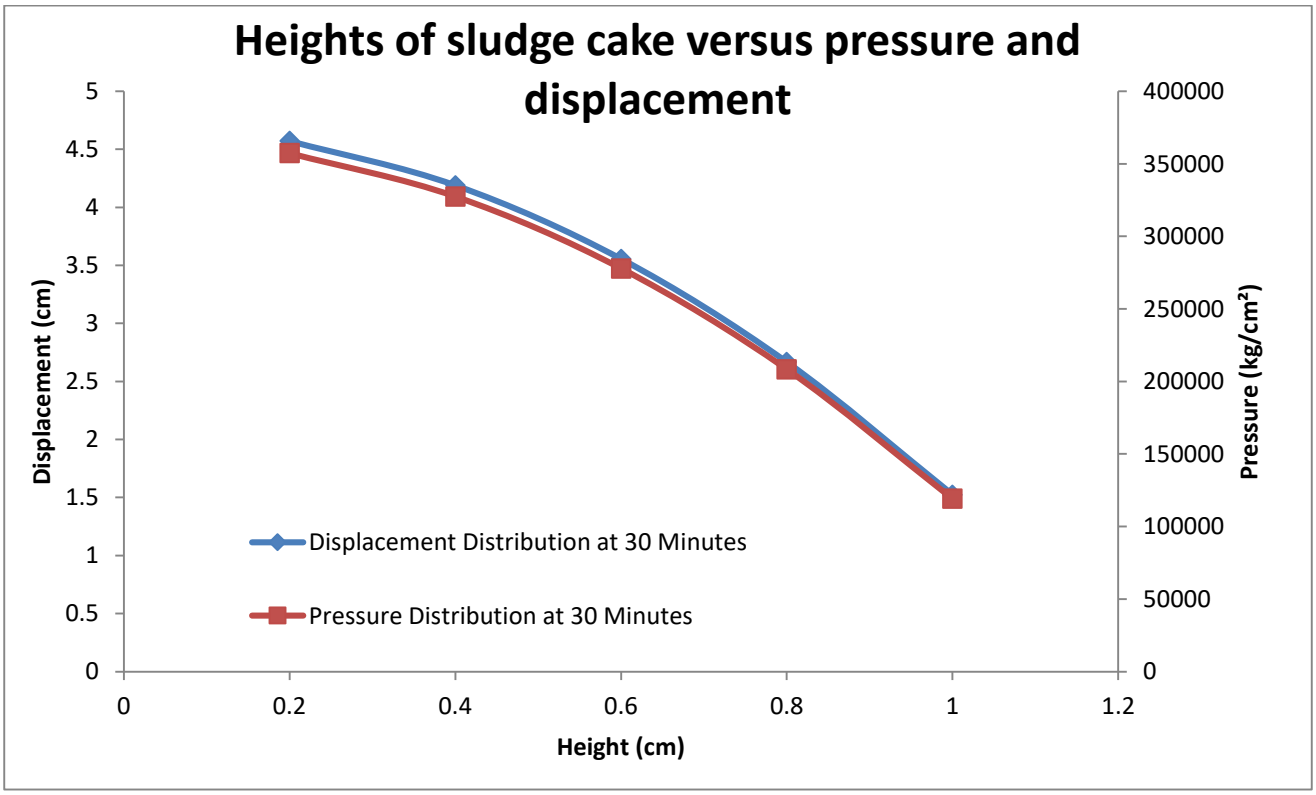

Fig.2: Plot of Heights of sludge cake versus pressure and displacement at 30 minutes

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It is evident, that from the plot of height of sludge versus pressure and displacement, there is a gradual trend to uniformity of pressure and displacement along the cake height as the time of expression increases. Hence the rate of displacement is directly proportional to the compressive pressure, which implies that the internal pressures are functions of both position and time. The effective pressure is not a physical quantity. The effective pressure is then simply the drag on all the particles in the distance from x to L divided by the cross-sectional area. This implies that the drop in hydraulic pressure from water pores across the sludge length resulting in an increase in displacement is exactly equal to the rise in solid compressive pressure.

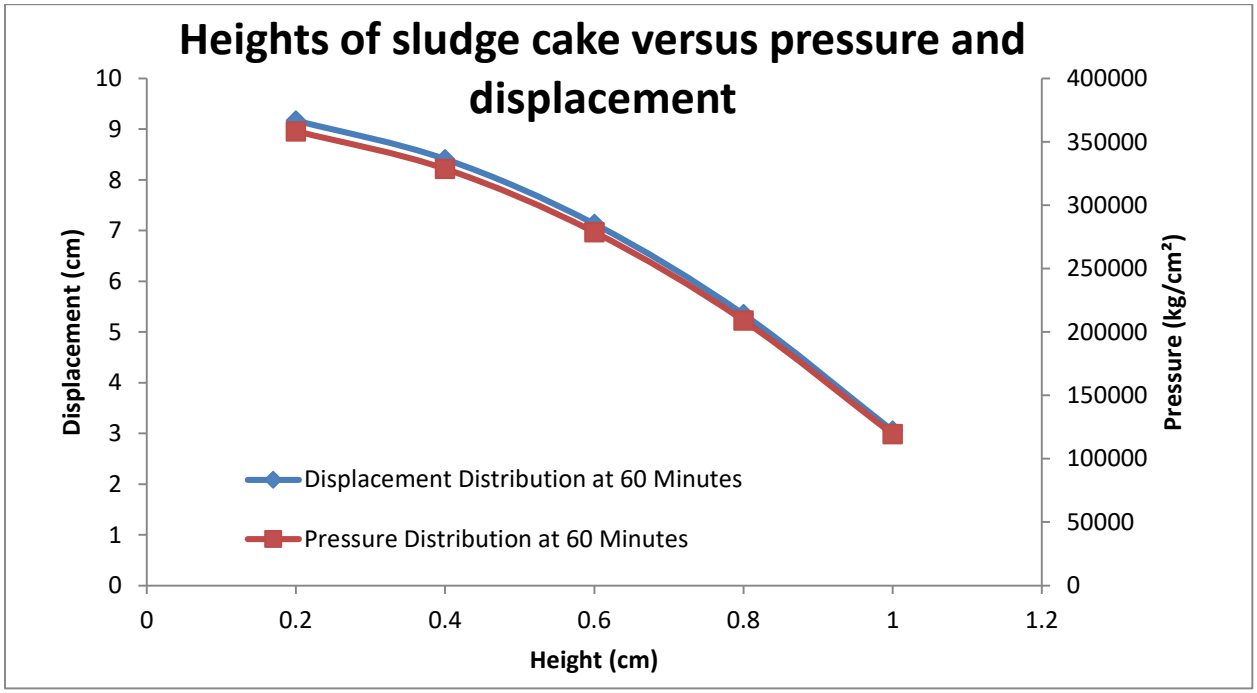

Fig.3: Plot of Heights of sludge cake versus pressure and displacement at 60 minute

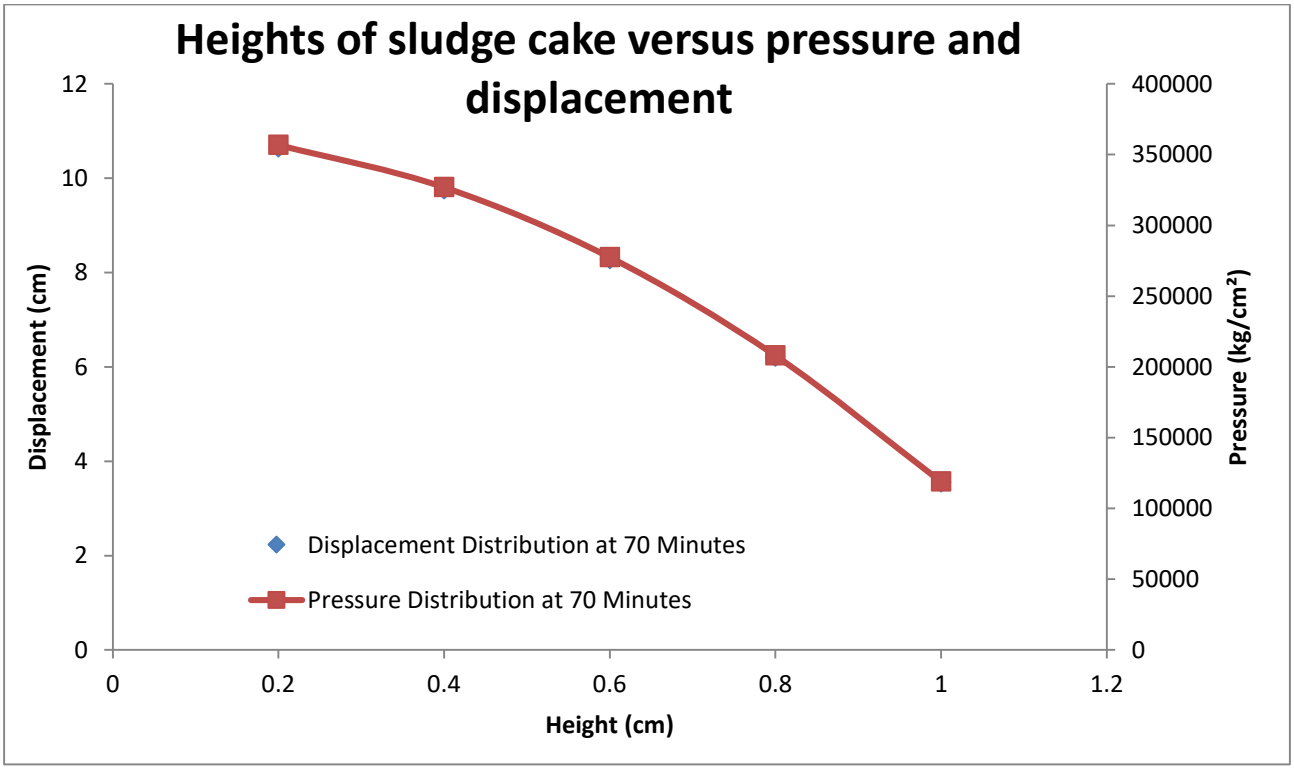

Fig.4: Plot of Heights of sludge cake versus pressure and displacement at 70 minutes

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Sludge filterability is a function of porosity which in turn depends on the pressure difference across the filter cake. Therefore the study of pressure distribution along height of sludge cake can aid in the variation of the filterability parameter used to quantify sludge dewatering. A decrease in the depth of the expressed cake, results in a decrease in the pressure drop. Hence, an increase in displacement implies a corresponding increase in pressure change. It is important to note that the effective pressure is directly proportional to the compressive pressure whose values especially in filter presses could be negative indicating the fact that it is a counteractive force (compressive), which when compared with the axial strain deformation, as shown in Figures (5, 6) displays a correlative result (i.e. the higher the axial strain deformation, the greater the effective pressure distribution).

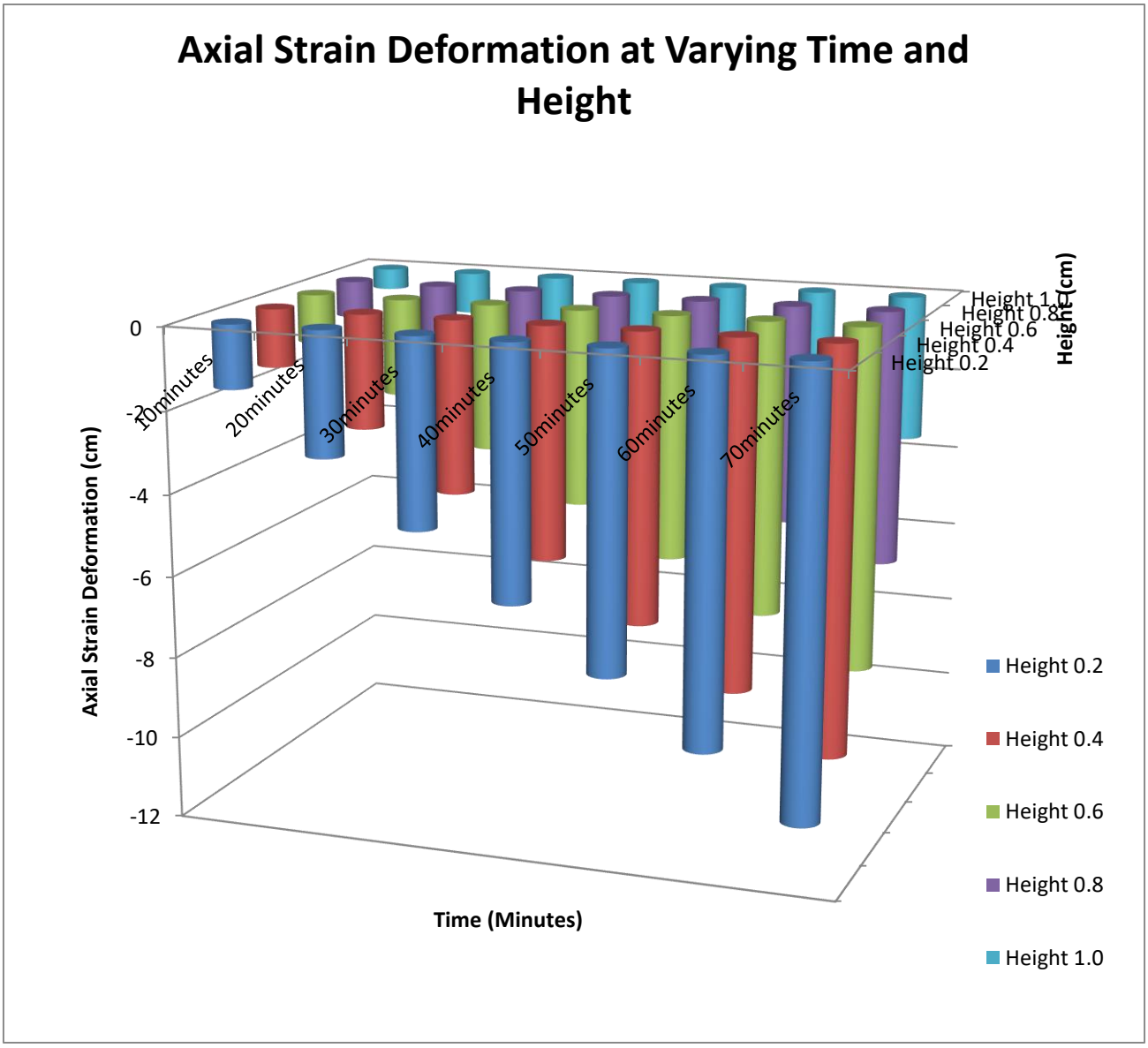

Fig.5: Plot of Axial Strain Deformation at Varying Time and Height

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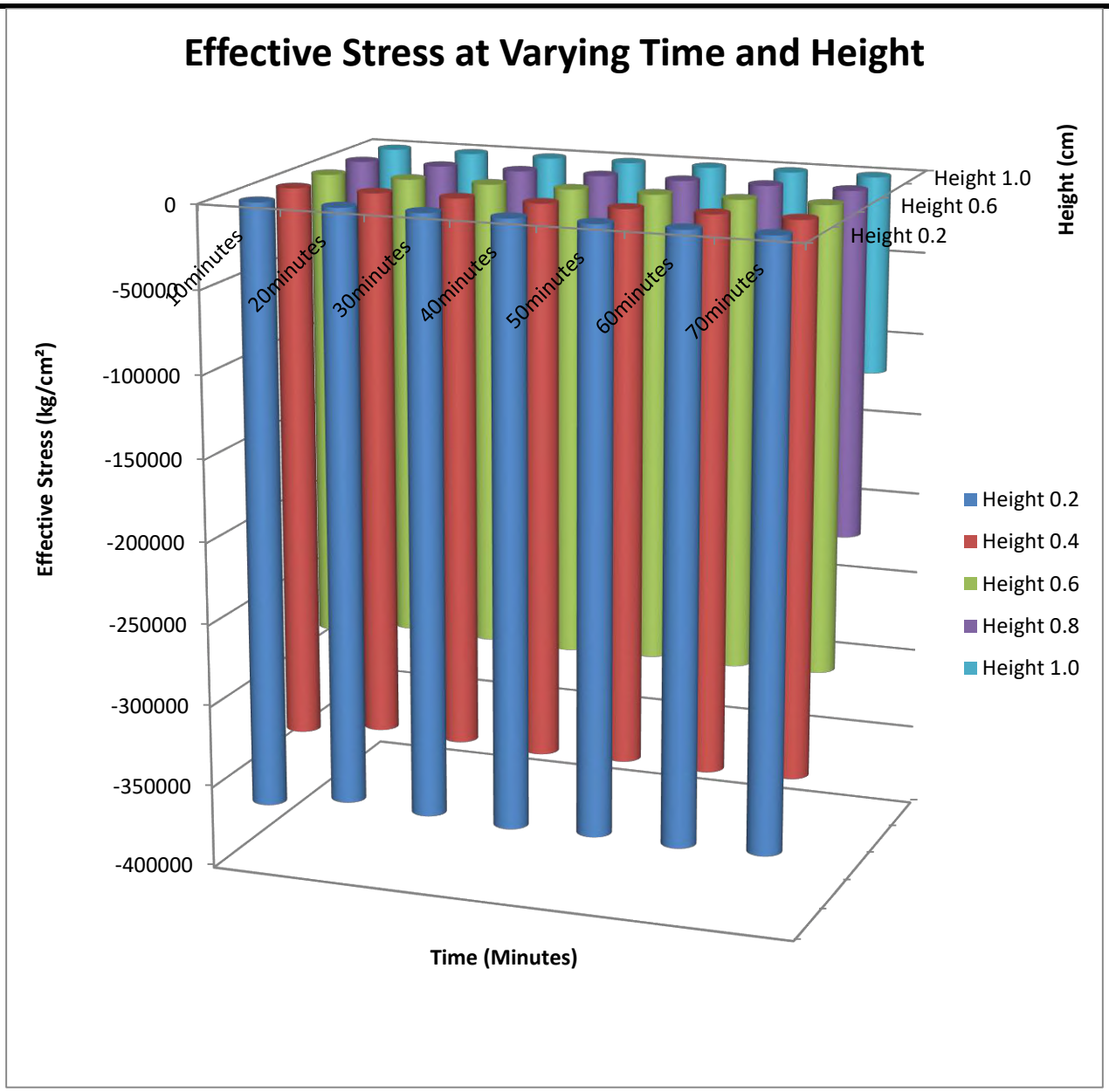

Fig.6: Plot of Effective Stress Distribution at Varying Time and Height

At the beginning of the expression the whole pressure drop available is across the medium itself since as yet no cake is formed. As the pores of the medium are normally small and the rate of filtrate flow is slow, the flow conditions are almost invariably laminar (Tiller, 1974, Svarovsky, 2000). When the particles are retained at the surface of the medium, they form a cake. As soon as the first layer of the cake is formed, the subsequent expression takes place on the top of this cake and the medium provides only a supporting function. A greater proportion of the available pressure drop is taken up by the cake itself. This results in an effective increase in the bed resistance as a result of solid particle compaction (displacement) thus leading to a gradual drop in the filtrate flow rate in constant pressure expression.

III. CONCLUSION

1) It has been demonstrated that the expression mechanisms under constant pressure consist of two flow phenomenon; of filtration and consolidation, and these phenomena, though occurring progressively from filtration, changes at a transition stage with increased time of filtration, with no visible flow of filtrate, but with evidences of displacement in the sludge cake height as a result of solid settlement. A process called consolidation.

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2) The rate of displacement is directly proportional to the compressive pressure, which implies that the internal pressures are functions of both position and time.
3) The drop in hydraulic pressure from water pores across the sludge length results in an increase in displacement which is exactly equal to the rise in solid compressive pressure.

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HCIFR: Hierarchical Clustering and Iterative Filtering Routing Algorithm for Wireless Sensor Networks

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Abstract— *The hierarchical clustering and iterative filtering algorithms are combined to form an energy efficient routing algorithm which supports in improved performance, efficient routing at the time of link failure, collusion robust and secure data aggregation. The idea of combining these two algorithms which may lead to improved performance. Initially clusters are formed by neighborhood. The cluster is a combination of one clusterhead, two deputy clusterheads and cluster members. This system uses a Hierarchical clustering algorithm for efficient data transmission to their clusterhead by cluster members. The clusterhead aggregate the collected data and check for trustworthiness. The data is aggregated by clusterhead using the iterative filtering algorithm and resistant to collusion attacks. Simulation results depict the average energy consumption, throughput, packet drops and packet delivery under the influence of proposed algorithm.*

Keywords—Cumulative Credit Point, Hierarchical Clustering, Iterative Filtering, MLE(Maximum Likelihood Estimator), Secure Data Aggregation, TDMA (Time Division Multiple Access).

I. INTRODUCTION

A WSN is a collection of sensor nodes and a small number of data collection devices. The sensor nodes are low cost, low-power, small-size devices, and are used for sensing applications like temperature recording, military surveillance, fire detection etc. The sensor nodes are used for gathering information which is present in environment of their interest. The sensor nodes send their sensed information using a wireless medium to a remote base station (sink). The base station aggregates the collected data and draw conclusions over sensed data.

Routing is an important and challenging design issue need to considered for WSN. "A properly designed routing protocol should not only ensure high message delivery ratio and low energy consumption for message delivery, but also balance the entire sensor network energy consumption, and thereby extend the sensor network lifetime. The main feature of WSNs are: scalability, self-organization, self-healing, energy efficiency, network lifetime optimization, less complexity, less costly, security, routing, size of nodes and connectivity between the sensor nodes. Every sensor node in the network should be a source or destination but not both.

HCIFR protocol has the advantages:

- HCIFR ensures that the energy consumption of the wireless sensor network can be reduced. So that the maximization of network lifetime can be achieved.
- HCIFR algorithm takes routing decisions dynamically. So the data delivery to the clusterhead and finally to the base station.
- HCIFR uses the Iterative Filtering algorithm for secure data aggregation.

Clustering is concept used in the proposed system for the reduction of energy consumption. Clustering means grouping the different set of nodes which are their neighbours. Cluster members can send their sensed data to the clusterhead with less energy consumption. The clusterhead can send the final aggregated data to the base station. The clusterhead is responsible for collecting data, checking for the redundancy and aggregate the remaining data. The aggregated data can be transmitted to the base station.

The data can be aggregated using the averaging technique by clusterhead. Through this technique there are possibilities of security attacks on sensor nodes whose battery power is dead. So to avoid these type of attacks, the Iterative Filtering (IF) algorithms are used.

This paper is coordinated by: section 2: explains literature survey, and different routing algorithms. Section 3: contains methodology of proposed system which includes dynamic hierarchical clustering and iterative filtering. Section 4: depicts the results obtained from evaluation of the proposed system. Section 5: conclusions.

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II. RELATED WORK

Hiren Kumar Deva Sarma, Rajib mall and Avijit Kar proposed a system which is energy efficient and reliable routing for mobile WSN for deploying the sensor nodes, clustering concept is introduced. A cluster consists of clusterhead, two deputy clusterhead, and cluster members. The role selection of the sensor is done by base station using the cumulative credit point [1]. Mohsen Rezvani, Aleksandar Ignjatovic, Elisa Bertino and Sanjay Jha proposed a system which is an improvement of Iterative Filtering algorithm. This algorithm is collusion robust against security attacks. The algorithm used to find the error rate by calculating the bias and variance of each sensor node and eliminate the error rate using the MLE. The malicious nodes are blocked by the clusterhead and send the final aggregated data to the base station. In this workshop [2], H. K. Deva Sarma, A. Kar, and R. Mall proposed a concept called cumulative credit can be used a parameter for the role selection of either clusterhead or deputy clusterhead [3].

In this paper [4], S. Lindsey and C. S. Raghavendra proposed an algorithm called PEGASIS (control proficient assembling in sensor data frameworks), a close ideal chain-based convention that is a changeover LEACH. In PEGASIS, every node connects to its nearby neighbour and alternates transmitting to the base station, in this way decreasing the energy spent per round. In this paper [5] D. B. Johnson, and D. A. Maltz proposed an algorithm routing the packets between the mobile wireless hosts in adhoc network. This algorithm is capable of adapting of frequently changing the paths dynamically at the time of link failure or link unavailability. The paths are changed when there is overhead. In this paper [6] J. N. Al-Karaki and A. E. Kamal have surveyed on the routing challenges, design issues while designing the routing protocols. The basics of the routing, routing types and routing protocols have been covered under this survey.

In this paper [7] A. Manjeshwar and D. P. Agarwal proposed an energy efficient algorithm called TEEN (Threshold sensitive Energy Efficient sensor Network protocol). There are many algorithms based on network classification like reactive and proactive networks. TEEN is been mainly proposed for reactive type of networks. Evaluate the performance of the protocol for a simple temperature sensing application. In terms of energy efficiency, this protocol outperforms from all existing sensor network protocols. TEEN perform much better than LEACH. In this paper [8] "A. Manjeshwar and D. P. Agarwal" has proposed an improvised version of TEEN algorithm called APTEEN (A hybrid protocol for efficient routing and comprehensive information retrieval in wireless sensor networks). This algorithm combines all the best features present in reactive and proactive networks. It collects the data periodically and also give real-time warnings when there are critical events. This algorithm can also be extended further to sensor networks with uneven node distributions.

In this paper [9] I. F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci has done survey on sensor networks. The basics of the sensor networks, network creation, protocol stack, and different types of algorithms for routing the packets in sensor networks. These all concepts is explained in detail. In this paper [10] W. Heinzelman, A. Chandrakasan, and H. Balakrishnan has proposed an algorithm called Energy-efficient communication protocol for wireless microsensor networks. The energy consumption can be reduced by using this algorithm. The clustering concept is used for energy consumptioj reduction and also the load on one clusterhead is been reduced by sharing the load to other clusterheads.

III. PROPOSED WORK

Initially the sensor nodes are deployed in the network randomly. The node sends "Hello" packets to its neighbour nodes, in this same way "Hello" packet will be flooded to the entire network. Based on the neighbourhood, the sensor nodes forms different clusters in the network. After formation of the clusters, the transmission of the data can be sent through the following phases as shown in fig 1.

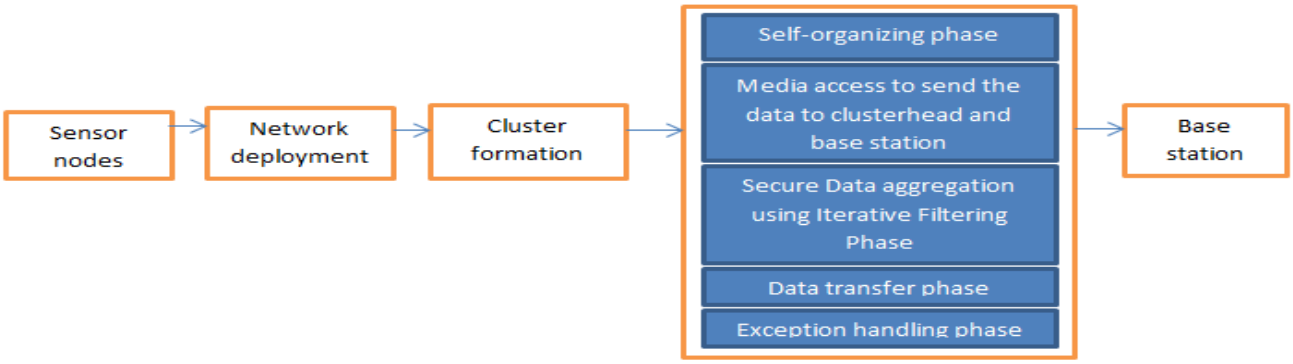

Fig 1: Architecture diagram of Proposed System

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A. Self-Organizing Phase: Once the clusters are formed as per the neighbourhood, the role selection of the sensor node can be clusterhead and deputy clusterheads will be done in this phase. The selection will be done by base station using the Cumulative Credit Point. Cumulative Credit Point is a combination of three values is: energy of the node, node degree and the mobility. The corresponding weight will calculated using these three values. The cumulative credit point of the nodes are arranged in descending order. The first threshold value will be selected as a clusterhead, second and third highest threshold values will be selected as deputy clusterheads. The clusterhead is involved in data collection from their cluster members. The clusterhead shares its data to one of the deputy clusterhead. The deputy clusterhead is involved in data transmission. It will forward the data to the base station by connecting deputy clusterheads of other clusters.

/*Algorithm to find the cumulative credit point of the sensor node*/

Input:

D → Node degree

E→ Energy of the node,

G→ Geographical location of the sensor node.

Output:

CP →cumulative credit point of the node

Variables: N →the total number of sensor nodes shortlisted by the base station.

V_D, V_E, V_M, CP, wt_1, wt_2, wt_3

Step 1: The sensor node degree is calculated as pantile count (V_D).

V_D = [(Total count of contestant nodes which is having lesser degree than the degree of the contestant node interested, in the cluster) / N] × 100

Step 2: The sensor node energy level is calculated as pantile count (V_E).

V_E = [(Total count of contestant nodes which is having low energy level (E) than the energy level of the contestant node interested, in the cluster) / N] × 100.

Step 3: The sensor node geographical location is calculated as pantile count (V_G).

V_M = [(Total count of contestant nodes who have less mobility level than the geographical location (G) of the contestant node interested, in the cluster) / N] × 100

Step 4: Compute the cumulative credit point CP for each node inside the cluster as follows:

$CP = (wt_1) V_D + (wt_2) V_E + (wt_3) V_G$

Where wt_1, wt_2, and wt_3 are weight factors given to different constants, for example, node degree of the node, energy level, and geographical location regulated in the below condition:

$wt_1 + wt_2 + wt_3 = 1$

B. **Media access to send the data to its clusterhead and Base station:** TDMA (Time Division Multiple Access) is used to send the data from cluster members to its clusterhead, and the clusterhead share its data to deputy clusterhead. The base station also receives the data from the deputy clusterhead in TDMA.

C. **Secure Data aggregation using Iterative Filtering Phase:** The data received from its cluster members will be aggregated using the iterative filtering algorithm. If the sensor nodes send the incorrect data then the clusterhead identifies the node which has sent incorrect data by calculating the Bias value of each sensor node (Error rate is calculated), the Variance value of each sensor node (noise ratio is calculated) and using the MLE (Maximum Likelihood Estimator). The MLE finds the original signal or data from Bias and Variance value. In this way, the clusterhead finds the original data and aggregates with the data sent by other cluster members.

D. **Data Transfer Phase:** this is the phase where the final aggregated reaches its destination called Base station: Finally the aggregated data is shared by clusterhead to its deputy clusterhead. The deputy clusterhead forward the data to the base station by connecting the different and nearest deputy clusterhead of other clusters.

E. **Exception Handling Phase:** This phase specifies how to handle in situations like link failure, and clusterhead is not able to withstand its position. At the time of link failure, alternative routes will are used by the deputy clusterheads or cluster members to send the data. The routes are calculated dynamically. When the energy of the clusterhead is reduced in such a way that it cannot collect the data then the clusterheadship is transferred to one of its deputy clusterhead. The deputy clusterhead for that cluster will be selected by base station.

IV. RESULTS AND DISCUSSION

The NS2 network simulator is used. Consider a sensor network of 82 sensor nodes deployed randomly in the field as shown in below fig. The routing algorithm is verified for different network scenarios. The results of the proposed routing algorithm are also compared with the results of other algorithm. M-LEACH protocol is selected to compare with the proposed protocol by considering the mobility of nodes while routing the packets.

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Initially the 82 nodes are deployed in the network dynamically as shown in fig 2

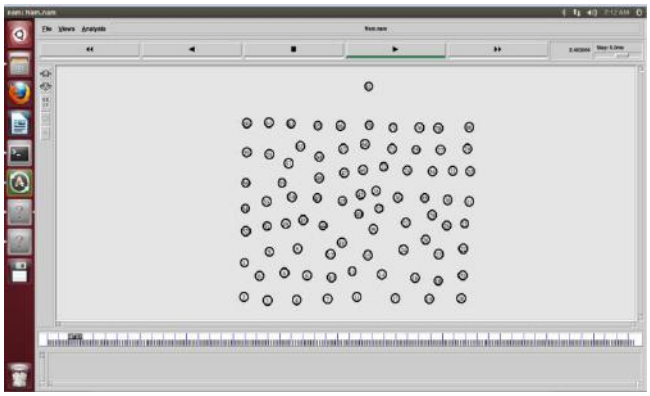

Fig 2: The deployment of sensor nodes in the network

The sensor node 0 is sending the hello packets to its neighbours inturn the neighbours will broadcast the "Hello" packets to its neighbours as shown in below fig 3

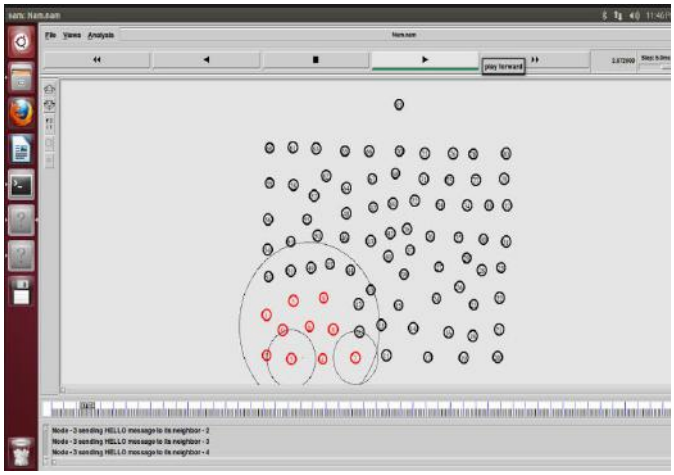

Fig 3: The transmission of "Hello" packet by node 0 to nearest neighbours to find the neighbourhood

The sensor nodes have formed different clusters in which each color represents one cluster as shown in below fig 4.

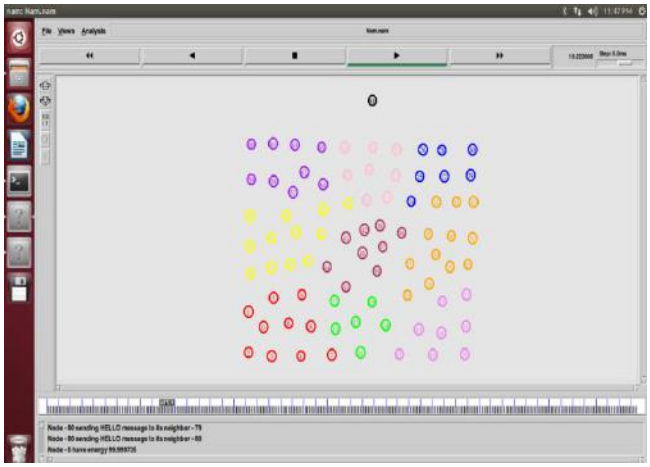

Fig 4: Nodes have formed different clusters

The sensor nodes of each cluster declare its clusterhead and deputy clusterhead1 and deputy clusterhead2 has been selected based on the cumulative credit point. For example the blue cluster which is at rightmost top corner, the cluster consists of 74, 75, 76, 77, 78, 79, and 80. Based on the threshold value of the node 78 is selected as clusterhead. The deputy clusterhead1 is 75 and deputy clusterhead2 74 as shown in below fig 5.

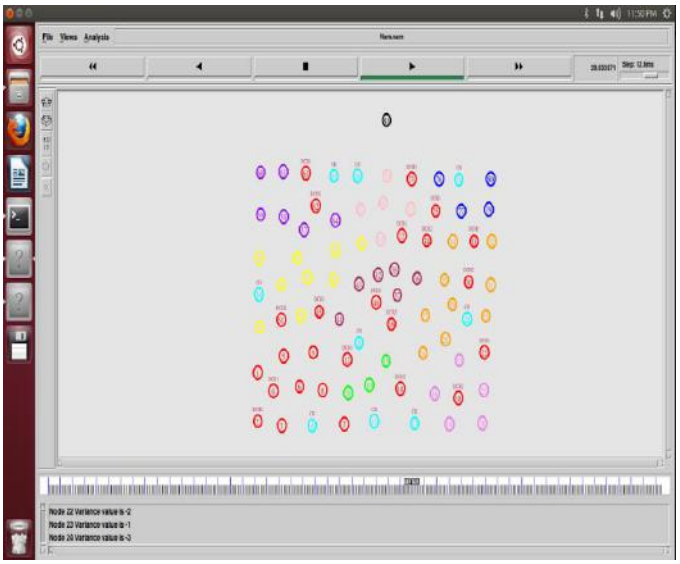

Fig 5: The clusterhead and deputy clusterhead of all the clusters are declared

The iterative filtering algorithm is used to find malicious or misbehaved node in the wireless sensor network. For example node number 1, 2, 14 and so on are malicious node as shown in below fig 6.

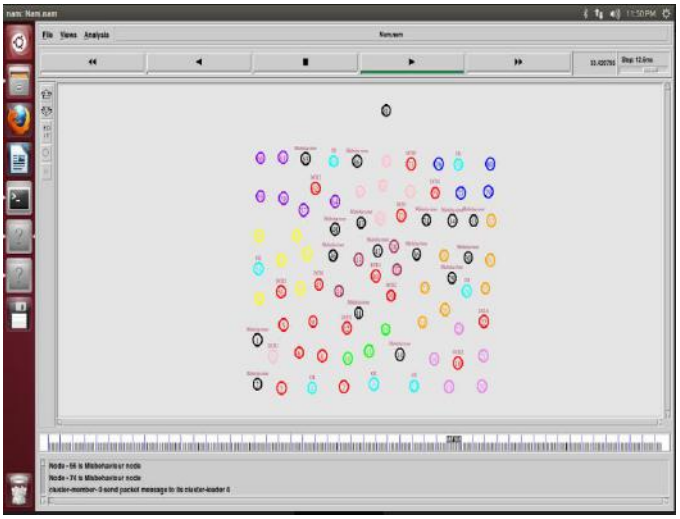

Fig 6: The malicious nodes have been blocked by clusterhead which are in Black color

A. Performance measures

The below mentioned measures are used for comparison of the performance for proposed protocol and existing protocol called M-LEACH protocol based on the below parameters.

- Average energy consumption
- Throughput
- Packet drops
- Packet delivery.

Average Energy Consumption: It means that the average energy required for sending the sensed data to the base

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station. The comparison of both algorithms is shown in the form of graph as in fig 7.

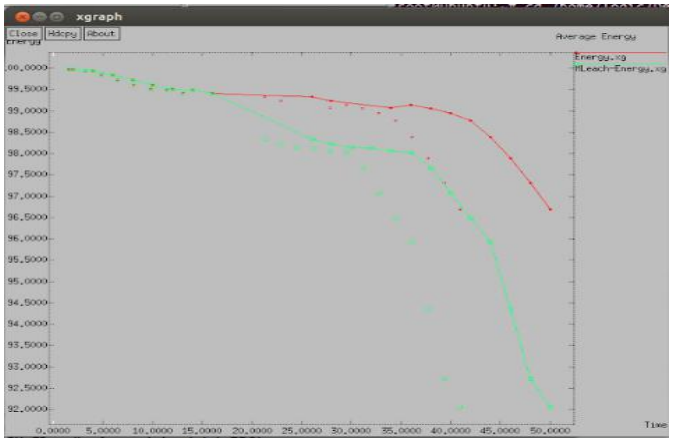

Fig 7: Comparison of M-LEACH algorithm and HCIFR algorithm based on energy consumption

Throughput: It is the ratio between the actual numbers of packets transmitted by the nodes in the system to the numbers of successfully delivered packets at the base station. A protocol with higher throughput is desirable. The graph is shown in fig 8 how the throughput based on speed of delivery is varies from the proposed algorithm to M-LEACH algorithm.

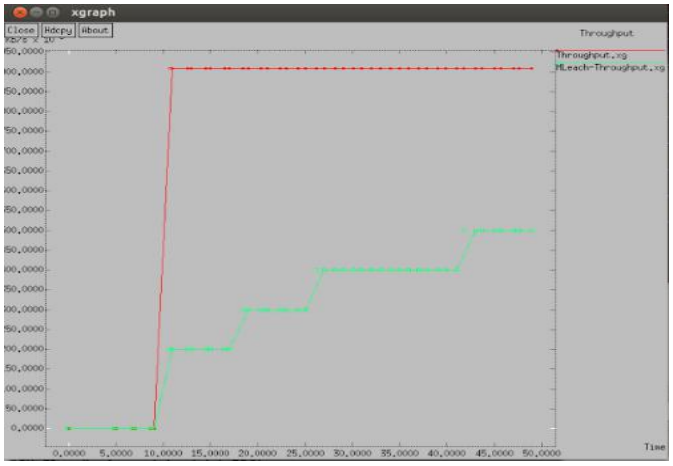

Fig 8: Comparison of M-LEACH algorithm and HCIFR algorithm based on throughput

Packet drops: Packet loss occurs due to the computer network failure while the packets reaching to its destination. The packet drops of the HCIFR algorithm are compared to the M-LEACH algorithm as shown in below fig 9.

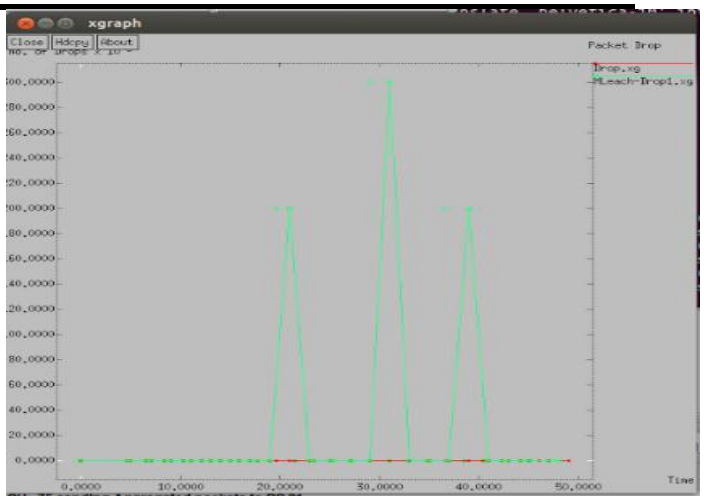

Fig 9: Comparison of M-LEACH algorithm and HCIFR algorithm based on packet drops

Packet delivery: The successful delivery of a packet over a wireless sensor network depends on the routing algorithm used to route the packets. The packet delivery of the HCIFR algorithm is compared to the packet delivery of the M-LEACH algorithm is shown in fig 10.

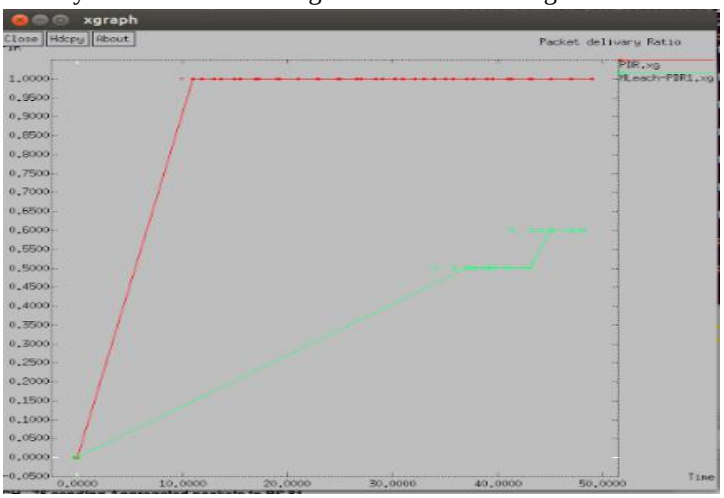

Fig 10: Comparison of M-LEACH algorithm and HCIFR algorithm based on packet delivery to the base station

V. CONCLUSION

An energy efficient routing algorithm is proposed for efficient routing of the sensed data from the cluster members to its clusterhead, then clusterhead aggregates the data using the Iterative Filtering algorithm which is collusion robust and checks for trustworthiness. Then the data from clusterhead shares with its one of the deputy clusterhead and finally to the Base station. The proposed algorithm is also fault tolerant. The proposed routing algorithm outperforms when compared to the M-LEACH algorithm.

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Comparative Study of the Quadratic and Linear Shape Function Model in Cake Expression

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Abstract— *The principle underlying expression basically involves the separation of a solid from the liquid in which it is suspended by passing the mixture through a porous medium with pore sizes too small to allow the passage of the solid particles at an applied pressure. The analytical method of the finite element method has been used to determine pressure, displacement and concentration distribution along sludge cake height in a filter press expression process. The ranges of displacement in a sludge cake height with increase time of expression increases with a decrease in sludge depth. The displacement increases continuously with increase time of expression. The finite element formulation basically involves the properties of the sludge in question as distinguished from other solution. The solution domain was idealized as a one-dimensional quadratic shape function for the purpose of this analysis and the displacement function formulation method were employed in solving the pressure distribution. The results of the finite element solution further showed that concentration increases with decreasing height of sludge cake interface during sludge dewatering. There is however an increasing tendency to uniformity of concentration with increment in the time of expression.*

Keywords— Expression, Effective stress, Sludge cake.

I. INTRODUCTION

Solid-liquid separation consists of the separation of suspended solids from a liquid. This is often a multi-stage process that involves pre-treatment, solid concentration, solid separation, and post-treatment (Tien, 2012). One of the most popular methods of separation is filtration that is widely used in food and beverage, chemicals, petroleum, pharmaceutical, pulp and, and water and wastewater treatment industries. Filtration can be used either as the solid separation stage or as post-treatment stage (Rushton et al, 2000; Tien, 2012). For example, in wastewater treatment, filtration is employed in both primary and secondary treatment as well as bio-solids dewatering. Deeper understanding and fundamental study of the expression process would help to advance the filtration technology and to improve solid separation efficiency, increase filtrate flow rate, and lower the separation cost.

The sludge has high water content and compressibility attribute and as such it is expedient to dewater it to reduce its volume and prevent environmental health hazard. The dewatering of sludge using the filter press method has been in existence far back as in the 1920s. Since then, a number of equations have been presented by various contributors aimed at improving the performance of the sludge filtration/expression process, Carman, (1934), (1938); Grace, (1953); Coackley, (1956); Ademiluyi and others, (1983), (1987); Gale, (1975); Anazodo, (1974); Ademiluyi, (1986). However, their research was limited to experimental work which could not provide an insight into the interactive nature of sludge filterability. As previously sighted in literature (Anazodo, 1974; Ademiluyi, 1986) the inapplicability of Darcy's law of fluid flow to the dewatering process stems from the fact that Darcy's law is only applicable to rigid materials where porosity is constant. This uniformity in porosity implies a corresponding uniformity in displacement, pressure and concentration throughout the cake height. This is not true with compressible or deformable materials in for sludge cake. Porosity decreases from sludge to the cake height closest to the septum (Hemant, 1981; Bear et al, 1991; Lee et al, 2000; Svarosky, 2000; Challeppah et al, 2009; Challeppah et al, 2010). In the course of this porosity variation, displacement, pressure and concentration also vary. Even though the direction of porosity and all other parameters considered will be intuitively assessed, there is still the need to provide a theoretical base for such assessment. It is in the light of the foregoing that finite element method of analysis has been used in this research to evaluate the distribution displacement, pressure and concentration along the expressed cake height with a comparative review of the quadratic and linear shape function models. It is hoped that the study will find practical application in the evaluation of models necessary to describe cake expression phenomenon.

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II. RESULTS AND DISCUSSION

As presented in previous publications, the finite element model equation for pressure distribution using a displacement formulation matrix and concentration distribution has been developed for both the quadratic and linear shape function models. The quadratic shape function models prove to be more effective in describing the pattern of sludge cake displacement, pressure and concentration distribution at a constant pressure. As shown in figures (1, 2) below, the displacement plots seems to be exactly the same in both model cases. It is clear that as long as there are still void spaces and water pores in the sludge cake, displacement function will be on the increase as constant pressure pending on the effect of the hydraulic pressure.

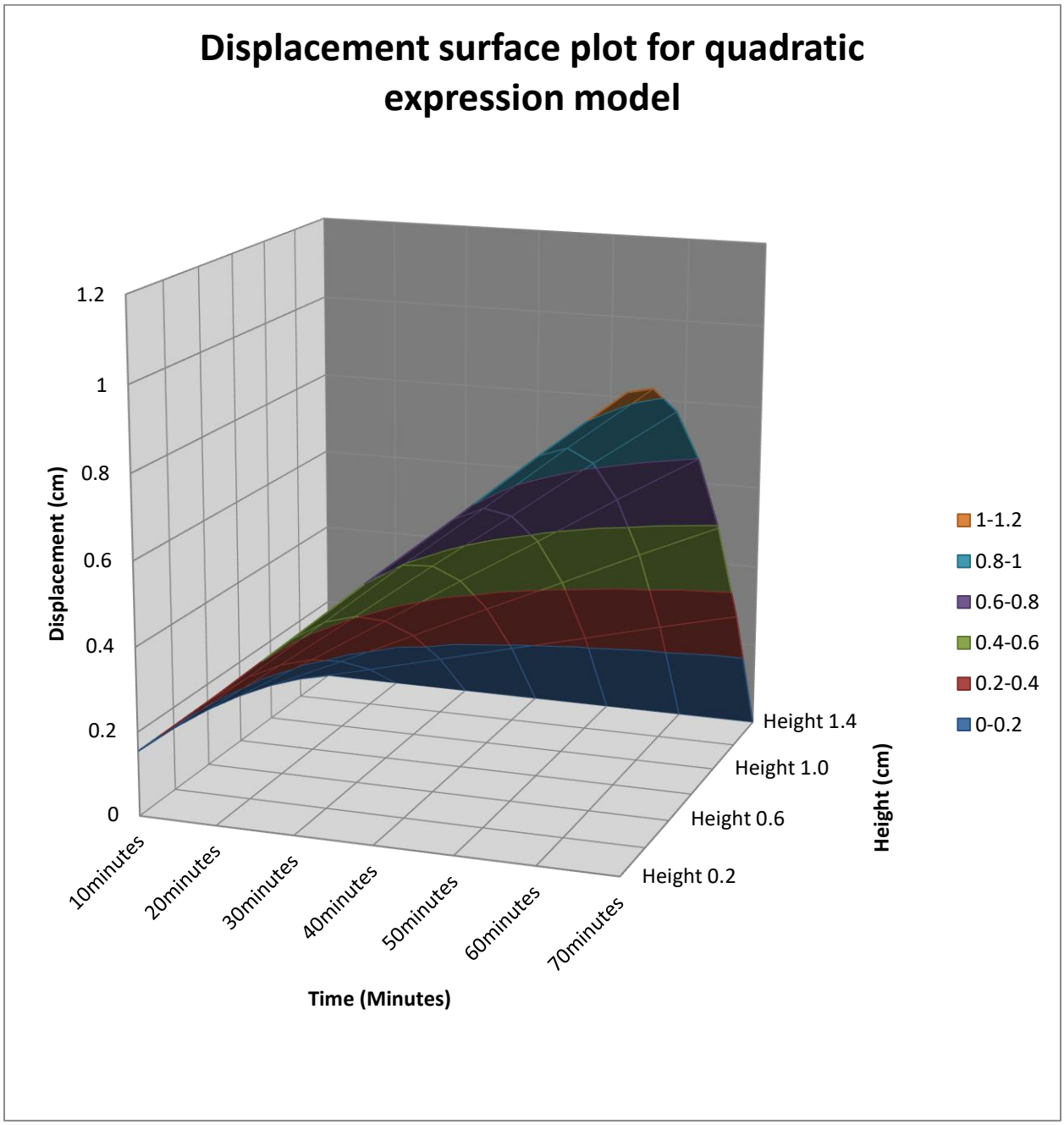

Fig.1: Surface plot for an expression displacement distribution of a quadratic function model.

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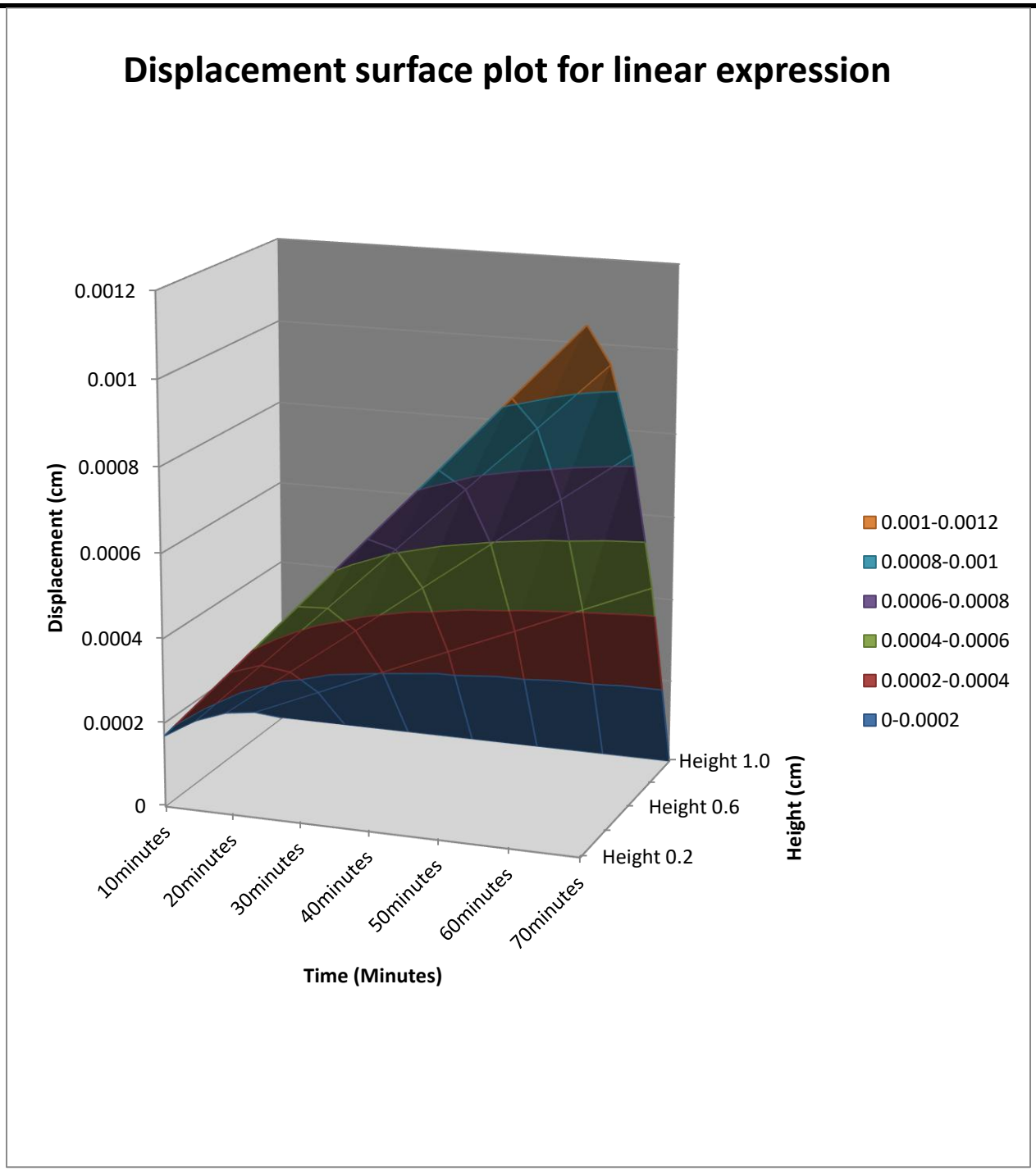

Fig.2: Surface plot for an expression displacement distribution of a linear function model.

The effective stress increases with decreasing height of sludge cake at different times of expression. The filter cake has an unstable structure, stabilized by some force related to flow velocity. In general an extremely loose packing exists and disturbances will easily cause changes in the structure. One of such disturbances is the unavoidable result of the process of flow. The drag force exerted by the liquid on the particles and on the filter material causes a cake pressure or filter medium pressure, which increase with the direction of flow. As shown in Figures 3 and 4 below, the curve of the quadratic function model depicts a typical expression case, conveying a picture of steady increases in pressure from the initial timing of 10 minutes to the final of 70 minutes. Its shows the relationship of the transition point between

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filtration and expression, hence confirming the initial plot of filtrate volume at varying time as a polynomial function.

But the linear function model has some discrepancies, though pressure buildup from the plot (Figure 4) is progressive, the uniformity does not really depict an expression phenomenon, hence branding the quadratic function model a better choice when designing an effective pressure distribution profile in cake expression.

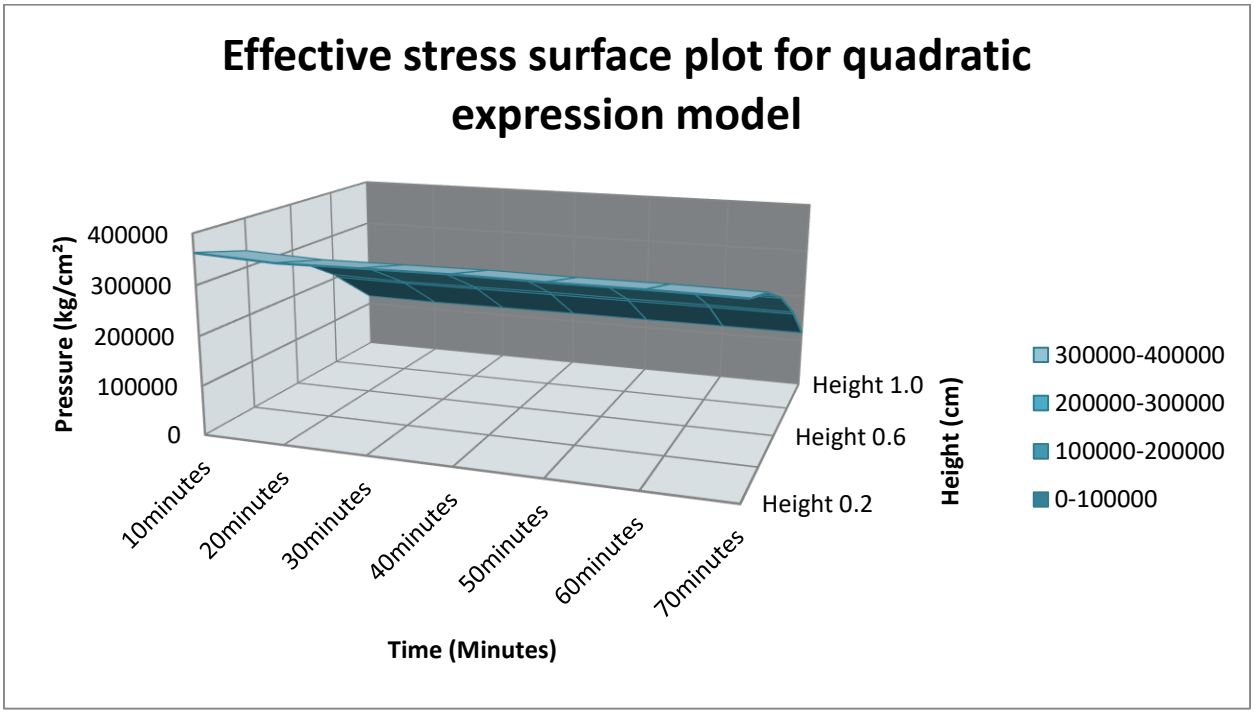

Fig.3: Surface plot for pressure distribution of a quadratic expression model

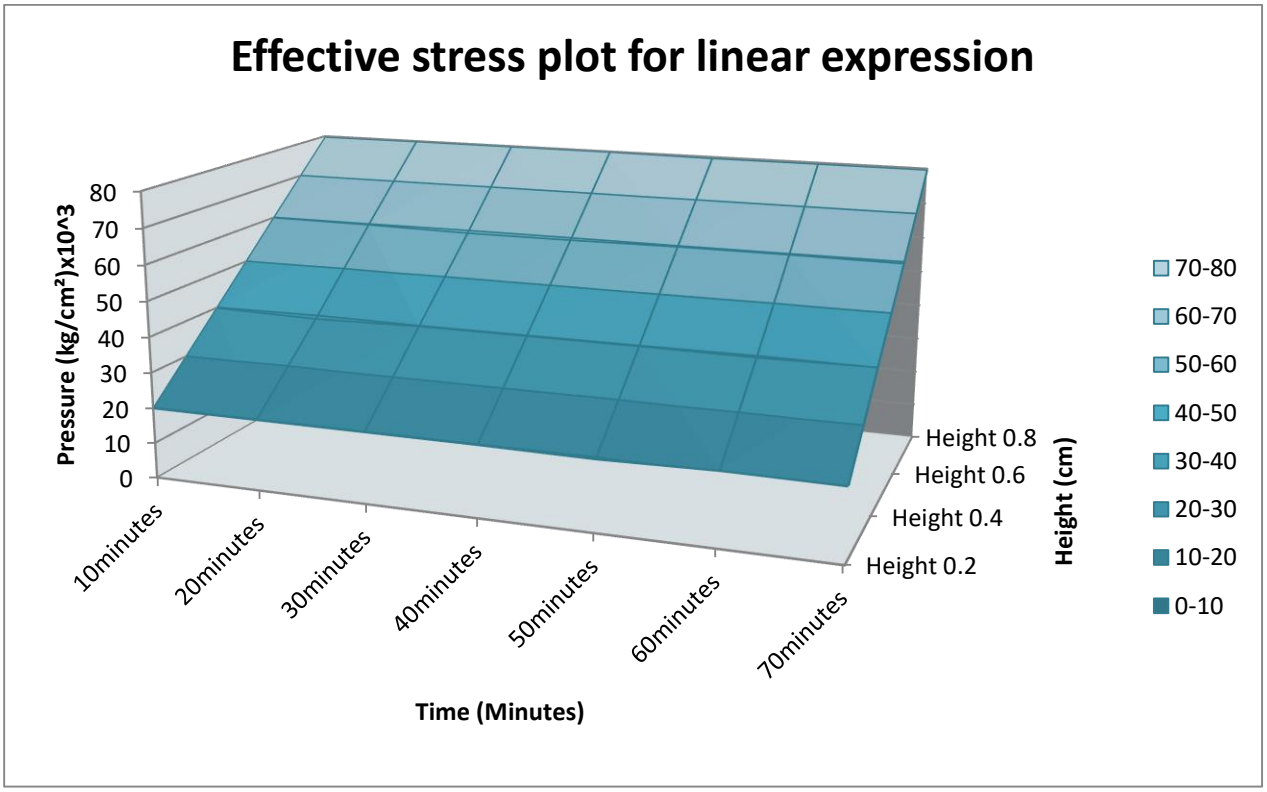

Fig.4: Surface plot for pressure distribution of a linear expression model

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It is evident, that from the plot of height of sludge versus pressure and displacement, there is a gradual trend to uniformity of pressure and displacement along the cake height as the time of expression increases. Hence the rate of displacement is directly proportional to the compressive pressure, which implies that the internal pressures are functions of both position and time. The effective pressure is not a physical quantity. The effective pressure is then simply the drag on all the particles in the distance from x to L divided by the cross-sectional area. This implies that the drop in hydraulic pressure from water pores across the sludge length resulting in an increase in displacement is exactly equal to the rise in solid compressive pressure.

However, the tendency to uniformity in concentration along the cake height is adjudged reasonable in the quadratic model plot as shown in figure (6) since it is expected that porosity decreases with time towards the filter septum. The linear model though tending to uniformity when considered on an average time of expression does not conform to the design expectation due to the outrageous values of concentration at certain times of expression. These occurrences could have theoretical explanations, but from the review of this study, it has been observed that the linear shape function model does not permit to a large extent the consideration of extra design location in the sludge cake, hence reducing the potency of the model from generating appropriate results that predicts the properties of the expressed cake.

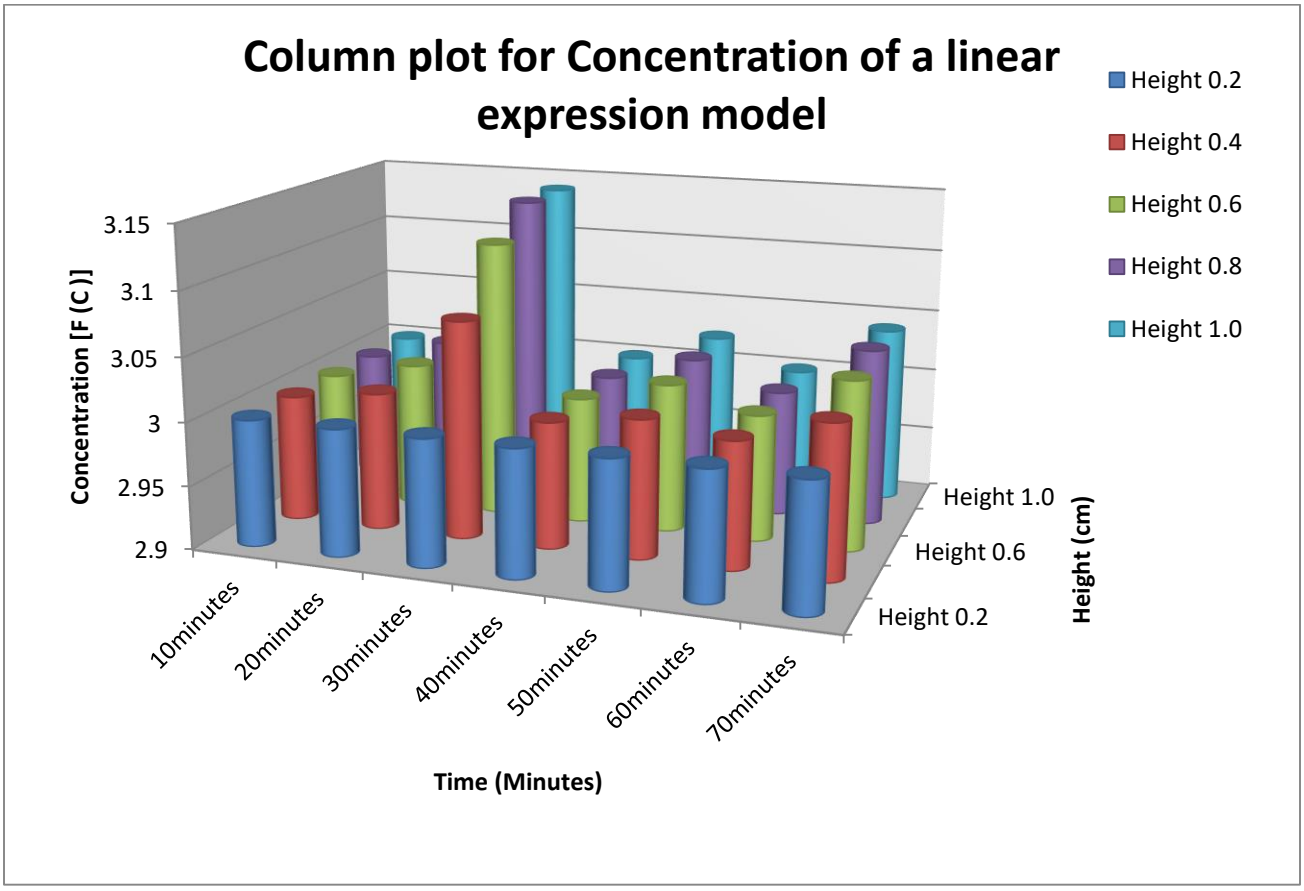

Fig.5: Column plot for concentration distribution of a linear expression model

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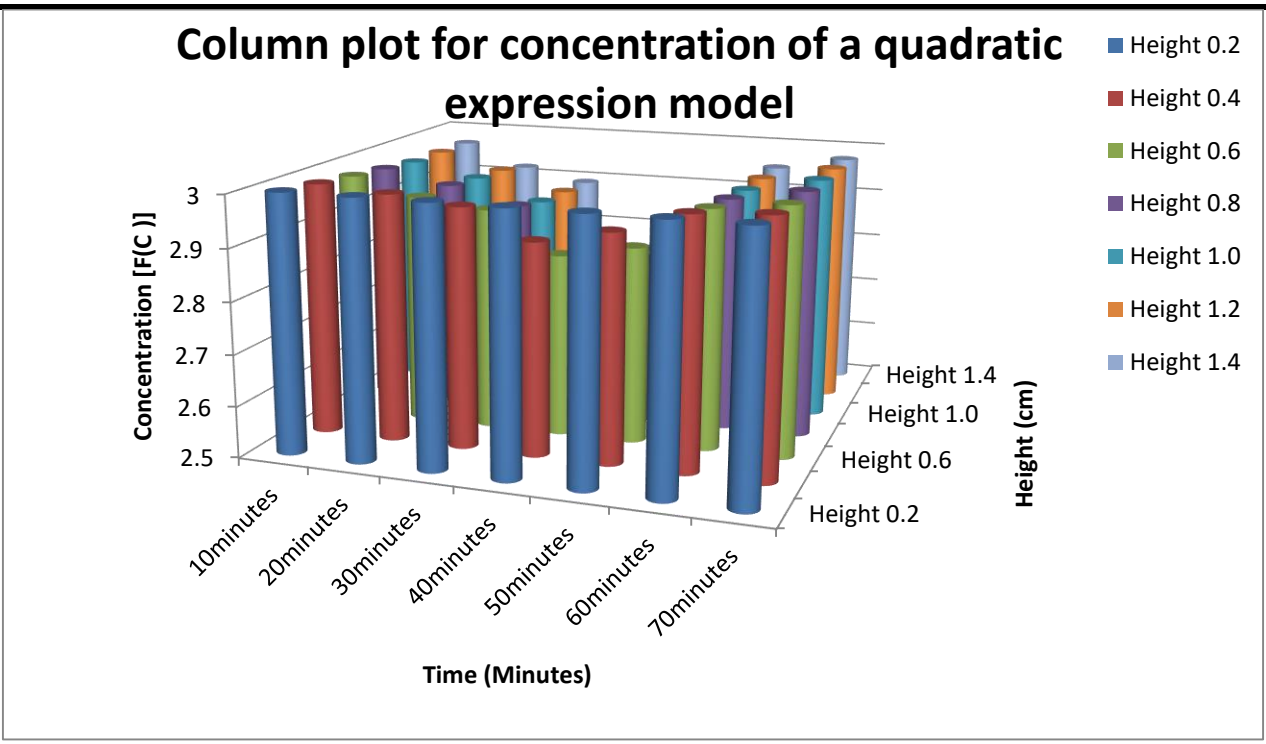

Fig.6: Column plot for concentration distribution of a quadratic expression model

III. CONCLUSION

From previous publications the results of the finite element solution have shown that;

1) Displacement along the sludge cake height increases with an increase in the effective pressure.
2) Effective stress increases with decreasing height along sludge cake at different expression time.
3) Concentration increases with decreasing height of sludge cake measured from sludge cake interface during sludge dewatering.
4) There is however an increase tendency to uniformity of concentration with increment of time.

All these conclusions were made possible from the results generated with the finite element linear and quadratic shape function models. But for industrial design purposes it is advised that more emphasis be based on the quadratic model due to its advantage of allowing more design points to be considered within the system environment being modeled.

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A Study on Best Quality Practices at King Faisal University (KFU), Alhassa, Saudi Arabia

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Abstract— *This paper aims to examine the quality best practices in King Faisal University (KFU). The quality best practices issue has taken a huge consideration among different Saudi Arabian sectors. These sectors include education, manufacturing, government, private, healthcare, IT, service and non-profit organizations. This research concentrates and discusses the quality management in Saudi Arabian higher education system.The study is a specific reference to one of the well-known public university in Saudi Arabia i.e. KFU.*

The importance of conducting this research is to examine the quality best practices in KFU in terms of many aspects. These aspects include university in general, colleges, curriculum, employees, faculty members and students. Although some colleges attain academic accreditations, there is a lack of knowledge in terms of main quality best practices.

The substantial expectation of this research is to eliminate the quality drawbacks in KFU. Another emphasis is to provide a number of recommendations to enhance the quality best practices in KFU.

Keywords—Higher Education Institutions (HEIs),King Faisal University (KFU), Deanship of Development & Quality Assurance (DDQA), Quality Assurance, Quality Enhancement (QE),Total Quality Management (TQM).

I. INTRODUCTION

This chapter introduces the study and shows the importance of the topic and discusses the reasons for conducting the research.

1.1 Background of the Study

Quality is playing a critical role in higher education. Both administrators and academic of Higher Education Institutions (HEIs) are constantly looking for ways to obtain more effective and meaningful educational instruction. Example of these investigators is King Faisal University and its Deanship of Development & Quality Assurance (DDQA).

DDQA administrators have started to establish quality sector to improve the quality, standards of their higher education, and to make their educational system more effective. In fact, one of the main DDQA's objectives is implementation of public policies related to the total quality management (TQM) in the university.Recently Saudi universities have started to shed light on quality management by implementing the total quality management concept.

TQM has successfully been implemented in some Higher Education Institutions (HEIs) in Saudi Arabia. This research aims to compare the quality work of this university with the TQM principles.

1.2 Problem Statement

The implementation of quality practices in Saudi Arabian higher education institutions has gained great interests. However, most of these institutions still not mature enough to deal with these practices. King Faisal University as a case will study comprehensively their quality practices performance. Therefore, this research attempts to answer the following questions:

- **What is the impact of adopting best quality practices in KFU?**
- **How to align best practices with KFU quality objectives?**

1.3 Objectives of the study

This study encompasses mainly following objectives:

- Explore thebenefits and recommendation of best quality practicesas a successful implementation in King Faisal University.
- Identify best quality practices to support the implementation of TQM concepts at the KFU.
- Identify the impact of adopting quality best practices in KFU.

1.4 Research Methodology

This study conducts by using a quantitative method (i.e. questionnaires). The target audience of this study was faculty members at KFU. The sample size was 21 faculty members who were categorized based on their job title, gender and education level.

The questionnaire was developed by using Google forms. It was divided into two sections; Demographics and Quality Best Practices. The questionnaire was designed mostly with close ended questions, with Likert scale from 1-5 with options (strongly disagree, disagree, neutral, agree, and strongly agree). Only one question had different options that are (Bad-Good-Satisfied-Very Good- Excellent). Questionnaires were sent to the target

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audience via emails, and Whatsapp in the beginning of March 2017. Total of 40 faculty members received the survey. However, only 21 were filled it.

The data was analyzed and interpreted thoroughly. Both descriptive and measurable analysis was conducted.

1.5 Scope of the study

This study focuses on the performance of quality best practices implementation in Saudi Arabian higher education system, specifically, the King Faisal University (KFU).

1.6 Definition

This study includes a number of abbreviations that relates to quality management in higher education. The main abbreviations and its definitions describes as following:

Quality Assurance (QA): Quality assurance provides to the standards maintained by the institutions through check of external bodies(Biggs, 2003).

Quality Enhancement (QE): Quality enhancement refers to the continuous improvement in the institution system (Biggs, 2003).

Total Quality Management (TQM):A network of interdependent components that work together to try to accomplish the aim of the system (Deming 1994).

Higher Education Institutions (HEIs)

King Faisal University (KFU)

II. LITERATURE REVIEW

2.1 Introduction to Quality

Although the literature provides many explanations of the quality, there is no a unique definition. Below are examples of these definitions:

- "The lack of quality is the losses a product imparts to the society from the time the product is shipped" (Genichi Taguchi).
- "Quality should be aimed at the needs of the customer, present and future" (Edwards Deming).

The literature discusses that quality includes two dimensions; products and services as shown in Table 1(Bergman and Klefsjö 2003). However, for the scope of the study, the quality dimension, which is taken into consideration in higher education, is the service quality.

Table.1: Quality Dimensions

Quality Dimensions	
Products	**Services**
Reliability	Reliability
Performance	Credibility
Maintainability	Accessibility
Environmental Impact	Communication
Appearance	Responsiveness
Flawlessness	Courtesy
Safety	Empathy
Durability	Tangibles

Previous research has defined quality management term in many ways. However, in relation to quality in education, Borgue & Bingham-Hall (2003) defined quality as "conformance to mission specification and goal achievement--within publicly accepted standards of accountability and integrity". Quality basically maintains balance between the internal and external forces. The quality to a college could be derived by recognition of the institution and a training program (Eagle & Brennan, 2007),

Dr. W. Edwards Deming was the first scholar to introduce the concept of TQM. According to Hasson&Klefsjo (2003), TQM defines as "Management strategy that has interrelated components, namely: core values, techniques and tools". Therefore, TQM refers to the administration technique that, which will improve the quality and profitability in associations. It is a yearly quality process, which moves towards the flawlessness of the vision of the association.

2.2 Quality of Higher Education

Some researchers discuss that the quality will enable organizations practices or tasks to become successful (Bergman and Klefsjö 2003, Feigenbaum 1994). Higher Education Institutions (HEIs) are not excluded. In fact, Feigenbaum (1994) believes that the higher education quality is a critical factor and will lead tostrong competition among countries.

The concept of quality of higher education has defined in several ways based on the industry (Campell and Rozsnayi2002). Example of these definitions are illustrate in Table 2.

Table.2: Quality of higher education definitions related to industry (Campell and Rozsnayi 2002)

Quality as excellence	To be the conventional scholastic view that holds as its objective to be the best.
Quality as fitness	This approach requires that the item or administration has congruity with client needs, prerequisites, or goals.
Quality as enhancement or improvement	Emphasizes the pursuit of continuous improvement and is predicated on the notion that achieving quality is centralto the academic ethos.

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However, some research argued that quality in education is totally different than industry (Tribus 1994, Kwan 1996). Kwan (1996) stated that it can be distinguished between education and industry in four ways, objectives, processes, input and outputs.

Moreover, the literature shows that it is vital to identify customers and stakeholders in higher education. Owlia and Aspinwall, (1998) classified higher education stakeholders into five groups; employers, society, faculty, families and students. According to their results students were given the highest rank.

Quality improvement is an ongoing process, and to enhance quality, HEIs need to implement TQM strategy. The main TQM role in academia is to provide guidance in educational institutions to enable them continue improvement through the entire educational process.

Some research (Ahire et al. 1996, Flynn et al 1994) provides many constructs for TQM implementation as shows in Table 3.

Table.3: TQM constructs

TQM constructs (elements)	
Leadership	Supplier quality management
Vision and plan statement	Evaluation
Process control and improvement	Product design
Quality system improvement	Employee participation
Recognition and reward	Education and training

HEIs have to consider the key elements of TQM in order to improve the quality. These elements include leadership, continuous improvement, employee participation and empowerment and information management (Mohammed et al 2016).

For the purpose of this research , six elements (i.e. best practices) are selected, which are Leadership, Vision and Plan Statement, Evaluation, Quality System Improvement, Faculty Members Participation, Education and Training, and it added new element called Education learning outcomes.

The conceptual definitions of the constructs and the practices that support their implementation are presented in the following section.

2.3 Study constructs

Leadership

Leadership can be defined as "the ability of top management to establish, practice, and lead a long-term vision for the firm, driven by changing customer requirements, as opposed to an internal management control role" (Anderson et al. 1994).Malcolm Baldrige Quality Award (1999) identifies the crucial role of leadership in terms of creating the goals, values and systems that enable performance improvement.

Top management role and involvement is a key practice in any organization.The main responsibilities of top management leaders include establish quality policies, establish and deploy quality goals, provide resources, provide problem-oriented training, and stimulate improvement. Lack of top management involvement might lead to serious negative consequences. In addition, it is vital to engages people in quality activities. According to DuBrin (1995),encourage people to assess the level of quality is an important leadership practice.

Vision and Plan Statement

Vision and plan statement encompass two aspects: Vision statement and plan statement. The purpose of a vision statement is to link the firm's values, aspirations and purpose to enable employees make decisions that are align with and supportive of these objectives (Meredith and Shafer, 1999).The organization need to have quality policy that shows overall intentions and direction of an organization with regard to quality. On the other hand, a plan statement is a formalization of what is proposed to happen in the future.Employees at different levels should be engaged in drawing up plans and should be encouraging their commitment to the realization of these plans (Mann, 1992).

Evaluation

The concept of evaluation can be defined as "systematic examination of the extent to which an entity is capable of fulfilling specified requirements"(ISO 8402, 1994). The organizations should continuously evaluate its various business strategies to achieve a competitive advantage. Another evaluation practice which relates to improvement and corrective actions is quality audit. In addition, Benchmarking is a influential tool to use as a continuous process of evaluating a firm's products, services, and processes against its roughest competitors or industry leaders. Quality related data also should be combined with employees' performance standards at the different level within firms.

Quality System Improvement

Quality system is defined as "the organizational structure, procedures, processes and resources needed to implement quality management"(ISO 8402, 1994). Three main practices should be identified when quality system establishment; quality manual, procedures, and work instructions. Finally, quality system should be continuously improved and maintained (Randall, 1995).

Faculty Members Participation

Employee (i.e. faculty member) participation can be defined as "the degree to which employees in a firm engage in various quality management activities" (Juran

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and Gryna, 1993). Teamwork is a key characteristic of faculty member's participation. Teamwork can be groupedinto collaboration between managers and non-managers, between different functions (Dean and Bowen, 1994).

Moreover, for gaining effective faculty member participation, they should be committed to their jobs and report their own working problems as well as problems they discover in other areas of the firm(Deming, 1986).

Education and Training

Training refers to the achievement of specific skills or knowledge, while Education attempts to provide employees with general knowledge that can be applied in many different settings (Cherrington, 1995).Employees at different organization levels should participate in specific work-skills training. In addition, employees should accept quality perception education in order to improve their commitment to quality. New employees should take more education on quality awareness.

Education learning outcomes

This best practice includes all issues are related to the evaluation of curriculum and program learning outcomes such as: exams, assignments, and assessment activities.

III. COMPANY'S PROFILE

KFU is one of the largest educational institutions in the Eastern province in Saudi Arabia. It is a distinctive center for providing knowledge and developing professional, administrative and leadership skills.

Vision

Excellence in education and scientific research; and leadership in community engagement.

Mission

To provide quality education and lifelong learning, encourage innovation and scientific research, strengthen community engagement and to prepare qualified and competent people within a motivating environment that are up to date with modern technology.

Values

Loyalty, Quality, Institutional work, Transparency, Justice, Innovation, and Lifelong learning

King Faisal University is a public university with the main campus in the city of Hufuf in Al-Hassa, Saudi Arabia founded in 1395 AH/ 1975E. King Faisal University was initially established with four colleges; the College of Agricultural and Food Sciences and the College of Veterinary Medicine and Animal Husbandry at the main campus in Al-Hasa; and the College of Architecture and Planning and the College of Medicine and Medical Sciences in Dammam. In later years, the following colleges were established: (College of Education, College of Administrative sciences, College of Science, College of Computer Science and Information Technology, College of Clinical Pharmacy, College of Medicine, College of Engineering, Community College in Baqiq, College of Dentistry, College of Applied Studies and Community Services, College of Arts and College of Law). In 1430 H/2010 E, the Dammam campus became completely independent and the University of Dammam "Imam Abdurrahman Bin Faisal University" was established. At present, King Faisal University includes (16) colleges with a total of (110) academic programs for Diploma and Bachelor levels, and (35) academic programs for postgraduate studies. Furthermore, it has a Veterinary Teaching Hospital and (8) research centers providing services in different scientific and applied fields.

The number of full-time students enrolled in the undergraduate program at KFU has reached (40,000) male and female students, and about (2000) male and female students enrolled in the MA program. While the number of part-time students enrolled in the Distance Learning Program has reached to (150,000) male and female students.

Around (4000) full-time students and (9000) part-time students complete their studies every year and obtain undergraduate and postgraduate degrees in different academic disciplines. Furthermore, KFU has more than (1600) employees including administrators and technicians, and about (2000) faculty members. Figure 1 shows the KFU main statistics.

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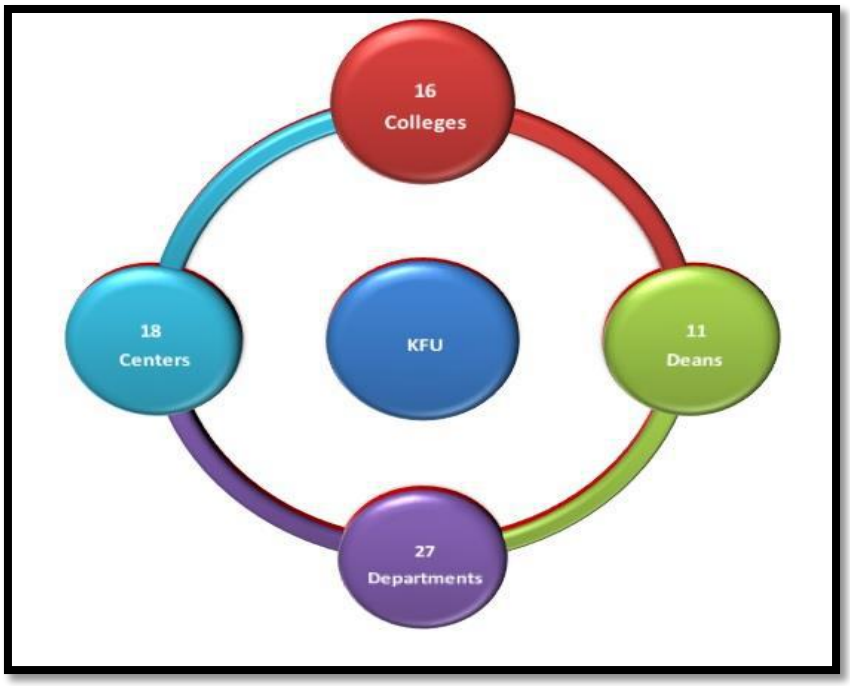

Figure 1: KFU Statistics

IV. FINDING AND DATA ANALYSIS

Before the actual data collection, the survey was sent and reviewed by some experts who were knowledgeable in survey design. Based on their feedback, the initial version was modified and a pilot test conducted. As part of the pilot test, the instrument was emailed to two experts (two Academic staff) in order to solicit their feedback on the survey. Then the survey was revised based on the pilot test results. The key reason for deploying the pilot test was to make the survey items more understandable and well written.

As mentioned earlier in chapter 1, the main audience of this project was the KFU faculty members. This section starts with a demographic analysis. The demographic part of the survey can be divided into two groups. The first describes the personal and organizational information. The second part shows the familiarity of quality assurance best practices.

The survey included 21 respondents who worked in the different colleges at KFU. At the beginning of the questionnaire, respondents were asked to specify their gender. The results show that the majority of participants were male faculty members (18 out of 21) (Figure 2).

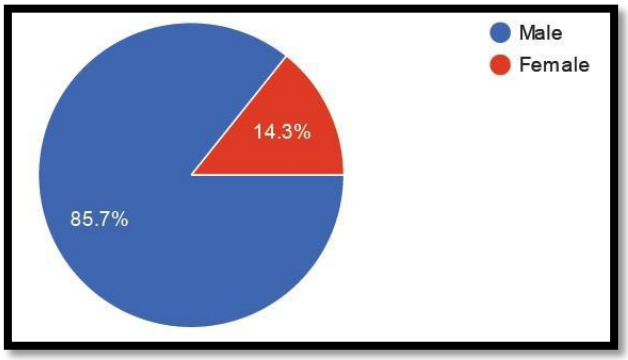

Figure 2: Gender

V. CONCLUSION AND RECOMMENDATIONS

Most of the Saudi Arabian educational institutions still not mature enough to deal with these practices.

Due to the lack of the research in this area, there is a scarcity of literature on the quality best practices investigation particularly in Saudi higher education context. For the body of knowledge, by empirically examining the questionnaire developed for this study, the results reported contribute to and enrich the literature in this area.

The research found that there is an increased awareness among the faculty members within KFU, of the importance of pursuing quality. Generally, they accept the fact that quality is the basis for moving organizations forward.

Main findings

The study concludes with very interesting and important venues. Table 4 below summarizes the main research findings.

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Table.4: Main Findings summary

Quality Best Practices	Main Findings (KFU case study)
Leadership	The survey analysis showed that • There was strong evidence that top management empowerment had been implemented. • Top managers often organized discussion meetings after quality problems had happened
Vision and Plan Statement	The data analysis indicated that • The organization had a long-term vision statement that had been drawn up several years ago and many faculty members were clear as to what the vision statement was. • KFU has long-term overall business performance plans. • KFU put its quality improvement plans in terms of quality problems that it had.
Evaluation	The survey analysis showed that • There is a need to increase the faculty members' awareness regarding benchmarking, internal and external quality audits. • Overall agreement regarding the quality improvement.
Quality System Improvement	The data analysis indicated that KFU sometimes did not follow these documents very well. In reality, KFU did not use these quality tools. These according to the luck of recognition of faculty members
Faculty Members Participation	The results suggest that • There is an overall agreement regarding having cross-functional teams within KFU. • More than 65% of participants agree that their feedback were highly considered however, 57% only implemented in the evaluation.
Education and Training	The survey analysis showed that • Sufficient resources for employee education and training were provided by KFU. • Quality awareness education was sufficiently conducted even though top and middle managers. • Training for quality management knowledge was sufficient (71% was agreed with this).
Education learning outcomes	The data analysis indicated that The vast majority of participants showed their agreement regarding all statements for this quality best practice.

Limitations and Suggestions for Future Research

Although this study provides insights into the Saudi Arabian higher education context, it has some limitations. This study was limited to a specific geographical region (i.e. Saudi Arabia). The results obtained may have been influenced by Saudi higher education system and quality best practices across the organizations sampled (i.e. KFU) or participant in the research. To reach a greater generalizability, future research would benefit from a larger sample size, as well as greater diversity of higher education contexts.

Another limitation is that the number of KFU faculty members is 2000, however, only 21 was participated in this study due to the time constrain.

Consistent coordination as well as faculty awareness, training and development need further attention. Suitable system support to help saving faculty member's time in filling in the same information multiple times would be helpful.

The quality team should not act as big bully but rather facilitate faculty empowerment and engagement to collect meaningful feedback is crucial too. Quality team should work will a clear strategy and should set realistic deadline

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for any assigned task. The management also needs to get involved with the quality committee more seriously.

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