September 2012

Adama Science and Technology University

ASTU

PROCEEDINGS OF THE 1ST INTERNATIONAL CONFERENCE – (IC 2012)

"Sustainable Development through Science & Technology: Lessons from Emerging Economies"

September 6-8, 2012

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International Conference (IC 2012) on Sustainable Development through Science & Technology:
Lesson from Emerging Economies
September 6-8, 2012
Adama Science and Technology University (ASTU), Adama, Ethiopia
Venue: "Chafe Oromia" Meeting Hall, Adama, Ethiopia

Conference Schedule

Reception: *05 September 2012 (19:00-21:00)* **Hotel:** *Kereyu Hill Resort*

DAY ONE: September 6, 2012				
Time	**Activities/Topic**	**Speaker/presenter**	**Facilitator**	**Chairperson/ Rapporteur**
8:00-8:30	***Registration***	***Participants***	***Registration Desk***	-
8:30-8:40	***Program Introduction***	***Ato Abebe Gemechu***		
8:40-8:50	***Welcome Address***	***H.E. Prof. Jang Gyu (John) Lee, President, ASTU***	***Dr. Lemi Guta***	-
8:50-9:05	***Opening Remarks***	***H.E. Juneydi Saddo Minister, Ministry of Civil Service***		-
9:05-9:10	***Congratulatory Remark***	***H.E. Mekonnen Manyazewal Minister, MoI***		
9:10-9:15	***Congratulatory Remark***	***H.E. Alemayehu Tegenu Minister, MoW&E***		
9:15-9:20	***Congratulatory Remark***	***Mohamuda Ahmed Gas State Minister, MoST***		
9:20- 9:30	***Key Note Address***	***H.E. Dr. Kaba Urgessa State Minister, MoE***		-
Session 1: Government Role and Public Policies				-
9:30-10:15	***Plenary Speaker 1: Strategic Thinking for Economic Development and Innovation: From Binding Constraint to Capacity Building for Growth Poles***	***Prof. Keun Lee Seoul National University, South Korea***		***H. E. Dr. Kaba Urgessa*** ***Ms. Hana Yesuneh***
10:15-10:30	***Discussion***	***Participants***		
10:30-11:00	Tea Break		*Organizing committee*	
11:00-11:45	***Plenary Speaker 2: Government Role and Public Policies in Science and Technology: Evidence from the Integrated Circuits Industry in Korea, Malaysia, Singapore and Taiwan***	***Prof. Rajah Rasiah Malaya University, Malaysia***	***Dr. Lemi Guta***	***H. E. Dr. Kaba Urgessa*** ***Ms. Hana Yesuneh***
11:45-12:05	***Overview of Science, Technology and Innovation (STI) Policies of Selected African Countries and the Space for Engagement of Ethiopian Higher Education Institutions in the STI System***	***Dr. Ayele Abebe, ASTU***		
12:05-12:30	***Discussion***	***Participants***		
12:30-14:00	LUNCH ***(Tokuma Hotel)***		*Organizing Committee*	

Day One Session 2: Science & Technology Education, and University-Industry Cooperation				
Time	***Activities/Topic***	***Speaker/presenter***	***Facilitator***	***Chairperson /Rapporteur***
14:00-14:45	***Plenary Speaker 3: Research University as the Core of Regional Development and Innovation***	***Prof. Sunggi Baik Pohang University of Science and Technology, South Korea***	***Dr. Mengistu Sime***	***H. E. Mr. Wondwossen Kiflu, State Minister, MoE*** ***Dr. Haileleul Zeleke***
14:45-15:00	***Discussion***	***Participants***		
15:00-15:20	***Reinforcing Quality and Relevance of Education in Public Higher Education Institutions: Implications for Attaining GTP Goals***	***Dr. Mulu Nega Kahsay Addis Ababa University (AAU)***		
15:20-15:40	***Challenge and Opportunity on Industry- University Cooperation: In the case of Ethiopian Textile and Leather Industries***	***Tadesse Bires Ministry of Science & Technology (MoST)***		
15:40-16:10		***Tea Break***	*Organizing Committee*	
16:10-16:30	***Revenue Generation Strategies in Sub-Saharan African Universities***	***Fisseha Mamo MoE and University of Twente***	***Dr. Mengistu Sime***	***H. E. Mr. Wondwossen Kiflu, State Minister, MoE*** ***Dr. Haileleul Zeleke***
16:30-16:50	***Status of Experiential Integrity in Higher Education and its Implications for Educational Transformation***	***Endalew Fufa ASTU***		
16:50-17:10	***Blended Learning : Ethiopia***	***Darleana McHenry Ed.D., USA***		
17:10-17:50	***Discussion***	***Participants***		
19:00 -	***DINNER (Adama German Hotel)***		*Organizing Committee*	

DAY TWO: September 7, 2012				
Session 3: Industrial Technology and Human Resource Development				
Time	**Activities/Topic**	**Speaker/Presenter**	**Facilitator**	**Chairperson/ Rapporteur**
8:30-9:15	***Plenary Speaker 4: Core Issues for Developing an Effective Workforce***	***Prof. Ronald Jacobs HRD Director, International Programs, University of Illinois, USA***	***Dr. Mengist Hailemariam***	***Dr. Hailemichael Tesso*** ***Dr. Solomon Alemu***
9:15-9:30	***Discussion***	***Participants***		
9:30-9:50	***HRD practice Gaps and Impediments among large Manufacturing Firms in Ethiopia: A need for a national level strategy and a room for U-I-G cooperation***	***Gemechu Waktola ASTU***		
9:50-10:10	***Application of Solar Air Heater in Drying Agricultural Products to Boost the Ethiopian Economic Development***	***Dr. Addisu Bekele ASTU***		
10:10-10:40	Tea Break		*Organizing Committee*	
10:40-11:00	***PV-Diesel Based Hybrid Power Systems for Rural Electrification in Ethiopia: Way Forward for Sustainable Development***	***Dr. Muluwork, Kahsay, & Desta G. Bahir Dar University***	***Dr. Mengist Hailemariam***	***Dr. Nega Tolla*** ***Mr. Abebe Megersa***
11:00-11:20	***Cane Sugar Productivity Potential in Ethiopia: The Role and Direction of Research***	***Ambachew Dametie and Firehun Yirefu Ethiopian Sugar Corporation***		
11:40-12:30	***Discusion***	***Participants***		
12:30-14:00	LUNCH ***(Tokuma Hotel)***		*Organizing Committee*	
14:00-16:00	*Technical Tour (Turkish Textile Factory & Adama-I Wind Farm Project)*		*Organizing Committee*	
	BANQUET (KEREYU RESORT)		***Organizing Committee***	

DAY THREE: September 8, 2012				
Session 4: Technology Development and Industrialization				
Time	**Activities/Topic**	**Speaker/Presenter**	**Facilitator**	**Chairperson/ Rapporteur**
8:30-9:15	***Plenary Speaker 5: Harnessing ICT for Africa's Catch up Lessons from Indian Experience***	***Dr. K. J. Joseph Ministry of Commerce Chair, Centre for Development Studies, India***	***Mr. Jeylan Aman***	***Dr. Ziyn Engdasew*** ***Mr. Shibru Ayalew***
9:15-9:30	***Discussion***	***Participants***		
9:30-9:50	***Global Standards and Education***	***Prof. Young Kyun Kim Scientific Director, AAIT***		
9:50-10:10	***Industrialization Through the Introduction of Venture Capital in Ethiopia: Considering the experience of other Emerging Economies***	***Yishak Mengesha, Meshesha Demie & Bayisa Milkesa Commercial Bank of Ethiopia (CBE)***		
10:10-10:40	Tea Break		*Organizing Committee*	
11:00-11:20	***Regional Disparities Establishment of Large & Medium Scale Manufacturing Industries in Ethiopia: Panel Data Analysis***	***Samson G/Selasie Bahir Dar University***		
11:20-11:40	***Assessment of Climate Change Impacts on Cascade Reservoirs Operations (A Case Study on Gibe Hydropower Schemes, Ethiopia)***	***Tilaye Kassaw Arba Minch University***		
11:40-12:30	***Discussion***	***Participants***		
12:30-14:00	LUNCH *(Tokuma Hotel)*		*Organizing Committee*	
Session 5: Ethiopian Industrialization Plan				
14:00-15:30	***Ethiopian Industrialization Plan: MOI Project***	***Dr. Mebratu Meles, ECBP-Ethiopia Tatek Temesgen , ASTU Dr. Doohee Lee & Dr. Dongwha Kum, South Korea***	***Dr. Kasim Kimo***	***Dr. Wasihun Yimer*** ***Dr. Hunduma Dinka***
15:30-16:00	Tea Break		*Organizing Committee*	
16:00-17:30	***General Discussion & Reflections***	***All Plenary Speakers & Participants***	***H.E. Prof. Jang Gyu (John) Lee***	
Closing Session				
17:30-17:40	***Closing Remarks***	***H.E. Prof. Jang Gyu (Lee) President, ASTU***	***Dr. Lemi Guta***	
19:00-	***Dinner Reception (Adama German Hotel)***		***Organizing Committee***	

Preface

There is a universal acknowledgment of the role of science and technology in social transformations and human advancement. In Ethiopia, the role of science and technology in all-round and sustainable development of the nation has been well recognized and remarkable efforts are being exerted to materialize science and technology in the country. To be part of the dynamic and fast growing world, Ethiopia has recently paid momentous attention to the field of science and technology. Having a vision to transform itself into a middle-income country in 2025, the country has made science and technology one of its top priorities in poverty reduction and sustainable development. Guided by the popular GTP of the country, the nation has now set off for a universal transformation through the application of science and technology.

As an institution looking forward to excel in science and technology, ASTU has been committed towards realization of scientific and technological innovations. Its goal is to develop highly qualified, capable, competent, and innovative human resource in the field of science and technology and to transfer relevant scientific knowledge and skills required for nation building and for the socio-economic advancements of the country.

ASTU's aspirations to develop into a full-fledged science and technology university will call for strong linkage, cooperation, and partnership with various national and international universities, development sectors, stakeholders, and relevant personalities. With this general view in mind, ASTU has planned to organize an international conference emphasizing the role of science and technology in poverty reduction and sustainable development. As part of the national development and transformation agenda, this conference aims to build a platform whereby an opportunity is created to tap the experience of rapidly emerging economies and eventually to support the country's Sustainable Development and Poverty Reduction Program.

Acknowledgements

Welcome Address

H.E. Prof. Jang Gyu (John) Lee, President, ASTU

Good morning everyone!

Welcome to the City of Cactus, the City of Earthly Man, and the City of the Brain. That is the meaning of Adama in various languages.

Your Excellencies from various ministries

Invited speakers:

- Professor Keun Lee, from Seoul National University of Korea
- Professor Rajah Rasiah, from Malaya University of Malaysia
- Professor Sunggi Baik, from Pohang University of Science and Technology of Korea
- Professor Ronald Jacobs, from University of Illinois of USA
- Dr. K.J. Joseph, from India, Ministry of Commerce of India
- Dr. Dohee Lee , from Korea Institute of Science and Technology, and
- Dr. Dr. Dongwha Kum, from National Academy of Engineering of Korea

Paper presenters from home and abroad

Guests from government industries, academia and research centers

It is my great pleasure and honor to welcome you to the International Conference on "Sustainable Development thigh Science and Technology: Lessons from Emerging Economies". In the next three days, we will exchange over thoughts and ideas on science and technology's role for industrialization and economic development. Four days ago, I attended the funeral service for His Excellency, Prime Minister Meles Zenawi, and witnessed how much the peoples of Ethiopia, Africa, and other continents appreciate his visionary and transformative leadership. He dreamed to see that Ethiopia, in the coming decades, would begin to join the ranks of the prosperous nations. He intensely hated poverty. He often said that, with poverty, it is idle to hope for peace and democracy, nor can we truly honor the freedom and dignity of an individual or the community. Mr. Meles is no longer with us. However, for the sake of Ethiopian prosperity in the future, we need to vow to continue on the path shown to us by H.E. Prime Minister Meles Zenawi.

Industrialization and economic development based on science and technology is a key to escape from hunger and poverty. It was shown by recently emerging economies like South Korea, Malaysia, Brazil, and India. In this forum, the experiences of the emerging economies, and the recent situations of Ethiopia will be presented. I expect that you will join the forum to seek together a solution to free Ethiopia from poverty. We have arranged five plenary speeches and sixteen contributing papers into four sessions. In the last day, we will present on Adama Science and Technology University Project, sponsored by the Ministry of Industry, on the subject of "Industrial Development Roadmap, Strategic Plan for the year 2013-2025, envisioning and formulation of appropriate institutional setup" to be followed by a panel discussion. We have also arranged a visit to the Adama-I Wind Farm and Turkish Textile Factory, as a technical tour tomorrow afternoon. Adama Science and Technology University did our best to prepare this conference. However, since this was the first attempt for us on this kind of international meeting, you may experience some inconvenience during the course of the whole event. Please embrace our inexperience and tolerate inconvenience and enjoy our academic feast.

I thank you very much

Opening Remarks

H.E. Ato Juneydi Saddo, Minister, Ministry of Civil Service

Chairperson, ASTU Supervisory Board

Dear invited guests,

Dear distinguished international experts and paper presenters

Dear representatives of various industries and business enterprises

Dear representatives of higher education and research institutions

Ladies and gentlemen:

Dear participants,

I am honored to open this International Conference entitled ***Sustainable Development through Science and Technology: Lessons from Emerging Economies*** organized by Adama Science and Technology University. I would like to extend my appreciation for the university in preparing this conference that informs policy makers, academics, industry and business enterprises, and wide range of stakeholders.

Special thanks go to Prof. Lee, President of ASTU, and all those who sponsored this conference to become a reality. I commend the efforts of all those who actively engaged in planning and implementation of this international conference.

Sustaining rapid and equitable economic growth is one of the pillars of the Growth and Transformation Plan of Ethiopia. In this endeavour, the role of science and technology is crucial. History, time and again, has shown that socio economic transformations in a country could not be realized without the utilization of science, technology and innovation.

Dear Participants,

This conference aims at building a platform to tap the experience of emerging economies and eventually to support Ethiopia's Sustainable economic growth and development by emphasizing the role of science and technology.

One of the lessons we learned in the last few decades from the emerging economies is that successful economic and social development could be achieved mainly due to their having both an export-based market economy and accumulation of technological capabilities. Hence, our country needs to continue focusing on science, technology and innovation to support its export-driven economy. The strategic direction that Ethiopia follows with regard to higher education is clearly articulated in the GTP. Higher education institutions provide education that is compatible to the human resource demand of the economy and the labor market.

Ladies and Gentlemen,

The capacity building programs that are being undertaken to improve performances of higher education institutions will be further strengthened. Moreover, capacity building programs in science and technology, both in undergraduate and postgraduate levels will be intensified. Research undertakings at higher education institutions will continue to be guided by the role they play in the economic growth and development of the country.

In fact, a number of areas for further improvements need to be considered by all relevant stakeholders. Particularly, the link between government, higher education institutions, and industry needs to be further strengthened. There should be increased support for the development of human resource and capabilities for research and development activities through the provision of funding as well as improving science and technology facilities.

Dear participants,

It is my sincere belief that this conference will help creating more opportunity for stakeholders in science and technology to discuss issues of significance for economic development. I reckon that various thematic areas of the conference that are carefully chosen provide the opportunity to focus on important issues that matter most for development. This conference will also be instrumental in sharing of diverse experiences and in creating possibilities for networking and partnerships for future collaboration.

Dear Participants and conference organizers,

I am confident that, through your active participation, the conference will achieve its goals and deliver on the expected results. Thus said, I officially declare that this international conference on sustainable development through science and technology is opened

I wish you all the best,

Thank you

Congratulatory Remarks

H.E. Mekonnen Manyazewal, Minister, Ministry of Information

Dear invited guests
Distinguished participants
Ladies and gentlemen

I am very pleased for being invited at this important conference. Let me take this opportunity to thank Adama Science and Technology University for taking the initiative to organize this important conference. For us as a Ministry of Industry, this is a welcome development and initiative. I am sure this is the first; it is not going to be the last initiative. Such an initiative will give us an opportunity to get insight in terms of policy refinement and program development so that we can accelerate our industrialization process. I think there are three critical components of the conference: sustainable Development, science and technology, and lessons from emerging economies. Sustainable development has to be actually sustained. Otherwise, it is not development. Development which is bright at one moment and which is retarding at another period in not sustainable development. So improvements of the livelihood of the people and eradication of poverty have to be sustainable. People's livelihood has to improve continuously. So, sustainable development is a must. How do we ensure that development is sustainable and it is beneficial to the majority of the people is through science, technology, and innovation. I am

sure we are not going to debate about this thing. History has shown practically that, without science and technology, development cannot be sustained, or it cannot be sustainable. So, the critical role of science and technology in sustaining development and ensuring sustainability of development is very evidential.

The third component, which is lessons of experience, indicates that we should learn lessons form different countries, particularly countries that have transformed their economies and the livelihood of their people. In this process, the role of the government in investing on universities is very critical and irreplaceable.

Without an effective developmental government action, accumulation of science and technology innovation capability will no come because there should be public investment in human resource development, there should be diversified investment in our universities in science and technology. When we look at the situation of Ethiopia, our investment in our human development, the expansion in universities, and the beginning of expansion of science and technology universities clearly demonstrate that without this critical public investment in our human resource development, there is not going to be sustained science and technology innovations, and therefore, no sustained development of the country. Because of this recognition, there is increased public investment in our universities. Second, the critical role of the government is ensuring that there is conducive business environment for the private sector to develop. Without the private sector, development is not going to be sustained. Growth is not going to be dynamic. So, that is why the government is also investing in ensuring macro-economic stability, ensuring that the investment environment is conducive, ensuring that public services through the Civil Service Reform to ensure transparency and efficiency of the public services are ensured so that the private sector concentrates on its investment and doing business. So, in this area too, the role of the government is very critical. While on the one side, the government is creating this conducive environment both on the macro side and investment side and also investing in the human resource side, the universities, which are very critical as a source of knowledge, skills and producing professionals for the need of the economy for innovation, we need to make effective collaboration between the government and universities. These are public investments which should produce the right skills and knowledge and the right amount of human resources that the economy requires. The third element of this collaboration is the

industry, the industry sector, which is ultimately the user of the human resources that the universities produce. The research that the universities do should focus on the problems of the industries. Then and only then will the collaboration succeed and be sustained. So, the research that universities are doing should be based on the problems that the industries face whether it is about future employees which they would really recruit and give them opportunity without significant cost to them─ people who are innovative, people who have the initiative and the drive to work, to innovate, and to improve the management capability of the industries. So, it is this collaborative effort that we really need to establish on a sustained basis and make it a win-win situation for our country and industrialization process. The government has invested in engineering capacity building program, which I am sure you know Adama Science and Technology University is a product of that reform, that program. And also, the technical and vocational training system is completely ruled by the engineering capacity building program and the third component of that program is the quality infrastructure, which is critical for industrialization and also the fourth component, the private sector development. All of these combinations have a mission and vision of ensuring that Ethiopia develops a competitive industry that generates employment that creates the right environment for the livelihoods of the population. So, for me, I think the message is the university industry government collaboration needs to be broad-based, strengthened, and sustained over a long period of time so that science and technology innovation is sustained and developed in a way that fits into our industrialization plan. So, from this conference, I can sense the tone and context for this collaboration to develop in the future, and I wish you productive engagement and discussions.

I thank you for your attention

Congratulatory Remarks

H.E. Ato Alemayehu Tegenu, Minister, Ministry of Water & Energy

Your Excellency, Ministers of various Ministries
Invited guests
Adama University Community
Representatives of government and private sector institutions

Ladies and gentleman

On behalf of the Ministry of Water and Energy of the Federal Democratic Republic of Ethiopian and myself, I would like to express my gratitude to Adama Science and Technology University President Office for inviting me to this conference to give an overview of water and energy sector of Ethiopia. There is no doubt that this forum will help us to provide you information on the efforts being made by the government of Ethiopia for the development in water and energy sector. Such conferences are very important for promotion, exchange of information, creating awareness of the implementation of GTP in water and energy sector.

Dear Participants,

Ethiopia is endowed with water resources and a variety of energy resources. That is the main reason why many scholars named the country '' The Water Tower of Africa''. However, it is worth to note that most of the water and energy resources are almost untapped. This is a clear

indication that the government of Ethiopian has started construction of mega hydropower projects in different regions. Currently, the country is engaged aggressively in implementing the programs laid under the Growth and Transformation Plan of the water and energy sector. The main programs under way in the water sector are Water Supply and Sanitation Development, Irrigation and Drainage Development, Ground Water Development, and Surface Water Study. The government, including all the stakeholders, has been undertaking the concerted efforts to improve the access of safe drinking water. To reduce poverty and to ensure sustainable socio-economic development, the government of Ethiopia and the public and the private sectors have engaged in study, design, construction, rehabilitation, and maintenance of the water supply and sanitation projects as well as capacity building activities in various levels. The Universal Access Program has lifted access to clean drinking water to 78.1% in rural areas, 88% in the urban areas, and the national access to water supply in both rural and urban areas is currently 79.8% up to the end of 2000 Ethiopian Fiscal Year. The government is working to reach 98% in rural areas, 100% in urban areas and the national access to water supply is expected to reach 98.5% by the end of GTP, which in 2007 EC. Similarly, in irrigation, development activities are also showing remarkable progress. Currently, 127,000 hectares of land is under construction, 658,068 hectares is on feasibility study and design stage, and 178,000 hectares of land is on pre-feasibility study and detail study stage. All of these are medium and large-scale irrigation projects, which use surface water. Moreover, 5000-50,000 hectare is under constriction and on feasibility and design stage using ground water potential. The Ministry's plan with regard to ground water development is to produce 1 to 50,000 maps of water distribution and quality to reach 22.7 national coverage at the end of the GTP plan. In the surface water study, in addition to the current 473 hydrology stations, 25 standardized new hydrology information centers have been planned to be built for improving the quality of the national hydrology information. Another important work in the sector is the establishment of basin authorities. A number of authors like the Awash-Abay are formed and others are in the process. The Ministry is involved in rehabilitating 1000,000 hectares of land in order to improve the lives of the population residing around the areas of the basin.

Dear conference participants

Excellencies

Similarly, the main programs being implemented in the energy sector are construction of generation plants, transmission distribution plants including rural electrification, development and promotion of alternative energies, hydropower refeasibility and feasibility studies, coordination work for bio-fuel development, and regulation of the standards of transport fuel institutions. It becomes evident to all public and private sector development actors that access to affordable, adequate, and appropriate energy services is a pre-requisite for sustainable development. Without energy and water, there is no development. For achieving the efforts being made to lift up the poor out of poverty, the government of Federal Democratic Republic of Ethiopia has implemented several energy development programs focused on renewable energy guided by national energy policy. As Ethiopia is endowed with 45,000 hydro power potentials, 7000 MW geothermal, 1.3 million MW wind potential, and average annual 2.2 million per day solar energy potential, the country has planned to reach the generation capacity of the power sector from the current 2179 MW to reach 10,000 MW at the end of the first GTP period. Among the big hydro power projects currently under construction to reach this target are the Renaissance Dam, which has a power capacity of 6000 MW, Gilgel-Gibe III, with a capacity of 1700 MW, and Gennale-Dawa, with 250 MW capacity. Not only the hydropower development, there are also wind and solar developments which are under constructions. Ashagoda Wind, with 120 MW, Adama Wind, which is 50 MW in already completed. An additional of 150 MW capacities is expected to be constructed at Adama. Those are the power construction projects currently going on. It is also under preparation to generate about 15,000 MW in the coming GTP II. Another remarkable achievement registered is on the power transmission sub-station and distribution in infrastructure development. The current electricity access is 47,000; it is planned to reach 75% at the end of the first GTP. Ethiopic has made current wide dissemination of energy efficient lamps in the domestic sector as a promotion and for improving the awareness of population on the energy-efficient lamps as compared to the traditional lamp. The promotion campaign resulted in substantial awareness of all categories of the society; it is also believed that the campaign has built the confidence of the customers of the technology and has maximized the advantage of reducing expenditures of energy. As a result of these measures, the country has saved about 170 MW. In the alternative energy development and promotion, the Ministry is working to attain over 10,000,000 bio-mass cook stoves, 10,000 household bio-diesel stoves and 10,000 small-scale bio-oil press machines, 25,000 bio-gas cook stoves, 3,000,000 solar, 3,500 water heaters, 10,000 solar cookers, and 5000 TV installations disseminated all over the country,

among others. Other programs of the energy sector are coordinating bio-fuel development and regulation of the standards of the transport fuel institutions. The Ministry of Water and Energy is under preparation for launching capacity building in the sector during the GTP 1 and GTP 2 periods. For this purpose, eight universities which include Adama, Addis Ababa, Arba Minch, Bahr Dar, Haramaya, Hawasa, Jimma, and Mekelle Universities have been selected to run the program in collaboration with foreign universities in fastest growing countries like Korea, china, and Brazil. The selected universities are already involved in designing the curriculum in the areas of dam, material hydrolytic, irrigation and drainage engineering, agronomy, hydropower engineering, hydrologic turbine engineering, transmission and distribution system design, control and system automation, and power economy. The program is going to start in October, 2012. Based on the country's human resource development demand, it is planned that 4532 and 459 people are to be trained in the water and energy sector respectively within the GTP I and II. Finally, I would like to assure you that my ministry in ready to work and cooperate with any development partner for the achievement of our GTP goals.

I thank you for your attention**!**

Keynote Address

H.E. Dr. Kaba Urgessa, State Minister, Ministry of Education

Ladies and Gentlemen,

It is an honor for me to deliver this opening remark on behalf of the Ministry of Education. I would link to take this opportunity to express my deepest sorrow upon the passing away of our marvelous Prime Minister Melse Zenawi. The last couple of weeks have been very tough for our citizens at home and abroad. The nation bitterly grieved his death and the pain has never gone away yet. Our late Prime Minister was the prime architect of the various development policies that yielded remarkable results over the past two decades.

Clearly, Ethiopia has impressive history of more than two millennia of state sovereignty and independence. Yet, poverty and backwardness out-shadowed the rich history and its nation's pride for long, largely due to repressive regimes that existed until recently. It was from those regimes that the government of Federal Democratic Republic of Ethiopia had inherited myriads of chronic problems with huge and broad spectrum of development deficits two decades ago. Nevertheless, due to persistent struggles of the government of Ethiopia and its citizens, a nation that used to have virtually no economy in the past has now become one of the world's fastest growing nations at consecutive rate of 11% with increasingly promising prospects. The nation has heavily invested on infrastructural development, and it is attracting sizable Foreign Direct

investment (FDI). It has also built various developmental and democratic institutions with several ongoing efforts to ensure sustainable development.

Furthermore, Ethiopia has envisioned developmental targets as indicated in the most popular five years Growth and Transformation plan (GTP). According to the GTP, Ethiopia anticipates gradual structural transformation in the economy from agrarian society to a nation of exporting industries; it also aspires to join middle-income countries in the coming two decades or less. By and large, we are cognizant of the fact that implementation of such a bold and ambitious development plan necessitate extraordinary commitment on the part of the government of Ethiopia, unreserved involvement of citizens, and support from international community and development partners. So far, the achievements have been very much encouraging. Among such achievements, expansion of education is one of the areas where Ethiopia has achieved incredible progress through the principles of fairness and equity. In terms of budget, the Ethiopian Government spends a large percentage of the country's annual budget on education amid competing needs for limited government budget. This is a noteworthy proof of commitment of the FDRE by any global standard. If you take higher education in particular, today we have 31 public and many private universities and many other colleges with a high intake capacity, which will continue to grow significantly.

Furthermore, the FDRE is very much aware that education is the major instrument to guarantee all rounded national development and accelerate economic growth. Most importantly, science and technology education has been very much recognized for its pivotal role as a pillar of economic and technological advancement. It is clearly evident from practice and research that without development of science and technology, a country can never reach at competitive edge in knowledge based economy. This is why the MoE has reoriented its human resource development priority toward science and technology education and training. Consequently, the MoE took various steps out of which two major ones are the implementation of 70/30 strategy in favor of science and technology education and designation of selected universities as centers for science and technology. In fact, Adama Science and Technology University is one of them.

Nevertheless, the accomplishments so far did not come without challenges. In spite of the country's tremendous achievements in increasing enrollment of students at all levels of education, issues such as ensuring gender balance, improving education and training quality and

relevance, and other cross-cutting issues are increasingly becoming concerns and areas of challenges. Of course, it is obvious that the government alone cannot ensure quality and relevance of education. Even though the role of government and public policies are pivotal, there is no guarantee that our achievements so far will sustain unless we base them on solid foundations of partnership and collaborations among key stakeholders. Sustainable development is certain only when all other development actors including industries, NGOs, citizens and others join hands with the government. I sincerely believe that today's international conference is all about this. As the title has it, it is about sustaining development through science and technology. I would like to appreciate Adama Science and Technology University for taking the initiative to organize such a large conference on which prominent international scholars, experienced and emerging researchers are invited.

Today, we are here to share lessons from the emerging economies of the world and learn from findings of diverse scientific research papers on how to accelerate and sustain our economic and technological development. The government of Ethiopia and the MoE will highly value and seriously consider your recommendations on the thematic areas. We would like to hear from you on what roles should our universities play in capacity building for advancement of science, technology, and innovation. We would like to learn from international experiences on how to effectively develop human resource to support our country's industrial development endeavor.

One of the challenges we have with our universities so far is their lack of integration with our industries. One of the pillars of our country's science and technology policy is university-industry cooperation. The major challenges that our industries are facing today revolve around shortage of innovative technologies and skills to utilize the available ones. We expect our universities to be centers of applied research and breeding places of technology innovation that can easily be transferred into our industries. We also want our industries to absorb the knowledge created within our universities and improve their competitiveness. We are eager to take relevant lessons on how to develop skills within both our universities and industries that can easily grasp and make use of advanced science and technology.

In general, I would like to emphasize that our higher education institutions need to redefine their roles in fostering university-government and industry links in a more pragmatic way. They have to realign their research focus towards practical development agenda of the country while

maintaining academic excellence as well as scientific contributions, and pave the ways to build absorptive capacity for technology and innovation transfer. That is what makes organizing highly focused, thematically relevant, and timely international conference such as this one by Adama Science and Technology University of great significance.

Finally, I would like to welcome both local and international guests and hope that you will have a productive time during the conference period. I once again appreciate the energy spent by Adama Science and Technology University and I believe that the university will summarize and make the key lessons from this conference available for future use.

Thank you!

Congratulatory Remarks

H.E. Ato Mohamuda Ahmed Gaaz, State Minister, Ministry of Science and Technology

Your Excellency, Ato Juneydi Saddo, Minister of the Ministry of Civil services and chairperson of ASTU's Supervisory Board,

Your Excellency, Ato Mekonnen Manyazewal, Minister of the Ministry of Industry,
Your Excellency, Dr. Kaba Urgessa, State Minister of the Ministry of Education,
Higher officials of Oromiya Regional state,
Your Excellency, Professor Jang Lee, President of Adama Science and Technology University,
The state and higher education protocols,
Distinguished participants,
Ladies and gentlemen

I would like to start my congratulatory words from Mach 2012, when Adama Science and Technology University gathered us in a similar auditorium for a symposium that was marking the launching of the Research Park. That is the time when I became aware of the intentions, determination, and commitment of Adama Science and Technology University in its specific field. Most of us were very much moved at that time because the launching of the Research Park was associated with the Rift Valley, and it was named Rift Valley Research or Technology Park.

Many of us in that symposium were moved, and I was particularly moved from a point of view of national sentiment because I belong myself to the Rift Valley. But most of the audiences were moved because they were aware and they had background information about the contribution of a research park to the economic development of the United States of America. The contribution of Research Parks to American development and the implication of this to Ethiopian economy actually moved everybody. In particular, the idea that the Rift Valley, the Ethiopian Rift Valley Research Park, is going to do something to the economic growth of Ethiopia moved every Ethiopian at the symposium. Now, once again, Adama Science and Technology University has come up with another milestone in this International Conference, which is the first of its kind. Here, the theme that ASTU has formulated is 'Sustainable Development', which is a timely theme for the Ethiopian economic development. ASTU is also telling us that sustainable development will not come unless there is one gateway, and that is 'science and technology'. Nobody is going to challenge this theme, but they are going further, and they are saying that there are lessons to be learnt from emerging economies. They are putting this phrase to the theme to substantiate their argument, and this is one gateway to science and technology. So, a number of scholars and academicians have gathered in this conference to give us those lessons. This really merits congratulatory remarks.

I was privileged at one time to listen to the renowned scholar, Professor Gebissa, during the launching of the Ethiopian Academy of Science. The Professor showed us slides from his childhood in the countryside about the Ethiopian agriculture. We said this is ok; it is something we are familiar with. He said he was going to show us another slide, some 30 or 40 years back and the present one, the present reality. The slides are still the same, when he was a child in the countryside and when he is a professor and a world-known scientist. He said this is Ethiopian agriculture. And the remarks he made was that science has made no contribution to the Ethiopian agriculture. So, this is one reality. I happened to come across a book by Rebert paarlberg, a leading scholar on small-hold agricultural development. The tile of the book is 'Starved for Science: How Biotechnology Is Being Kept out of Africa'. We cannot be different; Ethiopia cannot be different. So, I think ASTU wants to address and throw some light on this murky landscape. We have science and scientific outputs on the one hand, and we have the Ethiopian agriculture, on the other. So, ASTU in telling us that we have to build a conveyor-scientific output to the Ethiopian agriculture. This also invites another congratulatory remark to

Adama Science and Technology University. On the issue of technology, I would like to say a few words in relation to this topic and regarding the knowledge related to production force, motivation, and unproductively. I think the Ministry of Industry is doing fine in this country. They are hunting for every available piece of knowledge to increase production and productivity in the industry and in other sectors as well. So, if we feel a bit more comfortable about institution embodied in knowledge, we have areas of deficiency and that lies in the hardware or the technology ware. That is, understanding or uncovering the knowledge embodied in equipment machinery, semi-finished products or finished goods. In this area, as a nation, we are not in good shape. The human ware is not ready, and we have got to learn a lot from the experience of the emerging economies in this regard. In this regard, too, I would like to congratulate Adama Science and Technology University for bringing the topic for the brainstorming and to the attention of policy makers as well. In the past, all researches were inapplicable in nature. Let us give Ethiopia a number of applied researches. Mostly in Africa, and in Ethiopia as well as we can't be different, all the researches were donor-driven. They were not demand-driven. Now that we have the science, technology and innovation policy in place, and the policy stipulates clearly that, from now on, Ethiopia's research is going to be focusing, or it is going to be demand-driven, focusing on problems that exist in agriculture, in industry, and in other sectors. This is the area where focus is going to be made. Therefore, we have a very conducive policy environment for research. It is up to us to coordinate, integrate, and correlate the industries and the universities, and the agriculture sector and the service sectors to universities. Universities have got a lot to do in solving problems. So, applied research is going to be in focus and I hope we are going to learn a lot from this conference. I would like to say thank you for making this information and knowledge available to the scholars and academicians in higher education of Ethiopia.

Let us give ASTU a big hand, and I thank you all for your attention.

Session 1

Government Roles and Public Policies

Partial view of the conference scene

New Strategic Thinking for Economic Development and Innovation: From Binding Constraint to Capacity Building for Growth Poles

Prof. Keun Lee
Director, Center for Economic Catch-up
Seoul National University, South Korea

Abstract

Recent literature in economic development has debated on the relative importance of institutions, policies, and geography as competing determinants of economic growth or factors responsible for the reversal of fortune between former colonies and others. While more research has appeared in favor of the first factor, i.e., institutions, there is also criticism against its relevance, foremost of which is the proposal that human capital is a more robust determinant. Most of the studies on this subject search for one universal determinant of economic growth regardless of the stage of development. The opposite extreme is the argument presented by Rodrik and other scholars who emphasize the importance of identifying the binding constraints for each country An ideal compromise may come in the form of stage- or group-specific factors for economic growth that are neither universal nor country-specific. This compromise make sense because economic development is a lengthy dynamic process that hinges on the specificities of the countries concerned, and that requires corresponding policy tools for countries at different stages of development (Lee and Mathews 2010). This last view is consistent with Lin's (2012) concept of new structural economics, which states that development policy should consider structural differences between developed and developing countries. One similar study is that of Lee and Kim (2009), which finds that technological development and higher education are more effective in generating growth for upper middle- and high-income countries, whereas secondary education and political institutions seem important for lower-income countries. Along this line of thought, this paper introduces in the next section three new thinks for economic development, focusing on capability building, growth poles and latecomer's advantages. Then, it moves on to suggest specific policy ideas for low income countries.

Government Role and Public Policies in Science and Technology: Evidence from the Integrated Circuits Industry in Korea, Malaysia, Singapore and Taiwan

Prof. Rajah Rasiah
Malaya University, Malaysia

Abstract

This presentation seeks to underline the importance of the government's role using science and technology (ST) policies in stimulating economic growth by attempting to answer the question of why the GDP per capita of Korea and Taiwan, which were less than that of Malaysia's in 1970, shot up to exceed 4 and 3 times more respectively in 2010, and Singapore's per capita income rose from 2.5 times that of Malaysia in 1970 to reach almost 6 times in 2010. The answer will target ST policies of these countries with a sectoral focus on the integrated circuit (IC) industry that was promoted by all four countries. The sectoral focus is critical because countries do not excel in all industries and the dynamics of national innovation systems is often decisively intersected by sectoral, regional and local innovation systems. Timing, specificities and the embedding environment that characterize sectoral innovation systems are critical in ensuring that the public goods associated with ST help synergize firms to reach the technology frontier (Nelson, 2008; Malerba and Nelson, 2012). The link between ST policies and specific industries is vital as the former provides the macro and meso dynamics for firms (micro) to evolve and compete (Katz, 2004; Sercovich and Teubal, 2012).

Rather than opening infant firms to competition, ST policy in Japan in the 1950s and 1960s, and in Korea and Taiwan in the 1970s and 1980s sought to evolve their capabilities to compete in global markets (Johnson, 1982). Universities were strengthened to generate both the human capital, and the learning and generation of stocks of technical knowledge in these countries. Planning, coordination and action bodies, such as, the Ministry of International Trade and Industry (MITI) of Japan were started to ensure that flows of foreign knowledge were coordinated through vetting, monitoring and appraisal to synergize national firms. National human capital that accessed and developed tacit and experiential knowledge studying and working abroad were strongly accessed by Korea and Taiwan to build their innovation systems (Vogel, 1991; Saxenian, 2006). Because of its small size, Singapore took advantage of its entrepot endowments to target foreign MNCs through a leveraging strategy to stimulate technological upgrading since 1965 but particularly since the 1980s. Although no Singaporean

firm are at the technology frontier in ICs, the strategy has largely been successful because incentives and grants, and R&D labs have been targeted at upgrading and performance without a focus on ethnic or national preferences. Despite targeting similar goals through its Action Plan for Industrial Technology Development of 1990 (Malaysia, 1991), the Malaysian government achieved less spectacular results because of ethnic colouring of the implementation processes. Not only were nationally created incubators led by inferior managements, the meso organizations begun to assist firms were themselves led by inferior heads in Malaysia (Rasiah, 2011). Hence, whereas technology transfer agreements, and grants approved were carefully vetted and appraised individually and collectively as a policy instrument in Korea, Taiwan and Singapore, they were only recorded in Malaysia.

The IC is chosen for assessment here because of the significance of knowledge as a public good in the industry. ST policies – including incentives and grants – and universities and R&D labs are vital in supporting firms in industries that are knowledge-intensive. The specificity of participation in IC R&D, wafer fabrication, brand name marketing and designing is important as investments involved are lumpy and characterized by high knowledge synergies. They have both scale economies, as well as, public goods characteristics (social returns exceeding private returns).

Although the ST paths taken by IC firms in Korea, Taiwan and Singapore were different but government support remained central in the formative years of the IC industry. Initial structural conditions drove the centralized chaebol framework in Korea following the promotion of IC firms since the promulgation of the Heavy and Chemical Industry (HCI) in Korea in 1975 (Kim, 1997). Significant amounts of R&D were internalized and undertaken in the chaebols of Samsung, Hynix and LG in Korea. The internalization was also a consequence of the failure of public research institutes to generate commercializable knowledge that firms could easily use (Kim, 2003), though it was resolved since 2000 following the introduction of performance instruments (Lee, 2011). The small firm framework of Taiwan drove R&D at the Industrial Technical Research Institute (ITRI) of Electronics Research and Service Organization (ERSO). Incubators evolved from ERSO but particularly located at the Hsinchu Science Industrial Park to become high tech IC firms. Whereas United Microelectronics Company (UMC) was evolved from the acquisition of the semiconductor division of Radio Company of America (RCA) and Taiwan Semiconductor Manufacturing Corporation (TSMC) began as a joint-venture with

Phillips, the subsequent high tech firms were spun out from ERSO, such as Winbond, Vanguard and Yi Wei Mask. ERSO has remained a major platform for incubating new high tech firms in Taiwan, though the government has since 2000 stopped owning them. Singapore has provided equal access to foreign firms to seek grants, infrastructure support and R&D labs to attract wafer fabrication, designing and R&D activities to successfully leverage technological upgrading to high value added activities. Malaysia has not been as successful. Despite the creation of the Malaysian Institute of Microelectronic Systems a la ERSO, and the introduction of incentives and grants, ethnic preferences – at least until 2005 – has discouraged similar results in Malaysia. Ethnic preferences have also been a problem with the brain gain program of the government. Indeed, the massive expansion of universities in Malaysia – from 5 public and no private in 1980 to 24 public and 42 private in 2011 – it is not reflected in the growth of R&D scientists and engineers in the population of the country. Hence, whereas the number of R&D scientists and engineers in Korea, Singapore and Taiwan reached 4,162, 5,736 and 4,159 respectively, Malaysia's reached only 736 in 2006. Also, the reluctance of the Malaysian government to offer grants to potentially successful projects that were sought by non-government linked companies and non-*Bumiputera* companies meant that the share of R&D expenditure in GDP of Malaysia only reached 0.64% while those of Korea, Singapore and Taiwan reached 3.23, 2.39 and 2.58% respectively in 2006.

While ST policies are important in providing the systemic structure for micro firms to learn and innovate to compete internationally, the smooth coordination of the link between the macro (policy institutions), and meso (organizations) and micro (firms) is vital for it to generate the desired outcome of propelling firms to the technology frontier in particular industries. The IC industry is a classic example where countries with similar production and export capacities in the 1970s and 1980s have experienced contrasting results. Whereas Samsung, TSMC, Hynix, UMC, Winbond, Vanguard of Korea and Taiwan have since 2005 been ranked among the top 15 firms in the IC industry on the basis of patents taken in the United States and revenue earned, and firms in Singapore firms on the basis of participation in high value added activities, apart from a handful of foreign firms, most IC firms in Malaysia are entrenched in low value added activities. Thus, whereas Korea, Singapore and Taiwan have managed to sustain rapid growth from dynamic ST policies, the lack of similar dynamic ST policy synergies has slowed down growth in Malaysia since the late 1990s

Overview of Science, Technology and Innovation (STI) Policies in Selected African Countries and the Space for Engagement of Ethiopian Higher Education Institutions in the STI System

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Preface

This paper explores the Science, Technology Innovation (STI) policy development, review and implementation in the African continent and draws important lessons to support the higher education institutions in Ethiopia to play their role in the national innovation system.

African countries have duly recognized that building their capacities in STI is essential to transform their economies. Efforts at developing STI capacities at continental, regional and individual country levels are discussed.

A synthesis of the role of HEIs in building national STI capacity as well as the impact of university-industry link is presented. Based on results of earlier empirical studies, the major drivers and barriers of university – Industry cooperation as well as the benefits and situational factors that significantly affect their relationships are summarized.

The Ethiopian STI policy which envisages the creation of a national framework to search for, select, adapt, and utilize appropriate and effective foreign technologies , as well as the establishment of a national innovation system is briefly overviewed. The critical issues as well as the intended strategies have been put forward .This study clearly shows that there is a huge space for the Ethiopian HEIs to engage in the national STI policy implementation as core actors within the national innovation system. Moreover, this paper attempts to provide strategic options that Ethiopian HEIs may consider to support their effort in significantly contributing towards the STI policy implementation to transform the national economy.

List of Acronyms

AAS	African Academies of Science
AMCOST	African Ministerial Council on Science and Technology
ASTCPA	Africa's Science and Technology Consolidated Plan of Action
ASTII	African Science, Technology and Innovation Indicators
ASTIPI	African Science, Technology and Innovation Policy Initiative
ATPSN	African Technology Policy Studies Network
AU	African Union
COMESA	Common Market for Eastern and Southern Africa
ECA	Economic Commission for Africa
ECOWAS	Economic Community of West African States
FDRE	Federal Democratic Republic of Ethiopia
GDP	Gross Domestic Production
GERD	Gross Domestic expenditure on R&D
GTP	Growth and Transformation Plan
HEIs	Higher Education Institutions
MDGs	Millennium Development Goals
NEPAD	New Economic partnership for Africa Development
R&D	Research and Development
SADC	Southern African Development Community
SMEs	Small and Medium Enterprises
STI	Science, Technology, and Innovation
TeCAT	Technology Capability Accumulation and Transfer
TEVT	Technical Education and Training Program
UNCTAD	United Nations Conference on Trade and Development
UNECA	United Nations Economic Commission for Africa
UNESCO	United Nations Educational, Scientific, and Cultural Organization

1. An overview of STI Policy Development in Africa

1.1 Promoting STI for the Development of Africa

Many believe that by harnessing STI, African countries have a greater chance of addressing poverty, diseases and environmental destruction efficiently and sustainably. Indeed, significant improvement in the standard of living, competitiveness and overall prosperity in the continent is highly linked to STI development (ATPNS, 2010). Serageldin (2008) argues that developing countries may not achieve their development goals without a well-developed capacity in scientific research and technological expertise. Ultimately, developing countries wealth depends not by the resources they control, but rather by the knowledge, they accrued and utilized.

African countries recognize that building their capacities in science, technology and innovation is essential to transform their economies. They took initiatives individually and collectively towards the development of national and regional STI capacities. At national level, STI and related policies and strategies are reviewed or developed. At regional level, there are also efforts that help formulate STI frameworks, for example, by Economic Community of West African States (ECOWAS) in 2005 and that of the Southern African Development Community (SADC).

National and regional initiatives are strengthened by the African Ministerial Council on Science and Technology (AMCOST), which was established in 2003 by NEPAD and the AU. AMCOST, as a continental institutional arrangement, plays key role in promoting pan-African activities, including the development of common STI indicators, policies and programmes. AMCOST supports African political leaders and policy-makers in a number of ways. These include

- Providing the platform for critically examining emerging STI issues and their implications for development.
- Making specific decisions that will promote the application of science and technology to achieve NEPAD goals and MDGs.
- Providing political and policy leadership to develop and adopt science, technology and innovation strategies, plans and programmes.
- Serving as a focal point for exchanging information on good practices of STI policy development.

AMCOST has been influential for the development and adoption of the first '*Africa's Science and Technology Consolidated Plan of Action'* in 2005. This Plan of Action contains clusters of priority programmes and related indicative projects to be implemented over an initial period of 5 years by African countries in partnership with the international community.

The Africa's Science and Technology Consolidated Plan of Action' envisions "Africa that is free of Poverty and well integrated into the global knowledge economy." The overall goals of the plan include:

- to enable Africa to harness and apply science, technology and related innovations to eradicate poverty and achieve sustainable development; and
- to ensure that Africa contributes to the global pool of scientific knowledge and technological innovations

A number of programs and projects are outlined which needs to be implemented through regional, continental and international cooperation in STI. These include:

- Improving infrastructure or facilities for R&D and promote sharing of such facilities;
- Creating institutional and policy arrangements that enable African countries to mobilize and share their scarce resources to conduct science and generate technological innovations;
- Strengthening the continent's human skills base by increasing the number of scientists, technicians and engineers.
- Improving the quality and intensity of regional cooperation
- Building a strong political and civil society constituency for science and technology in Africa.
- Improving the quality of science, technology and innovation policies of African countries through processes that promote sharing of experiences and policy learning.
- Strengthening the capacity of regional economic bodies to mainstream science and technology into their sectoral programmes and projects.
- Promoting the application of science and technology to achieve specific MDGs; and
- Promoting innovative ways and means of financing science and technology in Africa.

These programs and projects have been further clustered into different levels of categories as outlined in Table 1.

Major Program Cluster	**Specific programs**
Biodiversity, biotechnology and indigenous knowledge	• Conservation and Sustainable Use of Biodiversity • Safe Development and Application of Biotechnology • Securing and Using Africa's Indigenous Knowledge Base
Energy, water and desertification	• Building a Sustainable Energy Base • Securing and Sustaining Water • Combating Drought and Desertification
Material sciences, manufacturing, laser and post-harvest technologies	• Building Africa's Capacity for Material Sciences • Building engineering capacity for Manufacturing • Strengthening the African Laser Centre (ALC) • Technologies to Reduce Post harvest Food Loss
Information and communication technologies, space science and technologies	• Information and Communication Technologies • Establishing the African Institute of Space Science
Improving policy conditions and building innovation Mechanisms	• African Science, Technology and Innovation Indicators Initiative (ASTII) • Improving Regional; Cooperation in Science and Technology • Building Public Understanding of Science and Technology • Building a Common African Strategy for Biotechnology • Building Science and Technology Policy capacity • Promoting the Creation of Technology Parks

Source: Africa's Science and Technology Plan of Action (2005)

Currently the social and economic growth that is observed in Africa is partly the result of technology diffusion and adoption. Moreover, there are number of evidences that suggest the political commitment of African governments in recognizing the importance of STI for the future of Africa. The African Manifesto for STI (2010) demonstrates such initiatives. The manifesto envisions a new renaissance for the proper governance and utilization of STI. This new vision on STI for African development emphasises, among other things on the following areas:

- the Need to Embed African STI in the African Agenda
- Leadership for governance of STI
- Capacity Building and Public Engagement in STI
- Youth and Gender Engagement
- Knowledge Circulation, Valorisation and Appropriation Strategies
- Collaboration and Regional Integration

- STI investments
- regulation and Mediation of STI
- Innovation Incubation
- Building sustainable STI infrastructure

Many global and continental level institutions are providing the strategic thrust to increase Africa's participation in the global STI. Some of the major institutions include the African Union (AU), the United Nations Economic Commission for Africa (UNECA) Science and Technology divisions, the African Technology Policy Studies Network (ATPS), The African Academies of Science (AAS), the African Union-NEPAD platform on Science and Technology, and the UNESCO/ AU STI policy initiative 2009.

1.2 Regional networks for R&D in Africa

The 2007AU summit under the theme Science, technology and scientific research for Africa development clearly signify the strategic importance of STI for the future of Africa. Building on such initiatives, African countries have exerted efforts individually as well as at regional level to enhance the STI policy development, review, implementation and capacity building at various levels. For instance, the West African regional science, technology and innovation policy reviews and statistics workshop, which was held in Bamako (2010), had the following objectives:

- Analyse recent national experiences and trends regarding science, technology and innovation policy-relevant indicators in West African countries;
- Training of high-level technical staff from S&T statistical bodies in West African countries;
- Increase the number of countries regularly producing quality S&T indicators, in line with the requirements of the CPA;
- Strengthen local capacities as indicated in the CPA, for the production of such indicators, with the final aim of establishing sustainable local S&T statistics systems in West African countries;
- Promote the use of S&T indicators to support evidence-based S&T policy making;
- Share experiences with other countries in the region regarding S&T indicators, and to address the problems encountered in collecting and analysing S&T statistics.

STI policy and decision makers as well as professionals from 12 west African countries (including Benin, Burkina Faso, Cape Verde, Côte d'Ivoire , Gambia. Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger and Nigeria) deliberated on the various STI issues towards utilization of STI for the nations' development.

NEPAD Science and Technology Sector has been implementing the "AU/NEPAD Africa's Science and Technology Consolidated Plan of Action (CPA)" in the following three pillars: knowledge production, capacity building, and Technological innovation. NEPAD Agency as a technical body of the AU is mandated with

- facilitate and coordinate the implementation of continental and regional priority programmes and projects,
- mobilise resources and partners in support of their implementation,
- conduct and coordinate research and knowledge management, and
- monitor and evaluate the implementation of programmes.

A report on activities of the NEPAD agency in the implementation of the **Africa's science & Technology consolidated plan of action** (2010) illustrates that regional coordination and STI capacity building is being planned and implemented through various joint programs and projects.

For instance, NEPAD agency has establishes four regional networks for Biosciences research and development programs. These are the

- Southern Africa Network for Biosciences (SANBio) covering 12 southern African countries,
- the Biosciences eastern and central Africa Network (BecANet) covering countries in eastern and central Africa,
- the West Africa Biosciences Network (WABNet) covering the 15 countries of Economic Community of West African States (ECOWAS) region; and
- the North African Biosciences Network (NABNet) covering six countries in North Africa.

Regional groups, such as ECOWAS, COMESA, SADC, etc are providing opportunity as a platform for regional cooperation in various dimensions of STI. Through policies, institutional

arrangements and financial support, these regional economic communities create a stage for facilitating cooperation among institutions and governments. Several of the economic, political and trade treaties refer to the need to strengthen cooperation in the field of STI. Furthermore, the founding charters of several of the regional Economic Communities, which make commitment to the use of science and technology for economic integration (Mugabe, 2006).

UNESCO in line with African Science, Technology and Innovation Policy Initiative (ASTIPI) is conducting many sub regional workshops in Africa in STI policy reviews starting in 2008 and plan to end in 2013. So far these workshops have helped countries to develop their own national STI policies or review existing ones. Some of these include

- Regional workshop for STI policy review in Central Africa - (April 2011)
- National STI workshops in Botswana and Zimbabwe (February 2011)
- West African Regional Capacity Building workshop in STI Policy and Statistics (May 2010)
- East and North Africa STI policy review (March 2009)
- STI policy review for countries of the Southern African Development Community(September 2008)
- Assessment of the status of science and technology policy formulation
- STI policy in West Africa (2010)
- STI policy in East Africa (2011)

1.3 Africa STI development Indicator

A recent report (AU/ECA, March 2012) indicated that the state of Africa's innovation policy environment "is underdeveloped and largely inadequate in terms of sustaining a dynamic innovation ecosystem. Some of the key areas that need special attention include promotion of innovation in the education system, and among small and medium enterprises (SMEs), innovation financing for experimental development, technology transfer and commercialization of research outputs, and monitoring and tracking of STI performance on the continent."

There are considerable efforts by African countries to develop a system of STI development indicators that help gauge the implementations of their policy to further formulate or develop

evidence based policies and strategies. One of these attempts aims at improving policy conditions for scientific research and technological innovation in Africa. It specifically focuses on strengthening capacities to develop indicators and related science, technology and innovation policies and strategies. Research and information gathering, training courses, inter-governmental committee on indicators and surveys, development of an African Science, Technology and Innovation (ASTI) Outlook bi-annual report, and design of national strategies and policies constitute core activities of the programme. The African Science, Technology and Innovation Indicators (ASTII) initiative is a response to AMCOST demand to address the lack of evidence-based policy processes. A report on African Innovation Outlook 2010 (2011) pointed out that a first continental level study was conducted between 2007- 2010 in 19 countries: Algeria, Angola, Burkina Faso, Cameroon, Egypt, Ethiopia, Gabon, Ghana, Kenya, Lesotho, Malawi, Mali, Mozambique, Nigeria, Senegal, South Africa, Tanzania, Uganda and Zambia.

Based on international best practices, this study was aimed as a first initiative to inform Africans and other stakeholders about the status of the STI activities of the continent and trigger further discussions for the improvement of STI programs and projects by addressing key African STI problems and looking for possible solutions.

The study addressed the challenges and structural impediments for economic growth and human development for STI and the dire need to improve institutional capacities. Due emphasis was given in the survey for the research and R&D activities in selected 13 African countries using two main R&D indicators. These indicators are Gross Domestic expenditure on R&D, and R&D personnel.

In terms of Gross domestic expenditure on research and experimental development (GERD), only few countries have achieved or exceeded the 1% target set by the AU in 2006. In most countries, the R&D intensity or the GERD/GDP percentage range between 0.20% and 0.48%. Moreover, in all the surveyed African countries the lion's share of the GERD is accounted by the public sector, i.e. the government and public higher education Institutions. The African governments are the main source of R&D funding to the public universities, government research institutes, and other organizations and individuals undertaking R&D activities. Funds

from international organizations and other donors also significantly contribute to the financing of R&D activities in African countries.

With respect to the types of R&D activities, there is a considerable variation among the countries. Some focusing on applied research while others give emphasis to basic researches. In some of these counties as high as 83% of the researches are applied researches where as some countries devote resources for basic research for as much as 36% of the GERD.

The human resource deployment in STI expressed in terms of research density (the number of full time human resources as compared to the total population) also shows variation from country to country. From the surveyed countries, the highest research density was 825 researchers per million inhabitants while the least density is 25 per million inhabitants.

In all countries surveyed, the participation of women in R&D is found to be well below 40% indicating the need to increase women participation in the sector through increased opportunity in scientific careers.

Most researchers in the surveyed countries are employed in government research institutes or public university Laboratories. This indicates the need to increase the role of the business enterprises in R&D. With regard to the qualification of R&D personnel only in few countries as many as 36% of the researchers have PhD degrees while the rest have high number of staff with non-tertiary education. Of all the researchers, about 50% are working on a full time basis on R&D activities.

The study also revealed that despite agricultural research dominated the research agendas of African countries in the 1990s (especially in Anglophone countries); research in medicine and related fields now dominates. In addition to the challenges of dealing with traditional tropical and other infectious diseases such as sleeping sickness and malaria, the HIV/AIDS pandemic and the continuing effects of tuberculosis have led to renewed R&D effort in these areas. Issues related to food security, the effects of drought, poor crops, and the impact of internationalisation and open trade on certain markets have yet to generate appropriate R&D. (Africa Innovation Outlook 2010, p 107)

The study also revealed that the production of science is dependent on a wide range of systemic, institutional and individual forces and that the scientific effort in most of the countries reflects physical and material realities and challenges related to the three main areas of food security, disease control and industrialization. The survey clearly showed that in few African countries where scientific output is substantial and even growing are not as productive as developing countries elsewhere in the world; these countries therefore do not have a significant effect on the overall findings in this regard. It is recommended that for Africa to become more competitive with respect to scientific output will require greater investment in human capital development, the strengthening of scientific institutions and equipment, as well as significantly higher funding for science. (Africa Innovation Outlook 2010, p 98)

1.4 STI policy review in some selected countries

A report released on Ghana's STI policy review (2011) clearly indicated the renewed commitment of the country to harness STI to meet overcome its economic, social, environmental, and technological challenges. As one of the African countries aspiring to become a lower middle income country , Ghana is striving to build an economy that also base its competitiveness in knowledge and technology based sectors in addition to the traditional gold, cocoa, timber and also recently oil and gas industry.

The STI policy review of Ghana focused on how its STI policy is well integrated into the national development plan and how the implementation of this policy is contributing to the betterment of the lives of its citizens in a sustainable manner.

The report stated, "the review finds that many of the building blocks for fostering innovation and technological development – including reputable universities, research institutes, and a growing private sector – are already in place in Ghana. However, the STI system does not focus sharply enough on Ghana's socio-economic needs. Existing STI support programmes for the private sector do not appear to be encouraging technological upgrading or innovation. Resources are spread thinly across the system, and as a result, many of the country's important STI institutions are unable to effectively carry out their mandates. Funding allocations for STI are determined by the Government and donor programmes and often do not relate to the priorities of research

institutes and universities, and much less to those of the private sector, farmers and informal enterprises." (Ghana STI Review, 2011, p iii – iv)

The Ghana STI policy review of 2011 made the following recommendations

- improving the leadership, coordination and management of STI
- developing programmes that encourage innovation and technology adoption by the private sector
- growing the science, engineering and technical workforce; and
- creating incentives to align the public technology providers with the needs of the private sector.

The review also showed that building partnerships with other countries and organizations around the world as a critical need for the success and sustainability of STI development. Particularly mention was made in the report at the World Bank and UNCTAD; the Government will work towards implementing these recommendations.

Tanzania has also completed in June 2011 a review of its STI policy implementation with particular focus on how its Higher education Institutions. This study under the title "Review and Evaluation of the Performance of Tanzania's Higher Education Institutions in Science, Technology and Innovation" provided insight on how well the country's HEIs programs in STI are aligned with the national development policies and strategies.

The review asserted that the Government has defined an important set of clear national development policies and strategies as well as STI policies and strategies. The review findings show that Tanzanian HEIs performance in STI is characterized by

- an environment where there exists policy instruments related to the development and finance of tasks of HEI, training, research , and extension
- a weak recognition of research ,
- limited existence of funding, human resources and equipment.
- lack of incentives for active researchers,
- very limited significant scientific production, at the international levels, and a weak relationship between research and postgraduate studies,

- a lack of recognition and credibility of HEI on behalf of external academic and development agents. Also, the quality and relevance of the research that is undertaken,
- no institutional nor national mechanism for assessing research performance by stakeholders
- limited efforts in attracting the private sector, individuals, business people, trade unions and community organizations into contributing significantly to the national STI effort
- the need for regional and international collaboration

The main recommendation of the review is the development of a roadmap to address the current challenges and improve the performance of HEIs in STI. The proposed eight objectives for the roadmap are road map has efforts to improve the performance of HEI in STI. The eight proposed policy objectives to lead the Roadmap are:

- To improve the quality in the education and training to develop a critical mass of a well trained human resource base.
- To complement existing research capacities among HEI and with those of government and other public and private institutions.
- To develop associative capacities in research through the creation of national and participation in international networks.
- To create open research and innovation forum
- To understand and define actions related to brain drain, brain gain, and brain circulation.
- To promote and create new postgraduate studies including STI management.
- To increase and maintain constant Government´s financial support of STI
- To identify research areas, including actions to define research activities around viable traditional knowledge. (Bastos and Rebois, 2011, p 6-8)

OECD has conducted a comprehensive assessment of the innovation system of South Africa in 2007, focusing on the role of government, and providing concrete recommendations on how to improve policies, which affect innovation performance, including R&D policies.

As the largest economy on the continent, the role of STI to enhance its competitiveness at a global level is critical. The review assessed the national innovation system and provided direction for future optimal utilization of STI. The review enabled to portray the status of the country's innovation system that relate to government, the knowledge infrastructure and to some extent the private sector.

The review showed some of the success achieved in broad areas of the system's performance in spite of the unpromising initial conditions. Some of the factors that contribute to the success include recent policy developments, the structures developed for policy-making and implementation, and certain features of the main research and innovation performers. The review has also highlighted some of the challenges that need to be addressed. One of these challenges includes the overemphasis of the role of the government institutions over the business enterprises and private institutions. Shortage of well-trained and experienced human resource for STI activities remains a problem that should be resolved. The weak link between industry and HEIs still need to be strengthened. Generally, improvement is needed in the two major components of the innovation system: The Knowledge infrastructure (education and research and the policy and governance (political system).

Paul (2012) stressed that the South African Government should foster science and technology innovation policies that are dovetailed with the overall industrial and export-import policy. It should focus on the minimizing the gaps and inequalities between institutions and the social structural conditions of the society. In addition, the replacement of the current aging scientific workforce by a younger generation is very essential. Moreover, investment in R&D needs to be at least at 1% of the GDP.

2. The role of HEIs in STI policy development and implementation

A number of empirical studies (Mansfield (1997, 1998), Adams (2002), Zucker & Darby (2005)) have shown that the utilization of academic knowledge to be valuable for bringing technological change, innovation and growth in the industry where new knowledge, techniques, and skills of a kind that industrial firms would find them difficult to provide by themselves. It has been also recognized that countries with stronger research universities have better opportunities to attract

and support innovative industries in the economy than other regions. A number of quantitative studies (for example, Mansfield, 1998; Cassiman & Veugelers, 2006) confirm a positive association between the university-industry link and innovativeness at the firm level. According to Hanel & St-Pierre (2006), Monjon & Waelbroeck, 2003, among others, no casual relations between collaboration and a firm's ability to introduce incremental types of innovation can be found.

Despite this evidence on a possible positive effect, many researchers (for example, Hall et al., 2003; Jacobsson, 2002; Fontana et al., 2005) emphasize that our knowledge on the interaction between universities and industry is still limited and ambiguous. The issue of *through what processes* of *R*&D collaboration with universities affects a firm is far from unambiguously resolved by previous research.

Davey et al (2012) tried to investigate on the drivers and barriers of university - business cooperation in European universities. They argued that besides drivers and barriers there are other factors that play important role in the university business cooperation. Particularly the *Benefits* and *situational factors* significantly affect their relationships. Figure 1 shows the factors affecting the extent of the university –business cooperation.

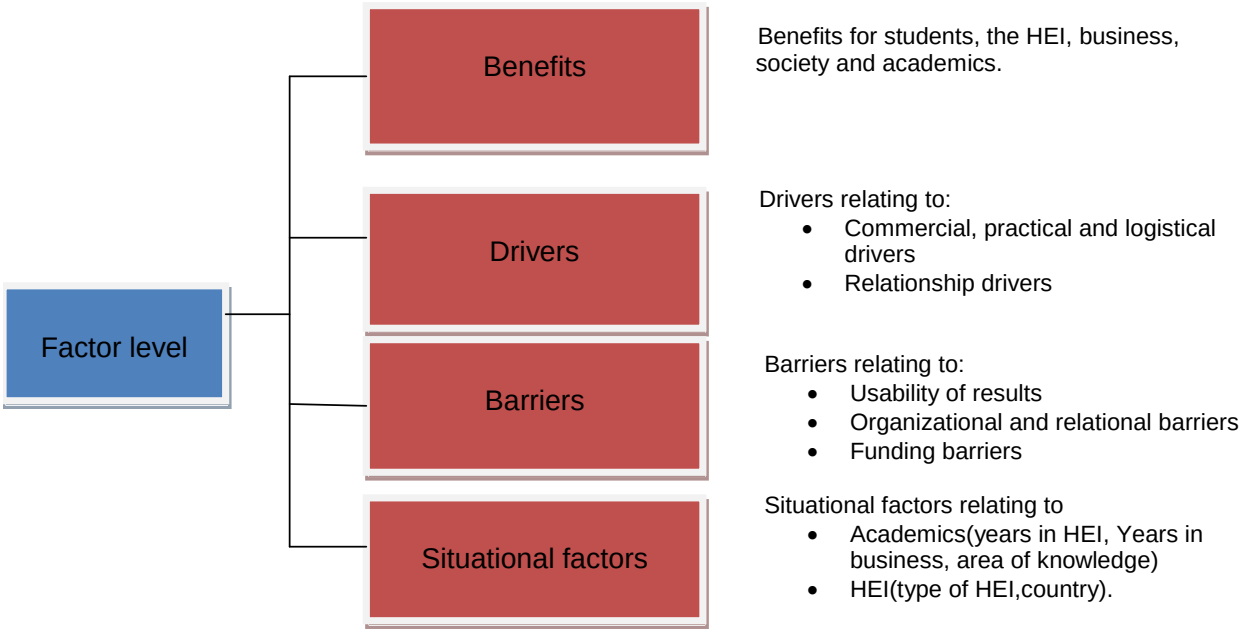

Fig.1 Factors affecting the extent of university business cooperation (Source: Davey, et al., 2011)

According to Davey et al., (2012), two major categories of drivers for the university –business cooperation are identified. These are the relational and business drivers. Table 2 shows the elements of these two types of drivers in detail.

Table 2. Types of drivers for university-business cooperation (Source: Davey, et al., 2012)

Type of driver	**Explanation**
Relationship drivers	Drivers that relate to the relationship between the academic/HEI and the business, and these include • Existence of mutual trust • Existence of mutual commitment • Having a shared goal • Understanding of common interest by different stakeholders(e.g. HEI's business, individuals, students • Prior relation with the business partner • Cooperation as effective means to address social challenges and issues
Business drivers	Drivers that relate to the business factors that motivate UBC, and those include: • Employment by business of HEI Staff and student • Possibility of accessing funding/ financial resources for working with business • Short geographical distances of the HEI from the business partner • Flexibility of business partner • Access to business sector record and development facilities, • Commercial orientation of the HEI

Table 3 provides the explanations for the three types of major barriers in university –business cooperation: namely, the usability of results, funding barriers, and relational barriers.

Table 3. Types of barriers for university-business cooperation (Source: Davey, et al., 2012)

Types of barrier	**Explanations**
Usability of results	Barriers that relate to the way the results of UBC(mainly R&D results) are utilised by business and these include • The focus on producing practical results by business • The need for business to have confidentiality of research results • Business fears that knowledge will be disclosed
	Barriers that relate to the provision of funds for UBC from both internal and external sources and these include

Funding barriers	• Lack of external funding for UBC • Lack of financial resources of the business • Lack of HEI funding for UBC • Financial crisis
Relational barriers	Barriers that relate to or affect the actual UBC relationship or interactions occurring between academic/HEI and the business and these include • Business lack awareness of HEI research activities/ offerings • The limited absorption capacity of SMEs to take an internships or projects • Differing time horizons between HEI and business • Differing motivation/ values between HEI and business • HEIs lack awareness of opportunities arising from UBC • Bureaucracy within or external to the HEI • Limited ability of business to absorb research findings • Differing mode of communication and language between HEI and business • A lack of contact people with scientific knowledge within business • Difficulty in finding the appropriate collaboration partner • No appropriate initial contact person within either the HEI or business

In connection with the roles of African universities in development, many writers argued that most African universities perform poorly in producing effective and well-trained entrepreneurs for the private sector. These universities did not produce work force, which led to the innovation and adaptation of technologies for development. Most industries at all levels are run with imported technologies and here has been no significant technological innovation and adaptation in most part of the continent.

Despite recent encouraging initiatives in terms of the focus on STI for development, African universities ought to do a lot more in terms of contributing towards national development. In some circumstances, it may be necessary that African HEIs undergo major changes in terms of their curriculum, their teaching staff and their organisation. They need to give more emphasis to teaching and research in relevant technologies and vocational training for African economies that should be competitive at a global level. African universities should ensure that they are producing entrepreneurs who are competent managers, organisers and risk takers in the context of underdeveloped but growing African economies.

A UN report (2009) on science and technology cluster in Africa stated that Africa's development challenges are partly attributed to failure of its HEIs in developing the necessary capabilities that are demanded by the national development policies and strategies. These institutions fail to develop capacity focusing on the building of skills and technical capabilities, including the following key issues

- Training of scientists, engineers, technicians and policy makers;
- Promoting grass-roots 'inclusive innovations;'
- Developing local institutions that can scale-up locally generated grass-root innovations;
- Strengthening the capacity of local scientific and engineering institutions to conduct the R&D needed to adapt these technologies for local use and to generate socially and economically relevant new technologies;
- Developing the technology transfer know-how, as well as the management of intellectual property rights required to move innovations from the laboratory to the market;
- Helping local enterprises become more innovative; and
- Improving the governance and financial sustainability of the national STI system. (UN report , 2009 p.12)

In their study on making university –industry work, Edmondson et al. (2012) addressed the challenge of bridging the industry-university divide by highlighting what makes HEIs attractive as industry partners, what structures and approaches make for excellent partnerships. They argued that the need for policymakers to create a conducive environment of funding and regulation for long-term strategic partnerships to thrive. HEIs need to have the autonomy to operate effectively, and form partnerships. Furthermore, it is necessary to Reward universities with strong partnerships with the industry. Moreover, they suggest that universities need to strive for excellence as industries want to collaborate with the best universities.

3. The New Ethiopian STI Policy and the roles of Ethiopian HEIs

3.1 The New Ethiopian STI Policy

The FDRE Government issued its first National Science and Technology Policy in 1993 (1986 EC) to improve the science and technology capabilities for national development. The

major objectives of this policy were building capability to generate, select, import, develop, disseminate and apply appropriate technologies; and improving the knowledge, culture and awareness creation about the importance of science and technology.

However, through the course of time, it became obvious that this national science and technology policy need to be reviewed and a new one to be developed. Some of the drawback of the 1993 policy includes:

- Weak integration with current national development plan including the GTP
- Focus on the supply side of R&D rather than the demand by industry and businesses
- Lack of emphasis to the some critical economic sectors like the manufacturing and service sectors
- Limited role for the private sector for science and technology development

Owing to these and other shortcomings, the Ethiopian House of people representatives in February 2012 adopted a new STI policy. The new STI policy addressed the major weaknesses in the previous policy and provided clear directions to future STI endeavours to contribute to the national development.

The new STI Policy takes the national vision of '*alleviating poverty and becoming one of the middle income countries'* and " envisages the creation of a national framework that will define and support how Ethiopia will in future search for, select, adapt, and utilize appropriate and effective foreign technologies as well as addressing the establishment of national innovation system. It is clear that strengthening the integration and cooperation among various stakeholders will be of paramount importance to realize the policy's objectives." (Ethiopian STI policy, 2012, p.2)

The national STI vision of the country is "To see Ethiopia entrench the capabilities which enable rapid learning, adaptation and utilization of effective foreign technologies by the year 2022/23." Moreover, its mission is stipulated as "To create a technology transfer framework that enables the building of national capabilities in technological learning, adaptation and utilization through searching, selecting and importing effective foreign technologies in manufacturing and service providing enterprises." (ibid. p.3)

Based on its vision and mission, the national STI policy has seven major objectives. These are

1. Establish and implement a coordinated and integrated general governance framework for building STI capacity;
2. Establish and implement an appropriate national Technology Capability Accumulation and Transfer (TeCAT) system;
3. Promote research that is geared towards technology learning and adaptation;
4. Develop, promote and commercialize useful indigenous knowledge and technologies;
5. Define the national science and technology landscape and strengthen linkages among the different actors in the national innovation system;
6. Ensure implementation of STI activities in coordination with other economic and social development programs and plans;
7. Create conducive environment to strengthen the role of the private sector in technology transfer activities sustainably. (ibid. p.4)

The policy formulation process has identified eleven key strategic issues and respective directions, and strategies have been developed for each of these issues. The critical policy issues include Technology transfer, human resource development, manufacturing and service providing enterprises, research, financing and incentive schemes, national quality infrastructure development, universities, research institutes, TVET institutions and industries linkage, intellectual property system, science and technology information, environmental development and protection, and international cooperation. (ibid., p. 5)

This paper focuses only to those areas in the policy related to the role of higher education institutions in the ST policy implementation process.

3.2 The space for HEIs in STI policy implementation: HEIs roles in the national STI system

The new STI policy stresses on the need to integrate the efforts of a wide range of national and international stakeholders in the implementation process. In fact the policy itself helps develop the framework necessary for the establishment of the national innovation system through which the various stakeholders will come together to play their respective roles in a more integrative and cooperative manner.

Among these key stakeholders, the higher education and research institutions are core actors in the national innovation system. The policy clearly identified the gap between the current research

focus and activities in Ethiopian HEIs and research institutions and the country's development need. Therefore, it is essential to gear the overall research themes and activities towards fulfilling the technological demands for the economy. Moreover, "as far as technology learning is concerned, the current situation of our country confirms that universities are not taking the leading role and are lagging behind the industries." (Ethiopian STI Policy, 2012, P 13)

Excerpt from an interview conducted by Ethiopian *Herald* with an expert from the MoST also reflect the current situation and put forward the expectations of the role of the Ethiopian HEIs. The expert discussing on some of the anticipated challenges in the implementation of the new policy said, *"The first challenge might be the resistance that we could face from various directions. This might happen regarding the research direction. This direction may need to shift towards technology adoption and adaptation. This is the challenge that we might face from some universities."* (Ethiopian Herald, June 26, 2012?)

Moreover, in response to the question regarding the often-heard critics that Ethiopian HEIs research focusing on the theoretical aspect rather than technological adoption and adaptation, the expert responded as, "We *hope the educational institutions will play a very important role in the effort to effectively implement this policy as it is a vital national policy. Not only at institutional level, as a country, we are not even capable of properly utilizing the existing technologies. We are at a low level in properly and effectively using contemporary technologies. The policy is set in such a way that the country would resolve these drawbacks at a large scale. That is why we focused on building our capability above all. The policy in general intends to fill the gaps that we have faced so far."* (ibid.)

Taking into account these limitations in the Ethiopian HEIs in STI practices, Universities, research institutions and TVET are considered as one of the critical issues that need to be well dealt in order to achieve the national vision. As is the case with all the identified critical issues in the policy, general directions and major implementation strategies are devised. Table 4 shows the major implementation strategies that pertain to Higher Education institutions with respect to the critical issues.

It should be noted that by *strategies pertaining to HEIs* should not mean these are the only areas where HEIs engage. It simply try to put forward some of those areas that are directly involve

these institutions as key implementers. Otherwise, as core actors in the national innovation system, HEIs are engaged in all ST as element of the system.

Table 4 Some of the STI Strategies pertaining to higher education Institutions (Source: Ethiopian STI Policy 2012)

Critical issues	**Strategies pertaining to HEIs***
Human Resource	• producing highly qualified technicians, engineers and scientists in line with the demand of the national economy; • Balancing the enrolment numbers of higher education students in favour of the science and technology • conducting practical training in cooperation with industry; • Increase the number of females enrolling in engineering, science and TVET institutions; • Enabling the establishment of workforce in manufacturing and service providing enterprises with the knowledge and skills necessary to learn, adapt and utilize technology.
Research	• Support research institutes to develop their capacity to search, learning, adapting and utilizing effective foreign technologies; • Ensuring research works are in line with the technological needs of national development programs; • Supporting joint research activities among universities, research institutes and industries; • Supporting medium and large industries to establish research centers on technology adaptation.
Financing and incentives	• Securing sources in line with the economical development for their contribution to technology transfer.
National Quality infrastructure	• Incorporating issues of national quality infrastructure in the curricula
Universities, research institutions and TVET colleges	• Establishing a system that integrates and synergizes technology transfer issues among universities, research institutes, TVET institutions and industry; • Creating a conducive environment for university academia and students to engage in technology transfer activities in industry; • Creating strong linkages among universities, research institutes and industry addressing technology adaptation; • Establishing a system that enables universities to provide an advisory role to industry in relation to technology transfer activities.
International cooperation	• Strengthening exchange of professionals and scientists through South- South and North-South cooperation initiatives; • Initiating joint research programs with international partners, within Ethiopia, that has direct contribution to the national development agenda.

The STI policy and strategies clearly show the wider space the HEIs need to fill and play active role in implementing the STI activities for national development. It is not about the creation of space for the institutions as such but will be more important to focus on how HEIs could effectively discharge their responsibilities.

There are initiatives that are being undertaken by Ethiopian HEIs in line with the STI strategies outlined in the policy. However, these efforts need to be both strategic and systemic in their approach. A number of studies (for example, Barnett (2011), Etzkowitz and Roest (2008) , Edmondson et al.(2012) , Loo et al (2011) , Puukka (2011)) have tried to put forward some important approaches to enhance strategic Industry-university partnership.

Some of these recommendations, which are specific to the HEIs, have been discussed in this paper. In fact, it is essential that each of the HEIs need to probe more and look inward to improve its services as to render what matter most in contributing towards national development. However, a number of lessons could be learned from other HEIs to inform the change process that Ethiopian HEIs may consider to actively engage in the national innovation system. It is therefore important to consider some of these lessons drawn in the following section.

3.3 Strategic options for supporting STI policy implementation by HEIs

- **Planned Cultural change in HEIs:** It is necessary to accelerate the cycle of HEIs and industries partnership through adopting open mind and be receptive to mutually beneficial partnership. This entails cultural changes in many of HEIs towards provision of a demand -driven services rather than the conventional supply-driven higher education.
- **Learning and development of university leaders and staff:** HEIs management and staff must learn how to reach out the industry and manage such relationships. Young scientists and technologists need to get opportunities to establish partnership locally and at international levels, and get a better understanding of business. Formal trainings may strengthen the partnership building efforts of staff and create a stronger university leadership.
- **Development of strategic partnerships:** HEIs need to make Industry-university partnerships a strategic priority and communicate and advocate regularly to the entire

academic community. The leadership need to focus on the development of long-term strategic industry university partnership. This in part requires the assessment the core strengths of the university and the opportunity in the industry for long-term strategic collaboration and setting broader goals instead of short-term contracts.

- **Excel in areas where HEIs strive to have excellence:** Identifying center of excellence by HEIs is important, but practically excelling in those identified areas speaks much louder than putting words in strategic plans. Industries want to collaborate with the best HEIs and not with all, hence striving for excellence is important. It is essential to redefine the role of HEIs beyond the conventional teaching learning process and embrace the responsibility of being a source of competence and problem solving for the betterment of the society.
- **Promoting a multidisciplinary approach to research and learning*:*** This demands the breaking down of the traditional academic silos and drive a new multidisciplinary culture and curricula. Industry-university partnership requires working together across a number of disciplines, such as technology, design and engineering. Therefore, developing multidisciplinary programmes could also help encourage industries to be engaged in such programs.
- **Establishment of Government - industry –university joint forum:** Applying the concept of Triple Helix, it is essential to develop mechanism that helps the establishment of a sustained partnership of government – university –industry. The formation of Government- Higher Education - Industry Resource Integration Center (Daniel Kitaw, 2006) is an option that needs to be considered by all concerned. The **national STI council** should play a pivotal role in this regard.
- **Ear marked support to HEIs:** Targeted support to universities and research institutions by the government and industry is also another way to facilitate the government –industry –university partnership. This should take into account rewarding HEIs with active engagement in collaborative actions with industry.
- **Development of science and technology parks:** Science and technology parks in many countries have played a significant role in scientific and economic development. These parks help to minimize the gap between economic sectors and the academia and research community. They provide the physical environment needed for development and

- flourishing of scientific innovations; reduce investment in infrastructure and transaction costs. They promote technology transfer and provide opportunity for practical, problem - solving oriented education and training. A well planned development of such parks within Ethiopian HEIs support the national Innovation system.
- **Increased involvement of Ethiopian HEIs at regional and continental STI agenda:** Increased engagement and visibility provide Ethiopian HEIs opportunities for experience sharing and strengthening local capacities, access to resources, training and development, and enhance their cooperation and networking efforts.
- **STI policy implementation Action plans at institutional and national levels to execute the Ethiopian STI policy and strategies:** The development of such plans provides the opportunity to pursue strategic actions by each institution and provide synergy to harness the collective efforts to impact on the STI system. Besides the HEIs, the MoE - Higher Education sector could be instrumental in consolidating and encouraging such efforts.

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Session 2

Science & Technology Education and University-Industry Cooperation

Some of the attendants of the opening of the conference

Research University as the Core of Regional Development and Innovation

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Abstract

The world has transformed into one big market and a global village as technology connects everyone in every corner of the world; and the forces of capitalism brings down walls of economic, social and cultural barriers between different geographic areas. On the other hand, the global village is faced with such universal threats as climate change, shortage of natural resources, epidemic diseases, and terror and violence. It is the challenge of this era to reconcile with these global problems and find ways to achieve sustainable growth through scientific and technological innovation. As the breeding ground of innovation, universities are well fit to take on the challenge.

The speaker identifies disciplinary boundaries and geographical barriers as two elements to be removed from a university. By taking interdisciplinary and cross-disciplinary approach in academics and research, a university is better fit to produce solutions for the complex issues of the 21st century. And by overcoming the geographical locality and becoming a truly globalized entity, a university is able to serve as the core platform of global network as required by regional and national mission and vision.

The speaker also elaborates on multifarious roles and responsibilities of research universities. Recent developments at POSTECH are introduced as an example, which involve refinement and extension of its role as a leading educational and research institute of Korea and the regional core of innovation and knowledge clusters. For example, POSTECH widely collaborates with the local governmental and industrial sectors through establishments of *Pohang Technopark, Deagu-Gyeongbuk Medical Cluste and Regional Innovation Center,* and makes various efforts to attract the world's leading scientists and engineers by hosting and establishing a number of research institutes into the region. POSTECH is truly committed to taking a central role to bring in various programs and initiatives that promote top-quality education, innovation, and entrepreneurship, ultimately creating regional economic value.

Reinforcing Quality and Relevance of Education in Public Higher Education Institutions of Ethiopia: Implications for Attaining GTP Goals

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Abstract

This study attempts to look at the quality and relevance of Public Universities and its implications for attaining GTP goals. As well known, trained labor force is a necessary condition for socio-economic growth and competitiveness of a nation. Cognizant of this fact, the Ethiopian government has ratified and implemented several legal and policy frameworks (see the 1994 Education and Training Policy (ETP), 2003 & 2009 higher education proclamations, the 2008 Strategy and Conversion Plan, ESDPs I-IV). As a result, the higher education system has expanded and diversified in order to meet the highly trained labor force need of the country. At present, there are about 31 public universities in the country, which account for 83% of the total higher education enrollment. Following the recent five year (2011-2015) Growth and Transformation Plan (GTP), the higher education landscape of the country has been further focused in favour of science and technology programs. As the overall government's planning framework, the goal of GTP for higher education is to attain an undergraduate enrolment from 185, 788 in 2010 to 467,445 in 2015 while improving quality. The paper is based on two arguments. Firstly, I argue that quality of education is threatened in the public universities by many interrelated problems, particularly in the areas of science and technology. The second concerns the argument that enrolment expansion by itself is not sufficient to address the educated labour force needs of the economy as indicated in GTP, unless quality and relevance are reinforced in the higher education system. These and related issues were examined in this paper using an exploratory research method. Data were collected from two public universities by employing interview and documentary analyses. The findings indicated that the sampled public universities are yet to respond to the manpower requirements of GTP in terms of relevance and quality. The findings suggest that attention need to be paid for aligning universities' programs and GTP manpower requirement within the remaining lifespan of GTP. This can be done through enforcing quality and relevance regulations and resources. Finally, implications for policy options regarding the current expansion and the level of quality and relevance are discussed.

Keywords: Quality, Relevance, public University, Growth and Transformation Plan (GTP)

1. Background

It has long been recognized that human resource development is a key factor for economic growth and competitiveness of a country. Central to human resource development is empowerment of people with knowledge and skills. Education in general and higher education in particular plays crucial role in this regard. With this perspective, many countries across the globe have been connecting their higher education system more closely to their economic development and poverty alleviation strategies. This has led to rapid expansion and diversification of higher education across many countries.

In the Ethiopia context, the need to accelerate economic growth and alleviate poverty through rapid expansion of higher education is evident over the past years. In the first and second phases of the country's economic development strategies, the role of education in human resource capacity building is identified as one of the key pillars in the economic transformation process of the country. To that effect, the government has been allocating 5.5 to 6% of the GDP to education since 2006 (UNESCO, 2010). The share of higher education budget from the total education expenditure rose from 10.21% in 1999/00 to 24.5% in 2010/11 (MoE, 2010/11). In correlation, the country has registered significant changes in terms of improving access to higher education over the last decade.

The number of public universities increased from two in 1991/92 to 31 in 2011/12 at national level (MoE, 2010/11). The total degree enrollment in both public universities and private higher education institutions (regular, evening and summer programs) increased from 23,320 in 1998/99 to about 447,693 in 2010/11 with an annual average growth rate of 21.8% (MoE, 2010/11). The share of female participation is about 27.0%; still a very low picture. Similarly, the total number of students enrolled in postgraduate programs increased from 864 in 1998/99 to 20,150 in 2010/11 with annual average growth rate of 30.0%, of which 13.8% are females. This shows a remarkable enrolment and institutional expansion of the Ethiopian higher education system; it has quadrupled within a decade with expectations for continuity over the coming years.

However, despite the significant increase in the overall enrolment, the current gross higher education participation rate of the country (5.3%) remains very low when compared to other

average of Sub-Saharan countries (6%) and to the demographic characteristics of the country. In Trow's (1973) words, the Ethiopian higher education is still elite (less than 15% enrollment), though it is being populated. Also, many issues of concern about quality and relevance of the higher education system are on the rise vis-à-vis the rapid institutional and enrolment expansion.

Recently, the country has introduced and started implementation of its third phase development plan (2010/11-2014/15): the Growth and Transformation Plan (GTP) with the ambition to sustain the two digit economic growth of the country in the coming five years. The main thrust of GTP is to contribute to the achievement of Ethiopia's vision of being a middle-income country by 2020-2023. The overall objective of GTP is to sustain broad based, fast, and equitable economic growth (maintaining a GDP growth rate of 11%) so as to eradicate poverty in due course (MoFED, 2010, p.29).

During the GTP implementation period, agriculture is expected to grow annually on average by 8.6 % while industry and services are expected to show average annual growth of 20% and 10.6%, respectively (*ibid*.). This obviously requires a trained labor force in quantity and quality. With respect to this, enhancing expansion while maintaining relevance and quality of education is identified as one of the strategic pillars for attaining the strategic objective of GTP.

Concerning higher education, total undergraduate enrolment rate in government institutions is expected to grow from 185,788 in 2009/10 to 467,445 in 2014/15 in favor of programs in science and technology. Similarly total enrolment in TVET is expected to increase from 717603 in 2009/10 to 1,127,330 in 2014/15. Ensuring relevance and quality of the higher education system is also identified as a key priority in the education pillar of GTP. This involves strengthening regulatory systems (HERQA and HESC), assuring the relevance and quality of education provided in higher education institutions, and improving management and administration of universities. These suggest that the Ethiopian government seems to have recognized the role of higher education in boosting knowledge based economic development of the country. But to make significant contribution to economic growth and development, higher education should be of high quality and relevant that meets the skill-demand of the economy. Thus, the purpose of this paper is to examine the issues on attaining GTP goals in terms of quality and relevance of education provided by public universities. Two basic questions are addressed in this paper. First, is the issue of relevance and quality of education addressed in the current enrolment expansion in

science and technology? How and to what extent do the public universities address the GTP goals in their training programs?

2. Conceptual Framework

The focus of this paper is on issues of quality and relevance of public higher education in attaining GTP goals. Accordingly, the conceptual framework used in this paper begins with an overview of key concepts such as quality and relevance. Next, the environment of public higher education institutions is briefly discussed.

2.1. Quality and Relevance

Quality and relevance are interrelated concepts that are subject to many interpretations. In higher education, there are many conceptions of quality. Quality is an elusive, multi-dimensional, multi-level, slippery and dynamic concept that is heavily grounded in contextual settings of an educational model and mission of institutions. To the relativists, quality like beauty lies in the eye of the beholder. It means different things to different people.

Sustaining the stakeholders' view, Harvey and Green (1993) identified five discrete but interrelated approaches to defining quality. Quality as exceptional refers to the crystal touchstone that epitomizes excellence, high level performance, passing a minimum set of standards unattainable by most. In this view, quality is achieved if the standards are surpassed. Quality as fitness for purpose focuses conformity with institutional missions as well as capacity to fulfilling the industry's or customer's requirements is the principal perspective underlying this. Quality as perfection focuses on consistent or flawless outcome. It focuses on the specifications of processes. This dimension of quality is not always applicable to higher education. Quality as value for money refers to the desired outcome of the institutions in term of business and profits. This view embodies efficiency, effectiveness and accountability. This way of thinking seems to be of interest to those who fund higher education including government, administrators, parents and students. Quality as transformation refers to the classic notion that views quality in terms of change of the learner from one state to another. In educational terms, transformation refers to the enhancement and empowerment of students or the development of new knowledge through the learning process. This notion of quality presupposes a fundamental purpose of higher education in terms of transforming the life experiences of students. Quality as transformation is a meta-quality concept. The other concepts are possible operationalizations of the transformative process

rather than ends in themselves. For the purpose of this study, I argue that any definition of quality should consider student learning (the knowledge and skills attained by students) and experience at the forefront.

Relevance of higher education indicates the multiple relationships between higher education institutions and their environment. It concerns the role and place of higher education in society, but it also covers access and participation, teaching and learning, the research function of the universities, the responsibility of higher education to other sectors of society, the world of work and the community service function of higher education (UNESCO, 2001).

Relevance is perceived in terms of the degree of alignment between the aims of higher education institutions and social expectations. This includes relevance in training as well as relevance in job placement. Relevance and quality are interrelated concepts. Efforts to improve quality of higher education should consider evaluation of its relevance. Relevance of education cannot be attained with low quality education.

2.2. The environment of Public higher education institutions

Higher education institutions do not operate in a vacuum. The social, economic, political/ legal and cultural forces within their environment influence quality and relevance of education. Hence, in this paper, higher education institutions are viewed as open system organizations that receive certain inputs from the environment, transform them, and discharge the outputs to the external environment in the form of graduates and services. Among the organizational theories, the institutional perspective is employed to conceptualize the environment of the private higher education institutions.

According to institutional theory the environment of public higher education institutions comprises the legal framework, regulators, suppliers, competitors, and socio-cultural elements. These elements have their own effect on the health operation of public higher education institutions. Each of these factors is described as follows:

Legal Framework: this refers to the legislative and regulative aspects through which governments influence the operation of an organization. It includes the government laws, acts, set of rules and regulations, and reform policies that govern and influence the functioning of an organization. The

higher education proclamation and the Growth and Transformation Plan may be included under this category.

Regulators: This refers to regulatory agencies that possess some pubic authority to regulate and ensure compliance with laws, regulations, and established rules. This involves evaluation and application of sanctions for non-compliance with rules. Quality assurance agencies and professional associations in higher education can be cited for instance. Regulatory agencies can be dependent on or independent from government or politics.

Suppliers: these are the organizations that provide the university with the input resources that it needs to produce output and services (Jones and George, 2003). The students, staff, financial and physical resources are the main inputs of a university. In this perspective, the preparation and quality of incoming students matters a lot for the university's quality assurance practices.

Competitors: these are organizations engaged in similar activities and produce outputs and services that are similar to particular organization's products. Strong competitive rivalry results in student and resource competitions, and ensuring efficiency.

Socio-cultural factors: These are related to the social behavior of human beings and their environment. This dimension may include values and attitudes toward knowledge, ability, hard work, achievement, quality learning and material gain; values and perceptions of power and cooperation, and beliefs about student learning, professions and occupations.

In this paper, the legal framework, regulators, suppliers and GTP are considered as components of the conceptual model. The schematic diagram of the model is portrayed as follows.

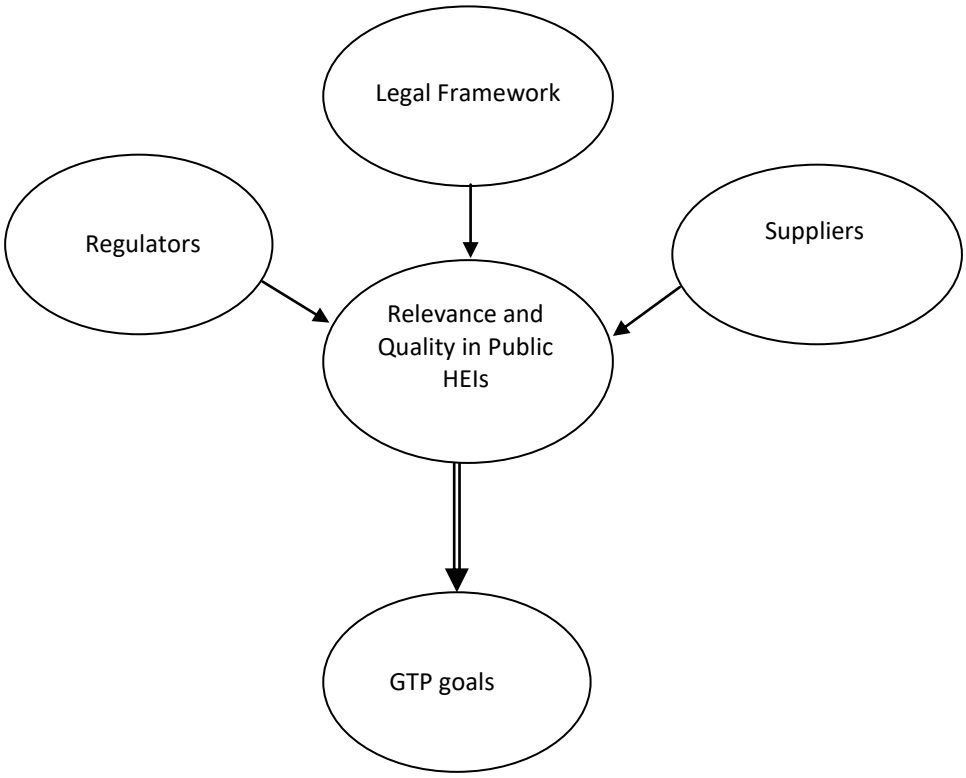

Figure: **Conceptual Model**

The single arrows indicate the direction of the influence among the variables while the double arrow indicates implications to attaining GTP goals.

3. Methodology of the Study

This study employs an exploratory research method. Data were collected from two public universities (Addis Ababa Institute of Technology and Addis Ababa Science and Technology University) using documentary analyses and interview. It depends mainly on secondary sources of data. The higher education proclamation, circulars from the Ministry of Education, National Student Learning Assessment reports published NoE, and Statistical Abstracts of the Ethiopian education. Also, interviews with vice president of Addis Ababa Science and Technology University and scientific director, instructors and students of Addis Ababa Institute of Technology were conducted. Unstructured interview were employed to collect the primary data. During analyses, an attempt was made to validate the data collected from different sources.

4. Major Findings

Major results of data analyses concerning relevance and quality of public universities and the determinant environmental factors are discussed in this section. Also, the implications of the findings to the attainment of GTP goals are drawn.

4.1. Relevance and Quality of education

With regard to relevance, the Ministry of Education has been implementing a strategy and conversion plan (2009-2013) since 2008 to achieve the 70:30 professional and program mix in favour of science technology across all public universities. In 2010/11, as the annual statistical abstract of the Ministry of Education indicated, about 63% of the students are enrolled in science and technology programs across all public universities (MoE, 2010/11). A similar pattern was observed in the two sample universities. The Addis Ababa University has about 13, 000 students attending training programs in the areas of engineering and technology in two of its campuses. In the case of Addis Ababa Science and Technology University, a total of 1825 are attending their education in 10 schools and 22 departments related to engineering and technology. The interviewees in both universities reported that the training programs are in line with the requirements of GTP. There is, however, no documented evidence that shows the universities' strategic planning based on the specific manpower demands of GTP. There is also no evidence concerning manpower planning vis-a-vis GTP goals at national level.

This shows that all public universities are allowed to open and run programs in the areas of science and technology regardless of their capacity, availability of resources and infrastructure required for quality of education. This suggests that the limited government resources are dispersed across universities to accommodate the increasing student population in those areas. This obviously affects the quality of education and establishment of centres of excellence in science and technology in the country. The interviewees from the two case universities expressed their concern about quality of education in the rapidly increasing student enrolment. As the interviewee from the Addis Ababa Institute of Technology indicated, there is mismatch between student intake and existing infrastructure, teaching staff, laboratories, equipments and laboratories and this obviously affects quality of student learning. The interviewees further noted

that there is lack of process technology with the Ethiopian brand to undertake practical research, because the Ethiopian industries depend mainly on raw material.

The Addis Ababa Science and Technology University has no laboratory establishment. Its students undertake laboratory works at the Addis Ababa Institute of Technology laboratories. This shows that the universities have no adequate infrastructure and laboratories to run their practicum programs.

Further analysis of data on qualification and experience of teaching staff was conducted. The results show that the staff qualification mix of the Addis Ababa Institute of Technology at Addis Ababa University comprises 10% Diploma, 34 % Bachelor, 44% Masters, and 12% PhD. This staff qualification mix is below the standard set by the Ministry of Education. In the case of Addis Ababa Science and Technology University the staff qualification mix comprises 16% Bachelor, 77% Masters, and 7% PhD. Such staff qualification mix is not in line with the requirements of the Ministry of Education, though it is relatively comprises more staff with Masters Degree. This has implications to the quality of education provided in the universities.

Student interviewees from the Addis Ababa Institute of Technology witnessed that many of their instructors are new graduates and have no adequate teaching experience to properly conduct their courses. The problem related to shortage of qualified and experienced staff is shared by staff interviewees from the same university. Majority of the staff interviewees in this university noted that they are overloaded in their teaching assignment due to the increasing student population. They could not properly follow up their students in terms of the frequency of assignments' and laboratory works. Students are required to practice in laboratories in a group of 12 or more students.

The findings discussed above indicated that relevance and quality of education in the area of science and technology is threatened by a multitude of problems including lack of adequate manpower planning related to GTP goals. There is no evidence concerning the incorporation of the detailed manpower requirement of GTP in the universities strategic plans. Findings

concerning the influence of the higher education environment on quality and relevance are presented in the section that follows.

4.2. Influence of the higher education environment

This section presents the findings concerning the extent to which the quality and relevance of PHEIs is influenced by external environmental factors.

4.2. 1. Legal framework

The 2003 higher education proclamation (no.351/2003), which was modified in 2009 (no. 650/2009), sets all the requirements, principles and laws for the establishment and functioning of a higher education institution in the country. It demands the establishment of a national quality assurance system as well as internal quality assurance mechanisms at institution level.

Analyses of documentary evidences (news letters, government circulars and research reports) suggest that the problem is not inherent to the proclamation itself; rather lack of commitment and capacity on the part of all actors to properly translate the laws into action is the major challenge. This is attributed to the absence of robust and dynamic regulatory bodies, which will be further explored in the section that follows.

4. 2. 2. Regulators

HERQA and HESC are the two regulatory bodies established by the higher education proclamation to oversee and ensure the quality and relevance of the higher education system of the country. HERQA is entrusted to ensure quality, whereas HESC is responsible for maintaining the relevance of the higher education programs and curriculum.

HERQA is entitled by the proclamation to undertake institutional quality audit, and accredited PHEIs and assess the public universities' internal quality assurance systems (HERQA, 2006). The objective of HESC is to formulate strategies and advise the government in order to make higher education compatible with the country's human resource needs and relevant policies with due consideration to global development.

Despite the requirements of the higher education proclamation, the two sample universities have not established a functioning internal quality enhancement system until recently. There is also no established manpower planning that addresses the requirements of GTP. This is attributed to the absence of a strong and well functioning regulatory body that enforces the proclamation.

These results show that the major challenge is inability to properly implement existing laws and regulations due to the absence of strong and vibrant government regulatory body such as HERQA and HESC.

4. 2.3. Suppliers

The quality of university education is determined to a considerable extent by the abilities of those it admits and retains as students. There is a wide spread agreement that success in university education is strongly related to pre-university academic preparation and achievement of students (Kuh, 2007). The national learning assessment conducted at the end of Grades 8, 10 and 12 indicates that average results were scored markedly below the 50% average set in the ETP document at the three educational levels. These low results in the national learning assessments would indicate that students at the three educational levels have low academic preparation and the majority of those students transferring from one educational level to the next tier are without adequate grounding in terms of requisite academic achievement levels. This obviously affects the quality of education at the private higher education institutions.

With regard to intake, the universities enroll many students that are assigned by the Ministry regardless of their strategic plan and existing infrastructure and facilities. This obviously is a challenge for the public universities to properly train and produce quality graduates. The interviewees from the three universities noted that they have no autonomy to select and admit students to their programs as per their strategic plan and availability of facilities and infrastructure. The Ministry decides on the admission of student to their programs. The interviewees from the Addis Ababa Institute of Technology further argued that the number of incoming students is beyond the capacity of existing facilities, and what they are doing is to control quality upon exist, i.e. to tighten the process through rigorous exams.

4.3. Implications to attaining GTP goals

The main objective of GTP is to contribute to the achievement of Ethiopia's vision of being a middle-income country by 2020-2023. In this regard the main pillars of GTP development plan include: agriculture and rural development, industry, trade, mining, infrastructure development (road, rail way, energy, telecommunication, urban and construction development, transportation services, water supply and irrigation), social development (health and education), Capacity building and good governance (information and communication development). Enhancing expansion and maintaining quality and relevance of education is a major pillar of GTP. Concerning higher education, the plan is to achieve an undergraduate enrolment rate from 185, 788 in 2009/10 to 467,445 in 2014/15. Similarly, the TVET enrolment is expected to increase from 717,603 in 2009/10 to 1,127,330 in 2014/15. Ensuring relevance and quality of higher education system, and sstrengthening regulatory bodies and HE management are also identified as key priorities in GTP. Such an expansion plan can be considered important to the development plan of the country only when relevance and quality is taken care of.

Looking at current situation, the market niche in the growing economy is in the areas of small scale enterprises. The government has also been promoting and supporting as a means of creating job opportunities for graduates of TVET and universities. These job opportunities require marketable and transferable competencies and skills that lead to self employment. This has an implication to the mode of training and the nature of qualification required. Such jobs may not necessarily require higher qualifications, if students are made to have marketable and entrepreneurial skills, which in turn requires investing in some tailored made, intermediate skill and work related training programs. This requires robust manpower planning at central level to align training programs to the training labour force demand of GTP and maintain quality of graduates.

5. Conclusion and Implications

The findings in this study indicated that quality and relevance of education is threatened in the public universities by a multitude of constraints. The universities are not yet to respond to the demands of GTP in terms of quality and relevance. There is no adequate manpower planning that

enable to align training programs to the labor force demands of the economy as indicated in GTP. The findings also indicated that there is no robust and capable regulatory body to enforce laws and enhance relevance and quality in higher education institutions. The major challenge is not inherent to the higher education proclamation; rather the problem is lack of proper translation of the laws and policies into action. Many of the public universities are running programs in the areas of science and technology without having adequate and professionally trained staff, infrastructure and facilities.

Under such circumstances it is very difficult to realize the goals of GTP in terms of producing capable graduates that fit to the manpower demands of the economic development. This suggests the need to consider other policy options to accommodate the increasing student population and achieve the expansion goal of GTP.

Based on the above findings and arguments, it is suggested that: (1) there needs to be a strong manpower planning at national levels that guides the training programs of universities in line with requirements of GTP. (2) the government of Ethiopia will have to revisit the expansion of programs across all universities. This is to say that rather than awarding university degrees at all universities in the same programs, it will be advantageous to seek for options where each university excel or specialize in some programs. This can be done by introducing professional colleges and creating center of excellence in science and technology in some of the universities and gradually replicating good practices and model achievements. Creating center of excellence or specialized colleges enables to use scarce resources and manpower more efficiently in paying areas to meet highly qualified human resource need of the country. (3) diversification of post secondary education is still timely in the Ethiopian context where the market niche is in areas of small scale enterprises. This is more manifested in the booming employment opportunities in said area. Thus, TVET (including polytechnics) will have to be strengthened to respond to these market opportunities. This can be implemented by injecting dynamism to the current TVET and introducing lower qualification. (4) strengthen and enforcing legal and policy framework to enhance relevance and quality of higher education.

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Challenges and Opportunities on Industry- University Cooperation: In the Case of Ethiopian Textile and Leather Industries

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Abstract

Within the manufacturing sector the Textile and Leather sub-sectors play a significant role in the development of the country's economy by contributing a large rate of employment opportunity, income generation, earning of foreign currency and poverty reduction. The silent feature of Ethiopian industries and higher institutions where leaving in their isolate island and untrustful each other for a long period of time .But currently government took initiation and commitment in order to create conducive environment in this industry era.

The main objective of this study is to solve industries problem, to create access to applied research activities which new products and processes evolve for improving quality and maximize product , to help industries to improve their productivity and efficiency to be competent in the world market and to enhance problem solving research conducting capabilities of university community, to make universities to give training for professionals in industry and to improve competitiveness by combining skills and resources through collaborative arrangement.

The methodology adopted in this study is based on collection of relevant data through questioner and discussion with representative sample size of 8 Ethiopian textile and leather industries and 4 Ethiopian higher education institutions. Accordingly from the outcome of the framework the main opportunities are:

- Government initiations in formulating conducive police, financial support, infrastructure development, bilateral and multilateral agreement.
- Commitment of industries to work together with government and universities and allocation of resources for research activity and
- Enhancing of universities and research centers their capability to undertake problem solving research.

On the other hand the major challenges are;

- Unwillingness of private sectors to participate in the linkage due to its long term return on investment.
- Lack of experience in adopting problem solving research work.
- Information gap among industries, universities and research institutions and
- Miss understanding of the concept of the linkage.

This study highly recommends that all parties should play their role to have effective collaboration through providing of efficient and effective policies, the industries should able to committed and invest in long term R & D, and actively participate in collaboration activities, the universities are also expected to strengthen their capability to conduct problem solving research work and reform their structure.

Key words:-Cooperation, Opportunities, Challenges, Problem solving research.

Acronyms

AFLAS	The Africa Federation of the Leather and Allied Product Association
AGOA	Africa Growth and Opportunity Act
CEL	Central Electronics Limited
COMESA	Common Market of Eastern and Southern Africa
CSIR	Council of Scientific and Industrial Research
DSIR	Development of Scientific and Industrial Research
EBA	Everything But Arms
EMIA	Ethiopian Manufacturing Industry Association
ESALIA	The Eastern and South Africa Leather Industries Association
GDP	Growth Domestic Product
GSP	Generalized System of Preference
IPRs	Intellectual Property Rights
IUL	Industry University Linkage
LDCs	Least Developed Countries
LIDI	Leather Industry Development Institute
MoI	Ministry of Industry
NRDC	National Research Development Corporation

PREO	Public Research and Educational Organizations
R & D	Research and Development
SDPRP	Sustainable Development and Poverty Reduction Program
TIDI	Textile Industry Development Institute

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1. Introduction

1.1. Introduction

The Textile and Leather sub-sectors play a significant role in the development of the country's economy by contributing a large rate of employment opportunity, income generation, earning of foreign currency and poverty reduction.

Currently in textile sub sector, there are more than 16 textile mills and 25 garment industries which are working actively. The industry is one of the largest labor intensive sectors in Ethiopia, which create more than 35,000 direct employees in textile & garment manufacturing, excluding the 500,000 engaged in the informal hand-loom weaving sector. The sector is composed of two major components. On the one hand it comprises the upstream segment called the textile mills (spinning, weaving, knitting, and wet processing) and on the other the downstream activities known as the apparel segment which includes garments made out of woven and knitted fabrics.

The sector comprises a large number of state owned enterprises and a growing number of private sector participants at all levels. The sector largely concentrates on cotton related products as this is a raw material that is available locally.

The Ministry of Industry (MOI) is eying on the textile sector as it wants to uplift this industry for generating foreign currency. The authorities aim to have yearly revenue of approximately US $1billion by 2015e.c.

On the other hand there are 43 leather and leather product factories which include 22 tanneries, 15 leather footwear firms and six leather and leather products. According to the leather

Association, the job opportunities created by the leather industry as a whole is estimated to be 17,000. The sector classified into three main sub sectors. These are the foot wear, the leather tanning and leather garment and goods sector.

The national plan, growth and transformation plan puts the leather industry as one of the priority sector and expects export of USD 500million at the end of the plan year in 2015e.c.

Studies shows that the linkage & collaborations of Ethiopian industries , higher education and research institutions are not strongly developed based on mutual interest of each parties, rather they have been leaving in their island for long time with full of fictitious to each other due to various reason, which are less interest of industries to invest on research and development activities, concentrating on short term return investment businesses, limitation of capital, lack of know how or unwillingness of top management about benefits of working in collaboration with research institutes & higher education are some of major cause of problems of industries ,while concerning higher education's and research institutes; giving of less emphasis to applied research in educational curriculum & strategy ,less experience in conducting applied research, shortage of researchers ,facilities and infrastructures ,shortage of financial support are some of major problem. In addition to this research results stay on shelves instead of being tested and disseminated and research institutions and Universities effort fails to improve problems. Now a day's government has undertaken various activates in form of policy formulation & development of necessary infrastructure to resolve the problem through establishing strong linkage among stake holders.

1.2. Objectives of the Study

1.2.1. General Objectives

The ultimate objective of this study is to identify the major challenges to offer the alternate remedies, to appreciate existing and expected opportunities about industry university collaboration work.

1.2.2. Specific Objectives

- To enhance partnership between industries and higher institutions.
- To enhance the practice of conducting problem solving research work among universities and research institutions.
- To avoid wastage of research results.

- To make industries to give great emphasis for research and development activities.
- To help higher institutions to give great emphasis on applied research through rearranging their educational curriculum.

1.3. Scope and Limitation

1.3.1. Scope

For the reason of strengthen collaboration between universities and industries a survey study has been carried out on 8 Ethiopian leather and textile industries and 4 Ethiopian higher education institutions.

1.3.2. Limitation

During conducting of this study there were various drawbacks: some of these are;

- Difficulties to get relevant information from concerned university & industries.
- Shortage of valuable resources and.
- Difficulty to obtain key information on certain issue from some inland source and website which used to compare and contrast of the analysis work.

1.4. Methodology

The methodology adopted in this study is based on collection of relevant data through questioner and discussion with representative sample size of 8 Ethiopian textile and leather industries and 4 Ethiopian higher education institutions.

2. Related Literature Review

2.1. Overview of Ethiopian Leather and Textile Industry

The textile and garment industry in Ethiopia dates back to 1939 in relation with Italian colonialism era, when the first industrial textile factory was established in Dire Dawa in the name of Dire Dawa textile mill. The first garment factory was Agusta garment but currently called Addis Garment, was established in the 1960s. Textile and garment sector is the third largest manufacturing industry, only latter than the food processing and beverage industry, and leather industry. The contribution of textile sub-sector to national GDP is 1.35% and to the output value of the manufacturing industry is 8.31%.[5]

The sector is composed of two major components. On the one hand it comprises the upstream segment called the textile mills (spinning, weaving, knitting, and wet processing) and on the other the downstream activities known as the apparel segment which includes garments made out of woven and knitted fabrics.[5]

The textile industry is a term used for industries primarily concerned with the design or manufacture of clothing as well as the distribution and use of textile. And it is the largest manufacturing industry in Ethiopia.[5]

The Ethiopian leather industry has been operating since the very inception of Asco Tannery, (now called Addis Ababa Tannery S/C) in 1928 followed by Asco Shoe factory also now renamed Tikure Abay Shoe S/C). According to the leather Association, the job opportunities created by the leather industry as a whole is estimated to be 17,000. Leather industry is the second largest source of foreign currency after coffee. The national plan, growth and transformation plan puts the leather industry as one of the priority sector and expects export of USD 500million at the end of the plan year in 2015e.c.

The leather sector classified into three main sub sectors. These are the foot wear, the leather tanning and leather garment and goods sector.

Footwear is the newly emerging industrial activities of Ethiopia among leather based industries. The total output estimated at 4 million pair per annum.

The tanning industry produces and exports all types of crust and finished leather from hides, sheep skins and goat skins. Currently there are 22 tanneries operating in the country. All the tanneries operating in the country are privately owned. Operative tanners have daily total installed capacity around 127,000 pieces of skins and 7200 pieces of hides.[1]

According to the study of International Trade Centre, the leather goods industry encompasses 14 leather product producers having total installed capacity of about 700 pieces of leather garment and goods (300 pieces of leather garment and 400 pieces of leather goods) per day. Generally, the industry exists at small scale level.[1]

Ethiopia pusses one of the world's largest livestock population, eighth for cattle, twelfth for sheep & lambs, & eight for goats. The livestock population of the country estimated 49 million cattle, 25 million sheep & 23 million goats. As result of this, leather has been at the core of the country's economy since many centuries.[6]

In view of indigenous raw material, employment generation & foreign exchange earnings the leather sector has been recognized as priority sector of the country.

A lack of qualified manpower in the textile and leather manufacturing sector has prompted the Government to establish Textile industry development Institute (TIDI) and leather industry development institute (LIDI). The textile and leather sector has vast potential to manufacture goods for export and bring in very much needed foreign exchange. However, the sector is still in its embryonic stage and the current production quality is rather poor, even when compared with other developing countries. The main reasons behind the low performance of the Ethiopian textile and leather industry are lack of specialized and experienced manpower.
There is also a lack of management and entrepreneurial skills, an inability to penetrate new markets and to compete with imported products.

Textile & leather Industry has been recognized as a priority sector by the Government of Ethiopia in view of its economic potentials in terms of utilization of indigenous raw materials.

2.2. Overview of Ethiopian Higher Education Institutions

The first higher education institution in Ethiopia, the University College of Addis Ababa University, was established in 1950.In spite of the country's need to expand the higher education sector, little progress was made in the subsequent 50 years. Until 1995, for example, there were only two public universities and sixteen affiliated and independent junior collages in the country. Recently, following the government's decentralization effort to expand the higher education

institutes in regional states, several more universities were added. The total number of universities where nine in addition to the three higher education institutions that are under different federal government entities and the eight teacher training collages under the regional government (Yizengaw 2007).In 2004, the ministry of education build an additional 13

universities several of which started class in 2007(university capacity building program, 2008) and 10 newly added universities. There are also 59 privately owned higher education institutions in the country.

The main aim of higher education institutions is to mature citizens and carryout research and consultancy activities to make significant impacts in the country's development in various sectors of the economy. To this effect the higher education institutions have been imparting fundamental education to students and carrying out research activities in their faculties and institutions.

If the available technology and the available skills are incompatible, either the technology needs to be adapted or the skills improved. Training does the latter; for instance, it makes it possible for people to use, repair and maintain machinery so far unknown or unfamiliar to them.

Training can help managers to appraise alternatives and choose more appropriate technologies to use installed capacity more efficiently, to be better supervisors, etc.

At different levels, training may enable workers to contribute to improving product quality, to adaptation of technologies, and to innovation.

Many of the universities with their teaching and research resources available in the faculties, schools and institutes carry out teaching and research activities. Nearly all faculties in Addis Ababa University have started post-graduate studies to satisfy the manpower requirement of the country, especially for the newly emerging regional universities.

However, in most of the faculties and research institutes, problems of research staff development, financial constraints, adequate selection of relevant research areas and proper research facilities including infrastructure, equipment and supplies are evident. As a result, the

research activities carried out are not to the universities satisfaction both in quantity as well as quality. The over crowdedness, impoverishment, dilapidated infrastructure, and poor status of the rewards and morale of the academic staff seem to lead to crisis in university education and research.

It is evident that, while it is essential for R & D institutions to establish a close relationship with the productive sector, effective linkages are often lacking. Research results, for example in the form of designs for more appropriate technologies, often stay on shelves instead of being tested and disseminated.[2]

2.3. Role of Government in Formulation of the Cooperation

The intention of the Ethiopian government for the future development of the country have laid down different policy and strategy, some of them are SDPRP ,entitled 'sustainable development and poverty reduction program', 'industrial development policy' they seen as a core policy objective ,whereby economic growth is the principal ,but not the only. The major trust consist of

- ✓ Overriding and intentional fuscous on agriculture
- ✓ Strengthening private sector growth and development especially in industry;
- ✓ Rapid export growth through production of high value added agricultural products and increased support to export oriented manufacturing sectors particularly intensified processing of highly quality skin/leather and textile and garments.

On the whole, it could be conclude that there is explicit attention of the present Ethiopian government for the two sectors; this include the further strengthening of such pivotal institutions as leather industries development institute and textile industries development institutes.

This policy attention is likely to create favorable conditions necessary for substantial expiation of activities in the textile /clothing and leather/footwear sectors.

At the national level there are several some governmental and nongovernmental institutions catering for the interest of private industries sector in general ,in particular ecpb , kaizen unit ,Addis Ababa chamber of commerce, Ethiopian manufacturing industry association (EMIA) the Ethiopia government has also recognized that these and other institutions cater mainly for the interest of industries. Government also formulates industry-university linkage policy which is, University, industries, research and TVET institutions can be demonstrated to be core actors in the national innovation system. The strength as well as effectiveness of the established linkages among these institutions largely depends on their tendency and capability to be involved in activities dealing with technology transfer. As far as technology learning is concerned, the

current situation of our country confirms that universities are not taking the leading role and are lagging behind the industries. Therefore, the linkages that exist among these actors should focus on contributing to capacitating the productivity of manufacturing and service providing enterprises. The shared effort should also focus on identifying appropriate technologies and their sources, understanding the technologies through learning-by-doing and adaptation as well as effective utilization. Thus, joint cooperation and support system among the actors will be established with the aim to support and facilitate the search, selection, importation, adaptation and utilization of effective foreign technologies.[7]

In addition to this government also formulates suitable environment for industry-university collaboration through establishing infrastructure and supporting financially.

2.4. Advantages of Industry University Linkage

Several main reasons, which are claimed to motivate the industry to increase university-industry cooperation, have been provided by Atlan(1990) and Peters and Fusfeld(1982).they are:(1) access to manpower, including well-trained graduates and knowledgeable faculty;
(2) access to basic and applied research results from which new products and processes will evolve; (3) solutions to specific problems or professional expertise, not usually found in an individual firm; (4) access to university facilities, not available in the company; (5) assistance in continuing education and training; (6) obtaining prestige or enhancing the company's image; and (7) being good local citizens or fostering good community relations.

On the other hand, the reasons for universities to seek cooperation with industry appear to be relatively simple. Peteres and Fusfeld(1982) have identified several reasons for this interaction:(1) industry provides a new source of money for university;(2) industrial money involves less "red tape" than government money;(3) industrially sponsored research provides university researchers a chance to work on an intellectually challenging research programs;(5)

some government funds are available for applied research, based upon a joint effort between university and industry.[3]

Effective collaboration between industries and universities /research centers in developed economies lies at the core of accelerates growth and competitiveness in industrial economies (World Bank, 2003.20; 2009.3).

Studies in Europe and the US tend to show that for firms, collaboration with national public research and educational organizations (PREO) may reduce the uncertainties inherent in the innovation process, expand markets, enable access to new or complementary resources and skills, create new technological learning opportunities, and allow companies to keep abreast of the evolution of scientific knowledge and technology (Hagedoorn et al, 2000; Lee, 2000; Fritsh and Lukas, 2001).therefore, collaboration with PREO is an alternative strategy allowing firms to deepen their innovative capabilities and strengthen their international competitiveness. This is particularly important in a context where science-based technologies, such as biotechnology, nanotechnology, information and communication technology and renewable energy are being developed and becoming pervasive, and where technological interdisciplinary and complexity, and the competitive pressures to shorten product life are increasing (Koumpis and Pavitt, 1999; Hagedoorn, 1996; Caloghirou et al, 2003).

Firms may collaborate with a university to access new knowledge developments and obtain scientific support for new product development (Powell et al., 1996; Lee, 2000).it would be expected that such collaborations would be based on new informal contacts where employees and students play important roles(Lam,2005).

Spin-offs are another form of participation of universities with firms in the development of emergent technologies (Koumpis and Pavitt, 1999).university-industry collaboration is likely to focus on the use of disembodied Knowledge and involve research students (Powell et al., 1996; Lam, 2005) and its outcomes will be in the form of new instruments, technical devices and eventually patents and publications (Koumpis and Pavitt, 1999; Mangematin and Nesta, 2001).[4]

2.5. Trend and Experience of Selected Country

The areas of focus for development and expansion of industry university collaboration in some asian countries were; defining the legal status of universities and their professors, relaxing or removing regulations that prevented faculty members from working with companies, developing

policies on intellectual property rights, establishing technology transfer offices, creating funding schemes, and ensuring adequate financial resources for research and development activities at universities, the policy framework of some Asian countries proposed to serve three purposes: first, to state publicly the intention of the government with respect to the direction universities and industry should take; second, to lay down legal rules for the conduct of universities and industry,; and third, to secure financial resources and incentives to facilitate collaboration.

Know a day's in some Asian countries, both developed and developing, that universities and public laboratories should make greater contributions to countries' overall economic growth and competitiveness. While universities, industries, and publicly-funded research institutions should be allowed to develop working relations with each other through their own initiative, governments also have a responsibility to establish laws and practices that would give proper incentives towards collaborative research activities.

In some countries, governments are taking pro-active measures to boost U-I collaboration, to allowing universities and industries to determine their own courses of action, Through providing only basic guidelines, leaving all technicalities to ministry directives, circulars, and notices. In addition to the legal framework, some countries draw up basic plans and goals for U-I collaboration with a view to setting forth future directions and accelerating the trend.

CHINA

The People's Republic of China (1994) stipulates that the legal person of an enterprise, institution or citizen is authorized to establish a corporation according to the law. Because universities are institutional legal persons under this law, it is possible for the university to make investments and establish a corporation with its own capital. In addition, the law stipulates that technology patented or not, can be regarded as capital. This set of stipulations paves the way for

universities to act independently and commercialize their technologies through enterprise incubation, or by holding equity stakes in private companies.

In the year 2000, there were 5,451 university-run companies. While most of them were not research-based, the science-related companies accounted for 2.3% of the total sales in the high-tech sector in the rapidly growing Chinese economy. This is a very high number compared with

other Asian countries. Such university-conducted business activities are concentrated heavily in the top five provinces. In the late 1990s, China took a series of more specific actions to push ahead with U-I collaboration. The Central Committee of the Communist Party decided in 1999 that bilateral and multilateral mechanisms for collaboration should be created in the form of mutual part-time jobs and training. Quite a high number of regulations were adopted by both the central and provincial governments in the years 1997, 1998, and 1999 in order to boost technical innovation and U-I partnerships. Among them there are two laws setting out the supplementary details of the rights and obligations of, as well as the contracts for, the parties involved in technology development, transfer and commercialization. The measures put forth in Several Opinions on Bringing into Full Play the Scientific and Technological Innovation Role of the University by the Ministry of Education (2002) are directly oriented toward U-I partnerships. This government decision states as objectives: "To promote universities to form technology transfer offices; to encourage universities to disseminate the use of technologies developed
In various forms such as through patent licensing, technology transfer…"

As a result of this decision, Chinese universities are able to make regulations aimed at encouraging inventions and technology transfer. Faculty members and students are encouraged and supported in their efforts to build or take part in venture businesses as part-time work.

Setting up the legal framework for universities is important in promoting U-I collaboration. What is of equal importance, however, is that Asian governments express their political will to bring about more active exploitation of knowledge developed by universities. In Japan, the Republic of Korea and India, such political will has been incorporated into "basic plans" of some kind, which lay down long-term priorities and funding policies. While the processes established in these plans are not identical, it is important to note that U-I relations have been given renewed emphasis in all of the countries.

3. Major Findings of the Study

3.1. Challenges for Industry-University Collaboration

3.1.1. Industries Challenge

A. Financial Constrain

Financial resource constrain is the major challenge in formulation of effective industry university linkage. This study shows that about 23 % of the major challenge for Ethiopian textile and leather industries is directly related with financial resource problem. Which are industries does not allocate budget for conducting a research activities which enables them to alleviate their problem and provide sustainable solution. This results the partnership between industries, researchers research institutions become weak in a long period of time.

B. Shortage of Technical Staff

Well qualified and experienced technical staffs are the back bone of sustainable development of the sector for handling and implementation of new scientific research and technological out puts, but according to this finding the sector faces major constraints which account 30% out of the major challenges in the collaboration. Shortage of the required quantity and quality of technical staff which affects sustainable development of the sector and foster collaboration activities are the main problems of the sector. Even most of the available technical staffs are not committed to receive and adapt new working process.

C. Shortage of Infrastructure

Presence of well equipped organizational structure with standardized infrastructure such as laboratory equipments, training centers, & R & D centers are major determinates of rapid development of industries. But according to this study and analysis of industries response the major constrain which account 15% out of major challenges for effective industry-university collaboration, is shortage of standardized laboratory equipments, training centers and R & D centers among industries.

D. Lack of Awareness

Continuous communication and awareness creation about importance and mutual benefits of industry-university linkage, through participating in seminars and workshops are crucial elements for effective accomplishment of industry-university linkage. But based on this finding

10% of the major challenges of the textile and leather sector evolved from lack of awernance, negelectance and lack of commitment of the administrative staff and decision makers of industries about benefits of collaboration.

E. Other Challenges

Besides to the above mentioned major challenges of the sector other tremendous constrains such as nature of investment, raw material & sub-assembly cost and currency rate affects the collaboration activity either directly or indirectly and accounts 12%out of the major challenges. For example unlike processing of goods and services to get immediate revenue from investment; conducting research and investing in IU linkage for product development and rehablasion are risky and long time return on investment. As result industries are not committed to invest on research and IU linkage. Similarly inflation of raw material & sub-assembly cost and currency rate affects financial capacity of the sector.

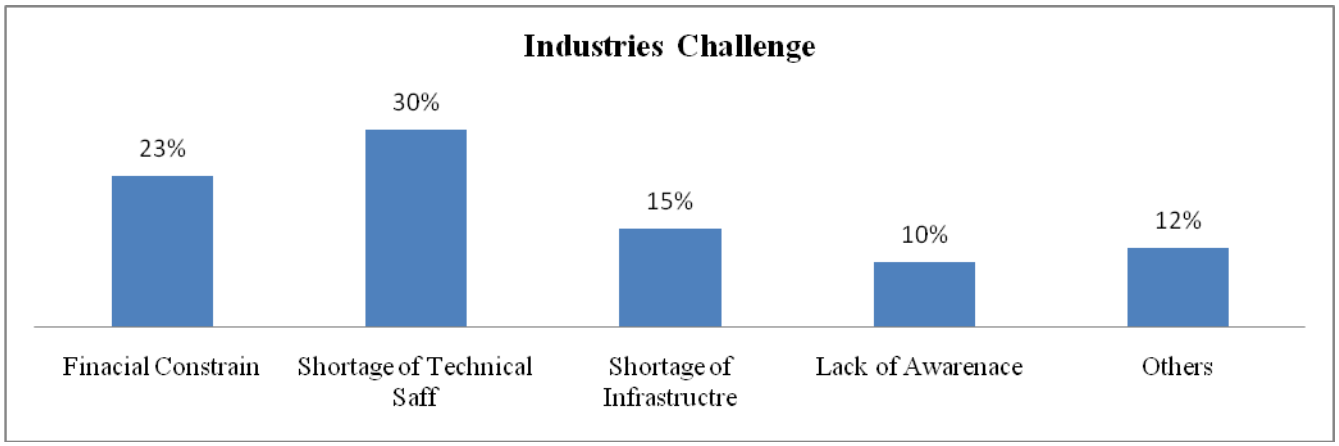

Fig. 1. Industries Challenge

3.1.2. Universities Challenge

A. Shortage of Researchers

Human capital variables measured by education level, training, educational, expenditure, literacy rate and so forth, for innovation and technological competitiveness of the organization.

According to this study the major challenges of universities which tackle them not to conduct problem solving research which directly focused on existing problem of industries is shortage of well qualified and experienced staffs in quantity and quality. These constrain accounts 18% out of the major challenges.

B. financial problem

According to this study the main cause of ineffectiveness of the collaboration work which accounts 20% out of the major challenges of universities is financial resource problem. This occurs due to absence of regular budget and weakness in searching from other sources. It makes difficult to cover some uprising, fixed and miscellaneous expense to establish smooth and effective industry-university collaboration activities.

C. Educational Curriculum Problem

Educational intensity, innovation and research & development experiences are the main pool of human capital which is measured in number and quantity of published basic and applied research, workshops, seminars conducted on research activities per year rather based on our finding 25% of major challenges evolved from problem of curriculum. The former educational policy and strategy in higher educational institutions makes teachers and students to focus only on teaching learning process rather than exposing to research activities. In general the impacts of former educational curriculum make students, teachers and researchers not to actively engage in research activities.

D. Shortage of Infrastructure

World class of equipments, utilities and research facilities, well equipped organized R & D centers, training centers and pilot mills are major elements for effective collaboration activities but according to analysis and response of concerned scholars the major problem which accounts 15% out of other major challenges is constrain of infrastructure .

E. Information Gap

The information gap between the needs of the industrial sector and the resources available at the higher education and research institutions highly affects the partnership among industries and

Universities. This study also shows that 12% out of the major challenges of the Ethiopian Higher education institutions occur from information gap between them. That is universities dose not disseminate their work to industries for practical purpose and they could not communicate with industries about what they are doing.

F. Others Challenges

Besides to the above major challenges of universities, absence of central body who can coordinate the collaboration work, poor practice of incentives to researchers etc are universities challenge and accounts 10% out of the major challenges.

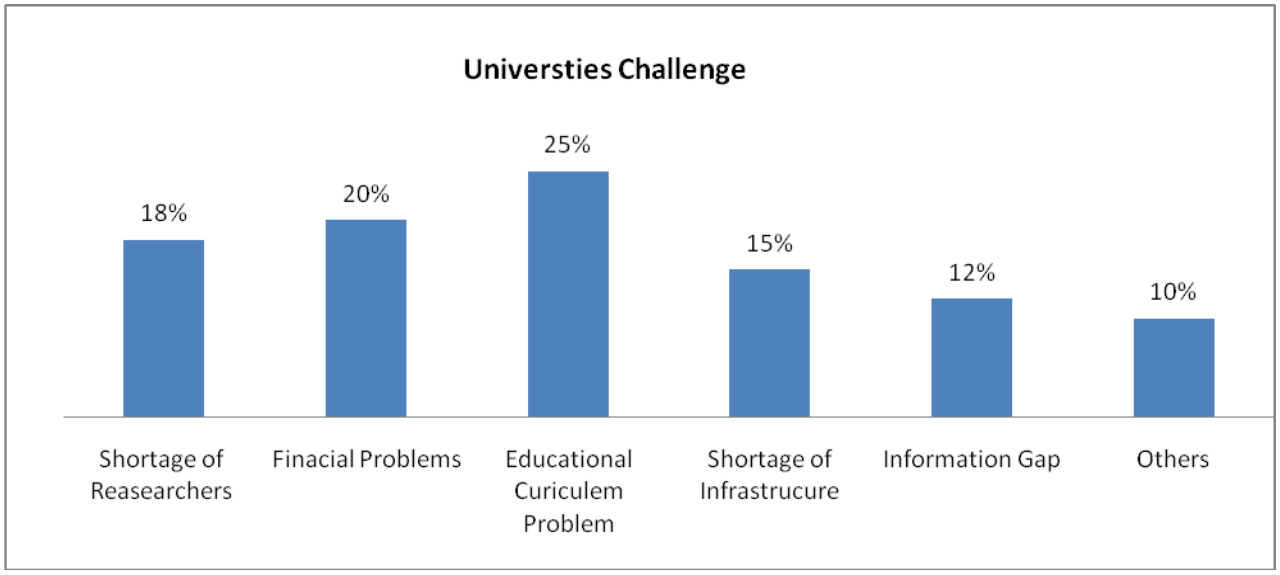

Fig. 2. Universities Challenge

3.2. Opportunities for Industry-University Collaboration

A. Government Policy and Strategy

Know a day's government shows his commitment through giving of priority for sectors to promote the manufacturing sector in Ethiopia. To enhance the sector government create suitable environment through formulating policy and strategy, organizing bilateral and multilateral agreements, providing financial support, and organizing stakeholder's discussion & negotiation and through development of infrastructure. Shifting of government policy from agricultural lead economy to industry lead economy is another opportunity while to facilitate industry-university

linkage. According to this privilege and opportunity Government Policy and Strategy accounts 25% out of the major challenges.

B. Market Preferential

The ultimate objectives of industry university linkage is to help industries to improve their productivity and efficiency to be competent in world market as a result different market

opportunities considers as one of major opportunities and account 15% of other opportunities, this increase the collaboration work. Some of preferential markets are; Africa Growth and Opportunity Act (AGOA), Everything But Arms (EBA) and Common Market of Eastern and Southern Africa (COMESA).

Generally speaking AGOA is a market opportunity provided by US government to sub-Saharan countries to export their products free from tariff and quota .AGOA came to effect on October 1,2000 after president Clinton signed init the historic law called ''AGOA 2000 ''on May 18,2000.The opportunities established by AGOA are targeted towards 48 sub-Saharan Africa countries. Initially the Africa Growth and opportunity Act was scheduled to cover the period 2000 to 2008, and builds on the exiting trade preference programs such as the Generalized system of preference (GSP).Ethiopia become the 18 beneficiary countries in terms of textile, garment and leather products .AGOA gives Ethiopia the opportunity to export textile, garment and leather product to the united sates duty free and quota free until 2008.It lets Ethiopia enjoy the privilege to export garments, and leather products from any other countries to U.S. market, duty free and quota free and the schedule of AGOA has been extended up to 2015.

Ethiopia has also been granted other opportunities such as everything but Arms (EBA) initiative .On 26 February 2001 the general affairs of council adopted everything but arms amendments to the EU's generalized schemes of preference (GSP).Published in the official journal on 1st March, this regulation has been implemented since 5th march 2001.

EBA extends duty and quota free access to all products of agriculture and manufacturing originating from least developed countries (LDCs) except arm and ammunition. Given the great number of developing countries, difference between them –in terms of level of development are huge. The rationale of the GSP is that developing countries cannot compete with developed

countries. At present, some developing countries cannot even face the completion of other developing countries .Thus; there is a need to target the tariff preference available under the GSP to these least developed countries .at present 49 developing countries belong to the category of LDC's. The provisions of the EBA regulations have been incorporated into the GSP regulation.

At the regional level it is especially the trade arrangement made within the common market of eastern and southern Africa (COMESA) that are likely to promote exports of textile and leather products (for example ,COMESA has an office in Addis Ababa). In the leather sector there are several regional associations. The eastern and South Africa leather industries Association, ESALIA, has its headquarters in Nairobi while the chairmanship is rotating. The Africa federation of the leather and Allied products association, AFLAS, is holding trade fairs on rotating basis, it is the same and true for the case of textile and garment sector.[8]

C. Existence of Supporting Institutions

To overcome the textile and leather industries problem and to facilitate rapid development of the sectors government delegates Textile Industry Development Institute (TIDI) and Leather Industry Development Institute (LIDI).

Thus, they play a greater role through producing trained personnel; give training for professionals who involve at industry and through conducting research work which is directly focus on current industries problem. Therefore, this is another opportunity which fosters the industry- university collaboration. According to our finding it accounts 22% out of the major opportunities.

D. Financial Support and Infrastructure Development

Currently, due to government prioritization of the sector and willingness of the participation of private sectors and non-governmental organizations, tremendous infrastructures development is under progress. According to information obtained from TIDI and LIDI, various technological parks, incubation centers, R& D centers, training centers are indifferent progress. Besides this governmental and non-governmental financial support are the one and the major opportunities which accounts 28% contribution for the success of the linkages.

E. Expected Commitment

Commitment of concerned bodies takes larger contribution during formulation of industry-university linkage. According to this finding the major opportunity which accounts 10% out of other opportunities are industries, universities and concerned bodies are committed to work together.

F. Other Opportunities

In addition to the above mentioned major opportunities, availability of easily trainable work force, overall growth rate ,subsidies & incentives, import and export policies, emergency of new technology etc. are also another opportunities for effective collaboration activities and it accounts 10% out of the major opportunities for IU linkage.

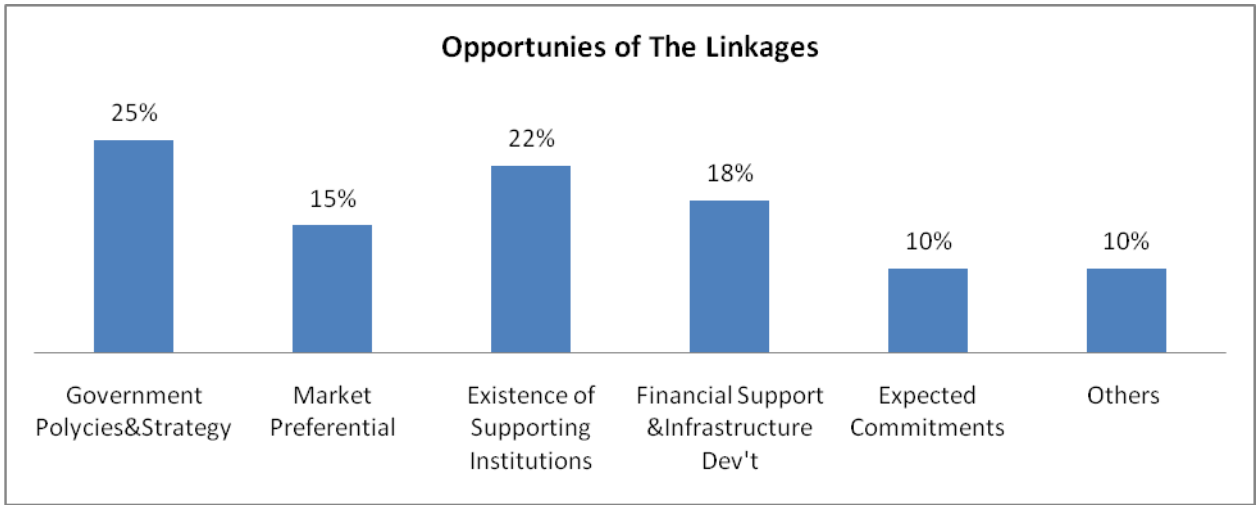

Fig.3. Opportunities for Industry University Linkage

4. Summary and Recommendation

4.1. Summary

Most of Textile & Leather industries, universities and research institutions where in great deportation concerning in partnership between them. The nature and types of challenges observed from industries and universities are different. According to this study and analysis of industries response, the major challenges observed at industries are financial constrain, shortage of technical staff, deficiencies of infrastructures, lack of awareness and ignorance of the importance of the linkages and other challenges which accounts 23%,30%,15%,10% and 12% respectively.

Regarding the main challenges of universities which prevent them not to involve in effective collaboration activities are shortage of researchers in quantity and required quality, limitation in budgeting of regular budget and searching of funds from external source, the problem of the former educational curriculum, infrastructure problem, information gap and others which weight

18%, 20%, 25%, 15%, 12% and 10% respectively among the major challenges investigates in this study work.

Now a day's different encouraging and bright hopes starts observed. According to the finding result of this study the major opportunities are government initiation and commitment towards development of the sector in form of workable policy and strategies, establishment of supporting institutes, different market preferentiality to product of the sector, some financial support and infrastructure development, expected commitment of stakeholders and others which account 25%, 22%, 15%, 18%, 10% and 10% respectively.

4.2. Recommendation

A. Concerning Industries

In order to alleviate the financial constrain of industries top managements should include the expense of collaboration activities in their strategic and annual master budget plan.

Providing continuous and sustainable on job and off job training is necessary to capacitate the technical staffs.

Special scheme is necessary to initiate investors to participate the development of infrastructures of collaboration works.

Establishment of R & D centers, well equipped training centers enable to resolve immediate problem of the industries.

Continuous communication and awernance creation about importance and mutual benefits of industry-university linkage, through participating in seminars and workshops is necessary for effective collaboration.

Even if the return on investment in industry-university collaboration work is long, it is essential to develop some incentives and scheme to encourage the investor of the sector to participate in collaboration work.

B. Concerning Universities

For effective collaboration with industries, universities should improve and resolve the bottle necks that prevent the shortage of researchers are mandatory.

To enhance the capacity of conducting problem solving research activities for researcher's universities should prepare special training program and establish special scheme and incentive structure for researchers and instructors.

Encourage faculty member and students in their efforts to build or take part in research work.

The financial constrain of universities could be alleviate through preparing regular budgets and preparing some projects for fund raising of the collaboration work.

To expose teachers, students and researchers towards research activities, universities should improve their educational curriculum continuously, rather than concentrating on regular teaching learning process.

To make the collaboration work more effective and sustainable universities should improve R & D centers, training centers, laboratories and available infrastructures.

Strengthen experience share about the linkage with in land and foreign expertise and institutions. Organize and facilitate IU-linkage coordination office as much as possible.

Create continuous workshops, seminars, symposium to promote the conducted research result and to fill the gap of information among stakeholders.

Universities should disseminate research results to industries for practical purpose.

Finally to strengthen industry university linkage through proper utilization of available opportunities such as government policy and strategy, market preferentiality, existences of supporting institutions, financial support and infrastructure development and commitment of concerned bodies all parties should play their role.

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Revenue Generation Strategies in Sub-Saharan African Universities

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Abstract

This paper, first of all, argues that almost all higher education systems in Sub-Saharan African (SSA) countries are increasingly under pressure due to rising student populations and mounting costs of teaching and research activities (World Bank, 2010). It then seeks to gather the actual practice of revenue generation in SSA public universities as a means to mitigate financial austerity. It attempts to analyze the enablers for and barriers to revenue generation within SSA universities. As a theoretical framework for this research we employ Resource Dependency Theory (RDT) that conceptualizes an organization and its environment as inextricably linked. This theory promotes that any action of the focal organization is aimed at acquiring resources from its environment (Pfeffer and Salancik, 1978). The key to organizational survival is the ability to acquire and maintain vital resources. In the organizational environment one can detect the key external resource providers. These resource providers or simply stakeholders are capable of influencing the behavior of a resource recipient university. University may implement various strategies either to comply with the environmental demands in ways close to their individual mission, or to avoid these demands (Pfeffer and Salancik, 1978:83).

Our empirical observations are based on case studies of four SSA public universities: two from Ethiopia (Adama Science and Technology University and Haramaya University) and one each from Kenya (Jomo Kenyatta University of Agriculture and Technology) and South Africa (Nelson Mandela Metropolitan University). This allows us to place the findings in a comparative perspective and to learn which enablers and barriers are particularly relevant for universities operating in different institutional framework. The case studies are based on interview checklist with open-ended questions and desk research including institutional documents (annual reports, planning documents, evaluation reports). The interviewees are university administrators, deans, department heads, and academics. The RDT-driven research model that guides the field work is

augmented by the academic literature on income generation strategies undertaken by universities in developing countries.

The results from our analysis of the case studies show that our sample universities have indeed widened their institutional resource base and engaged in revenue diversification strategies. They have managed to tap into additional financial revenue sources such as student fees, campus services, project funds from (bilateral and multilateral) donors, and regional and local authorities. Only in the case of the Kenyan and the South African universities do we see revenues from industrial firms, endowment and philanthropy. In order to link up with outside organizations and groups, a number of academic units (e.g. research centers, continuing education offices) and reach out/administrative units (e.g. technology transfer, promotion and marketing, consultancy and short-term training, etc.) are set up. Moreover, the case study universities to a varying degree have implemented procedures, incentives and professional approaches towards revenue generation in order to deal flexibly with the demands from (potential) resource providers. Some case universities in this respect have been facing barriers in terms of regulatory constraints, a lack of autonomy and an absence of sufficiently trained staff. In terms of enablers, the universities that are more active in revenue generation have introduced dedicated rewards and incentive structures, and have devolved responsibilities more towards the shop-floor level in their organization or strengthened their administrative capability. This has led academics to reach out more actively to external stakeholders by means of new degree programs and research themes. Although the analysis is still in progress, we have been able to detect evidence of the resource-dependency nature of such initiatives. The findings of the study will enable policy makers (lawmakers) to revise laws, award better institutional autonomy and improve resource allocation mechanisms. At the university level, it will have implications on the overall operations of the university in order to better manage resource dependencies.

1. Introduction

In the external environment of higher education institutions in Sub-Saharan African countries, we have observed a number important changes in the last decades (see World Bank, 2010; Teferra and Altbach, 2004). These changes include:

- Enrollment growth
- Declining state funding for higher education

- Devolution or decentralization of responsibility to the institutional level
- Governmental regulations to improve quality in teaching and learning
- Globalization and internationalization of higher education
- International competition for funds, faculty, and students
- New technologies such as ICT, etc.

The above mentioned changes are often caused by changes in the wider societal environment like economic, political, demographic and social and technological forces (Varghese, 2009:27-28; UNESCO, 2007; Sawyerr, 2004). The overall changes are translated into demands to solve problems of cost, quality, effectiveness, and access. In this research, I mainly focus on trends on enrollments and financing of higher education in Sub-Saharan African universities. I argue that financial sustainability is one of the key challenges for Africa's public universities today. Despite the tremendous diversity that exists in Sub-Saharan African countries, all higher education systems are increasingly under pressure due to rising student populations and mounting costs of teaching and research activities (World Bank, 2010).

According to the World Bank (2010), the total number of students pursuing higher education in Sub-Saharan African universities tripled, climbing from 2.7 million in 1991 to 9.3 million in 2006. As forecasted by the Bank, if current trends continue apace, the total number of students for the entire African continent could reach between 18 million and 20 million by 2015. However, public resources allocated to current expenditure in the higher education sector only doubled over the said period. This financial crisis for most African higher education systems has been recognized by several scholars since the 1980s (Teferra and Altbach, 2004). For instance, public expenditure per student declined from US$ 2,800 in 1991 to US$ 2,000 in 2006 (see World Bank, 2010). Such a reduction occurred when the rate of annual public expenditure per student to GDP per capita is 3 for sub-Saharan African countries. The said figure is by far greater than budget allocations to higher education by OCED countries which is 0.3 (see Santiago et al. 2008; World Bank, 2010). Governments of sub-Saharan African countries allocate close to 0.78% of GDP to HE (20% of education budget) while it is around 1.2% in OECD, however.

By 2015, for instance, the level of expenditure could be 75% higher than the volume of public resources that may be mobilized by sub Saharan African countries (Ibid). This financial gap

indicates that the proportion of governmental funding in the overall budgets of various Sub-Saharan African public HEIs continues to drop at a time when higher education is experiencing rising enrolments (World Bank, 2010; see also Johnstone & Marcucci, 2010; Bundy, 2004; Musisi & Muwanga, 2003; Ziderman & Albrecht, 1995). This implies that the rapid growth in the number of students is a challenge to the sustainable financing of higher education (World

Bank, 2010:1). Thus, almost all sub-Saharan African countries have faced the same challenge of designing sustainable funding models.

In the last two decades, several African countries including Ethiopia has been searching for ways of financial sustainability for higher education systems. Many national governments have made it clear that it will no longer be possible for public universities to rely solely on the state for funding. Consequently, universities have been challenged (directed) to generate their own funds. On average, as reported by World Bank (2010:74), universities' generated own resources account for approximately 28% of the revenue of higher education. The share of own resources is lowest (5% or less) in Madagascar and Zimbabwe and highest in Guinea-Bissau (75%). Generally speaking, the pressure to generate nongovernmental resources (other than the mainline) to achieve financial sustainability has been immense across sub-Saharan African universities. On the basis of the existing research undertakings on revenue generation at public universities in SSA, I argue that our knowledge and understanding about enablers for and barriers to revenue generation and diversification at public universities in sub-Saharan African countries seems to have been limited.

2. Study Objective

How can Sub Saharan African public universities improve their financial sustainability by diversifying their sources of resources and at the same time continue to accommodate the growth in student enrolment? I will try to address the following two issues: (i) identifying theory that provides useful conceptual tools for understanding organizational responses to resource scarcity/financial austerity and (ii) identifying enablers for and barriers to revenue generation from the case study universities in Ethiopia, Kenya and South Africa.

3. Theoretical Framework

As we have briefly discussed above, the financial resource (mostly in terms expenditure per student) from principal benefactors (governments) has been declining across Sub-Saharan African countries (Johnstone, 1998; World Bank, 2010). In order to understand how public universities as organizations obtain resource for their survival, theories that explain organisational responses to resource challenges are necessary and appropriate. Resource dependence theory (RDT) provides useful conceptual tools for understanding organizational responses to financial challenges or austerity (Pfeffer and Salancik, 1978; Aldrich and Pfeffer, 1976; Davis and Cobb,2009). This theory argues that no organization is completely self-contained. Organizations survival is thus dependent on the extent that they are able to acquire and maintain resources. The need to acquire resources creates dependencies between organizations and their external units and the scarcity of resources determines the degree of dependency. According to RDT, when resources are in a state of short supply, organizational stability is threatened. Organizational venerability occurs. Under such circumstances organizational efforts are directed at regaining stability, at removing the source of the threat to the organization.

RDT conceptualizes environment and organizations as inextricably linked. The environment is understood in terms of other organizations with which the focal organization interacts for acquiring resources (Levine and White, 1961; Thompson, 1967). For its survival, an organization must engage in an exchange with its environment. Pfeffer and Salancik (1978) indicate that organisations depend on environment for acquiring vital resources for their survival. Organizational environment include a variety of actors or stakeholders or resource providers that have various demands and expectations (see Freeman, 1984). These stakeholders have effects on the activities or outcomes of the resource recipient organization. The environment, along with resources, encompasses regulations, opportunities, competitors, and threats. These environmental aspects can enable for and erect barriers to the ability of the focal organization to obtain resources. The resource recipient organization will have to identify key stakeholders; and thus manage stakeholder relationships to ensure survival in that environment. This theory states that we cannot understand organizational structure or behavior without understanding the context within which it operates (Aldrich, 1979; Pfeffer and Salancik, 1978; Scott, 1992b). As in strategic choice approaches, resource dependence theory assumes an active role of individual

organizations in their struggle for survival. Organizations also try to actively influence their environment.

Thus, from the resource dependence perspective, universities can manage resource dependence difficulties arising from state funding by competing for resources from a market. As universities can operate in multiple markets (see Jongbloed, 2004), they may be able to establish multiple exchange relationships for mitigating disruptive resource instabilities through developing multiple revenue streams (Clark, 1998; Sporn, 1999; Slaughter & Leslie 1997; Wangenge-Ouma, 2011). RDT suggests two adaptive responses for the development of multiple revenue streams. On the one hand, universities can adapt and change to fit environmental requirements. On the other hand, they (universities) can attempt to alter the environment so that it fits their capabilities. The main contribution of resource dependence theory is the detailed analysis of adaptation strategies. These include merging with other organizations, diversifying products and services, co-opting/interlocking directorates, and/or engaging in political activities to influence matters such as regulations (Pfeffer and Salancik, 1978). Administrators of a university become more important because they are mainly responsible for the development and implementation of strategies that help to reduce dependency relationships with the environment. Using RDT as a lens, the following section discusses the various ways in which our case study universities have managed to generate resources. We also identify enablers for and barrier to revenue generation at our case study universities.

4. Cases and Data Collection

a. Case study universities

- Ethiopia: Adama Science and Technology University & Haramaya University,
- Kenya (Jomo Kenyatta University of Agriculture and Technology), and
- South Africa (Nelson Mandela Metropolitan University)].

Taking four public universities from three countries will allow us to put the findings in a comparative perspective for universities operating in different (i.e., regulatory, financial, and institutional) settings.

b. **Data collection** was done through interviews, observations, and desk research (institutional documents, legal documents, national policies and strategies, research literature, etc.).
c. **Information Sources**: Interviewees were conducted with university administrators & academics (university presidents, deans, registrars, heads of Continuing Education, Heads of Technology Transfer Offices, Heads of university companies, Heads of External Relation Offices).

5. Major Findings

The organizational environments of the four sampled case study universities offer several opportunities for revenue generation. Firstly, more students, and more different types of students, seek to obtain access to university education due to the expansion of lower level educational provisions (e.g. secondary education). Secondly, more segments of the labour force demand university graduates trained for highly specialized occupations. Thirdly, the expansion of knowledge itself globally. Fourthly, the national governments directly or indirectly indicate that they are unable to support 'mass' higher education at the same unit-cost level as they did for prior small or elite arrangements. In some national context (e.g. Ethiopia), public universities are legally encouraged or allowed to engage in revenue generation activities (see Higher Education Proclamation 650/2009 Article 66 &67). We also came to learn that the sampled universities are given substantial autonomy in dimensions of education and research which enable them to engage in income generation strategies and activities. For examples, they are legally allowed to select and admit their fee-paying students, introduce and eliminate degree programmes; determine prices for their products and services, and set the standards & curricula for such programmes and other diploma courses and contract education services. They can also decide on the modes of instruction and delivery. Concerning research, they can set priorities for research and non-education services. Overall, institutional autonomy in dimensions of education and research have enabled the universities to respond to the streams of endless demands rain up on them from diverse stakeholders who seek educational and research services. But we have learned that inadequate autonomy in terms of human resource (e.g. unable to set pay scale for employees) and financial autonomy (e.g. unable to borrow money from capital markets, funding modality (line-item budgeting) in case of Ethiopia, etc.) become barriers for aggressively engaging in revenue generation. While the existing public funding allocation modalities allow

the Kenyan and South African universities with the responsibility of internal allocation of resources, the case is not so the same with Ethiopian universities due to inflexibility of the funding model.

The finding of this paper indicated that one of the central points to engage to revenue generation in the sampled universities is the reduction in budgets from the main patrons/governments. It is equally argued that a need for managing risks that are caused by a sudden drop in income or to fuel further growth of the universities' activities constitutes one of the major divers for revenue generation. The existing institutional autonomy and environmental opportunities (in term of regulation in case of Ethiopia and funding modality in case of Kenya and South Africa) have become incentives for the case study universities to engage in revenue generation.

As expected in RDT, our case study universities have responded to enormous demands in their respective environments for acquiring vital resources/finance[1] (see Table below). But direct public funding continues to be the most important revenue for the sampled universities. They have widened their resource base from the diversity of entities/organizations such as fee-paying students, regional and local authorities, ministries, donors, industrial firms, etc. by providing educational and research services (degree awarding programs, contract research, consultancy and short-term trainings, bridging courses) and other non-academic services (rental of facilities, residences, selling industrial and agricultural products, cafeteria services, laboratory test, etc). Student financial contributions or fees have the potential to constitute a large revenue sources in all cases. Among the sampled universities, NMMU heavily engaged in generating revenue from research, followed by JKUAT and HU. The academic staff (mainly the level of qualification of academic staff) and research facilities of NMMU have encouraged its staff to engage in revenue generation from research. It is so because of incentives linked to research outputs. However, for instance, other conditionality and stringent reporting/accountability attached to donor funding (from bilateral and multilateral) become barriers for generating resources. In some cases, according to senior university leaders, 'small income sources' cause a disproportionate amount of paperwork and administration, raising the operational costs for universities. As universities

[1] In Ethiopian universities, revenues from university income generation activities are difficult to document due to a fear of reducing university budget allocations by the amounts of income generated. As disclosing data on generated income is expressed as "punishment for good deeds", information on such revenues is very sensitive, and is often as much as possible undisclosed; and when disclosed, the figures are underestimated and unreliable.

seek to respond to environmental demands, we see attempts not only for organizational survival but also for organizational legitimacy.

Table 1: Percentage of government and own generated (nongovernmental) resources

Source	**ASTU**		**HU**		**JKUAT**		**NMMU**	
	2007/08	2010/11	2007/08	2010/11	2007/08	2010/11	2007/08	2010/11
Government	86	93	78	83	44.5	38.2	53	50
Nongovernmental	14	7	22	17	54.5	61.8	47	50

Administrators of the four sampled universities become more important actors in responding to environmental opportunities because they are mainly responsible for the development and implementation of strategies that help to reduce dependency relationships with the environment. We have noticed that all senior university leaders are highly committed for revenue generation which has, as we shall see below, been manifested through setting regulations, funding, structures, and installing rewarding systems. This is because the university leaders positively see revenue generation as a means to gain more flexibility in their internal financial management, as public funding (also some donor's funding) often comes with complex administrative requirements. In other words, revenue generated from nongovernmental sources is perceived as being comparatively easier to manage and has the advantage that it can be allocated internally without restrictions. Concerning internal structures, we observed relatively centralized or decentralized, or more favorable unique combination of the two. While education and research activities are devolved to lower subunits mostly at departmental levels, financial, procurement, and human resource management are often centralized, sometimes highly centralized (e.g. JKUAT, HU, and ASTU). The sampled universities have also demonstrated greater systematic capacities to steer themselves. That ability has not taken any one form across the universities. While ASTU has shown mainly managerial values, the other three universities have fused managerial values with traditional academic ones. The latter approach seemed to have enabled revenue generation since the underlying traditional academic culture is not fully ignored or pushed aside.

In trying to bring more revenues, universities have devised several strategies to manage the demands made by those environmental stakeholders who provide resources critical to their survival and success. These include improving differentiation of their services (in terms of educational programmes and research areas) and products (e.g. agricultural and industrial products) for meeting stakeholder demands. They have established satellite campuses in several areas (cities/towns in their respective countries and Tanzania in case of Kenyan universities) including co-ventures (franchises) with non-degree awarding organizations. Students are often segmented according to academic level and/or as on-campus or distance studies, part-time or fulltime, etc. Students attend class during evening, weekends, etc. to combine work and study. These strategies enable them to take their services closer to their customers. Several other strategies are also devised to cater for heterogeneous environmental demands. One of the strategies is to establish a varied array of new academic units (research centers or institutes and Distance & Continuing Education offices) that undertake educational offerings and contract research. In such a strategy, departments are supplemented by centers or institutes to link to the outside world. These subunits are sometimes but not always multi-or transdisciplinary. However, shortage of qualified academic staff at the sampled public universities in Ethiopia is found to be key barriers to generate revenue from research undertakings. This implies that lack of adequate capacity in terms of experiences and expertise have played an important role not to engage in revenue generation in case of Ethiopian universities. They have tried to overcome the problem by mobilizing academic staff from other universities (local and overseas).

Developing or planning to develop new funding streams often leads to more management issues partly due to very diverse accountability regimes. The case study universities are forced to invest a lot both in time and resources in order to obtain additional revenue. We have learnt that our sampled universities have established outreach administrative units that reach across old university boundaries to link up more readily with external stakeholders/ resource providers. Again, there are no similar structures and names. The case study universities in Ethiopia and Kenya have established offices that coordinate and provide strategic leadership for revenue generation at their strategic apex (senior university management). Other support units include Technology Transfer Office, KTI in the case of ASTU, Project coordination offices, Marketing Units, Fund Raising specialist, Strategic planning unit, Finance Units for Income Generation, etc. These office can enable the universities to manage their resource dependencies with resource

providers. But these offices are staffed by senior academic staff (who can engage in research) rather than by professional managers.

Most of our case universities have lobbied for re-regulation and revised policies. A case in point is ASTU which managed to determine the pay scales for its senior support staff. All also create alliances/consortia with other universities for offering courses and undertaking research where they lack inputs in terms of human and non-human resources. Ethiopian universities have also used their legal rights to select board members to enhance linkages with their stakeholders (industry, regional and local community) in order to acquire vital resources for their survival.

Additionally, our case study universities have installed rewards and incentive structures for their staff and subunits. JKUAT has a comprehensive policy for revenue generation that the two Ethiopian universities are yet to formulate. All universities set reward for income generation at staff level. All but the Ethiopian universities formulated a formula for sharing profits at different levels (center, faculties/schools, departments, and non-academic units). Lack of incentives at subunits particularly in the case of sampled universities from Ethiopia is found to a barrier for revenue generation from educational services. No university have so far considered revenue generation as a promotion criterion. Although revenue generation has got such positive impacts as increased revenues, enhanced autonomy, quality of facilities, staff rewards (reduced turnover), increased quality/volume of research, it is suffering from moonlighting, inferior services, and the likes where finance is the only driving force.

6. Conclusions

This paper has examined some of the ways in which Ethiopia, Kenya and South Africa's public universities have employed their agency in response to environmental demands in terms of revenue generation. There is generally an attempt by the universities to shift the locus of their resource dependence by engaging non-government sources of revenue. The new income earning regime entails the universities to devise both adaption and altering strategies for revenue generation. It is reasonable to conclude that as a result of survival imperatives; the universities no more treat their financial challenges as the responsibilities of the governments but rather their own affairs. As shown in the findings, key implications for policy dialogue have been noted at

regulations (or preferably policy) and funding (resource allocation mechanisms) levels within the university and governmental levels.

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Status of Experiential Integrity in Higher Education and its Implications for Educational Transformation

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Abstract

This research dealt with the status of experiential integrity in higher education where implications for educational transformation were set as reflections. It investigated the status of experiential exchange, and consistent utilization of experiential resources among the teaching staff of Adama Science and Technology University. In that, descriptive survey method was used for its viability in investigating status. Target of the research were purposively selected instructors in four schools of the university such being schools of Education Science and Technology Teacher Education, Business, Engineering and IT, and Natural Science (N=20). The purposes underlined were experiences in teaching and roles they had in their respective schools. The sample parameter held 10 expatriate and 10 domestic staffs, who were contacted through both closed and open-ended questionnaire. While open-ended questionnaire helped in-depth data gain, closed-ended questionnaire helped to make the data regulated in line with the guiding points. Focal points of the inquiry were teachers' experiential exchanges on planning, implementing, evaluating and improving educational activities and interactions in due accord. Data for the research were collected and interpreted on the basis of the respondents' consents after clear purpose-identification and discussion. Key findings were that, the staff had some kind of exchange in terms of planning (courses and outlines), informal discussions on implementation and evaluation of learning activities but had no research, project and wide-range exchanges besides the academic lines. Their experiences in touring and exchanging innovative models were also limited. By and large, the experiential exchanges between and within groups of the concerned staff were more informal than formal. That indicated the likely loss of experiential resources which may be exposed to wastage with the disappearance of the holding staff owing to retirement, death, transfer or any other form of migration. In so far as smooth educational transformation is realized through integrity among the academic taskforce, the researcher recommends concerned agents to pay keen attention to inter-staff and intra-staff experiential exchanges in terms of planned and productive integrity.

Key Terms: *experiential integrity, educational transformation, higher education*

1. Background , Objectives of the Research and Problem Statement

1.1 Background of the Research

In the process of education, human elements have the role of communicating, sharing, promoting; and, above all, of transforming experiences (Warier, 2003). Such a promotion is made possible when knowledge and experiences are converged, interpreted and used in a meaningful way (Kok, 2007). Reforms in education require respective higher institutions to design activities that match the real world tasks of professional development and productivity in diverse fields (Mohanty, 2007). Besides personal competencies, teachers in higher education need to act integrally in order to be actors working for changes and transformation in education (Dubois & Wilkerson, 2008).

Ethiopia, with its development and transformation plan, has entered the world championship in education whereby universities are increasingly acting to develop huge number of trained and educated human resources which could be the pillar for economic development. Studying experiential integrity was essential as a viable means of networking potentials in human elements and creating consistent means of domestic knowledge resources with minimum of indifference and wastage.

Hence, this study was conducted to explicate the status of experiential integrity among teaching staff in higher education, based on the investigation of interactions and exchanges among diverse teaching staff in Adama Science and Technology University which was chosen for its familiarity and economic handling of data.

1.2 Research Objectives

The research aimed at explicating the status of experiential exchange and collaborative interactions among teaching staff to the grand, the specific aims being to identify status of experiential integrity; to verify mechanisms used for experiential exchange and integration; and to ascertain the transformative status of such an integrity.

1.3. Problem Statement and Basic Questions

As important as the availability of human resources in education is the extent to which respective institutions practically integrate and use experiences gained from the existing diverse staff. It is obvious that, teaching and learning do not take place in a vacuum. It is grounded on the active and

hospital roles of the teacher, the students and the experiential contexts. In that, circle individualistic competencies or one-shot interchanges alone may not guarantee the development of large scale reforms in teaching and learning. the implication goes for sure that, making integrated use of experiences is vital since it builds co-planning, co-acting and reciprocal exchange which, all together, brings about concerted success in goal-achievement. Ethiopian higher education has had long history of involving diverse staff in teaching-learning and research, and such an involvement is taken as the signifier of being transformative. Yet, the extent to which experiences are integrated and used in bringing about transformation in education is an issue of big concern that needs research and discussion. This issue of concern is not only with respect to teaching and learning but also the entire development in socio-economic realms to which education is responsive. Hence, the research underway was based on answering the succeeding questions. For the purpose of clarity, the research questions were divided into general and specific as follows: *To what status do diverse teaching staffs of Adama Science and Technology University integrate their experiences in the realm of planning, implementation, assessment, social interchanges, and problem-solving?* The specific questions were also stated as under:

- To what extent do the teaching staffs work collaboratively and interactively?
- What possibilities are there for such collaborations and interactions?
- What implications does this have for educational transformation?

2. Review of Related Literature

2.1 Experiential Integrity in Higher Education

Two of the greatest challenges higher educational institutions face today are those of harnessing the power of digital technology and responding to the information revolution (Mohanty, 2007). The opportunities and challenges technology presents are far greater than at any other time in the history of higher education. Regarding this, Evans (2003) asserts that, integrated network capabilities are essential for the development of distributed specialties, for which multifunctional and multifaceted team-working are a function.

Education, as the grandest human attribute and instrument of social change, requires transformation of experiential partnership which is of paramount importance to the staff and the institutions (Kozma, 2010). Packer (2004) states certain factors that are related to experiential

integrity and partnership such being personal goals, capability beliefs, context analysis and situational incentives. Experiential integrity pertaining to education, as a transformative and change-oriented business, must be shaped in line with socio-economic changes (Kozma, 2010). Such changes are manifest in terms of task teams, flexible work arrangements and development of follow-up schemes.

Changes in education are effected in people's cognitive and experiential gains (Goel & Goel, 2005), and the overall development is affected by the quality and motivation associated with human skills. Quality and motivation are, in turn, affected by the extent to which people gainfully exchange experiences. It is to such an affective reflection that Mohanty (2007) traces teaching in higher education in relation to philosophical and sociological trends, and the challenges in leading and illuminating the change dimensions. The creation of "Knowledge Society", earmarked in Swamy (2002), is also indicative of the need to build a society rather than educating a person as an individual pursuant. In the writer's very words, the 20th Century marks development in social, political and economic realms where overwhelming advancements and changes are observed to come in the realms of creating and building the knowledge society.

Alstete (1996) asserts the demands on higher institutions of education in terms of responsiveness to changing needs of society, greater and consistent competition and reflective effects of education to the society. Ng (1997) states also that, organizations need creative modalities in terms of interactive and productive aspects. Skills in global leadership in terms of innovative pedagogy (Brown & Atkins, 1988) and outreach experiences (Ashcroft & Foreman-Pack, 1994) are also expected to further solidification and solidarity in education in the footprints of global educational change dimensions.

2.2 Importance of Teachers' Experiential Integrity

According to McClure (2008), school leaders who foster collaboration among novice and veteran teachers can improve teacher retention and teacher satisfaction. Fry, Ketteridge and Marshall

(2003) characterize professional learning communities as groups of educators who work together to analyze and improve their classroom practice engaging in an ongoing cycle of questions that promote deep team learning. Wheelock (2000) states also that, collaboration helps teachers to question their activities in group circles, and the questions never remain mare. Fry, Ketteridge and Marshall (2003) assert also that, teachers' having different levels of qualification and expertise in teaching make higher educational institutions look for some means of enabling their staff to get engaged on tasks interactively and learn from one another.

2.3 Problems in Experiential Integrity

There are identifiable challenges on illuminating the path for experiential integrity. Both identification of problems and seeking sound methods of facing the challenges are traced in this part of the review. Pampering to the past experiences of quantitative shortages come qualitative snares on higher educational institutions in the world, and more specifically on those in developing countries (Aarts, 2012). The most perplexing feature tangling higher education today is failure to be in the pipeline of innovative pedagogy where problem-based and project-based learning are a matter of urge rather than preference.

3. Methodology of the Research

This research took a descriptive survey method, whereby primary sources of data were used for the realization of the study. Respondents were twenty purposively selected teachers in selected schools (Business, Education, Engineering and Natural Science) of Adama Science and Technology University. The purpose of selecting the destined respondents was their experiences in teaching. In the collection of data, closed ended questionnaire was employed which addressed five key issues such being planning, implementation, assessment, social interchange, and problem-solving.

Each key issue embraced sub-issues which stood to elaborate the necessary details (to the manageable scope) thereby serving as important hooks for drawing experiential data at ease. Both open-ended and closed-ended questionnaires were used to collect data provided that, contacting the respondents through interview was not convenient. Since reference was made to a homogeneous group, data collection took place at each staff venue. Data were also rechecked for consistency, and verified for validity, in line with the preselected questionnaire

guides. In the analysis, reference was made to percentage for its convenience to display data for direct implications.

4. Presentation and Analysis of Data

This part of the research dealt with the presentation and discussion of major findings. The presentation had its onset with the arrangements of key experiential focuses such as planning, implementation, assessment, social interchange and problem-solving.

4.1 Experiential Integrity on Planning

Teachers' experiential integrity on planning was based on the treatment of the following tabulated points to which the staff reacted in due accord:

Table 4.1 *Experiential Integrity Index on Planning in Teaching-Learning*

No.	**Points of Focus**	**Indicators**					
		Most		**Average**		**Least**	
		No.	**%**	**No.**	**%**	**No.**	**%**
4.1.1	Planning intents	2	10%	3	15%	15	75%
4.1.2	Planning tasks of focus	3	15%	4	25%	13	65%
4.1.3	Planning resources and means	-	-	2	10%	18	90%
4.1.4	Planning assessment modes	3	15%	1	5%	16	80%
4.1.5	Devising feedback loops	-	-	-	-	20	100%

From the data provided to 4.1 above, it could be clear that, three-fourth of the target teachers' experiences denoted the least integrity on making collaborative decisions on intents. Various theoretical assertions support however that, every instructional decision and activity chain must start with the formulation and clear statement of objectives (Dick, Carey & Carey, 2005).

Regarding integrative organization of learning tasks and planning resources and means of lesson-delivery,, teachers' experiences indicated the least co-action, and that showed the likely effect of

not having consensus on accomplishments. Coming to planning assessment modes, the highest number of responses tilted to the least. The respondents indicated their being individually acting in that realm as well. Regarding feedback scheme, the responses indicated no integrity at all which implied that, teachers hardly discussed on what type and how to give feedback to students, and how to develop their undertakings based on the feedback gained.

4.2 Experiential Integrity on Implementation

Table 4.2 *Experiential Integrity on Implementation*

No.	Focal issues	Most		Average		Least	
		No.	%	No.	%	No.	%
4.2.1	Team teaching	2	10%	3	15%	15	75%
4.2.2	Programmed discussion	4	20%	2	10%	14	70%
4.2.3	Innovative interchanges	-	-	3	15%	17	85%
4.2.4	Shared use of resources	6	30%	3	15%	11	55%
4.2.5	Comprehensive lesson handling	-	-	7	35%	13	65%

From the table data above, it could be known that, the least involvement was manifest in terms of team-teaching, planned discussion on the improvement of programs, innovative experiential interchanges, sharing of resources, and comprehensive handling of lessons. In the researched case above, team situation was not yet worked on. Programmed discussion among teachers of different experiences was rated to have been used to the most next to resource sharing whereas comprehensive lesson-handling was rated the least used.

4.3 Experiential Integrity on Assessment

Regarding collaborative integrity on assessment, respondents to the research issue above had the following experiences, as set in the table.

Table 4.3 *Teachers' Experiences on Developing, Using and Improving Assessment Models*

No.	Focal points	Most		Average		Least	
		No.	**%**	**No.**	**%**	**No.**	**%**
4.3.1	Producing valid assessment modes	2	10%	3	15%	15	75%
4.3.2	Making collaborative uses of assessment modes	-	-	3	15%	17	85%
4.3.3	Having cooperative roles in revisiting assessment modes	-	-	2	10%	18	90%
4.3.4	Collaborative improvement of assessment modes	-	-	1	5%	19	95%
4.3.5	Making modes lifelike by redeveloping			2	10%	18	90%

Teachers' reflections on producing valid assessment modes indicated (75%) the least involvement in collaborative production and use of assessment techniques. The implication is that, such a lessened integrity implies that, each teacher had his/her own mechanisms and that bore the feature of being all aloof to what was happening to the integral. Teachers' collaborations in revisiting assessment modes was also ascertained to have been worked on minimally.

Collaborative improvement of assessment modes was also earmarked as the least integrally dealt with. Making assessments as lifelike as possible was also traced as the least worked on. The other issue of experiential integrity was social interchange, for which the respondents' reactions went as under:

4.4 Experiential Integrity in Social Interchange

Table 4.4 *Teachers' Experiences on Social Interchange*

No.	Focal Points	Most		Average		Least	
		No.	**%**	**No.**	**%**	**No.**	**%**
4.4.1	Touring programs	-	-	2	10%	16	80%
4.4.2	Research symposia	2	10%	2	10%	16	80%
4.4.3	Enrichment training	3	15%	3	15%	14	70%
4.4.4	Presenting model works	-	-	1	5%	19	95%
4.4.5	Fieldwork and visits	5	25%	2	10%	13	65%

As indicated in the above table (Table 4), touring experiences were worked on collaboratively to an average status as denoted by 10 percent of the responses, whereas it was stated to have been the least considered, as denoted in 80 percent of the responses. Besides stating touring to have been the least worked on, two of the twenty respondents, both inpatriate, denoted non-existence of inter-staff touring and social interchange.

The rate of touring was marked the least by the expatriate staff than the inpatriate (disparity not traced for focus), though case explication for the disparity is beyond the coverage of this research. Enrichment training was also the least worked on aspect, as indicated by 70 percent of the responses, and presenting model works was marked to be the least worked on as denoted by 95 percent of the responses. The implication is that, the target staff did not have uniting threads.

4.5 Experiential Integrity on Problem-Solving

Under this grand issue, five selected sub-issues were set for scrutiny, such being experiential integrity on academic, social, moral, technical and status-oriented issues. Academic issues were related to instructional aspects, social issues to group role-assumption, moral issues to ethicality, and technical issues to means of adjusting learning-teaching resources in collaboration. Issues related to status-quo addressed gaps in interaction backed-up by academic status to which teachers' reactions were looked into.

Data presentation and reflection ran as under:

Table 4.5. ***Experiential Integrity on problem-solving***

No.	Focal Issues	Most		Average		Least	
		No.	%	No.	%	No.	%
4.5.1	Integrity on solving academic problems	8	40%	5	25%	7	35 %
4.5.2	Integrity in solving social interaction problems	-	-	3	15%	17	85%
4.5.3	Integrity in solving disciplinary problems	7	35%	3	15%	10	50%
4.5.4	Integrity in solving technical problems	9	45%	4	20%	7	35%
4.5.5	Integrity in solving status-quo barriers.	-	-	-	-	20	100%

From the above table (Table 5), it could be inferred that, the staff integrity in solving social problems or interactive problems was indicated to have been the least worked on, and the least of all the least was witnessed in terms of solving status-quo barriers (barriers pertaining to academic ranks). The respondent teachers' experiences denoted (45%) the most partaking in terms of solving technical problems (such as supporting one another on using instructional technology or other complementary gadgets) and on solving academic problems (40%) which related to teachers' instructional roles in terms of subject-matter handling. But, even the so asserted integrity in the academic aspect was not explicated in terms of the teachers' subject-mastery, pedagogical competencies and psychological cope up since that was out of the catchment of this research.

5. Discussion of Major Findings

This research , reference to experiential integrity implied the wholeness of parts, the expectation being that, all teaching staff were not only birds of a feather but also threads of the same yarn, though not products of the same fabric. In this research, focus was made on integrity in terms of interaction, exchange and collaboration among the teaching staff in terms of sharing and building experiences in planning, implementing, assessing, communicating experiences and problem-solving. In this part, reflections gained from the data treated in the research were presented and discussed.

5.1 Regarding Integrity in Planning

For the purpose of clarity, reference on planning was made to academic core points, provided that, other alterations would become confounding. Accordingly, experiential explications were made on teachers' collaborations in terms of intents, tasks, resources and means of teaching and learning, assessment modes, and mechanisms of providing feedback for clients. In that, intents and tasks held the highest attention whereas feedback mechanism, resources and means held the least. The implication, by and large, was that though the staff had some bright starts with shared vision on intents and tasks, they did not keep tracking on integral path to the end.

5.2 Regarding Integrity in Implementation

Experiential explications regarding implementation were made on team teaching, resource sharing, programmed discussion, comprehensive lesson handling (diversification), and innovative exchanges. The teachers' responses denoted the most experienced ties in terms of resource sharing and discussion and the least in team teaching and innovative interchanges. Comprehensive lesson handling was not tried at all. So, teachers' experiential exchange and integrity were highly won by individualistic accomplishments except temporary physical contacts witnessed in resource-sharing and discussion.

5.3 Experiential Integrity on Assessment Techniques

Regarding interchanges on assessment, the extent to which the concerned teaching staff produced valid tools by exchanging experiences, made comprehensive use of the assessment tools and techniques, had cooperative roles in revisiting, redeveloping and improving assessment tools and techniques was looked into throughout. In that, producing assessment tools held the most part whereas revisiting, improving and redeveloping of assessment tools and techniques were those worked on to the least status consecutively.

5.4 Experiential Integrity on Social Interchange

Regarding social exchanges, reference was made to experiences pertaining to academic tours and internships, research seminars and discussion, enrichment training (inter-/intra-national), presenting model works at symposia, and practical field work and site visits in and out. The teachers' experiences indicated most practices in terms of field work visits, especially in the technology areas, whereas least practices were explicated in terms of presenting model works, research, and academic touring and internship.

5.5 Experiential Integrity on Problem-Solving

Issues under this sub-part were related to academic, social, disciplinary, technical and status-quo barriers in teaching and learning. While the concerned teachers witnessed to have had the most interaction and self-reliance in terms of academic, disciplinary and technical aspects, they indicated having the least participation in breaking problems of social interaction and of status-quo barriers.

6. Summary, Conclusion and Implication

6.1 Summary

The research underway was held to look into the status of experiential integrity in higher education, reference being to exchanges in planning, implementation, assessment, social involvement, and problem-solving. In that, improvement of assessment modes, planning and execution of feedback loops on two-way bases, presenting model works, researches and holding academic tours, and status-quo barriers and related roadblocks to social interaction still project out as the "raw" materials demanding untiring commitment and deep processing.

6.2 Conclusion

In this research, it was found out that, experiential integrity in higher education, as explicated from teachers' experiences in Adama Science and Technology University, had bright features in terms of having common goals, technical provisions, resource-sharing, producing and using similar assessment modes, holding field works and visits, and attempts made to alleviate academic and disciplinary problems.

6.3 Implications for Transformative Action in Higher Education

Though it becomes ecologically and individually sound to dedicate this research to Adama Science and Technology University, more viably to the target groups, the researcher believes that, some, if not all, of the above issues may have relatedness to practices and experiences among the teaching staff of the other universities. So, findings from this research could be indicative of the fact that, how higher educational institute handles, organizes, values and utilizes human experiences, and promotes integrity with diversity has a lot to do with transformative education now and in the prospect (Feinstein, 2008; Dede, 2007). Further research could also be held on the factors which hinder good communication among the staff in higher education for pragmatic effects to come in the transformative realms of education.

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Increasing Academic Achievement, Enhancing Teacher Effectiveness Utilizing Thematic Learning and Professional Learning Communities

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Abstract

This applied research project Increasing Academic Achievement, Enhancing Teacher Effectiveness Utilizing Thematic Instruction, Blended Learning and Professional Learning Communities initiated in 2012 and scheduled to continue until 2017.This Professional Learning Community involves scholars from Ethiopia, Kenya and United States of America utilizing thematic activities in water through a series of blended learning activities. The project started with communication through social media on twitter, facebook and linked in and continued with conference calls via Skype and online classrooms. A series of academic activities and discussions between Ethiopia, Kenya and American scholars culminated into on site visits to Ethiopia and Kenya as visiting scholars.

The professor in the departments of sociology in the United States decided to include students from other Universities in the study abroad class. He video conferenced with Ethiopia and Kenya to familiarize the students with the culture and problems of the other society. At the end of the academic school year, American students will come to Ethiopia to experience the culture and

concerns first hand and engage in a project to benefit the community. The next year the students travel to Kenya for the same purpose.

Teaching colleges in the United States are being approached to provide credit to student teachers for teaching in rural areas of Ethiopia and Kenya which experience a teacher shortage. Young teachers from the United States adept at using technology in the classroom maybe the catalyst to encourage teachers in rural areas to embrace best practices and technology.
The project builds relationships between educators in Africa and the United States based on mutual respect. This free exchange of ideas and problem solving leads to better cultural understanding well as the development of best practices which serves the needs of students in all countries. Joint use libraries will be developed to expand the resources within the schools and give the public access to library resources to complete the needed research to support the development of a workable plan.

Professional Learning Communities extend classroom practice into the community; bringing community personnel into the school to enhance the curriculum and learning tasks for students; or engaging students, teachers, and administrators simultaneously in learning. Students, teachers and administrators enter the community and solve common problems together by combining resources.

The theme of this professional learning community revolves around water, access to clean drinking water, water for sanitation, energy, and agriculture. Educators, students, parents, community members, and municipal administrators discuss the issue most pressing in the United States or Ethiopia. Then match instructional objectives which utilize active learning to design plans to address these areas of need.

This project culminates into a work/study abroad program where American scholars bring needed resources to complete the plans designed by Ethiopia and Kenyan scholars. The students, faculty and community members work side by side to complete these projects for the betterment of the community and to bridge cultural understanding.

1. Introduction

This research project focuses on global education and the need of all countries to graduate children who can pass exams based on national standards and solve local problems which have a global impact. Children taught to act locally and think globally make better citizens.

The objective of this project is to mentor 100,000 parents, teachers to ensure that every child has a free and proper primary school education by utilizing thematic instruction and professional learning communities in the United States and East Africa. Encouraging students to reach out to each other to solve problems and share knowledge not only builds collaboration skills, it leads to deeper learning and understanding. Encouraging teaching staff to reach out and share ideas enriches schools and creates lifelong learners.

United States of America

In the past 10 years the school systems in the world have all committed to high stakes testing as a strategy to measure the United Nations goal of Universal Education for All Children. The No Child Left behind Act 2001, a national initiative in the United States, mandates a state wide assessment of student skills every spring to determine grade level mastery of subjects. These tests scores determine school districts funds and how they may use funds and may determine whether school leaders will be rehired for the following year. Each year the proficiency levels are to increase by a complicated formula. Schools that have similar performance level may have different rankings due to different growth predictions.

The purpose of this act was to close the achievement gap with accountability, flexibility, and choice, so that no child is left behind. The act negatively impacted rural, urban and immigrant populations because it utilizes a sole criterion, a score on a state wide assessment to determine academic success.

The bill sought to improve the academic achievement of the educationally disadvantaged by creating a universal system of measuring achievement. Provisions required increase teacher training and a parental choice component. The bill was never fully funded and made teachers solely responsible for the test scores of students. Its implementation created and aggravated an adversarial relationship between parents and teachers with each side blaming each other for

student failure. The act promoted informed parental choice and innovative programs without funding these programs or holding parents accountable for sending their children to school prepared to learn.

School administrators design school improvement plans each spring based on improving test scores. Teachers, students and parents feel pressured to attain a certain score which is published in local newspapers and on state and national websites. Learning and engaging in the learning process takes a back seat to a single number on a standardized test.

Ethiopia

Significant advances made in the move towards free primary education for all, which the Ethiopian Government has vowed to achieve by 2015 as one of the Millennium Development Goals. UNICEF is working closely with the World Bank and other partners to make a breakthrough in access to basic quality education with the School Fee Abolition Initiative, and the rights and needs of excluded, marginalized and vulnerable children are at the heart of these efforts. "There is no development without education," said ElleniMuluneh, a founder member of the Ethiopian Youth Forum. "The more we educate children, the more we become developed in the long run. Maybe one day we will manage to get every child in the country behind a school desk." Educational institutions work in collaboration to nurture students' and professionals' experiences to make education the tool of socio-economic progress.

Kenya

Educational quality has recently received a lot of attention in Kenya. Literacy levels are low, and are substantially lower in certain regions. Literacy levels are lower in public schools than private schools. Most children can solve real world, "ethno-mathematics" problems, while fewer can solve similar math problems in an abstract, pencil and paper format.5% of children are not enrolled in school, but the problem is far worse in particular regions. About half of children are enrolled in pre-school. Many children are older than expected for their class level, including 40% of children in class 2, and 60% of children in class 7.North Eastern Province and arid districts in Rift Valley and Eastern Provinces have particularly low performance; and many older children, especially girls, are not attending school. Many families pay for extra tuition, which focuses heavily on drilling and exam preparation. Schools struggle to plan their budgets because they

receive funds at unpredictable times. Children, whose mothers are educated, particularly beyond primary school, tend to have much higher rates of literacy and numeracy.

There is a severe shortage of teachers, estimated at 4 teachers per school. There are 30 universities in Kenya, 7 of which are public and 23 private. The 7 public universities have a total of 12 constituent colleges; The University of Nairobi is the oldest university in Kenya.

Goals of the project

The project aims to develop teachers' capacity in pedagogical and technological aspects which include teaching students the skills needed for the 21st Century. It promotes the Cultivation of professionals' skills of technology-use in education by providing training on the basics of blended-learning. It attempts to create the spirit of active technology-use and inspiration to learn with technology as they work, and work as they learn by utilizing technology and work even out in the community. Professionals develop skills on inquiry based learning, and project based learning in making profitable use of technology in education. Professionals demonstrate through professional learning communities the skills that students need to be problem solvers in the 21st Century.

2. Review of the Literature

Thematic Learning

Thematic learning is a pedagogical model based on the selection of a theme or topic of study. Access to clean water affects every person on the globe. Lack of water creates a crisis as well as too much water creating a dangerous situation. This theme becomes the critical thinking binder that helps bring different and seemingly unrelated information together into a unified whole. In fact I would characterize this as a holistic method. The model encourages a student to think around a subject. The model is inclusive and encourages the student to see and seek relationships between information and facts from various sources inside, and outside of, the classroom. It is also a scalar form of learning as it encourages students to look for thematic relationships between finite, or specific information, and larger even global thinking.

Thematic teaching units involve a group of correlated activities that are designed around water and cross several areas of the curriculum. They provide an environment that fosters and encourages process learning and active involvement of all students (Fisher, 1991). They build on

student's interests and prior knowledge by focusing on a topic central to our lives, water. This them helps children relate to real-life experiences and build on prior knowledge. Thematic units integrate content areas in a way that makes sense to students and help them make connections to real life and the importance of education. They transfer knowledge acquired and apply it in a meaningful way.

There are many benefits of thematic units. They address diverse learning styles of students and provide opportunities to learn in-depth factual information. Students learn process skills and metacognitive skills. Thematic learning between students in three countries promotes peace between diverse cultures. It teaches students to work as a team cooperatively and learn pro-social skills. They learn to solve global problems by acting locally.

Critical Thinking Skills

Many skills, including the objectives and benchmarks for core curriculum, state tests and national exams can be integrated into thematic instruction. Semantic maps provide a method for brainstorming ideas about how to include all subjects. Start with a topic that the entire community finds relevant and develop activities and skills. The connections can be made with all subject areas. This curriculum focuses mainly on math, science, and reading comprehension. Yet it utilizes movement, music, role play, film, art and hands on activities to teach the subject. These connections reinforce learning through meaningful experiences. They incorporate all learning modalities.

In-depth projects will be integrated into the classroom curriculum since the goal is to address real-life problems. Portfolio and performance based assessment allow students to think critically about the value of education. The Project Approach described by Katz and Chard (1989) involves children selecting a topic of interest, researching and solving problems related to the subject. The subject of water has been selected because it poses a risk for all populations as demonstrated in recent news events of flooding and drought in the United States as well as other countries.

Inquiry based learning and critical think addresses all areas of academic and social life. The questions generated in this curriculum lends itself to outside consultation with agencies and people in the community who address water needs. Field trips and guest speakers facilitating

experiments guide the teacher in implementing and planning appropriate activities. These activities may be different for different age and grade levels as well as different countries. The activities meet the objectives and standards of the various subjects. Students not only increase their skills but their knowledge as well.

Students in homes where parents support education and are highly educated themselves produce children who score well on the tests. Low-income and disadvantaged children receive intense teacher centered lessons focused on memorizing for a test. Students do not require the skills needed to compete in the 21st Century. Students require the following skills needed to compete in the 21st Century as cited by Tony Wagner (2008) in The Global Achievement Gap:

1. Critical Thinking and Problem Solving
2. Collaborations Across Networks and Leading by Influence
3. Agility and Adaptability
4. Initiative and Entrepreneurism
5. Effective Written and Oral Communication
6. Accessing and Analyzing Information
7. Curiosity and Imagination

Professional Learning Communities

Professional Learning Communities extend classroom practice into the community; bringing community personnel into the school to enhance the curriculum and learning tasks for students; or engaging students, teachers, and administrators simultaneously in learning. Students, teachers and administrators enter the community and solve common problems together by combining resources.

Astuto and colleagues (1993) label *the professional community of learners,* in which the teachers in a school and its administrators continuously seek and share learning and act on the learning. The goal is to enhance their effectiveness as professionals so that students benefit. This arrangement has also been termed *communities of continuous inquiry and improvement.*

The professional learning community reflects a powerful staff development approach and a potent strategy for school change and improvement. Persons at all levels of the educational system concerned about school improvement - state department personnel, intermediate service agency staff, district and campus administrators, teacher leaders, key parents and local school

community members find that they are more effective when they work together. Hord's review of the literature (1997), explored the concept and operationalization of professional learning communities and their outcomes for staff and students.

The use of social networks for educators has increase by 34% in the last three years. Participation grew in all three job categories – teachers, principals, and librarians. Educators joined general education-focused sites. Facebook continues as the #1 social networks for educators with Linkedin, edwebnet, Classroom 2.0, Twitter, Google+ and Edmodo following close. Concerns about privacy continue to be and issue as well as professional etiquette.
The other tools that educators use to connect are blogs, wikis, webinars, document, photo and video sharing. Webinars rank as the #1 tool used most by educators for professional purposes. Document sharing is the tool most used in the classroom. Educators report that Web 2.0 tools are used more for professional collaboration than for instructional purposes than in the classroom. This project aims to extend their use to the classroom and between classrooms in U.S.A., Ethiopia and Kenya. Educators in the United States reported that social network was valuable for: Online professional development support , Building a personal learning network, Creating professional learning communities ,Collaborating on initiatives and projects, Improving school-wide communications, Connecting with the local community. The top communities among Principals or Head Teachers, Teachers and Librarians; Discovery Education Network, Edutopia, Moodle, Blackboard, BrainPop Educators, Smart Exchange, Teacher Pay Teachers, PBS Teachers, and Thinkfinity

The U.S. Department of Education (DOE) encourages the use of social networks and online communities to assist educators expand t heir professional learning opportunities. The National Education Technology Plan 2010 states "Social networks can be used to provide educators with career-long personal learning tools and resources that make professional learning timely and relevant as well as an ongoing activity that continually improves practice and evolves their skills over time." This project expands this encouragement from the U.S. and extends it into Africa.

Project Based Learning

Confucius and Aristotle promoted learning by doing early in history. Socrates modeled learning through questioning, inquiry, and critical thinking referred to as the Socratic Method. John Dewey, 20th-century American educational theorist and philosopher, and endorsed learning by

experience and driven by student interest. Dewey challenged the traditional view of the teacher as the sage on the stage. He promoted active experiences that prepare students for learning in t a dynamic and constantly evolving world. As Dewey stated that, "Education is not preparation for life; education is life itself."

Maria Montessori launched a global philosophy with her approach to early-childhood learning. She showed through example that education happens by engaging the child in the environment. She developed schools or learning environments that encourage, exploration and discovery.

Jean Piaget explained how children make meaning from their experiences at different ages by observing children for countless hours in different cultures. He developed the constructivist approach to education in which students develop their fund of knowledge by inquiring, investigating, interacting, engaging and reflecting on their experiences.

Project-based learning is a dynamic approach to teaching in which students explore real-world problems and challenges. With this type of active and engaged learning, students are inspired to obtain a deeper knowledge of the subjects they're studying. Seymour Papert's, Massachusetts Institute of Technology mathematician, and a pioneer in artificial intelligence assertion that engaging students by starting with the concrete and solving hands-on, real-world problems is a great motivator. Project-based learning that freely crosses disciplines provides an education superior to the traditional "algebra at age nine, Civil War at ten, *Great Expectations* at eleven" structure.

In project-based learning, students try to answer questions that have relevance for them –and bigger than the immediate task at hand. Students conduct research using an available resources, Internet, books, journals and interviews with experts. They work on the project over an extended period of time. Access to water is a major concern in Africa and the need for clean water in the United States presents a challenge in dense urban areas. Access and conservation of waters requires students to utilize math, geography, reading, literature, history and science.

The need to find fresh water sources challenges adult scientists. Children using their more fluid intelligence may find solutions that evade adults with more crystallized intelligence. Project work is that it makes school more like real life," says Sylvia Chard, Professor Emeritus of

Elementary Education at the University of Alberta and co-author of *Engaging Children's Minds: The Project Approach*, a popular book for teachers of young children on learning through projects."In real life, we don't spend several hours at a time listening to authorities who know more than we do and who tell us exactly what to do and how to do it," she says. "We need to be able to ask questions of a person we're learning from. We need to be able to link what the person is telling us with what we already know. And we need to be able to bring what we already know and experiences we've had that are relevant to the topic to the front of our minds and say something about them."

Students engaged in learning tend to dig more deeply and to expand their interest in learning to a wide array of subjects. They retain what they learn rather than forget it as soon as they disgorge it for a test. They make connections and apply their learning to other problems. They learn how to collaborate, and their social skills improve. They are more confident talking to groups of people, including adults. A number of research projects suggest, project-based learning correlates positively with improved test scores, reduced absenteeism, and fewer disciplinary problems.

In K-12 education, project-based learning has evolved as a method of instruction that addresses core content through rigorous, relevant, hands-on learning. Projects tend to be more open-ended than problem-based learning, giving students more choice when it comes to demonstrating what they know. If schoolchildren are given the gift of exploration, society will be the beneficiary, both in practical and in theoretical ways, scholars say. "This is the way that mathematics started," notes MIT's Seymour Papert.

Project-based learning is not without its challenges. It's demanding of students -- and of teachers. Especially for teachers who have never experienced PBL before, projects require planning and management skills that may be unfamiliar. What's more, PBL puts teachers in the role of facilitator rather than classroom expert. Teachers may benefit from professional development to help them expand their classroom "tool kit" of teaching strategies. Just as it's essential that students buy in to PBL, teachers also need to feel empowered. Support from administrators, parents, and other community members can help teachers and students to overcome challenges and make the most of PBL opportunities.

3. Methodology

This Applied research examines the current perception of teacher effectiveness by teachers and student teachers and relates the results to improvement. This project uses the data collected to improve pedagogical training in teacher education programs. Applied research predicts a specific behavior in a very specific setting," says Keith Stanovich, cognitive scientist and author of *How to Think Straight about Psychology* (2007, p.106).

Applied research is a form of systematic inquiry involving the practical application of science. It accesses and uses some part of the research communities' accumulated theories, knowledge, methods, and techniques, for a specific, or client driven purpose. Applied research deals with solving practical problems and employs empirical methodologies. Applied research resides in the messy real world, transparency in the methodology is crucial.

Survey teacher training programs and teachers implementing methodology for teaching and learning, which focus on inquiry based learning and project based learning supported in it's pedagogical training. Pedagogical training rests at the core of the *learning process*. Pedagogy has to expand to meet the 21st Century challenges which encompass *blended-learning experiences*. Blended-learning expands opportunities for educators, students and the community to benefit from existing technological resources like Television, radio, internet and webinars. Thus giving educators the tools to reach more students, greater access to education for students and more problem solvers in the community.

Core Activities of the Project

- Holding need assessment and identifying the target area for training to be given;
- Focus of qualitative and quantitative Data.
- How do you plan your lessons to increase academic achievement and encourage responsible behavior and engage learners?
- What do you need that you currently lack to increase academic achievement and encourage responsible behavior and engage learners?
- How can you use what you have available in your environment to increase achievement and encourage responsible behavior and engage learners.

- What is the literacy and numeracy needs of rural populations?
- What problems do they encounter?
- How do schools teach them the skills they need to meet the problems that they face?
- How can you get the things that you needed to increase academic achievement and encourage responsible behavior and engage learners?
- How do you create professional learning communities within and outside the school setting to support further training, development and exchange of ideas?
- Forming professional networking inland and abroad for the best achievement of pedagogical breakthrough in creating communities of blended-learning;
- Developing task-scheme and role-shares on the foundation professional training for blended-learning;
- Communicating agreed-upon points of focus and starting training-scheme development;
- Producing training materials in the required number and quality
- Initiating training and scheduling follow-up
- Assessing its efficiency and effectiveness terminally as per the task-schedule
- Communicating progresses and problems vertically and horizontally
- Exchanging feedback with concerned bodies on the most likely solutions to pertinent problems
- Developing the ideas and experiential inputs of the professional communities through formal and informal means of communication by collecting, analyzing, and meaningfully using data.

This project involves the development of curriculum in Math, Science and Reading Comprehension to teach the objectives and bench marks of the National Curriculum in Kenya and Ethiopia and the Core Curriculum in the United States. Activities will be developed and taught in grades K-8 which shift teachers from being lecturers to facilitators of learning.

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Session 3

Industrial Technology and Human Resource Development

Technical Tour to Adama Wind Farm 1

Core Issues for Developing an Effective Workforce

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Abstract

This plenary presentation discusses core issues that all societies must address to develop an effective workforce. The issues are: 1) How to ensure that institutions are in place to prepare individuals to enter or re-enter the workforce; 2) How to ensure that organizations have the means to provide relevant learning experiences to their employees; 3) How to ensure that organizations can respond to changes in their business environments; and, 4) How to accommodate segments of the population when they undergo life transitions related to workforce participation. An effective workforce is critical for ensuring continued economic and social progress for all nations. The need to understand these issues and to implement appropriate national policies and business practices requires a meaningful discourse among practitioners, policy-makers, and scholars. The field of human resource development plays an influential role given its fundamental emphasis on workplace learning, change, and performance. The presentation will conclude by making the point that whatever actions taken must balance and respect the needs of individuals, organizations, and society as a whole.

Practices and Limitations of Corporate HRD in Ethiopian Manufacturing Industries: a need for Structured approach and Implications for National HRD Strategy

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Abstract

The purpose of the study was to explore practices and limitations of corporate HRD in Ethiopian manufacturing industries with the intention to identify if there is a need for structured approach that could guide national level HRD strategy for those industries. Data was collected from senior and HRD managers of selected large manufacturing firms in Ethiopia using questionnaires and semi-structured interviews. For questionnaire survey, a total of 134 (66%) samples were selected based on proportional stratified random sampling technique. The semi-structured interviews were conducted with HRD managers of eight large manufacturing firms which were selected based on judgmental sampling technique. Generally, the ADDIE (analysis, design, development, implementation, and evaluation) model for training design and Theory of Planned Behavior were at the heart of the design of this study. Data were analyzed using quantitative techniques (parametric tests) and qualitative techniques. Results clearly showed that significant differences were found between levels of practices on the stages of T&D design process. Moreover, various limitations constraining the firms' T&D activities were identified. Finally, the findings had two levels of implications: firm-level HRD practice and national-level strategy that were discussed at the end of this paper. There was enough support for Ethiopian large manufacturing firms to resort into intensively implementing on-the-job training in carefully structured ways. One aspect of doing so could be through implementing a technique of structured on-the-job training which is popularly known as S-OJT. Furthermore, the findings of the study also implied the need for national-level HRD strategy for improving employee T&D practices of large firms through implementation of S-OJT system and ISO within the manufacturing industries that could be carefully linked with the currently functional outcome-based organization of TVET system. This could be addressed at the national level through carefully planned collaborations among key stakeholders like universities, manufacturing industry, and government agencies (U-I-G).

Key words: training & development, manufacturing, Ethiopia, HRD strategy, structured

1. Introduction

Several studies have investigated the impact of HRD practices on performances of organizations (Ahmad & Schroeder, 2003). Particularly, the contributions of HRD on improving organizational outcomes through facilitating individual learning are quite evident (Salas, Cannon-Bowers, & Rhodenizer, 1999). According to Garavan, Heraty, and Barnicle (1999), competitive advantage of an organization can be achieved through continuous investment in HRD at the level of individual firms. Consequently, training (Tharenou, Saks, & Moore, 2007) and employee development (Jacobs & Washington, 2003) as HRD interventions have played significant roles in improving organizational performances.

1.1 The ADDIE Model and Systems approach

The literature provides enough evidence in which T&D practices better influence organizational performances on results criteria when conducted from the perspectives of systems approach (Abdullah, 2009; Hughey & Mussnug, 1997). When the firms develop the systems view of training, they will be able to see the big picture and realize that a great deal of attention must be paid to the component parts, the interactions among them and desired outcomes (Hughey and Mussnug, 1997). Fortunately, the field of HRD has long recognized the ADDIE Model (process of analyze, design, develop, implement, and evaluate) for systematic creation and delivery of T&D programs (Dobbs, 2006). In practice, developing systems view of organizational activities is as important as managing it (Jacobs, 1990).

The ADDIE model is central to organizations' T&D practices and constitutes the stages of T&D design process. Performing the ADDIE process of T&D using systems approach helps organizations to carefully conduct need assessment, design, develop, implement, and evaluate training activities without losing focus on organizational purpose. Previous studies such as Huang (2001) provided evidence in which those organizations that were able to attain greater effectiveness in their T&D practices were the ones with better T&D organization and system than those with less effective T&D practices.

1.2 Structured Training Approach

Both on-the-job and off-the-job training activities are relevant for firms to improve skills and knowledge of their employees. However, for manufacturing firms whose main purposes are production, the degree of influence each of them has could be different. According to Aragon-Sanchez et al. (2003), different types of training have different impacts on business results. Training performed inside a company with outside trainers affect several result measurements positively, but on-the-job training influences an even higher number of results positively. The same approach was supported by the findings of Aguinis & Kraiger (2009) who reported that on-the-job training led to greater innovation and tacit skills.

However, the question would remain to be how most firms will be able to make better use of on-the-job training activities while they are having, regardless of on-the-job or off-the-job, no better than average level of practices. Besides, when it comes to on-the-job training, level of structure of training contents and competency of in-house trainers obviously emerge as key issues.

One better way of addressing such concerns among firms can be by applying structured on-the-job training approach compared to the unstructured one (Jacobs, 1992; 2003; Johnson & Leach, 2001). The literature suggests that structured on-the-job training addresses those key concerns of T&D practices of the manufacturing firms through helping them benefit in three ways. First, customizes trainings to meet specific needs (Jacobs, 2003); second, enables firms to use their own experts and experienced employees with better instruction to become a trainer (Jacobs, 2003; Johnson & Leach, 2001); third, strengthen current on-the-job training practices of firms and helps them benefit better from structured and planned approaches than the unstructured one. There are enough empirical evidences to justify the benefits of structured on-the-job training (e.g. Jacobs, Jones, & Neil, 1992). According to Stolovitch & Ngoa-Nguele (2001), for economically less-developed countries, structured on-the-job training (S-OJT) appears to be a "natural" solution because it is relatively inexpensive, does not require highly specialized expertise to create and implement, and has demonstrated very high return in terms of transfer of learning and productivity payoff.

1.3 Standardization of Training and Outcomes

In today's very competitive business environment, in order to do well in the global marketplaces, meeting international standard practices is a requirement than an option for manufacturing firms. To win in the knowledge economy, HRD practices as well need to be standardized and focus on the transfer of knowledge and refinement of skills needed to meet the requirements that are associated with the development, production and dissemination of International Standards (e.g., ISO 9000:2000, 1999).

Clearly, successful training is a result of great instructional design. Therefore, there could be alternative ways of improving its effectiveness for manufacturing firms by installing internal or external standardization mechanisms of training outcomes. Internally, designing appropriate T&D system (Dobbs, 2006) and introducing standards and guidelines for T&D programs (e.g., ISO 9000:2000, 1999), could serve that same purposes. Furthermore, the implementation of structured on-the-job training (S-OJT) approach also helps in structuring training contents and their delivery (Jacobs, Jones, & Neil, 1992; Stolovitch & Ngoa-Nguele, 2001). Externally, firms may consider industry/nationally available skill or occupational assessment and certification programs. According to (Acemoglu & Pischke, 2000), external certification mechanisms of workplace skills gained through on-the-job training is widespread. In Ethiopia, there is a National Technical & Vocational Education and Training Strategy that provides an opportunity for trainees to be certified even after they acquired certain occupational skills through on-the-job training within their organizations (FDRE Ministry of Education, 2008).

2. The Research Problem

Despite the wealth of knowledge on organizational T&D practices in economically developed nations (Drost, Frayne, Lowe, & Geringe, 2002), much is not known about similar practices in developing countries such as Ethiopia. Consequently, this gap makes the generalization of existing findings a difficult task (Ahmad & Schroeder, 2003).

According MoFED (2010), Ethiopia's latest Growth and Transformation Plan for the period 2010/11-2014/15 targets the development of manufacturing sector of the country as a major driver of accelerated national economic development.

Unlike firms in developed countries, most organizations in Africa particularly manufacturing companies are characterized by weak global competitiveness, low productivity and poor innovativeness (WEF, WB, & ADB, 2011). For example, the Economist Intelligence Unit Limited (2000) argues that regardless of the growing optimism, companies based in the Sub-Saharan Africa have failed to break into world markets for manufactured goods. There are various reasons for that. Part of it, however, is associated with shortages in employee skills and other difficulties in manufacturing sector which has a lot to do with their T&D practices.

Therefore, this study intends to explore the following research questions:

RQ1. *What employee T&D activities are performed in large manufacturing firms in Ethiopia?*

RQ2. *What are the T&D design practice gaps (current and desired) in large manufacturing firms?*

RQ3. *What limitations exist to constrain T&D activities of large manufacturing firms in Ethiopia?*

RQ4. *How can large manufacturing firms in Ethiopia resort to more structured T&D practices?*

3. Methodology

This research was a combination of both correlational and survey research while the design was non-experimental. Since the units of analysis were organizations, T&D practices were measured at firm-level. Complete sampling frame for the study contained a list of 196 public and private large manufacturing firms from 13 industry groups. Data were collected from senior and HRD managers of those selected firms using questionnaires and semi-structured interviews. For questionnaire survey, a total of 134 (66%) samples were selected based on proportional stratified random sampling technique. The response rate for the questionnaires was 57%. The semi-structured interviews were conducted with HRD managers of eight large manufacturing firms which were selected based on judgmental sampling technique. Furthermore, documents produced by two reputable institutions were used as an additional source of qualitative data.

Generally, the ADDIE (analysis, design, development, implementation, and evaluation) model for training design and Theory of Planned Behavior were at the heart of the design of this study. Data from questionnaires were analyzed using quantitative techniques while data from interviews and documents were analyzed using qualitative techniques. To quantitatively generate

responses for some of the research questions, parametric (t-test and correlation) and tests were employed. On the other hand, for the qualitative aspects, recorded interviews were initially transcribed and translated before further use. Codes were developed and tentative categories were identified from the transcribed interview responses. Interview data were analyzed using thematic analyses. Mainly matrix displays were used to look for emerging themes and categories. In addition, from the documents, concepts and framework were adopted as data to generate more meanings within the context of this study.

4. Results and Discussion

Results and discussions are presented following each research question.

4.1. What employee T&D activities are performed in large manufacturing firms in Ethiopia?

Literature commonly discusses the types of training as technical, awareness, and managerial (Jacobs, 2003). The difference in the findings from the current study is on the way they are categorized. The distinct categories of training types that emerged from this study were technical and non-technical ones. Training programs were offered at on-the-job or off-the-job locations. On-the-job training programs were offered at the factory floors while off-the-job training programs were offered off the factory floors, either within the premises of the firms or outside of their premises. Some on-the-job training events were offered by in-house providers mostly for technical types of training; whereas some training types were offered by external providers mostly for non-technical training activities and were offered at off-the-job locations. The predominant external training providers for large manufacturing firms were found to be Ethiopian Management Institute and Chamber of Commerce.

Planning practices for T&D in large manufacturing firms were categorized based on planning intention of firms and origin of the planning process. Based on planning intentions of firms, some of the planning activities were basically “un-intended” and were mostly triggered by factors other than the ones that usually drove annual planning activities of the firms. Other planning practices were the “intended” ones and they were considered as part of the annual

planning process for entire firm operations. Based on planning origins, they followed either "top-down" or "bottom-up" approaches or the latter being the commonly practiced approach by most of the large manufacturing firms.

The "top-down" approach referred to the activities in which firms planned for training at the top-level of the hierarchy and forwarded it down the hierarchy for its implementation. On the other hand, "bottom-up" referred to the approach where departments or units originated their annual training plans and requested the top-management for budget approval. "Bottom-up" direction of planning for training was found to be most common practice for many of the respondent firms while few respondents used "top-down" planning approach. Respondents also specified the situations in which they used "top-down" planning. For majority of them, planning for training practice generally referred to budgeting process for their annual training activities. However, this did not refer to the way firms' performed the stages of training design process (ADDIE) for each training programs (Swanson, 1999; Dobbs, 2006).

The respondent HRD managers also reported on how they performed the ADDIE process. It was found that training need assessment practices in large manufacturing firms in Ethiopia followed either "structured" or "unstructured" procedures. Mostly, top-management, immediate supervisors and employees were the major parties that were involved most in training need assessment practices. However, employees did not, as such, have formal and direct participations in the process. The main sources of the need assessment process were supervisors and managers of units or departments. Generally, most firms considered their training need assessment practices as far less than how they wanted them to be.

Training contents were designed and implemented in two major ways and they were either "custom-made" or "ready-made". The implementation stages of T&D followed designs of training contents. Some kinds of associations were actually found among the customization level of the designs, type of the training, the type of providers, and location of implementation. In most of the cases, external training providers offered "ready-made" designs and implement them mostly off-the-job while in-house providers mostly designed custom-made training contents and often implemented them on-the-job.

Regardless of different models the literature suggests to evaluate training effectiveness (e.g. Kirkpatrick, 1976; Cooper, 1994; Tennant, Boonkrong, & Paul, 2002; Salas & Cannon-Bowers, 2001), the result of this study showed that training evaluations in those firms were carried out at two levels. This was based on the durations when evaluations were conducted by the firms: immediate and extended levels. In fact, evaluating training outcomes at these levels have some relations as well as differences with previous findings that suggested evaluation of training effectiveness at various levels such as reaction, learning, behavior, and result (Kirkpatrick, 1976). Only few firms had relatively better practices of training evaluation on extended results such as for a period of three or six months after the training events. Unfortunately, evaluation of training on the result criteria didn't seem to be evident from this particular study. However, this finding is still consistent with previous studies (e.g., Murray & Efendioglu, 2007).

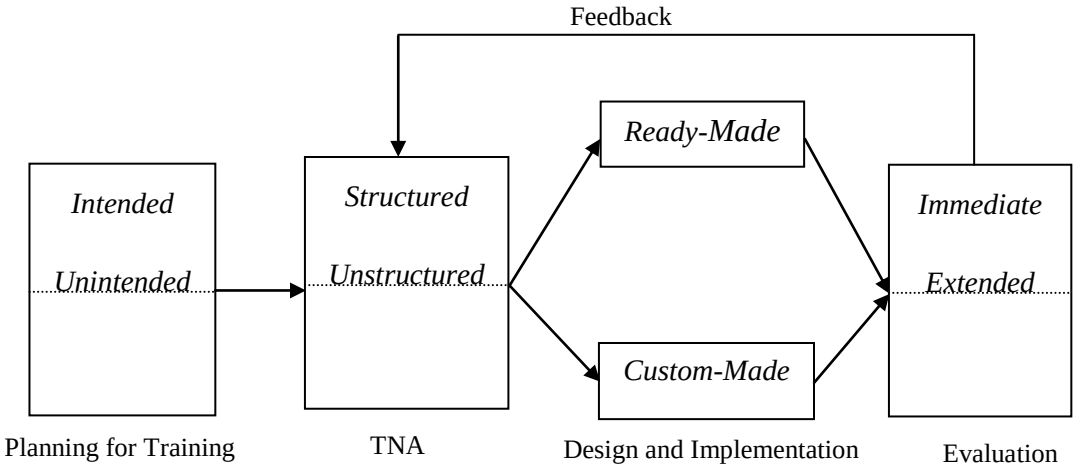

Figure 1*: Process Chart for Firms' T&D design activities*

Figure 1 summarizes the results and shows the T&D design activities of large manufacturing firms in Ethiopia based on interview data. Regardless of some level of variations in terms of T&D activities among large manufacturing firms in Ethiopia, almost all firms experienced difficulties and considerable limitations on their practices of training need assessment, design/development, implementation, and evaluation stages of T&D process. However, the promising aspect of it was that firms did express their desires to improve the current level of design practices into a better level in the near future.

4.2. What are the T&D design practice gaps (current and desired) in large manufacturing firms?

Table 1 reports results of *t*-test on the stages of training design process and employee development. The mean differences and *t* values in Table 1 were negative because the mean values for current level of T&D design practices were all less than the mean values of desired level of T&D design practices. The following sections on stages of T&D design process report the results of dependent *t*-tests.

Table : Results of paired sample *t*-test on stages of T&D design process

Stages	***M Difference***	***t***	***p (2-taied)***	***r***
Need Analysis	-0.94	-7.90	.00	.67
Design/Development	-1.32	-9.68	.00	.56
Implementation	-0.69	-5.37	.00	.53
Evaluation	-1.38	-9.81	.00	.75
Employee Development	-1.13	-8.85	.00	.72
T&D Design Practices	-1.19	-10.57	.00	.77

Note: df =75

Overall, on average, respondent firms had significantly higher level of desire for T&D design practices (M = 4.57, SD = .96) than their current level of T&D design practices (M = 3.38, SE = .11), t (75) = -10.57, $p < .001$, r = .77.

The levels of T&D design practices that large manufacturing firms perceive as their desired levels were much higher than the level of their current practices. This was also true for each stage of T&D design process. Desired levels of training need analysis, design, implementation and evaluation practices were much higher than current level of practices of need analysis, design, implementation, and evaluation which signified the gap between current level of T&D and desired level of T&D design practices. Similarly, firms also had exhibited significantly higher desired level of employee development practices than their current level of employee development practices.

The firms experienced significant gaps between their current level of T&D design practices and desired level of T&D design practices. The effects of theses gaps were larger on each stage of T&D design process with effective values r > .50. However, compared among the stages based

on their mean differences, relatively very larger gaps were observed on stages of training design/development and training evaluation while relatively lesser gaps were observed on the stages of training need assessment and training implementation.

Furthermore, Table 1 also shows the HRD managers desired to improve their current level of T&D design practices. Since the intentions of HRD managers also play key roles in T&D practices, those findings are very much interesting from the perspective of theory of planned behavior in which a person's intention to perform a behavior is the most important immediate determinant of the action (Ajzen, 1991).

In general, even though there are some variations in practice the evidences form the study showed that most of the T&D practices within Ethiopian large manufacturing firms appeared to have the pressing needs to better develop their T&D practices to a significantly higher level. However, there were some slight differences between the qualitative and quantitative results of current T&D practices. The quantitative results showed nearly average level of current level of T&D design practices of firms while the qualitative results seem to indicate even lesser than average practices. Regardless, the take-home lesson in both cases is that those large manufacturing firms generally had practically lower current level of T&D design practices than what one might expect from firms of their size.

4.3. What limitations exist to constrain T&D activities of large manufacturing firms in Ethiopia?

Six major obstacles affecting the effectiveness of the firms T&D practices were identified. These included: lack of systematic T&D practices, unavailability of training programs related to core operations of firms and un-matching of training schedules with that of external providers, ill-defined purposes of training, poor training transfer, lack of awareness and unsupportive attitudes as well as lack of T&D resources and appropriate T&D organizations.

4.3.1. How can large manufacturing firms in Ethiopia resort to more structured T&D practices?

There are various alternative approaches available for large manufacturing firms in Ethiopia to structure their T&D practices and use the opportunity to standardize the processes. It is a

possibility that such a structured process may lead to standardized certification of employees. From observation, there are practices in which external trainers offer certificates of completion after employees attend training events on-the-job. However, these certificates are only evidences of completion or attendance. International Standard Quality Management Guidelines for Training emphasize the need for appropriate training practices in organizations (ISO 9000:2000, 1999). This ISO standard for training also provides guidelines to assist firms and their employees when they address issues related to training within the ISO 9000 family of quality assurance and quality management standards.

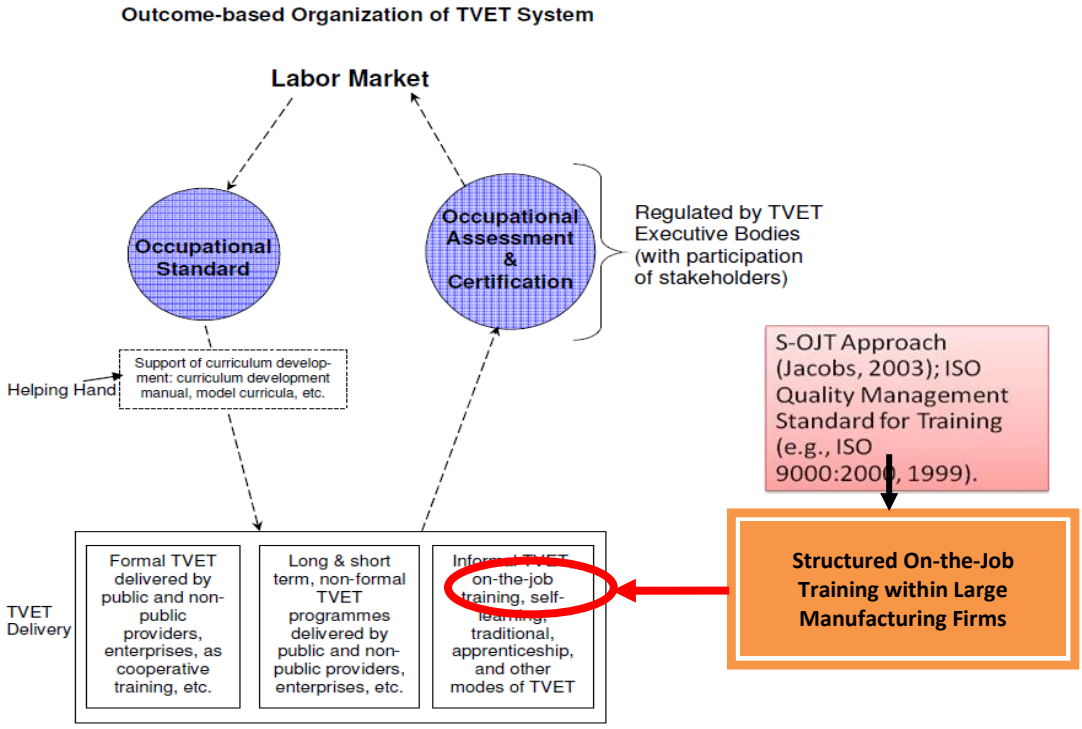

Figure 2: *Outcome based organization of TVET system of Ethiopia*

On the other hand, approaches such as structured on-on-the job training (S-OJT) when implemented as system (Dobbs, 2006) within firms may help them to standardize their T&D practices and could easily be connected with external certification mechanisms such as National Occupational Assessment and Certification in Ethiopia (FDRE Ministry of Education, 2008). Figure 2 shows where the outcome of structured training delivered on-the-job within firms can be linked with Outcome-based Organization of TVET System for the purpose of external certifications.

5. Implications

The findings of this study have two levels of implications: firm and industry/national level implications.

5.1. Firm Level Implications

Particularly for the people involved in the actual production process, human resources are one of the most important assets of any manufacturing organization (Tennant, Boonkrong, & Paul, 2002). Even if it is agreed that training and development is not supposed to be considered as a cure for every type of organizational problem, employee T&D must become a corporate obsession in Ethiopian large manufacturing firms for the fact that it is on this variable that the outcome of the overall competitive struggle of a firm may most strongly depend (Motwani, Fraham and Kathawala, 1994).

The findings of this study imply the need for the firms to develop systems view and practice of T&D in particular and HRD in general (Jacobs, 1990). A successful T&D practice cannot be isolated from the system it supports. Interestingly, systems approach to HRD should begin by identifying the organizations' business objectives and strategies (Jacobs, 2003; Abdullah, 2009). It is also necessary for the firms to support the T&D activities with adequate resources (such as T&D budget and personnel) and proper organization structure (responsible department). However, it is suggested that such decisions need to be justified with adequate cost benefit analysis for each of the firms.

Furthermore, the results also imply strong support to the need for more focus on training activities delivered on-the-job. Lack of external providers for custom made training contents, challenges of conflicting training schedules, and concerns from managers over fear of slowing down or interruption of production process are some of the supporting evidences. Our argument in support of the need for firms to resort into on-the-job training practices that are delivered within the firms rather fundamentally hinges on the relative benefit of on-the-job training activities when delivered in a structured way than the customary off-the-job training activities (Jacobs, 2003).

The literature suggests that structured on-the-job training (S-OJT) approach addresses those key concerns of T&D practices of the manufacturing firms through helping them benefit in three ways. First, customizes trainings to meet specific needs (Jacobs, 2003); second, enables firms to use their own experts and experienced employees with better instruction to become a trainer (Johnson & Leach, 2001); third, strengthen current on-the-job training practices of firms and helps them benefit better from structured and planned approaches than the unstructured one. There are enough empirical evidences to justify the benefits of structured on-the-job training (e.g. Jacobs, Jones, & Neil, 1992). According to Stolovitch & Ngoa-Nguele (2001), for economically less-developed countries, S-OJT appears to be a "natural" solution because it is relatively inexpensive, does not require highly specialized expertise to create and implement, and has demonstrated very high return in terms of transfer of learning and productivity payoff.

Based on the evidences from the findings, we argue in support of the need for firms to resort into on-the-job training practices that are delivered within the firms because of the relative benefits that on-the-job training offers when delivered in a structured way than the customary off-the-job training activities (Jacobs, 2003).

On the other hand, to help with structuring their T&D practices, manufacturing firms can implement International Standard Quality Management Guidelines for Training emphasize the need for appropriate training practices in organizations (ISO 9000:2000, 1999).

5.2. Industry/National Level Implication

Improving T&D activities to desired levels of practices at firm-level could mainly be the responsibilities of individual organizations. However, taken together at industry level, what individual firms do to develop their respective employees will obviously have both industry and national level implication and impact. As a result, we believe that such HRD practices do deserve some sort of attention from the government in terms of policy and some level of supports in integrating efforts and resources. Since, from national HRD perspective, skills developed within firms are part of the labor market, various stakeholders may come together to ensure that training and development of employees in the manufacturing industries are practiced in such a way that improves industry performance and consequently national competitiveness.

For example, considering the implementation of structured on-the-job training approaches in Ethiopian large manufacturing firms can provide an opportunity for potential partnership among manufacturing firms, relevant government agencies, and institutions that could provide assistances to firms in helping them structure on-the-job training contents. Accordingly, this may lead to some kinds of cooperation among key players such as manufacturing firms/industries, government (financing and assessment & certification), universities (structuring instruction, training skills, etc).

In general, the results of this study have enormous implications for practice and most of them have strong support from the literature. In today's very competitive business environment, in order to do well in the global marketplaces, meeting international standard practices is a requirement than an option for manufacturing firms. To win in the knowledge economy, HRD practices as well need to be standardized and focus on the transfer of knowledge and refinement of skills needed to meet the requirements that are associated with the development, production and dissemination of International Standards.

Proposed Model

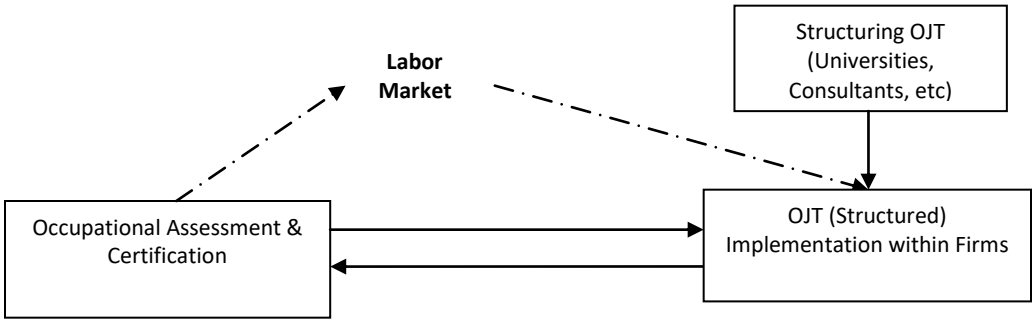

Figure 3**:** *Proposed Collaboration Model among key stakeholders*

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Application of Solar Air Heater in Drying Agricultural Products to Boost the Ethiopian Economic Development

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Abstract

Ethiopia, one of the biggest countries of East Africa is under fast growing economy. As energy is the base for any economic development, the government is giving high attention in finding alternate sources of energy to fulfill a high demand for energy supply in order to boost the development of the country. One of the best methods of fulfilling this energy demand is by increasing the use of renewable energy resources such as solar energy, which is freely available and because of its proximity to the Equator, Ethiopia receives adequate sunshine throughout the year.

In Ethiopia coffee is the main export item and the back bone of the country's economy but as coffee is produced by the farmers in more traditional way the quantity and quality of the coffee decrease during drying process. This is due to the fact that in villages most of the farmers dry the coffee by nesting on the rod where vehicles pass over it and most of the coffee will be lost there where the quality is also depreciate. The use of solar driers will reduce the quantity loss as well as will improve the quality of the coffee as well as drying time. This paper is going to investigate a better performance solar air heater with surface mounted inclined delta shaped obstacles that can be used in drying agricultural product like coffee. A three dimensional CFD analysis and experimental investigations of fluid flow and heat transfer characteristics in a rectangular duct having delta shaped obstacles mounted on one surface, is done. A rectangular duct of aspect ratio (AR) 6 has been selected for this study. One of the four walls of the duct is provided with obstacles and subjected to a constant heat flux while other walls are smooth and insulated. The computational model of the present physical domain is developed using GAMBIT 2.4 and the analysis is carried out using ANSYS FLUENT 12.1 commercial software package.

Key words: *Solar air heater, Obstacles, Agricultural product, Ethiopia*

1. Introduction

Drying involves the removal of moisture from agricultural produce so as to provide a product that can be safely stored for longer period of time.

"Sun drying" is the earliest method of drying farm produce ever known to man and it involves simply laying the agricultural products in the sun on mats, roofs or drying floors. This has several disadvantages since the farm produce are laid in the open sky and there is greater risk of spoilage due to adverse climatic conditions like rain, wind, moist and dust, loss of produce to birds, insects and rodents (pests); totally dependent on good weather and very slow drying rate with danger of mould growth thereby causing deterioration and decomposition of the produce. The process also requires large area of land, takes time and highly labour intensive.
Recently, efforts to improve "sun drying" have led to "solar drying". In solar drying, solar dryers are specialized devices that control the drying process and protect agricultural produce from damage by insects, pests, dust and rain.

In comparison to natural "sun drying", solar dryers generate higher temperatures, lower relative humidity, lower product moisture content, reduce spoilage and no quantity loss at all during the drying process. In addition, it takes up less space, less time and relatively inexpensive compared to artificial mechanical drying method. Thus, solar drying is a better alternative solution to all the drawbacks of natural drying and artificial mechanical drying (GEDA, 2003).

The solar dryer can be seen as an alternative method in securing food and energy for sustainable development of Ethiopia. With drying, most agricultural produce can be preserved and this can be achieved more efficiently through the use of solar dryers.
Solar dryers are a very useful device for:

- Agricultural crop drying.
- Food processing industries for dehydration of fruits and vegetables.
- Fish and meat drying.
- Dairy industries for production of milk powder.
- Seasoning of wood and timber.

- Textile industries for drying of textile materials, etc.

Thus, the solar dryer is one of the many ways of making use of solar energy efficiently in meeting man's demand for energy and food supply.

Also, food scientists have found that by reducing the moisture content of food to 10 to 20%, bacteria, yeast, mold and enzymes are all prevented from spoiling it. Micro organisms are effectively killed when the internal temperature of food reaches 145°F (Herringshaw, 1997). The flavour and most of the nutritional value of dried food is preserved and concentrated (Scalin, 1997). Dried foods do not require any special storage equipment and are easy to transport (Scalin, 1997). Dehydration of vegetables and other food crop by traditional methods of open-air sun drying is not satisfactory, because the products deteriorate rapidly (Whitfield, 2000).

Studies showed that food items dried in a solar dryer were superior to those which are sun dried when evaluated in terms of taste, colour and mould counts (Nandi (2009), Ayensu (2000). Solar dried food are quality products that can be stored for extended periods, easily transported at less cost while still providing excellent nutritive value.

Drying preserves foods by removing enough moisture from food to prevent decay and spoilage. Water content of properly dried food varies from 5 to 25 percent depending on the food. Successful drying depends on:

(i) Enough heat to draw out moisture, without cooking the food;
(ii) Dry air to absorb the released moisture; and
(iii) Adequate air circulation to carry off the moisture.

The solar dryer consists of two major compartments:

- ✓ The solar collector compartment, which can also be referred to as the air heater.
- ✓ The drying chamber, designed to accommodate a layers of drying trays.

The performance of this solar dryer is highly depending on the efficiency of the solar collector compartment (air heater). But the thermal efficiency of solar air heaters (SAHs) has been found to be generally poor because of their inherent low heat transfer capability between the absorber plate and air flowing in the duct, which increases the absorber plate temperature, leading to

higher heat losses to the environment resulting in low thermal efficiency of such collectors. Low heat transfer coefficients result from the poor thermal conductivity of air.

In order to increase the thermal performance of SAH, various designs with different shapes and dimensions of the air flow passage in flat plate-type solar air collectors have been developed in the literature (Dipprey and Sabersky 1963, Hollands and Shewan 1981, Choudhury and Garg 1991, Hachemi 1995, Hegazy 2000,Yeh et al. 2000, Moummi et al. 2004).

In the present work, a better performance solar air heater is going to be investigated using delta-shaped obstacles mounted on the absorber surface at angle of 60°.

2. Model ling

2.1. Physical Model

The physical model used in the present study consists of a long rectangular duct with inlet, test and outlet sections as shown in Fig. 1. The length of inlet section has been taken as 800 mm, which is greater than $5\sqrt{WH}$ as per recommendations of ASHRAE Standard 93-77, 1977 to get fully developed flow at the inlet of the test section. Similarly, the outlet length of 500 mm, which is greater than$2.5\sqrt{WH}$, is provided to remove any downstream effects on the test section; where *W* is the width and *H* is the height of rectangular duct. Air enters the inlet, gets heated in the test section and comes out from the outlet section. The inlet and outlet sections are insulated.

The top broad wall of the test section is provided with constant heat flux and all other walls of the duct are kept insulated. A number of obstacles are nested under the heated wall to enhance heat transfer coefficient between the hot wall and air.

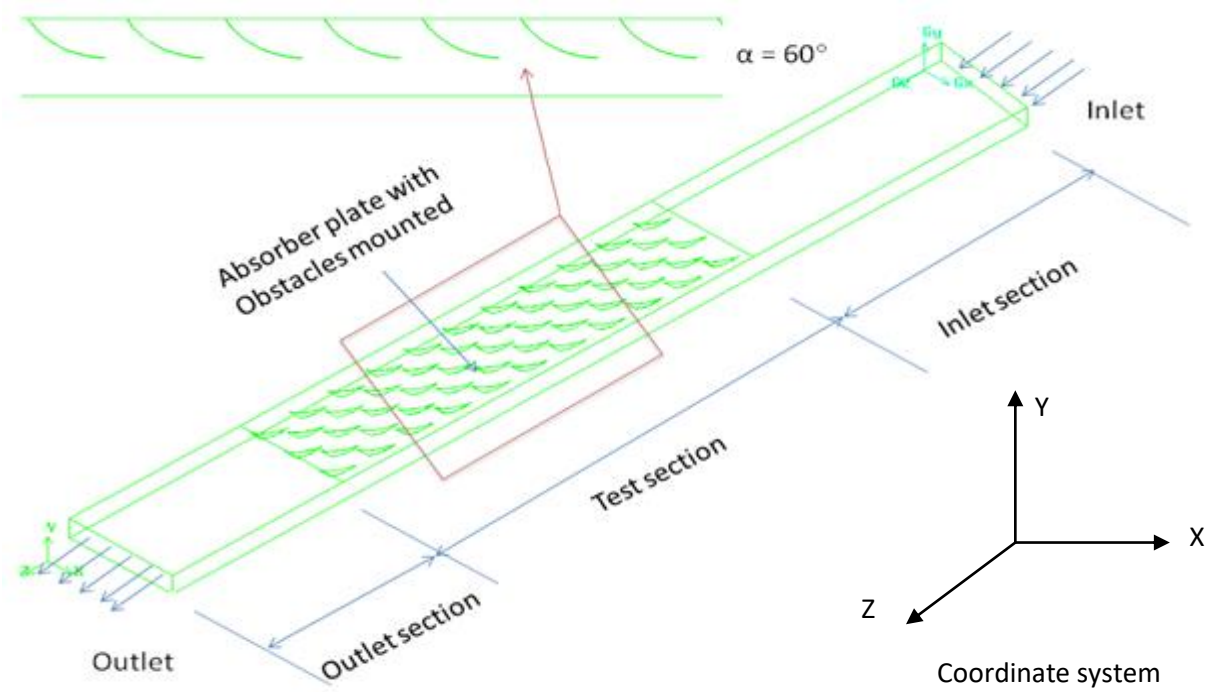


Fig. 1. Physical model with coordinate system

2.2. Assumptions

In the present analysis, the following assumptions have been incorporated:

1. The flow is considered incompressible **(**Mach number in the system of the present interest, namely solar air heater, is less than 0.3).
2. Body forces are negligible.
3. The flow obtained at the inlet of the test section where heating begins, is fully developed turbulent flow.
4. The properties of air are constant at local atmospheric pressure and mean air temperature. The variation in the properties is very small within the range of pressure and temperature involved.
5. The conduction resistance of the heated plate (i.e. the top wall of the test section of the duct) is negligible. The thickness of the heated plate is very small in comparison to the surface area normal to the heated flow. This satisfies the condition Biot number (Bi) << 0.1, which allows to neglect the internal conduction resistance in comparison to convective resistance (i.e. not treated as a conjugate heat transfer problem). (Incropera and Dewitt 2006).

6. The viscous dissipation is considered negligible in the energy equation. The viscous dissipation is significant only for flows at high velocities. For systems like solar air heater, with low velocities of flow it is negligibly small.
7. The axial heat conduction in the fluid is negligible (It is so when Re. Pr > 100 (Kays 1966)).
8. Steady state flow and temperature fields are analyzed.
9. The temperature field is fully developed near the end of the test section.
10. The effect of natural convection is assumed to be negligible.

2.3. Selection and Validation of Suitable Turbulence Model

The selection of suitable turbulence model used for analysis has been carried out in three steps:

1. The preliminary selection of suitable turbulence models from literature.
2. Selection of suitable models from amongst the first proposed models after being applied to smooth duct and comparing the result with standard correlations available.
3. The final selection of the most suitable model from the models selected in step 2 after being used for the analysis of the obstacles mounted duct and comparing the results with the experimental results.

Since the present analysis is concerned with heat transfer enhancement due to the obstacles mounted on broad heated wall of rectangular duct, the influencing parameters are both obstacle and flow field. Hence, to predict the heat transfer from the surface to the flowing fluid, the model should have capability to resolve the flow right down to the wall. Therefore, the following turbulent models are found to be suitable for the current type of studies. Standard k-ε model, Renormalization group (RNG) k-ε model, Realizable k-ε model, standard k-ω and Shear Stress Transport (SST) k-ω Model. These models are first used for smooth duct analysis as shown in the Fig. 2 and among these the best models approaching the standard correlations available in literature like the "Dittus Boelter correlation", are the Standard k-ε model and Realizable k-ε model. These models are further used for obstacles mounted duct analysis and after the result is being compared with the experimental one, it is found that the Realizable k-ε model with enhanced wall treatment is best approaching the experimental result of the present study and used for the rest of analysis. The validation of the present selected numerical turbulent model with the experimental result is shown in Fig. 3.

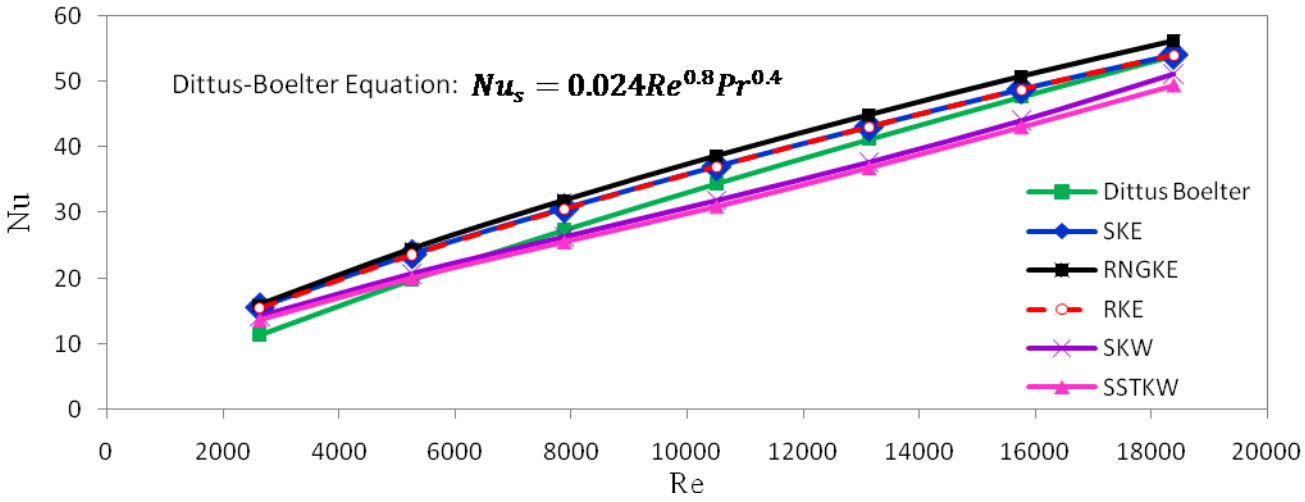


Fig. 2. Smooth duct analysis for selection of suitable turbulent model

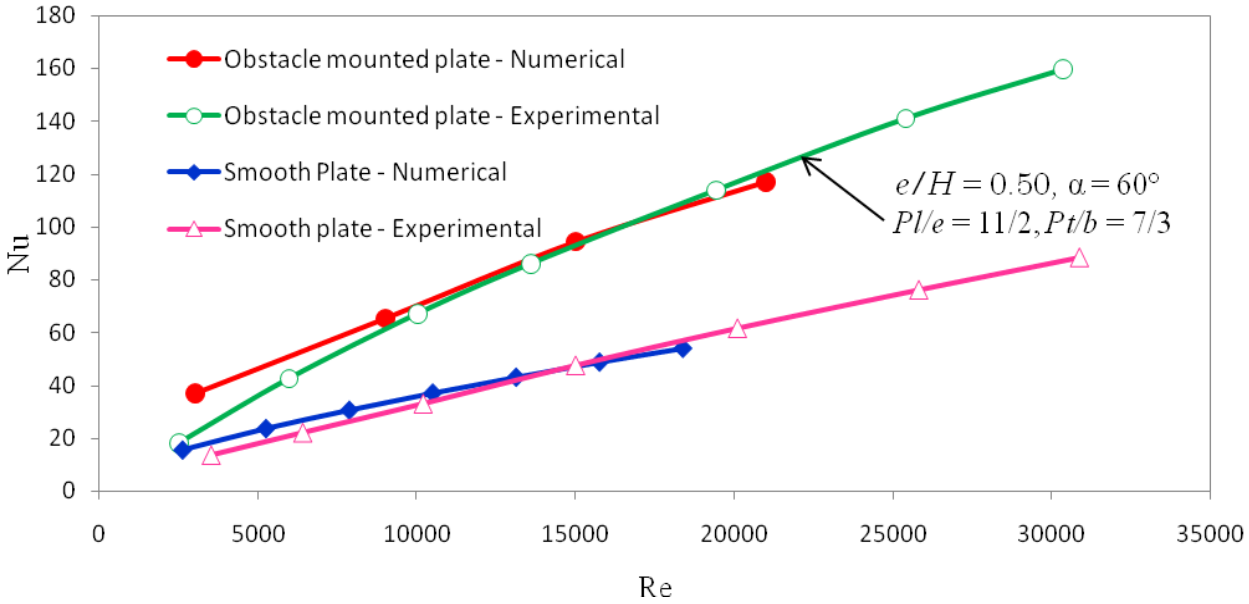


Fig. 3. Validation of the numerical result using the Rk-ε model with the corresponding experimental Result

3. Computational Procedure

3.1. Creating the Geometry

The geometry is created on GAMBIT preprocessor by "bottom up" approach. In bottom up approach, first the vertices are created in three-dimensional Cartesian coordinate system. Then connecting these vertices, edges are formed. From these edges, faces are created and finally the volume of the flow model is created from these faces. It is quite impossible to construct and analyze the whole geometry of flow domain because of tremendous computational efforts

required for this purpose. In this CFD analysis only a portion of the test section is modeled assuming the flow is fully developed at the point.

3.2. Meshing the Geometry

In order to accurately predict the result, the mesh near the obstacle should be very fine, thus a "fixed size function" is attached to all surfaces of the obstacles and to the absorber plate (Fig 4). Tetrahedral/Hybrid mesh element with T-Grid meshing scheme is used for meshing the model. The quality of the mesh is checked for equi-size skew and it is found to be below 0.75.

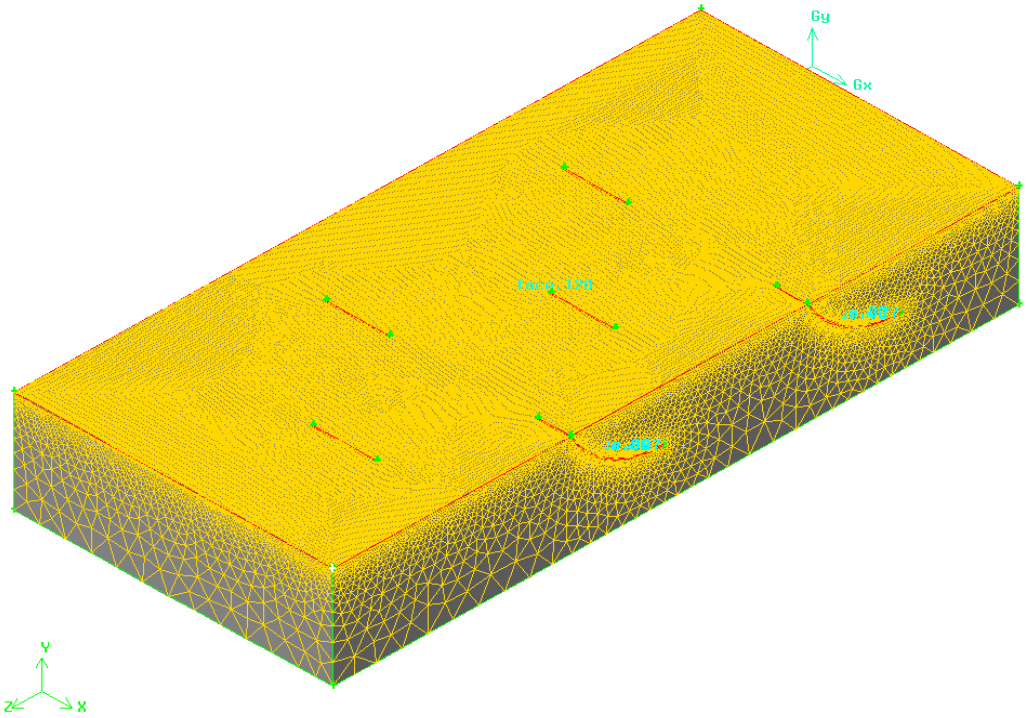


Fig. 4. Mesh of computational model P_l/e = 3/2, P_t/b = 7/3, e/H = 0.50, α = 60°, Number of cells = 2,822,417

3.5. Specifying the Boundary and Continuum Types

Before specifying the boundary and continuum types, the type of solver is required to be opted. Here, Fluent 5/6 solver is opted. Then the boundary types are specified at different faces as follows: "Velocity Inlet" for inlet face, "Pressure outlet" for outlet face, "Symmetry" for one side wall and "Wall" boundary conditions for the other faces. In specifying continuum types, panel fluid is selected for the model. Finally the mesh file is exported to the fluent solver.

3.6. Solution Process

3.6.1. Problem Setting

Pressure-based (Segregated) solution method is used to discretize and solve the governing equations for steady state condition. This approach solves for a single variable field by considering all cells at the same time. It then solves for the next variable field by again considering all cells at the same time, and so on. Since this analysis includes the heat transfer effect, the energy option is set on to solve for energy equations. Then the Realizable k-ε turbulent model is selected as discussed previously with enhanced wall treatment option for near wall treatment. For the heated plate material, steel is selected and the property of steel is supplied. Finally the boundary condition is set as follows:

Uniform velocity at inlet, uniform temperature at inlet, outlet pressure (atmospheric pressure), constant heat flux ($q'' = 800\ W/m^2$) on broad top section of the test section and all other walls as adiabatic. In addition, turbulence intensity at inlet and hydraulic diameter of the model are also given.

3.6.2. Solution

SIMPLEC algorithm is used to compute the flow field by pressure velocity coupling method and second order upwind scheme is used for discretization of convective terms. During the solution process, the convergence is monitored dynamically by checking residuals and surface integrals. Surface heat transfer coefficient is used as a variable for monitoring surface integral. When this value stops changing, the iteration can be stopped. The convergence criteria used for monitoring the residuals is as given in Table 1. Finally the solution is initialized and the iteration will start.

The convergence plot of scaled residuals (Fig. 5) shows that after about 400 number of iteration the residuals are settled and continuously decrease and seems to become constant after 2000 number of iterations. The convergence history plot of surface heat transfer coefficient on the absorber plate (Fig. 6) shows that from 1200 - 2100 number of iteration the surface heat transfer coefficient remains constant showing that the solution is converged.

The Wall Y^+ on the absorber plate (Fig. 7), which is less than 1.9 shows that the near wall mesh is fine enough and viscous sub layer is properly resolved. So the enhanced wall treatment method used for near-wall treatment is appropriate.

Table 1: Convergence criteria for monitoring residuals

S. No.	Residual	Convergence Criteria
1	Continuity	0.00001
2	X - Velocity	0.00001
3	Y - Velocity	0.00001
4	Z- Velocity	0.00001
5	Turbulent kinetic energy, k	0.00001
6	Specific dissipation rte, å	0.00001
7	Energy balance	0.000001

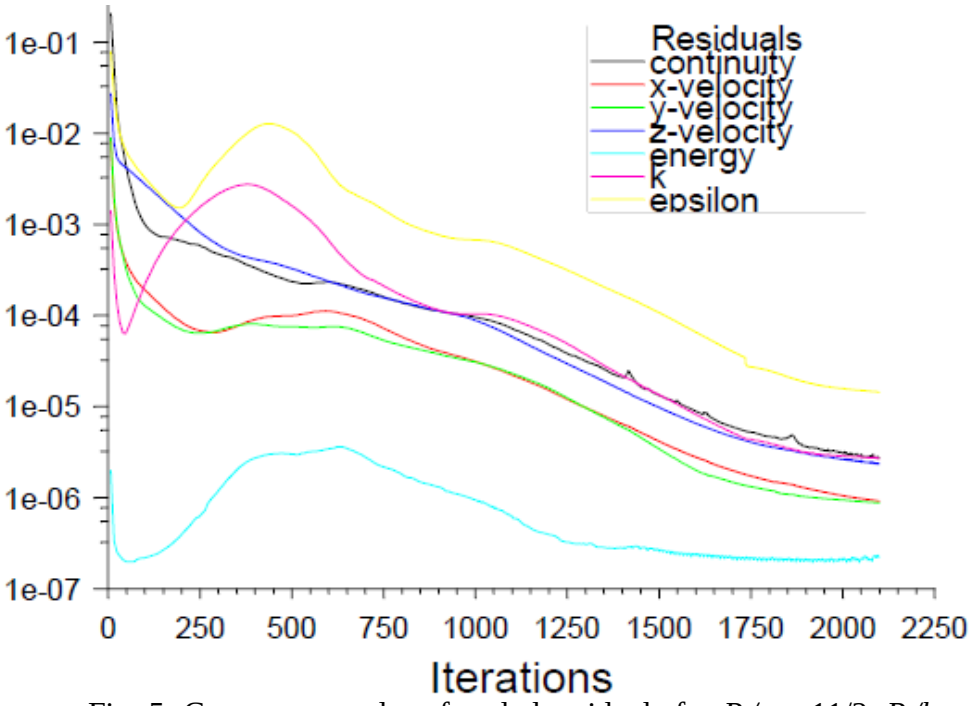


Fig. 5. Convergence plot of scaled residuals for P_l/e = 11/2, P_t/b = 7/3, e/H = 0.50, α = 60°, Re = 3000

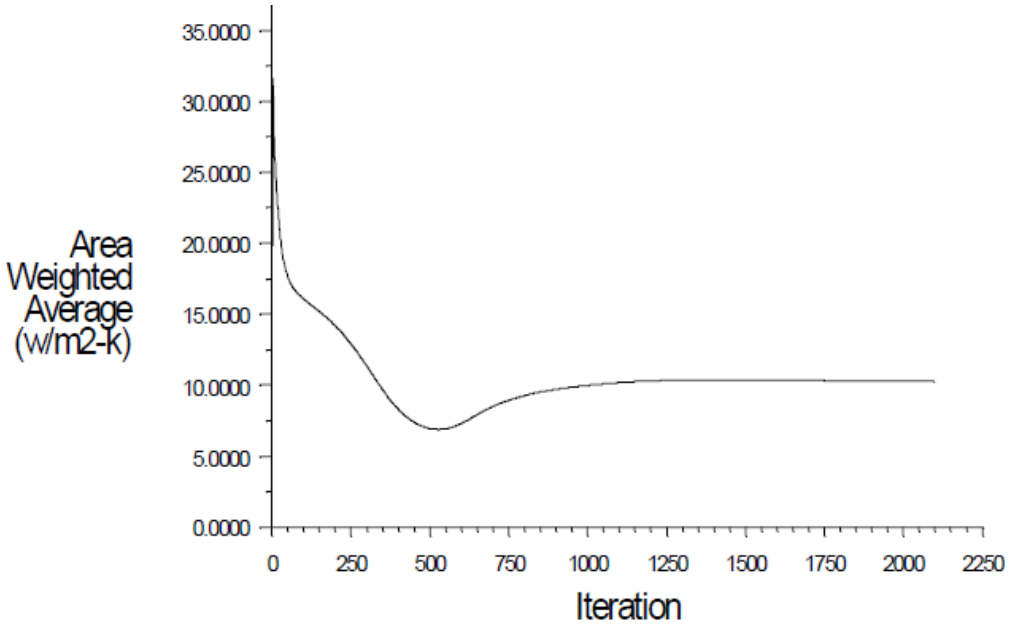


Fig. 6. Convergence history plot of Surface heat transfer coefficient on the absorber plate for P_l/e = 11/2, P_t/b = 7/3, e/H = 0.50, α = 60°, Re = 3000

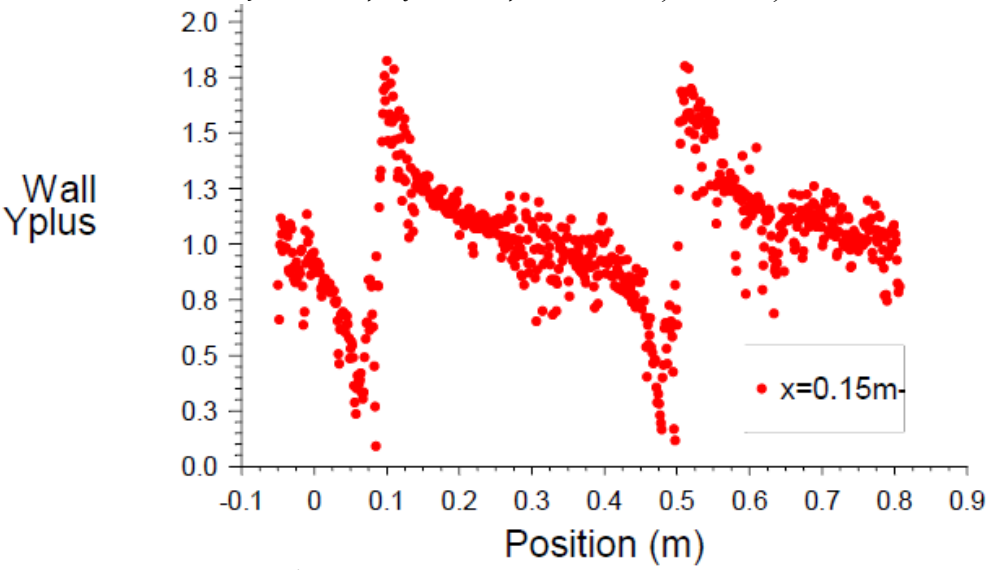


Fig. 7. Wall Y^+ plot on the center line of absorber plate for P_l/e = 11/2, P_t/b = 7/3, e/H = 0.50, α = 60°, Re = 3000

3.6.3. Grid Independence

For grid independence test, a solution adaptive refinement method is used. By using solution-adaptive refinement, cells can be added where they are needed in the mesh, thus enabling the futures of the flow field to be better resolved.

Sample grid independence test result for P_l/e = 11/2, P_t/b = 7/3, e/H = 0.50, α = 60 is given in Table 2. It shows that after about 2,488,032 numbers of cells, the variation in the value of convective heat transfer coefficient is negligible. Hence, the further analysis is carried out using mesh with 2,488,032 numbers of cells.

Table 2: Grid independence test result for P_l/e = 11/2, P_t/b = 7/3, e/H = 0.50, α = 60°

S. No	Number of Cells	Convective heat transfer coefficient, h [W/m^{2}K]
1	624967	4.46
2	1080577	5.013
3	1857752	5.847
4	**2488032 ***	**6.226**
5.	3117976	6.246

4. Results and Discussion

All figures are scaled up to show the flow structure clearly. The flow field is investigated in terms of vorticity, velocity contour, and turbulent intensity. Heat transfer phenomenon is studied in terms of static temperature distribution and surface heat transfer coefficient for different obstacles configurations.

4.1. Flow Pattern

Fig.8 shows velocity contour plot, for obstacles angle of attack of 60° at Reynolds number of 3000 and 21000 for minimum (P_l/e = 3/2) and maximum (P_l/e = 11/2) relative obstacle longitudinal pitches. For largest relative obstacle longitudinal pitch (P_l/e = 11/2) the flow reattached before reaching the next obstacle with small vortex upstream and large vortex downstream of the obstacles. Thus there is no interference of vortices for two adjacent obstacles. The velocity pattern obtained for Reynolds number of 3000 and 21000 is almost similar except that the velocity magnitude is very high at Re = 21000. At P_l/e = 3/2, since the distance between successive longitudinal obstacles is small, the flow past the obstacles separate again before fully reattached to reach the next obstacles. So, this study incorporates both a flow with reattachments and a flow without reattachments between obstacles.

4.2. Effect of Vorticity, Turbulence Intensity and Obstacle Arrangement on Heat Transfer and fluid flow

Fig. 9 shows Vorticity Contour plot for angle of attack 60° at Reynolds number of 3000 and 21000. The vortices generated were the result of the introduction or exploitation of secondary flows, rather than the manipulation or alteration of the main flow. As reported earlier, the heat transfer enhancement consists of main-flow enhancement and secondary flow enhancement. Louvered fin, strip fin and wavy wall are examples of main-flow enhancement method. The intentional generation of vortices to enhance heat transfer is a secondary flow enhancement method.

In general there are two types of vortices: transverse vortex (TV) and longitudinal vortex (LV). The rotational direction of a transverse vortex is normal to the main flow direction and the flow is two-dimensional, whereas the longitudinal vortices have their rotating axes parallel to the main flow direction and the flow is three dimensional. In fact, it is impossible to generate pure longitudinal vortices, since transverse vortices are always generated at the same time. The predominance of one over the other depends on the attack angle α. For angle of attack of 60° mainly longitudinal vortices are generated.

The contours of static temperature on the absorber plate presented in Fig. 10 show that the static temperature of the absorber plate next to the obstacles in the downstream direction is very low. This means more heat is lost from the absorber plate at this position and its temperature is lowered. This heat lost from the absorber plate is transferred to the flowing air.

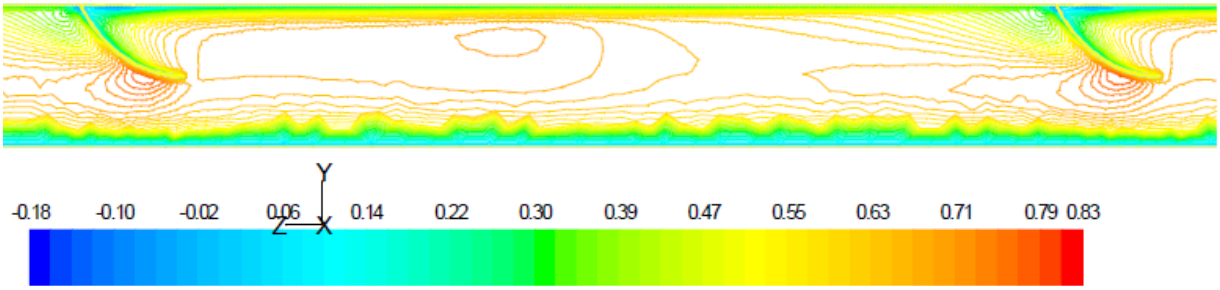
This can also be seen from Fig. 11 for turbulence intensity along the length of the absorber passing through the obstacles, showing the turbulence intensity maximum next to the obstacle in downstream and get lowered as get far from the obstacle up to the next obstacle. Similarly, the convective heat transfer coefficient is maximum next to the obstacle in downstream direction (Fig. 12).

The contour plots of the turbulence intensity caused by these vortices are shown in Fig. 11 for angle of attack of 60° at low Reynolds number (Re = 3000) and high Reynolds number (Re = 21000). Thus it is observed that higher turbulence intensity is occurred just next to the obstacle

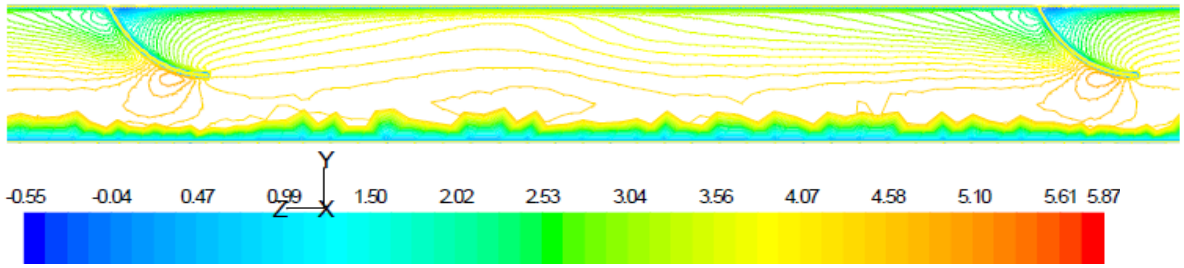
for all angles of attacks at both Reynolds number. This results in increase in convective heat transfer coefficient between the absorber plate and the air at this location (Fig. 12).

In this numerical study, the effect of obstacles arrangement have also been studied and the results for the maximum and minimum relative obstacles longitudinal pitch of the present study (P_l/e = 11/2 and P_l/e = 3/2) are presented. When the relative obstacles longitudinal pitch decreases to P_l/e = 3/2, since the space between obstacles decreases, the vortex generated will continue propagating up to the next obstacles. This will increase the turbulence intensity over the whole length between the obstacles causing heat transfer from larger space of absorber plate than the same in arrangement with larger relative obstacles longitudinal pitch of P_l/e = 11/2 in which the vortex generated die before reaching to the next obstacle. Thus, it has been observed that the turbulent intensity as well as the convective heat transfer is higher for lower relative obstacles longitudinal pitch.

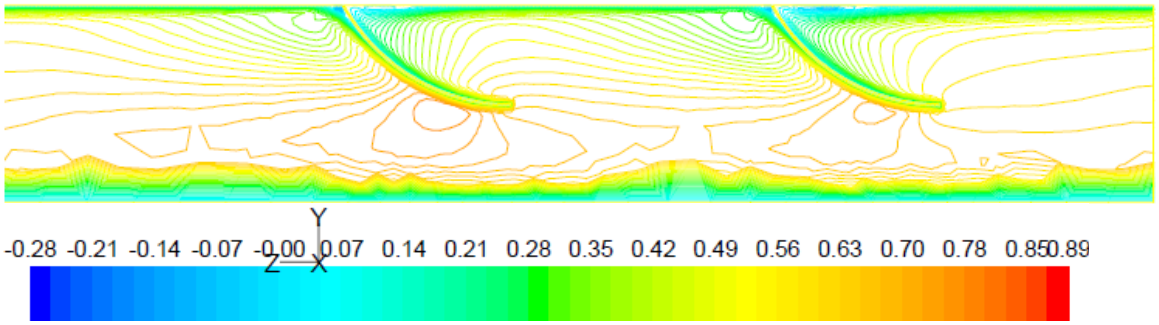
The location of maximum heat transfer coefficient is seen at the location of the obstacles as the flow impinges on the surface of the obstacles. The heat transfer enhancement is most distractive around the obstacle area. In particular, the largest increase in the local heat transfer occurs on the obstacle followed by a sudden drop immediately after the obstacle and rapid recovery of the local heat transfer coefficient before facing the next obstacle.



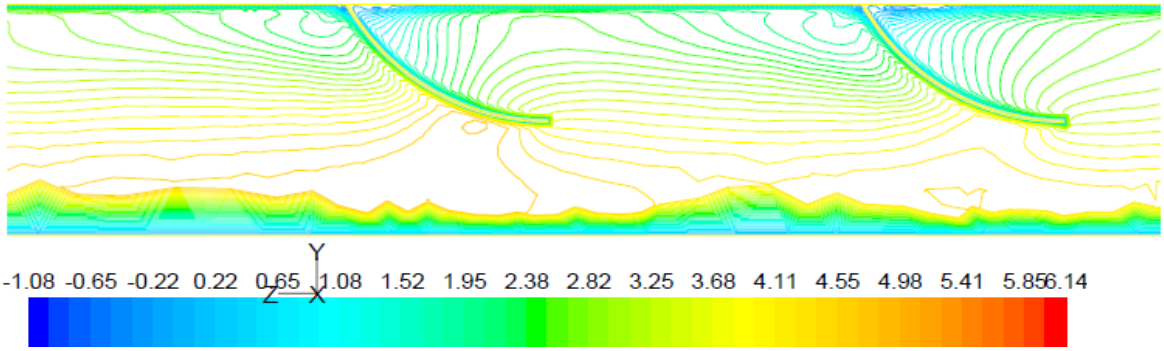
(a) P_l/e = 11/2, Re = 3000



(b) P_l/e = 11/2, Re = 21000

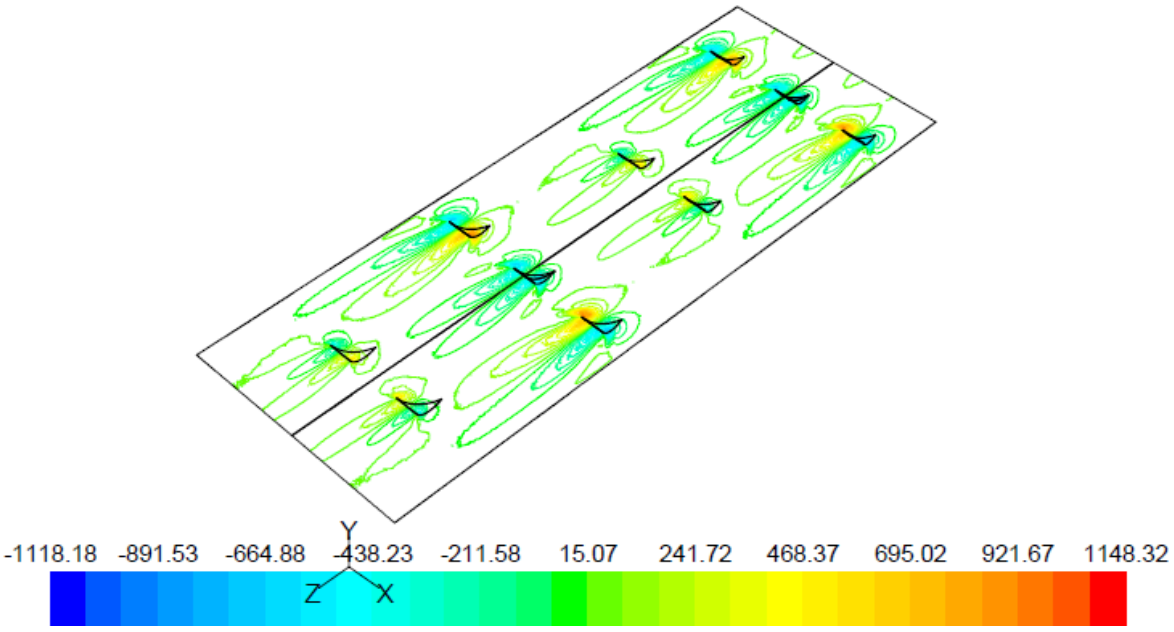


(c) P_l/e = 3/2, Re = 3000

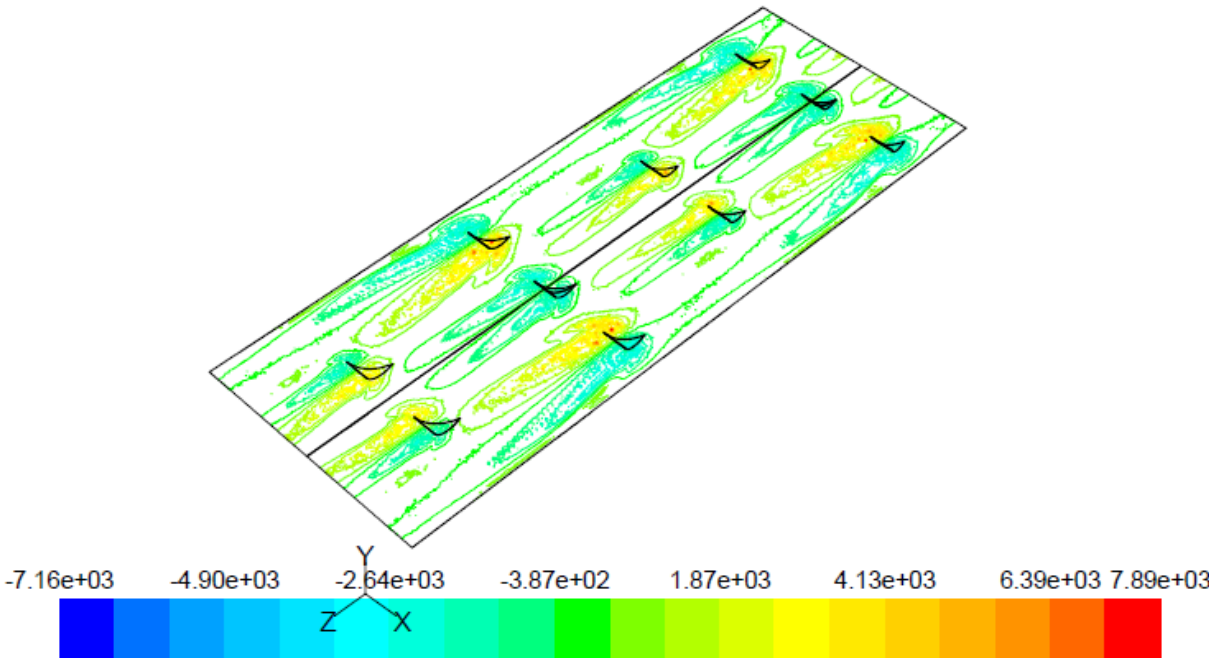


(d) P_l/e = 3/2, Re = 21000

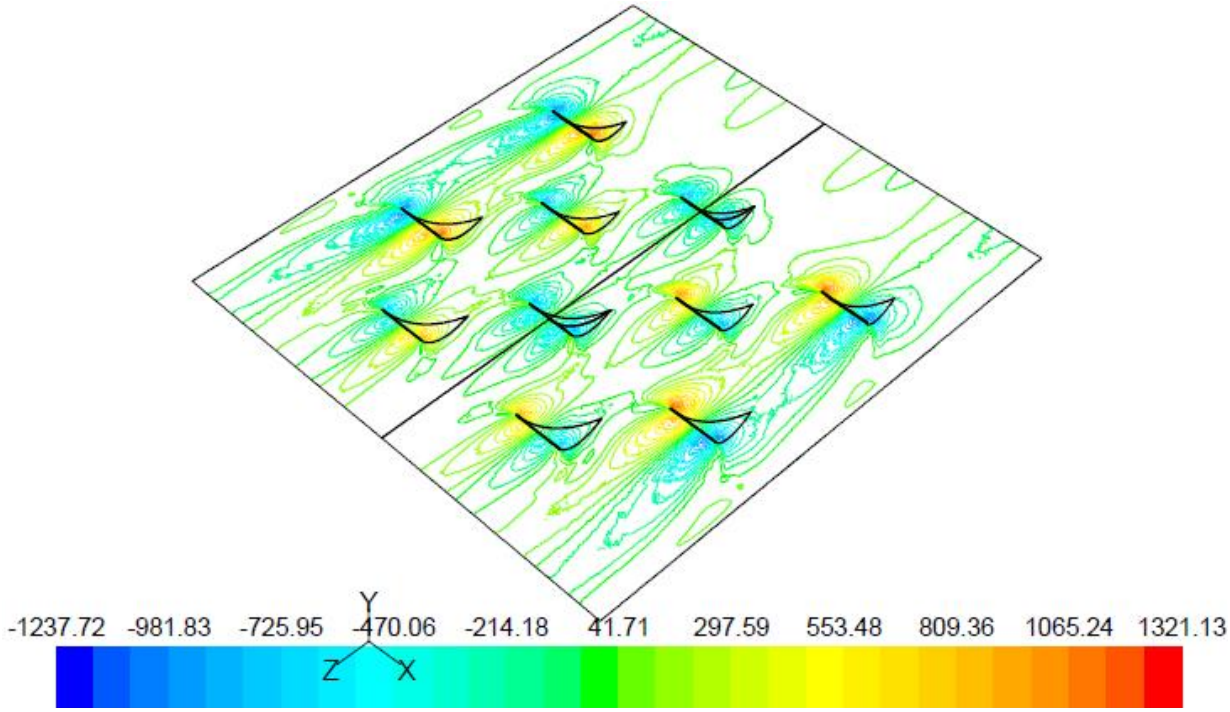
Fig. 8. Velocity contour for P_t/b = 7/3, e/H = 0.50, α = 60° obstacles



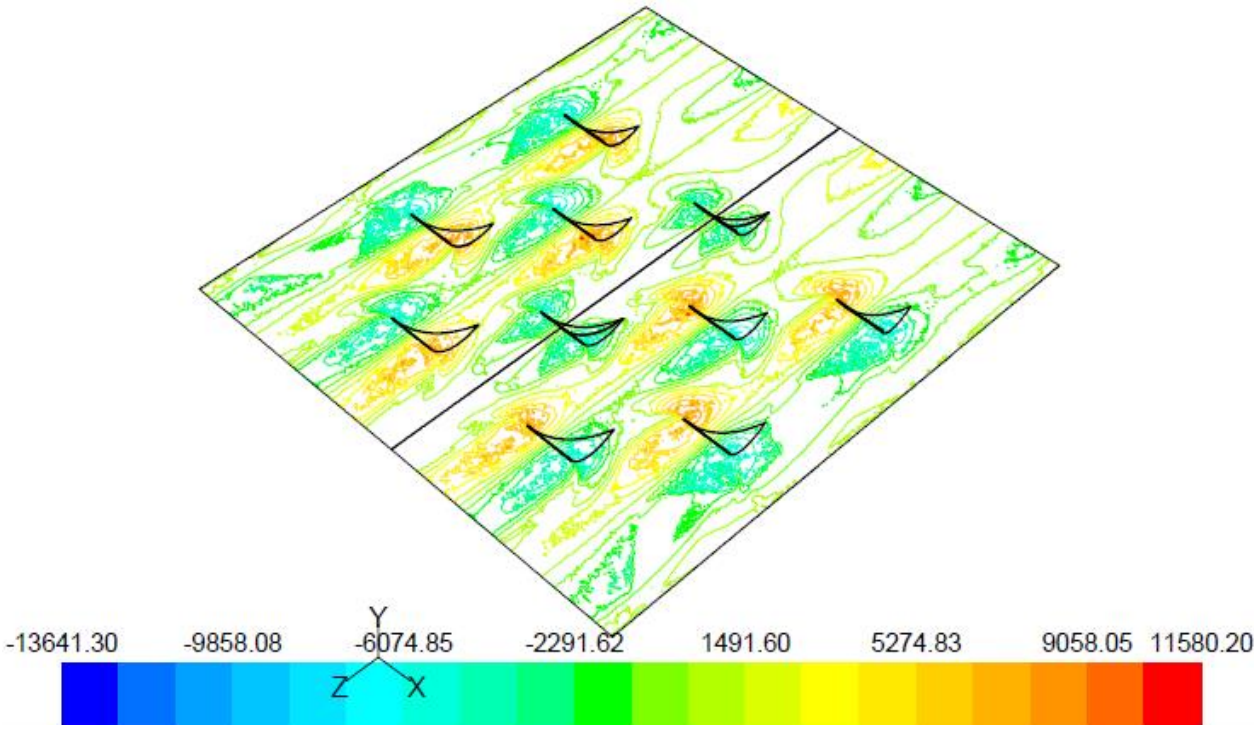
(a) P_l/e = 11/2, Re = 3000



(b) P_l/e = 11/2, Re = 21000



(c) P_l/e = 3/2, Re = 3000



(d) P_l/e = 3/2, Re = 21000

Fig. 9. Vorticity for P_t/b = 7/3, e/H = 0.50, α = 60° obstacles

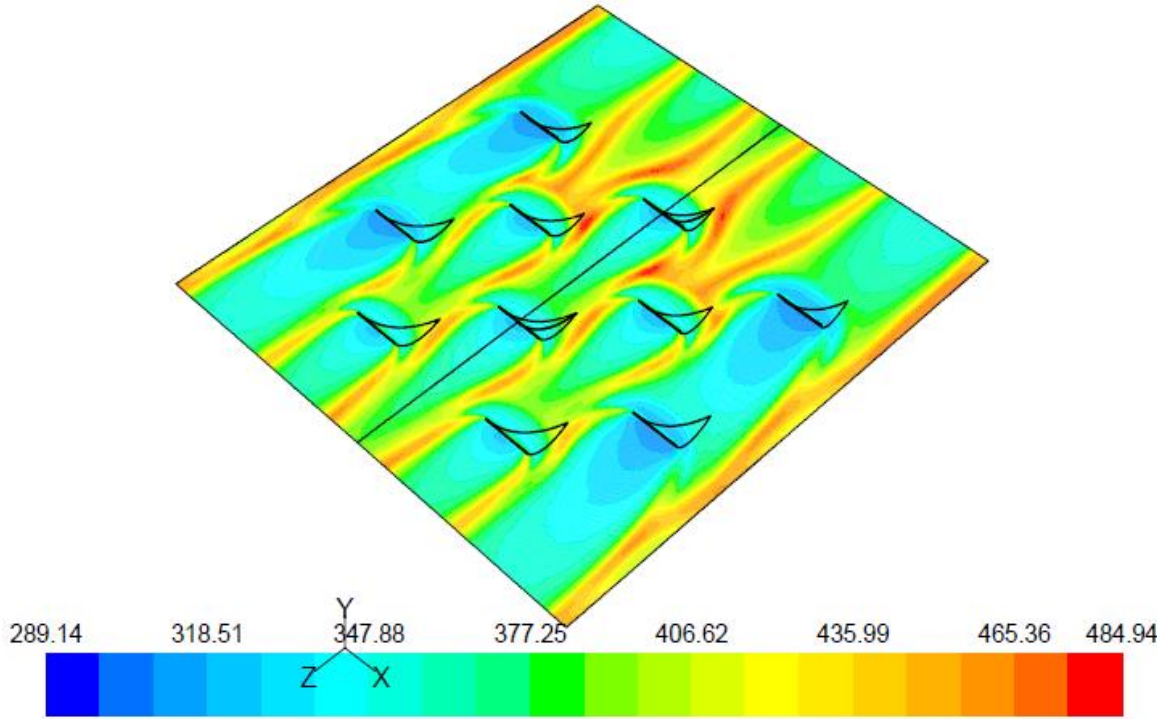


Fig. 10. Static temperature contours for P_l/e = 3/2, P_t/b = 7/3, e/H = 0.50, α = 60°, Re = 3000

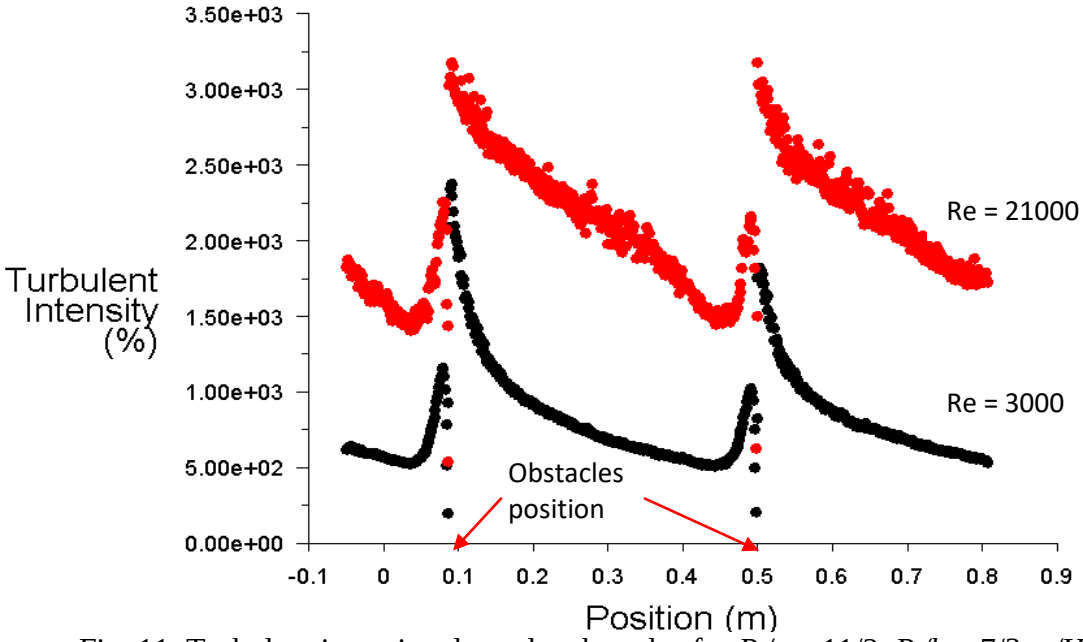


Fig. 11. Turbulent intensity along the obstacles for P_l/e = 11/2, P_t/b = 7/3, e/H = 0.50, α = 60°

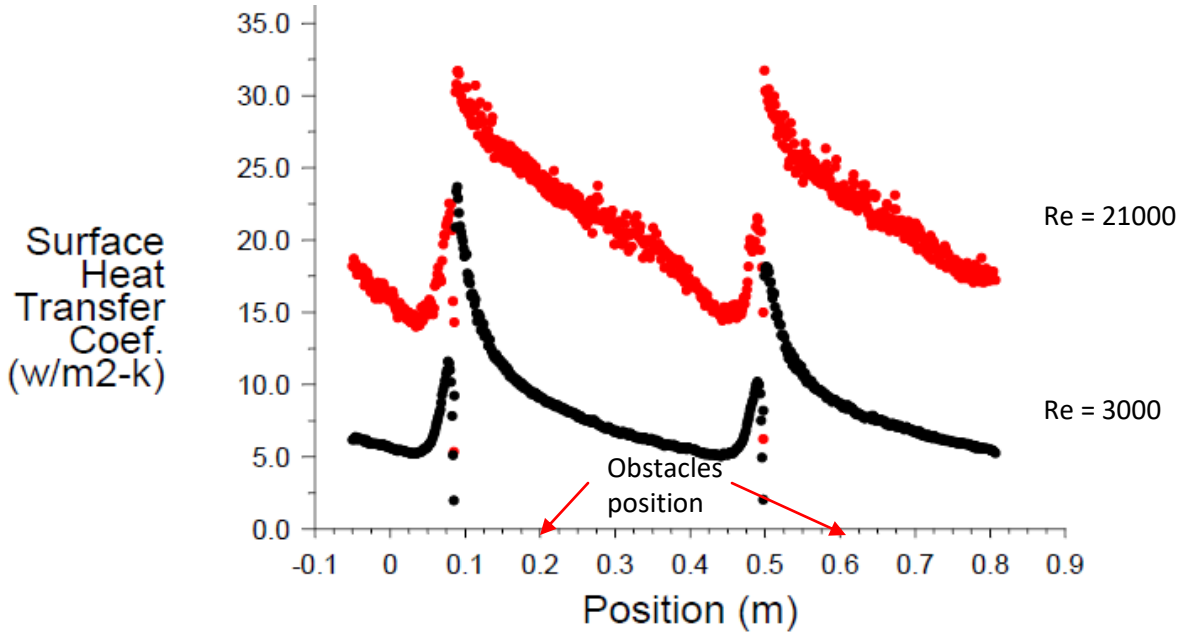


Fig. 12. Surface heat transfer coefficient along the obstacles for P_l/e = 11/2, P_t/b = 7/3, e/H = 0.50, α =60°

The heat transfer enhancement (Fig. 13) obtained from the present study and the corresponding pressure drop (Fig. 14) is figured as follow. The results are very much impressive and shows that when obstacles are mounted at certain angle of inclination (α = 60°), the enhancement in heat transfer is high compared to that of smooth.

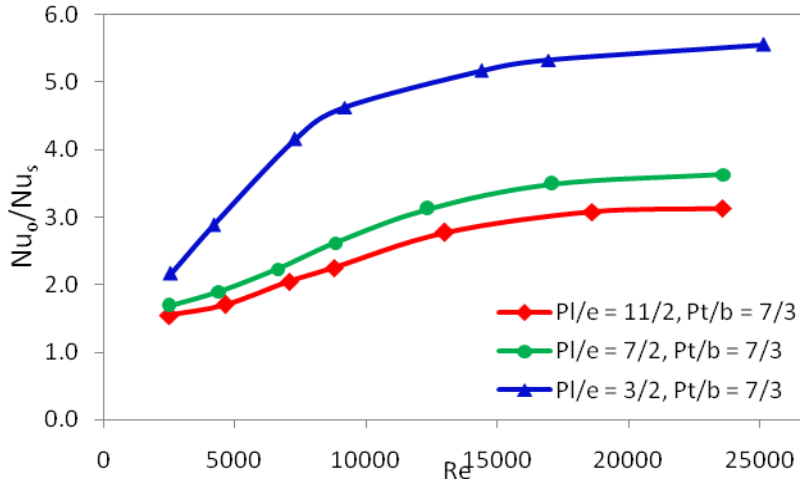


Fig. 13. Enhancement in Nusselt number (Nu_o/Nu_s) as a function of Reynolds number (Re) for *e/H* = 0.50
and α = 60°

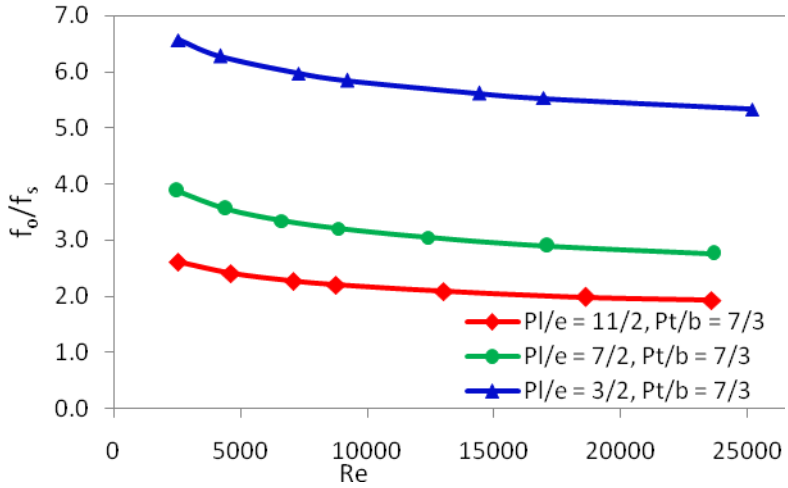


Fig.14: Enhancement in friction factor (f_o/f_s) as a function of Reynolds number (Re) for *e/H* = 0.50 and α = 60°

Thermo-hydraulic performance parameter (ε) can decide whether or not, a given obstacle mounted heat transfer enhancing surface is potentially beneficial. A value of this parameter greater than one is considered to be an acceptable proportion. Thus as shown in the Fig. 15 in all ranges of Reynolds number and for all obstacles longitudinal pitch (Pl/e) the thermo-hydraulic performance parameter is greater than one showing that the use of delta shaped obstacles with the parameters studied are viable for application in solar air heater.

Thermo-hydraulic performance parameter, $$\varepsilon = \frac{St_o/St_s}{(f_o/f_s)^{\frac{1}{3}}}$$

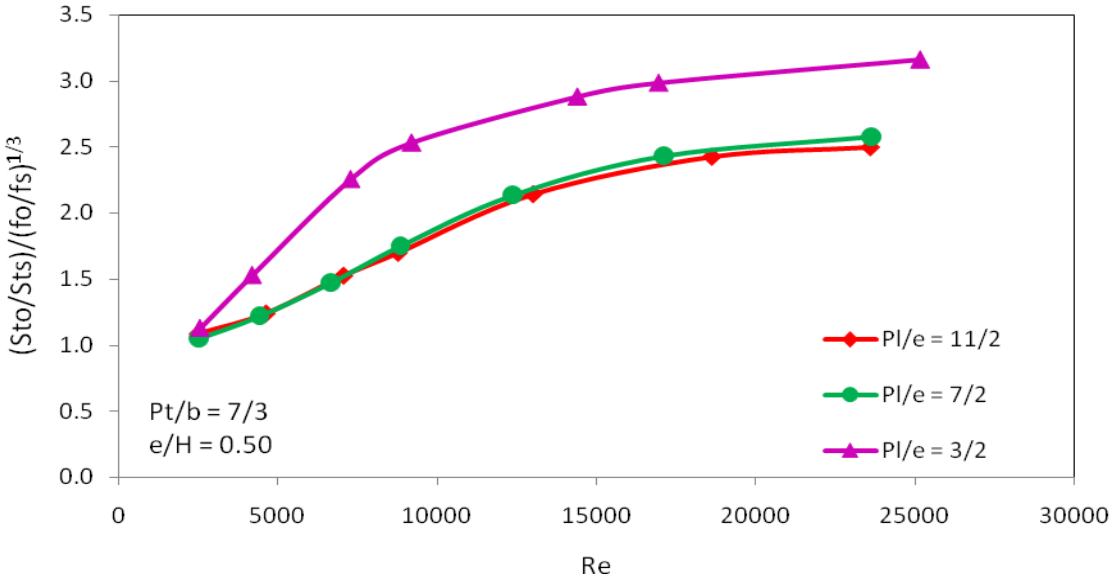


Fig. 15**:** Effect of relative obstacles longitudinal pitch (*Pl/e)* on thermo-hydraulic performance α =60°, *e/H* = 0.50 and P_t/b = 7/3

6.3 Comparison with Previous Work

In order to further see the advantage of delta-shaped obstacles mounted on the absorber plate, the present work is compared with previous works as shown in Table 3. The thermo-hydraulic performance parameter of the present study has been higher than corresponding previous studies. Thus, the present solar air heaters are the best options for drying agricultural products using solar energy (See Table 3 below).

Table 3: Comparison of the present work with the previous works done

S. No.	References	Geometry	Parameters		Nu_o/Nu_s	f_o/f_s	$\frac{St_o/St_s}{(f_o/f_s)^{\frac{1}{3}}}$
1	Parasad and Saini (1988)	Transverse Wire	Re: 5000-50000 e/D_h: 0.02-0.033	P/e = 10 P/e = 15 P/e = 20	2.38 2.14 2.01	2.38 2.14 2.92	1.78 1.66 1.41
2	Saini and Saini (1997)	Expanded wire mesh	Re: 1900-13000 e/D_h: 0.012-0.039 *L/e*: 25-71.87. *S/e*: 15.62-46.87		4	5	2.34
3	Momin et al. (2002)	V-shaped wire Ribs 60° angle of attack	Re: 2500-18000 e/D_h: 0.02-0.034 *P/e*:10, á = 30-90°		2.3	2.83	1.63
4	Bhagoria et al. (2002)	Transverse wedge shape rib roughness	Re: 3000-18000 e/D_h: 0.015-0.033 *P/e*:7.57-12.12 ö = 8-15°		2.4	5.3	1.38
5	Jaurker et al. (2006)	Rib-groove roughness	Re: 3000-21000 e/D_h: 0.018-0.036 *P/e*:4.5-10 g/p: 0.3-0.7		2.7	3.6	1.76
6	Karmare and Tikekar (2007)	Square grit ribs (staggered) á = 60°	Re: 4000-17000 e/D_h: 0.035-0.044 *P/e*: 12.5-36. *l/s*: 1.72-1		2	3	1.39
7	Bopche and Tandale (2009)	Inverted U-shaped tarbulator	Re: 3800-18000 e/D_h: 0.018-0.039 *P/e*: 6.67-57.14 Angle of attack of flow (á) = 90°		2.82	3.72	1.82
8	Present study	Delta shaped obstacles	Re: 2563-25176 e/H = 0.50 Pl/e = 3/2 Pt/b = 7/3 á = 60°		5.55	6.57	3.16

Conclusions

The present research work contains both numerical and experimental investigations of the characteristics of solar air heater with delta-shaped obstacles mounted on the absorber plate at an angle of 60°. The following conclusions have been drawn:

- The numerical analysis has been validated with the experimental one and the results predicted by the Realizable k-ε turbulence model best approaches to the experimental results and hence used for the further analysis of the computational model.
- The flow and heat transfer behavior of the delta shaped obstacles of different arrangements have also been investigated.
- The Nusselt number for both smooth duct as well as duct with delta-shaped obstacles is found to increase with an increase in Reynolds number and with a decrease in relative obstacles longitudinal pitch (Pl/e).
- The friction factor decreases with an increase in Reynolds number for both smooth duct as well as duct with delta-shaped obstacles. The friction factor due to the obstacles is always higher than the smooth duct.
- In order to see the advantage of delta-shaped obstacles mounted on the absorber plate, the present work is compared with the previous works available in literature and the thermo-hydraulic performance in the present study is higher than any of the previous. Thus, the proposed solar air heater with the delta shaped obstacles mounted on the absorber plate meets the expectation of high performance compared with the similar other categories.

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PV-Diesel Based Hybrid Power Systems for Rural Electrification in Ethiopia: A Way Forward for Sustainable Development

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Abstract

The focus of this paper is to show an optimal hybrid power system from the technical and economic view to meet the load requirements of rural sites which are detached from main national electric grid by taking Guaguata kebele near to Bahirdar, Ethiopia; as a case study.

Rural villages in Ethiopia utilize bio mass as main energy sources for cooking uses. However, due to hardship to women and its contribution to the rapid deforestations of the country, biomass sources need to be replaced by other renewable resources. On the other hand, though substantial effort has put to improve agricultural productivity, there exists shortage of food products in the country which cause quality of life to be poor. Irrigation and mechanized agriculture are believed to be the main solution for such extended problems in the rural communities. Utilization of fossil fuel for irrigation purpose is not advisable as Ethiopia depends on fuel imports from untrustworthy foreigners.

For a large community with families clustered around a small area, provision of power from the main grid is an excellent and the best alternative. Unfortunately, in rural areas , where the houses are scattered over a large area the proposition of power generation and distribution using the above mentioned techniques consume a lot of resources ; Consequently becomes unaffordable and expensive. This paper attempts to fill the gap. PV-based hybrid system, using solar / diesel generator, is an alternative to deal with this barrier and supply electricity to rural areas that is far from the grid.

Qualitative and quantitative analysis methods were employed in the research. During the collection of the solar intensity potential raw data of the selected site: National metrological service agency (NMSA), National Aeronautics and Space Administration (NASA) satellite and the universal instrument pyranmometer were used. The quadratic and the linear Angstrom regression equations have been used to calculate the monthly average values of solar radiation

from the sunshine hour. The results have been compared to internationally accepted NASA satellite data derived from Homer software of National Renewable Energy Laboratory (NREL).

Practicing the PV-hybrid system in the rural sites can alleviate the poverty by improving productivity, health and narrows the living style difference between of urban and rural; meets the goal to the Earth summit of June 2012, which says, countries need to increase the amount of renewable energy consumption throughout the world to 15 percent of total electricity consumption by 2020.

It can be concluded increasing the share of renewable energy in the economic sectors is, as highlighted in the Green Economy Report, vital to address the many challenges posed to the global community and, in particular, developing countries, including: energy security; climate change; impacts on health ;ecosystems and energy poverty.

Keywords: r**ural electrification, homer, hybrid photovoltaic**

1. Introduction

1.1. Background of the Problem

Ethiopia is one of the largest and the second populace country in Africa with a total land area of 1.126 million square kilometers and a total population of about more than 77 million. It has a demographic annual growth rate of 2.3%. Out of the total population, 85% lives in the rural area while 15% in urban and semi-urban settlements. The country is still among the least developed countries with Gross Domestic Product per capita below USD 120, living 37% of the urban and 45 % of the rural population to live below poverty line. Agricultural export is critical to the economy and accounts for 47% of the GDP. Thus, the rural population plays a central role in the country's economy [2].

The Ethiopian Electric Power Corporation (EEPCO), the sole electric power producer in the country, currently generates more than 2000 MW where it comes from two different power supply systems, namely, the Inter-connected system (ICS) and Self Contained System (SCS). ICS is mainly supplied from hydro-power plants as well as geothermal power plant. Whereas,

SCS consist of mini hydro-power plants and a number of isolated diesel generating units widely spread all over the country.

The country is toiling to maximize its power generation capacity with the expectation of reaching 10000 MW by the year of 2015.

Considering this figure for the country which has population of more than 77 million people one can evidently see that the power provision in the country is at its meager stage. In addition, since most areas of the country are not connected to the national electric grid, and as the power to the grid is insufficient, thus, rural areas are rely on kerosene and traditional fuel wood biomass to meet their energy demand, both for cooking and lighting. This unsustainable use of energy has for long been damaging to the environment and the human life. Therefore these negative effects of fossil fuels on the local and global environment oblige to search for other alternatives.

When we are looking for alternative resources, renewable energy may offer an ideal source of electricity for these remote areas which are far from national grid line. Application of renewable energy technologies (RETs) for rural electrification is increasing in recent years, but is not very extensive. The cost of photovoltaic system is about less than 4000 $/kW where as the cost of conventional power system such as oil, gas and coal is approximately three to four times lower [7, 8]. Thus, though photovoltaic is little far from being economic in comparison with conventional fossil fuel to provide electricity [9, 10]; they are used in remote areas where it is uneconomical to extend the electric grid [7, 11]. However, the demand for photovoltaic is also getting higher rapidly due to reducing of photovoltaic systems cost during the last decade. Moreover, the promising things is, the company is looking to drive module prices down to $1.50 - 2.00 per watt over the next decade, if it is to make large inroads in to the grid tied electricity market, without subsidy.

Nevertheless, a photovoltaic system alone may not easily satisfy loads on 24-h basis as the variation of solar electricity generation does not always match with the time distribution of load demand [4, 7, and 12]. The use of stand-alone wind electricity generation systems is also limited in rural areas since wind resource is site reliant and depends on the season. Therefore, stand alone photovoltaic or wind energy systems do not produce much usable energy for a considerable portion of time during the year consistently.

Photovoltaic-based hybrid system, using solar and/or diesel generator, is an alternative to deal with this barrier and supply electricity to rural areas that is far from the grid [4, 5, 12–16]. Photovoltaic and diesel generator have complimentary characteristics. The initial cost of photovoltaic system is higher than diesel generator, though the maintenance requirements of photovoltaic are less. Conversely, diesel generator can provide energy at any time, whereas energy from photovoltaic is greatly dependent on the availability of solar radiation [9, 11, and 18].

Often, the variations of solar energy generation do not go with the time distribution of the demand. Therefore power generation systems recommend the association of battery storage facility to smooth the time distribution mismatch between the load and solar energy generation and to account for maintenance of the systems [19, 20]. And, Use of diesel system with photovoltaic-battery reduces battery storage requirement. This makes the system more reliable, and can be used to operate when photovoltaic fails to satisfy the load and when the battery storage is depleted.

The literature review presented above shows that the photovoltaic based hybrid systems using diesel generators are superior to any other power providing renewable energy technologies for electrification application in the off grid areas. Apparently, significant effort has not been directed towards the investigation of diesel generators integrated with the photovoltaic energy systems pertinent to areas of the world with sufficient solar insulation energy. Therefore application of photovoltaic energy integrated with diesel generator is worth exploring.

In this investigation the researcher has been devoted to study on photovoltaic-diesel hybrid system for rural electrification of Guaguata Keble which detached from the main national electric grid. It is expected that such study will be useful for the selection of suitable energy resources by a designer to yield maximum possible gain of renewable energy with minimum possible additional capital cost and mechanical energy consumption of fuel for sustainable and reliable supply of electric power in the rural areas of this country.

1.2 Specific Objective

Based on the purpose, the researchers had covered optimal standalone PV-diesel hybrid power system for typical representative village in Fig.1 and 2 near Bahirdar, and:

- Design and investigate the photovoltaic-diesel hybrid power system optimization and simulation for the given energy source as reliable option of electricity using micro power optimization model soft ware tool.
- Ensure the solar isolation data of the specific site; conduct techno-economic analysis and evaluation of the system.
- Show reasonable installation of the system setup and suggest the measures to increase the contribution of renewable Energy in the country.
- Identify gaps/challenges and opportunities available.
- Propose recommendations on specific measures to improve the overall situation to the following institutions: (a) the donor community, (b) ministries involved (c) universities and (d) NGO involved.

1.3 Scope

This work is limited to research and education activities in relation to energy development (including energy efficiency) on the study of PV-diesel –battery hybrid modelling for electrification at the off grid rural areas in Ethiopia.

2. Methodology And Data Analysis

Yinsa is one of rural village which is found in Bahirdar zuria districts. It is 10km far away from Bahirdar.

Its area is estimated 5640 m^2 and village community of nearly 1395 families, which encompass 6975 people in total. The geographical location of village is similar to Bahirdar, having a latitude, altitude and elevation 11.36 ^{o} N, 37.23 ^{o} E and 1920 m above sea level respectively. The average daily temperature of the village is 27^{o}C minimum and 32^{o}C maximum.

The village has also three sub-kebeles such as Yinsa, Achaber and Guaguata. Among these kebeles, Guaguata keble has been taken as model kebele to study photovoltaic hybrid power system as per their electric power demand of the population.

The Guaguata's community is about 201 households, which take in 1206 people in total. This kebele contains one church and one elementary school. The community is primarily using kerosene, candle and dry cells for lighting.

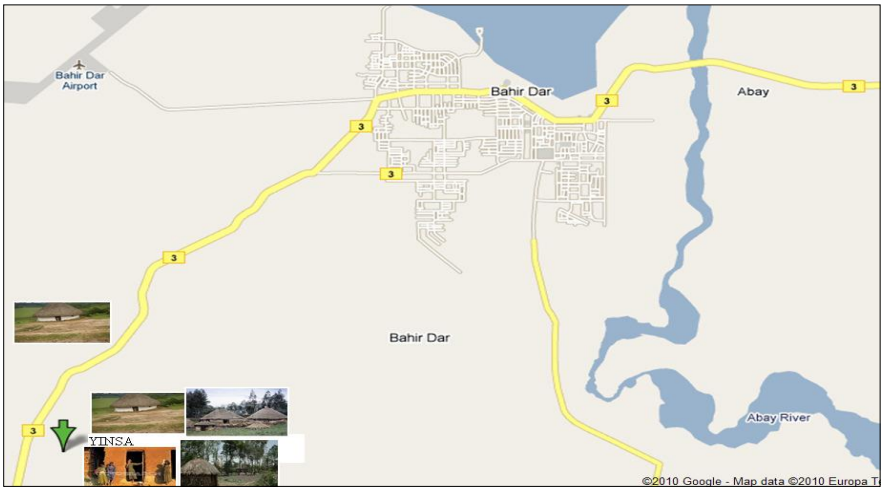

Figure 1: Location of the site using Google map

Figure 2: Pictorial representation of village

In this study, it has been taken sunshine hour data which are used for determination of solar energy using empirical formulae for the selected site from National Metrological Service Agency (NMSA) for analytical calculation. Besides, it has been determined the monthly average values of solar radiation from the sunshine hour using the quadratic as well as the linear Angstrom

equation. Furthermore, it has been measured the solar radiation using pyranometer directly for the given site

Figure 3: Pictorial representations of DL2e Data Logger and pyranometer

After doing so the result of the given site has been compared to internationally accepted data derived from software called Homer from National Renewable Energy Laboratory, NREL and with direct measurement of solar radiation using pyranometer. The following table 1 the daily radiation that has been obtained using homer by inputting the altitude and latitude of the site.

Table 1: Daily average solar irradiation results using homer

Months	**Daily average solar Radiation** kWh/m^2/day
January	5.955
February	6.227
March	6.626
April	6.676
May	6.248
June	5.667
July	5.054
August	5.253
September	5.884
October	5.964
November	5.989
December	5.697

The monthly average values of solar radiation from the sunshine hour using the quadratic as well as the linear Angstrom equation and from homer has depicted in table 2 [22].

Table 2: Daily Average solar radiation Results (kWh/m^2)

Months	**H quadrtic**	**H linear**	**H homer**
Jan.	5.687034	5.807357	5.955
Feb.	6.209316	6.276168	6.227
Mar.	6.647054	6.517721	6.626
Apr.	6.855869	6.655825	6.676
May	6.693218	6.428526	6.248
Jun.	6.12089	5.926369	5.667
Jul	4.812395	5.268394	5.054
Aug.	4.855791	5.307589	5.253
Sep.	5.983745	5.811412	5.884
Oct.	6.254316	6.07525	5.964
Nov.	5.803053	5.8871	5.989
Dec.	5.510778	5.69765	5.697

The daily average solar insolation results data using pyranometer, linear regression and homer has shown in the figure below.

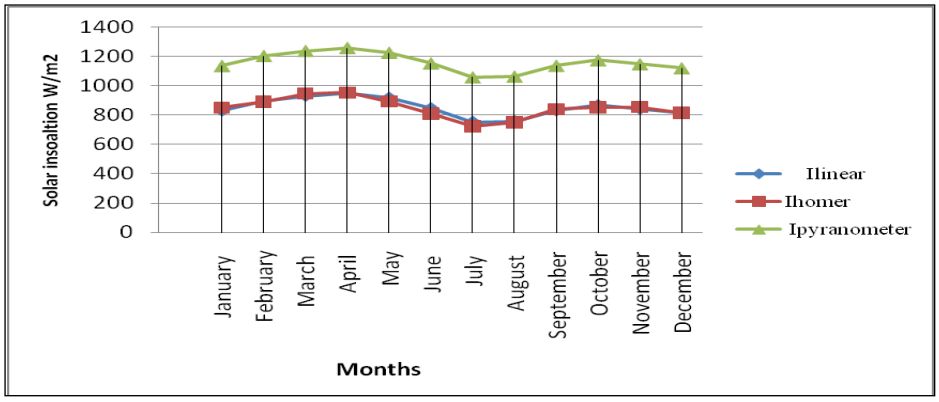

Figure 4: Daily average solar insolation results data using pyranometer, linear regression and homer.

Once it has been determined the solar radiation data of the given site, in the next step to estimate the electrical load demand of the community which is the most significant steps in the design of a hybrid system. The two types of loads (primary and deferrable) have been treated. Primary load that must be met immediately, where as deferrable load is the load that must be met within a certain time frame (although the exact timing is not important).

Used data to forecast the accurate load demand of the community are: *the number of household living in the village, the total irrigated area in hectare, the minimum and maximum suction head of the site, the type of crop growing on the site, the daily consumptive water requirement of crops per hectare and the daily consumptive power requirement of energy in the village.*

The type and power rating of the electric appliances that are supposed to be used by the community are given in table 3. These data help to estimate all the power required by the household and institution in the site.

Table 3: Typical wattage requirements for electric appliance

Types of electric appliance	**Power ratting in Watt**
Compact fluorescent	14 watt
Radio receiver/Caste player	15 watt
14" color television	50 watt

The energy demand requirement of the households in the given village is different depend on their current economic status. Therefore, the community is classified in to three categories according to their energy demand size as it shown the table 4. Table 5 shows the daily energy demand of the institutions in the given site.

Table 4: Household Energy Demand Size of Guaguata Keble

Electrical Appliances	**No. of households**	**Use Hours per day**	**System size [Watt]**	**Daily power use of household [Wh/day]**
2 bulb + Radio\ Caste player	101	5 hr	43	21,715
3 bulb + Radio \Caste player	70	5 hr	57	19,950
4 bulb + Radio\ Caste player +14" color TV	30	5 hr	121	18,150
Total	**201**		**221**	**59,815**

Table 5**:** Institutions' Energy Demand Size in Guaguata Keble

Institutions	**No. of institutions**	**Watt**	**Use hours per day**	**Daily Energy Use (Wh/day)**
Church	1	120	4hrs	480
School	1	220	4hrs	660
Total	**2**	**340**		**1140**

Hence, on a daily and hourly basis 30 % of power level has been added to the calculated load in order to randomize the load profile and make it more realistic by considering the future population increment and load demand increment. Therefore, total daily energy consumption for the community of families increase to 87.04l5 kWh. And the annual peak load will be 29 kW.

Table 6: Monthly average daily electrical load in kWh

Loads	**Jan.**	**Feb-May**	**Jun**	**Jul**	**Aug**	**Sept -Dec**
Deferrable load	7.80	7.80	7.80	6.63	6.63	7.8
Primary load	78.384	79.2415	79.2415	78.384	78.384	79.2415
Total load	86.184	87.0415	87.0415	85.0135	85.0135	87.0415

The following section describes the various inputs utilized in the HOMER model. The specifics for all the equipment considered for each power system schematic is listed and the resources of fuel supply and solar data are given which have been analyzed on the above section.

In the optimization process, various sizes of power inverters, PV modules, diesel generators, and batteries were included in the search space of the program.

Table 7: Technical data of PV, diesel units, batteries and inverters

Description	**Data**
PV	
Capital cost	4000 $/kW (maximum)
Model	Kyocera KD210GX-LPU 210 watt
Length x Width x Depth	59.1in x 39in x 1.8in
Weight	39.7lbs
Life time	25
Diesel generator units:	
Diesel type	Model BCJD 40-60SP
Maximum (Standby) power Output	40 kW
Continuous (Prime) power Output	36kW
Full load fuel consumption	11.1 Lit /h
Minimum load fuel consumption	6 Lit /h
Batteries	

Type of batteries	Surette 6CS25P
Nominal voltage (V)	6V
Nominal capacity	1156Ah
State of charge (SOC)	40%
Nominal energy capacity of each battery (V*Ah/1000)	6.94kWh
Inverters	
Inverter type	Sunny Island 5048U
Capital cost	715$/kW
Efficiency/power consumption	95.00%

After all the inputs utilized in the HOMER model for the Guaguata keble, the complete HOMER's graphic user interface that specify the total load requirements and all components of micro power system such as diesel generator, PV, converter and battery has been depicted by the following schematic diagrams:

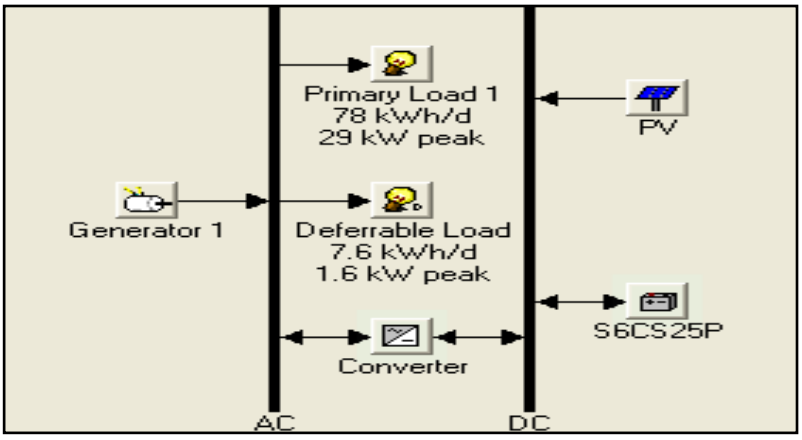

Figure 5: HOMER diagram for the hybrid PV-generator-battery-converter set up

3. Results and Discussions

This model was run repeatedly using different values for the most important variables and as a result a list of optimal combinations of PV, generator, converter, and battery are provided, which could be implemented as a hybrid system setup that fulfill the given requirement . The results are displayed in either of two forms; an overall form in which the top-ranked system configurations are listed according to their net present cost and in a categorized form; where only the least-cost system configuration is considered for each possible system type. Table 8 shows a

list of the possible combinations of system components in the overall form. And, Table 9 shows a list of the possible combinations of system components in a categorized form.

The following tables have been generated based on inputs selected from the input summary Tables 6 : 0.781$/lit for diesel price, cost of PV is 4 $/W. The diesel price is the current price for diesel oil in the country. Interest rates are assumed to be 6.0 % and project lifetime is 25 years. With regard to the generator, selected from locally available capacities, 32 kW and 36kW, the 32 kW generators has been found to be the most cost effective. As the list is long, part of it has been cut retaining only those of greatest interest. Looking at a few of the system setups listed we find the following remarkable results.

Table 8: Overall optimization results according to net present cost (NPC).

PV kW	Gen kW	Bat. No.	Conv. kW	Display strategy	Initial Capital $	Total NPC $	COE $/kWh	Ren. Fract.	Diesel Lit.	Gen hr.
0	32	-	-	CC	8,825	143,490	0.359	0.00	12,505	1825
1	32	-	1	CC	13,541	143,535	0.359	0.08	12,012	1825
1	32	-	2	CC	14,257	144,486	0.362	0.08	12,011	1825
2	32	-	1	LF	17,541	145,039	0.363	0.16	11,762	1825
2	32	-	2	LF	18,257	145,373	0.364	0.16	11,700	1825
1	32	-	4	CC	15,689	146,405	0.367	0.08	12,011	1825
2	32	-	1	CC	17,541	146,453	0.367	0.15	11,904	1825
2	32	-	2	CC	18,257	146,748	0.367	0.15	11,837	1825
2	32	-	4	LF	19,689	147,281	0.369	0.16	11,699	1825
2	32	4	1	LF	21,141	147,333	0.369	0.16	11,437	1825
2	32	4	2	LF	21,857	147,864	0.370	0.16	11,394	1824
2	32	-	4	CC	19,689	148,656	0.372	0.15	11,836	1825
3	32	-	1	LF	21,541	149,039	0.373	0.22	11,762	1825
1	32	4	1	CC	17,141	149,079	0.373	0.08	12,012	1825
3	32	-	2	LF	22,257	149,228	0.374	0.22	11,685	1825
1	32	-	7	CC	17,837	149,282	0.374	0.08	12,011	1825
3	32	4	2	LF	25,857	149,696	0.375	0.23	11,177	1825
2	32	4	4	LF	23,289	149,776	0.375	0.16	11,394	1825
1	32	4	2	CC	17,857	149,976	0.375	0.08	12,007	1825

Table 9: Optimization results, in a categorized form, ranked according to the NPC of each system type

PV kW	**Gen kW**	**Bat. No.**	**Conv. kW**	**Display strategy**	**Initial Capital $**	**Total NPC $**	**COE $/kWh**	**Ren. Fract.**	**Diesel Lit.**	**Gen hr.**
-	32	-	-	CC	8,825	143,490	0.359	0.00	12,505	1825
1	32	-	1	CC	13,541	143,648	0.360	0.08	12,024	1825
2	32	2	1	LF	19,341	145,456	0.364	0.16	11,526	1825
-	32	2	1	CC	11,341	147,280	0.369	0.00	12,510	1826
5	32	8	4	LF	38,889	158,010	0.396	0.36	10,462	1823
15	32	40	23	LF	121,293	163,679	0.410	0.92	1,684	328
19	-	50	28	CC	141,048	176,852	0.443	1.00	-	-

The most cost effective system, i.e., that with the lowest net present cost, is the stand alone generator setup, where the generator operates using a cycle charging (CC) strategy (a dispatch strategy whereby the generator operates at full output power to serve the primary load and any surplus electrical production goes toward the lower-priority objectives).

For this setup, the total net present cost (NPC) is $143,490, the cost of energy (COE) is 0.359 $/kW h, there is no contribution from renewable resources, the amount of diesel oil used annually is 12,505 litter and the generator operates for 1825 hr/year. The advantage of this solution is that the net present cost is the lowest, but renewable resources in no way contribute to the energy supply.

Of those compared, the second most cost effective system is the PV-generator-converter setup, with the generator operating with a cycle charging (CC) strategy (a dispatch strategy whereby the generator operates at full output power to serve the primary load and any surplus electrical production goes toward the lower-priority objectives). For this setup the total net present cost (NPC) is $143,648, the cost of energy (COE) is 0.360 $/kW h, the amount of diesel oil used annually is 12,024 lit and the generator operates for 1825 hr during the year. Again with this scenario, the part contributed by renewable resources is rather small, being only 8 %.

Further down in the list, there is a system comprising a PV-generator-battery-converter setup. For this setup the proportion from renewable sources is increased from 8% to 36%, with only a minor increase of 9.61 % in the cost. As we can see, the net present cost (NPC) is $158,751 and the COE is 0.397 $/kW h.

Here on this setup all the electrical energy demand has been supplied and there is no unmet load and shortage of electrical energy as it shown on the table 10. However, the contribution made by renewable resources is not quite much.

Table 10: Relationship between of electrical energy consumption and supply

Load	**Consumption** (kWh/yr)	**Fraction**
AC primary load	28,470	91%
Deferrable load	2,774	9%
Total	31,244	100%

Quantity	**Value**	**Units**
Excess electricity	3,366	kWh/yr
Unmet load	0.0000248	kWh/yr
Capacity shortage	0.00	kWh/yr
Renewable fraction	0.358	

Again further down in the list, there is also PV-generator-battery-converter setup. For this setup the proportion from renewable sources is increased from 36% to 92% with only a minor increase of 6.58 % in the cost. At this setup also, all the electrical energy demand has been supplied and there is no unmet load and shortage of electrical energy similar to the above set up.

This could be a good alternative for implementation as the contribution made by renewable resources is quite significant. The cost summary of PV-generator-battery-converter setup with having 92% renewable fraction has depicted in figure 6 and table 11.

Report – Modelling

92 % Renewable fraction

Diesel Price:	0.781 $/L
PV Capital Cost Multiplier:	1
PV Replacement Cost Multiplier:	1

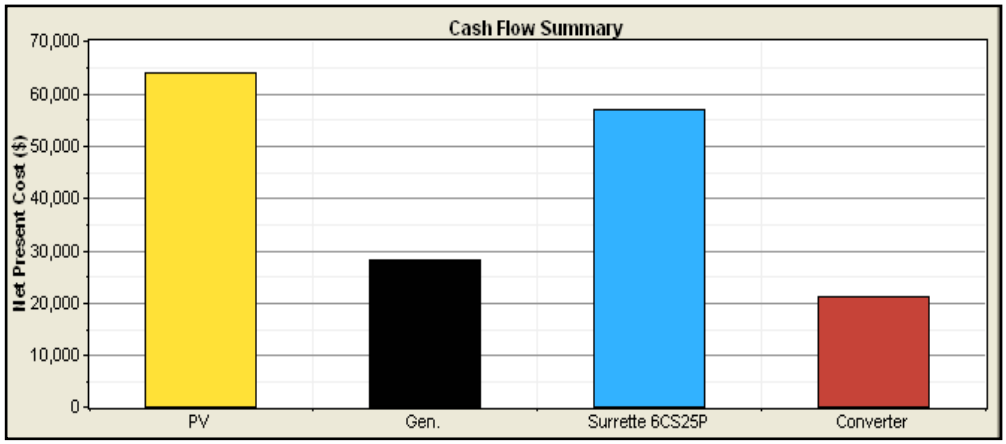

Figure 6: Cost summary for a 92% utilization of renewable resource

Table 11: Net present cost of the system setup

	Component Capital ($)	**Replacement** ($)	**O&M** ($)	**Fuel** ($)	**Salvage** ($)	**Total** ($)
PV	64,000	0	0	0	0	64,000
Generator	18,825	0	1,659	18,434	-911	28,008
Surrette 6CS25P	36,900	16,929	7,862	0	-4,860	56,830
Converter	15,752	6,573	0	0	-1,223	21,101
System	125,477	23,501	9,521	18,434	-6,994	169,939

3.1. Sensitive Analysis

Table 12: Sensitivity of PV cost to diesel price for feasible optimal system types

Diesel $/Lit	**PV Cap. Multi.**	**PV kW**	**Gen. kW**	**Batt. No.**	**Conv. kW**	**Disp. Strgy.**	**Initial Cap. $**	**Total NPC**	**COE $/kWh**	**Ren. Frac.**	**Diesel lit.**	**Gen. hr.**
0.781	1.00	-	32	-	-	CC	8,825	143,490	0.359	0.00	12,505	1,825
0.781	0.80	1	32	-	1	CC	12,741	142,848	0.358	0.08	12,024	1,825
0.781	0.50	19	32	41	24	LF	100,909	135,636	0.340	0.97	924	185
0.781	0.30	20	32	40	24	LF	86,009	119,707	0.300	0.97	875	176
1.000	1.00	17	32	43	24	LF	132,709	173,997	0.436	0.95	1,141	225
1.000	0.80	17	32	43	24	LF	119,109	160,397	0.402	0.95	1,141	225
1.000	0.50	20	-	50	30	CC	106,480	138,080	0.346	1.00	-	-
1.000	0.30	20	-	50	30	CC	90,480	122,080	0.306	1.00	-	-

Sensitivity analysis has also been carried out; the main objective this analysis is to deal with uncertainty which will be created by the input variables variation in the future. For instance the price of PV and diesel has been taken here. The current maximum PV price is assumed to be

$4000/kW and the minimum $1200/ kW, assuming a future fall in price. And the current price of diesel oil in the country is 0.781 $/lit and assuming that the price will increase to 1$/lit in future. Therefore, table 12 illustrates the respective sensitivities of the PV capital cost multiplier to the price of diesel.

4. Photovoltaic-Diesel Hybrid Power System Installation

Therefore the researcher has recommended the single-phase, two-wire line configuration on basis of our country's nominal voltage (i.e. 220V for domestic customers) and its benefits in the case of light loaded. In addition, the mounting structure of PV arrays has also been suggested by the researcher to be made locally using angle iron metals which is equivalent to the depth of the PV panel. The depth of PV panel that has been chosen is 44.1 mm.

Therefore the angle iron specification that to be used here is 6m×0.050m×0.050m so that it can hold PV array in appropriate way. The orientation angle of the mounting structure should be the same to the latitude of the given site. Figure 7 shows one option of single-phase line PV-hybrid power system installation for cluster villagers.

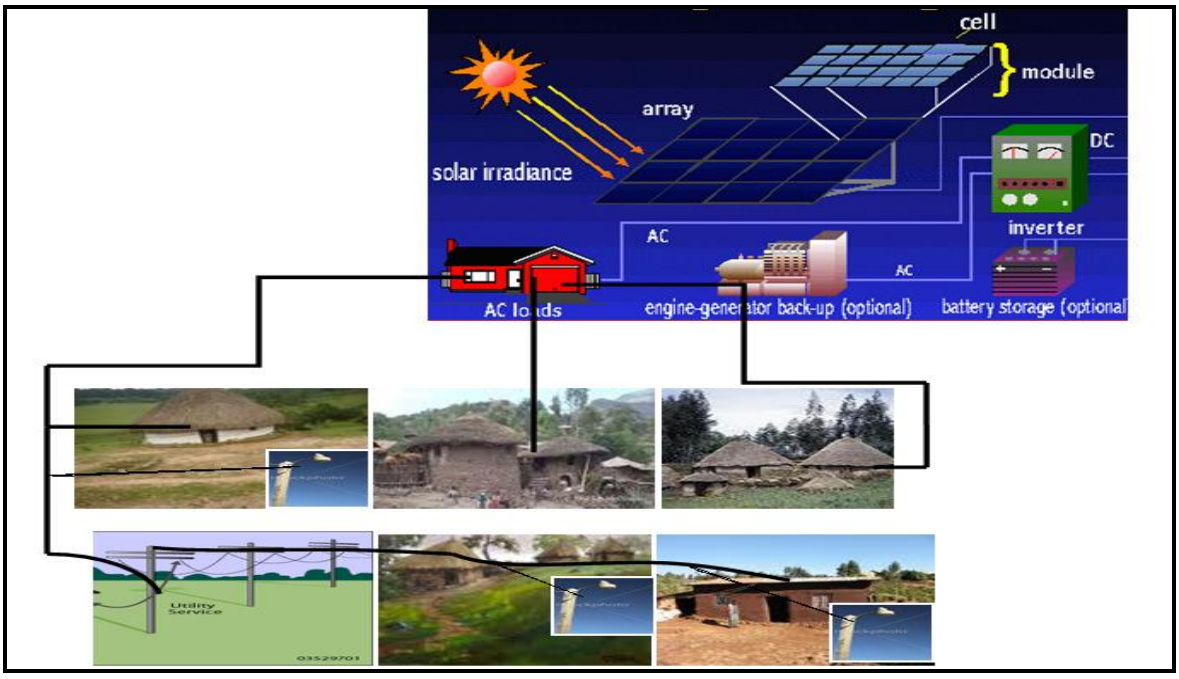

Figure 7: Schematic representation of single-phase line configuration of PV-diesel hybrid Power system

The second option that serves for dispersed villagers who are a little from power house has depicted in figure 8.

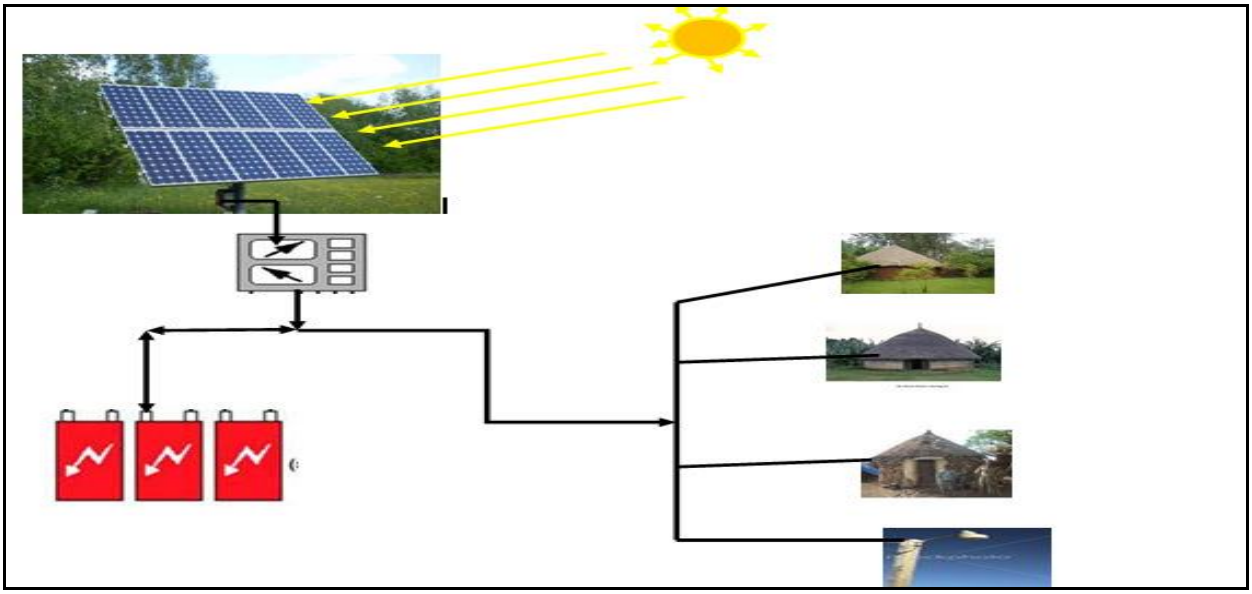

Figure 8: Schematic representation of PV installation for Gojo houses far from power house

5. Conclusion

The present work has been devoted to study PV-diesel hybrid powers system for rural electrification detached from the national main grid where supply of power from grid is impractical or extremely costly.

The major implications that can be drawn from this work as follow:

1) The hybrid PV-diesel power system offers several benefits such as: utilization rate of PV generation is high; load can be satisfied in the optimal way; accelerate rural access to electricity, diesel efficiency can be maximized; diesel maintenance can be minimized; reliable power supply; and a reduction in the capacities of PV, diesel and battery (while matching the peak loads) can occur. This is in addition to an improvement in the quality of life for many that are living in remote areas.

2) Also investments in mobilization of PV systems may stimulate/gear up the local economy (in a long-run) by exploitation of available local resources. The present work shows that the potential of solar energy cannot be overlooked.

3) More importantly, with use of this hybrid system, about more than 5183 kg /year of carbon emissions can be avoided entering into the local atmosphere. So it has great contribution in reduction of environmentally polluting emissions gases.

4) The findings of this investigation can be employed as a frame-of-reference in designing of hybrid PV-diesel-battery systems and other possible hybrid power systems for other locations having similar climatic and load conditions.

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Cane Sugar Productivity Potential in Ethiopia: The Role and Direction of Research in View of Experience of Other Countries

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Abstract

Sugar industry plays a great role in the Ethiopian socio-economy. The country's annual sugar production of the three sugar factories is about 300,000 tons. Yet, the rate of domestic sugar consumption is increasing from time to time, necessitating the importation of about 200 000 tons sugar per year. However, to bridge the gap between supply and demand as well as to exploit the international market opportunity, Ethiopia is establishing new sugar factories with large tract of sugarcane plantation besides expanding the existing ones. Consequently, the total annual sugar production will be boosted to 2.25 million tons in 2014/15. This would resolve the sugar deficit and ensure cost and quality product competitiveness in the international market, which is the strategic focus of the industry. On the other hand, such competitiveness mainly depends on the use of improved sugarcane variety and production technologies. Agro ecological characteristics of Wonji/Shoa, Metahara and Finchaa have made them to be conducive for sugar production; specially where the soils are productive, it enabled Ethiopia once to be one of the highest sugarcane biomass (55 t $ha^{-1}yr^{-1}$) producer by exceeding Zimbabwe, Iran, South Africa, India, and Australia whose biomass production was 53, 47, 44, 39 and 38 t $ha^{-1}yr^{-1}$, respectively. Contrary to its natural potential, productivity of the sugar plantations in the country could not be maintained owing to the failure to optimally utilize the prevailing natural potential of the country and due to a number of technical failures. The latter include: lack of improved sugarcane varieties; increased prevalence and effect of diseases and pests; reduced land productivity due to soil and water management problems such as salinity and water logging; lack of low cost sugar and/or sugarcane production technologies; and low technological backup due to weak institutional capacity of the Research and Training. In contrast, prominent sugar producing countries have increased their

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production and productivity with the use of improved varieties and sugar/sugarcane production technologies that aredeveloped through research. Cognizant of the role of research and training in the sugar industry, Ethiopian Sugar Corporation (ESC) carried out benchmarking study clearly identified the industry's strategic issues as decline in cane and sugar productivity, scarcity of improved technologies and increase in the cost of production to be the major ones. In order to address these issues, ESCRT is reformed and organized into four multi-disciplinary directorates, namely, Sugarcane Variety Development Research, Sugarcane Production Research, Sugar Technology Research and Training and Extension Directorates. Moreover, the Extension Service provides essential link between ESCRT researchers and factory/project operation staff through consultation and feedback. Finally, in the paper, the need for industry-university linkge and strategic focus of the industry research and other relevant issues are also discussed.

Key words: *Ethiopia, Sugar industry, Cane productivity, Research future strategies*

Introduction

Sugar industry plays a great role in the socio-economy of Ethiopia since it produces sugar for household and industrial consumptions, provides great job opportunity for the nationals, serves as source of energy; besides the co-products are used for miscellaneous purposes. The country's annual production of sugar from the three sugar factories (Wonji-Shoa, Metahara and Finchaa) is about 300,000 tons (ESC, 2011). Even though the country's annual consumption of sugar is considered low even by African standard, the rate of domestic sugar consumption is increasing from time to time. As a result, the country's annual sugar production could not satisfy the domestic consumption, and thus the deficit is being offset by importing sugar from abroad. Cognizant to the increasing demand of sugar in the country and its potential role for the economy, the Ethiopian Government has undertaken a large scale expansion and green field sugar development programs since 2004/05. Furthermore, a massive five years sugar development plan has also been started in 2010/11 with a vision of propelling the nation to be net exporter of sugar. Accordingly, ten modern and high capacity sugar factories are planned to be installed Together with the ultimate development of 442,780 ha (Anonymous, 2012[4]). Thus, the existing annual sugar production of 300,000 tons would be boosted to 2.25 million tons in 2014/15 (ESC, 2011), which subsequently would reach 3.7 million tons of annual sugar production.

[4] ሸማግር መፅሄት· ቁጥር 4 ገፅ 68-77(መስከረም 30 2005 ዓ.ም)

Though such a huge investment is being practiced, the cost of sugar production in the industry is rising as in any other developing countries. Moreover, the productivity of the existing sugar estates are not maintained from year to year and the known potentials are not fully tapped mainly due to the inability to optimize the cane production and sugar manufacturing processes through the application of improved technologies. This failure is further justified by the weakly organized and poorly staffed research units of the industry from the past to the present. Conversely, available literature indicated that with the use of improved technologies developed through research, different sugar producing countries had increased their production and productivity by 20 to 100% through the use of improved variety through breeding and by 25 to 80% through the use of improved sugar/sugarcane production technologies (Young, 2004; Edeme et al, 2005; Meyer, 2007; Rao and Kenedy, 2008; Singh et al, 2009; Rukai and Yuan, 2010; Nair, 2011).

Thus, to realize the sugar strategic goals of the government and ensure the competitiveness of the industry in the international arena, use of locally developed improved technologies is crucial and necessitates the capacity building of the research unit to be in par with the sugar industry development plan of the country. Therefore, this paper attempts to addresse cane sugar productivity potential as well as strategic issues of the country and the required future direction of the research for ensuring sustainable development of the Ethiopian sugar industry.

Sugar Development in Ethiopia: History and Current Status

The history of modern sugar production in Ethiopia began with the establishment of Wonji Sugar Factory in 1954 by a Dutch company (HVA) on 5000 hectares. On the same concession area, the second sugar factory has been established at Shoa in 1962 with an additional plantation area of 2000 hectares. Metahara Sugar Factory was then realized by kicking-off milling in 1969. Furthermore, in 1998 Finchaa Sugar Factory was added to the list of sugar enterprises, with a different irrigation system (sprinkler). The existing four public sugar mills that had initially different design capacities, namely, Wonji (1420 TCD), Shoa (1650 TCD), Metahara (5000 TCD) and Finchaa (4400 TCD) have attained a total annual production capacity of about 300,000 ton sugar by processing about 2.7 million tons of cane. In addition, about 20 million liter of ethanol is annually produced by Finchaa and Metahara Sugar Factories.

Currently, the construction of fourth intended high capacity sugar factory at Tendaho and a new sugar mill at Wonji which replaces the two pioneer small sugar mills (Wonji and Shoa) is

underway. The accompanying expansion brings about the total cane area to 37,000 ha. Moreover, due to its strategic importance, development of 225,000 ha of land is in progress along with establishment of ten modern sugar factories. At the end of the entire expansion and new sugar development projects the Ethiopian sugarcane plantation across the country will cover about 442,780 ha (Table 1).

Table 1: Existing, expansion and new sugar developments in the pipeline in Ethiopia

Sugar estates	Area to be developed (Ha)	TCD*	Region	Zone	Wereda	Irrigation source
Wonji-Shoa	18,500	6,250	Oromia	East shoa	Adama, Boset	Awash River
Metahara	10,280	5,000	Oromia	East shoa	Fentale	Awash River
Finchaa	21,000	12,000	Oromia	East Wellega	Huro Gudro	Finchaa River
Tendaho	50,000	26,000	Afar	Zone 1	Dubti, Asaita, Afambo	Awash River
Kesem	20,000	12,000	Afar	Zone 3	Dulecha	Kesem River
Kuraz	175,000	12,000[1]	SNNP	Lower Omo	Selamago and Egnangatom	Omo River
Tana-Beles	75,000	12,000[2]	Amhara	Awi	Jawi	Beles River
Wolkait	45,000	24,000	Tigray	Wetern	Welkait and Tselemti	Dukuko and Zarema Rivers
Arjo Dedesa	28,000	8,000	Oromia	Illubabor	Bedele	Arjo Dedesa River
Total	**442,780**					

* TCD= Refers to crushing capacity of the factory in tons of cane per day; 1, 2 = refers the number of sugar factories planned to be installed are 5 and 3, respectively (Source Anonymous, 2012).

Climatic Elements and Productivity Potential

Sugarcane is grown in the world from sea level to 1000 m of altitude or little more (for example, in Ethiopia it extends upto 1650 m.a.s.l., at Finchaa) with latitude and longitudes of 36.7° N and 31.0° S. It is considered essentially as a tropical long duration plant and thus it experiences all seasons namley, rainy, winter and summer during its life cycle. Principal climatic components that control cane growth, yield and quality are temperature, light and moisture availability. The plant thrives best in tropical hot sunny areas. The "ideal" climate for maximum sugar production from sugarcane is characterized as: a long, warm growing season with a high incidence of solar radiation and adequate moisture/rainfall, fairly dry, sunny and cool, but frost free season for ripening and harvesting and freedom from typhoons and hurricanes.

Temperature above 50 ^{o}C arrests its growth, while when it is below 20 ^{o}C its growth slows down. Low temperature reduces tillering. An average mean temperature of 26 to 32 ^{o}C is ideal for the

growth of sugarcane. The crop does best in tropical regions receiving a rainfall of 750 to 1200 mm per annum. Similarly, the geographic locations and associated climatic elements (Table 2) of Wonji/Shoa, Metahara and Finchaa have made these areas to be conducive for sugar production; specially where the soils are productive, these factors enabled Ethiopia to be one of the highest sugarcane biomass (55 t/ha/yr) producer by exceeding Zimbabwe, Iran, South Africa, India, and Australia whose biomass production is 53, 47, 44, 39 and 38 t $ha^{-1}yr^{-1}$, respectively (Table 3).

Table 2: Climatic and geographic location of the Ethiopian sugar estates

Location	Altitude (m asl)	Sun-shine hour	Mean temp. (^{0}C)	Rain fall (mm)	*PET (mm)	Mean RH (%)	Day wind speed (km/hr)	Night wind speed (km/hr)	Latitude	Longitude
Wonji/Shoa	1500	8:06	21.2	813	1892	55	6.2	2.3	8°31´N	39°12´E
Metahara	950	8:21	25.9	533	1860	59	3.9	1.2	8°51´N	39°52´E
Finchaa	1365 to 1650	7:55	23	1321	1930	61	2.8	2.1	9°30´N to 10°00´N	37°15´E to 37°30´E
Mean		**8:07**	**23.4**	**889**	**1894**	**58**	**4.3**	**1.9**		

- PET = Pan evapotranspiration

Table 3: Comparison of cane yields and its equivalent total dry matter of different sugarcane growing countries compared with Ethiopia (After APECS, 1987)

Countries	**Stalk yield ($t^{-1}ha^{-1}mon^{-1}$)**	**Biomass ($t^{-1}ha^{-1}mon^{-1}$)**
Australia		
• Average	6.8 (42)*	38
• Commercial maximum	8.3 (52)*	47
• Experimental maximum	16.1	90
India (Tropical region)		
• Average	7.3 (40)*	39
• Commercial maximum	16.7 (91)*	90
• Experimental maximum	18.3	99
Iran		
• Average	8.3 (45)*	47
• Commercial maximum	13.9 (76)*	78
• Experimental maximum	18.4	103
South Africa		
• Average	7.8 (58)*	44
• Commercial maximum	11.8 (85)*	66
• Experimental maximum	13.8	77
Zimbabwe		
• Average	9.6 (58)*	53
• Commercial maximum	15 (90)*	84
• Experimental maximum	16.7	93
Ethiopia (Wonji)		
• Average	10.1 (48)*	55
• Commercial maximum	14 (67)*	75
• Experimental maximum	21	113

* Values in parenthesis show percent of the experimental maximum

Contrary to the reports of APECS (1987), at Wonji-Shoa there was a drastic decline of productivity from 1973/74 to 1999/00 milling seasons (Figure 1). Whereas at Metahara, though there was a decline, it does not show uniform trend of productivity during these period. Nonetheless, as of 2000/01 to 2009/10, there was an increase in productivity both at Wonji-Shoa and Metahara (Figure 2). The latest ten years (2000/01 to 2009/10) productivity status of the three sugar factories also indicated that year-wise productivity does not show uniform trend except at Wonji-Shoa where a sharp decline was observed during 2004/05 – 2007/08 milling season (Fig 2). Such decline of productivity in the plantations might be attributed to lack of improved technologies (including cane varieties) in sugarcane production. Besides, soil and water related problems and management issues could also have played a significant role.

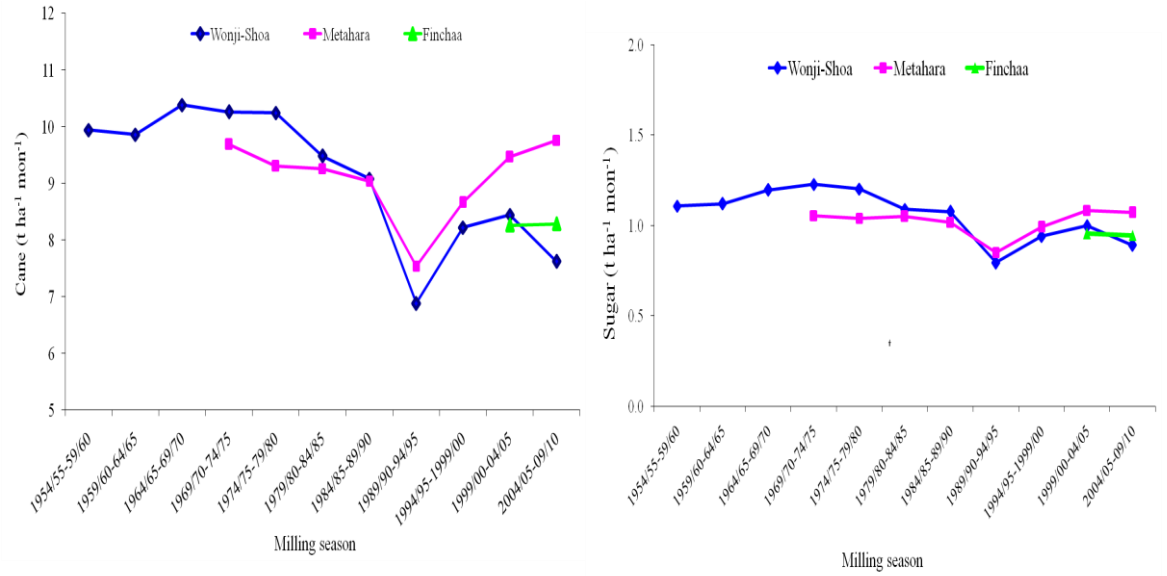

Figure 1. Long year cane and sugar productivity of Wonji-Shoa, Metahara and Finchaa sugar estates (five year basis)

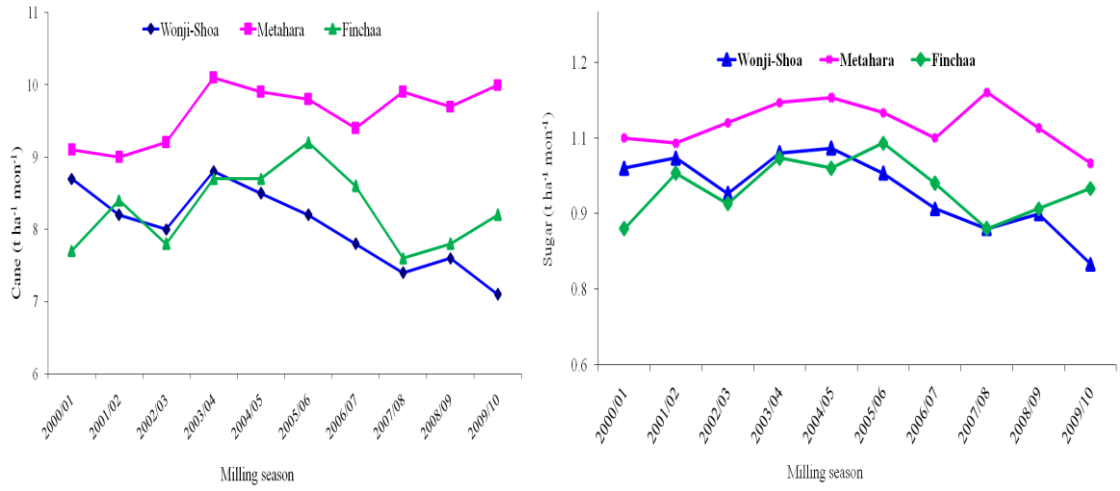

Figure 2: Ten years cane and sugar productivity of Wonji-Shoa, Metahara and Finchaa sugar estates

As indicated in figure 2, cane and sugar productivity showed more or less similar trend both at Wonji-Shoa and Finchaa. However, at Metahara, the sugar productivity showed a decreasing trend contrary to cane yield, particularly during 2007/08 to 2009/10 milling seasons. When we see the crop husbandry practice difference among these milling seasons, at

Metahara, there was a shift of fertilization program from Ammonium Sulphate Nitrate (26 % N) to Urea (46 % N). Whilst, in the other two sugar factories, there was no major change in the crop husbandry practice. Thus, the decline in sugar productivity in contrary to cane could be attributed by the change in the fertilizer management which deprives the contribution of sulfate for better sucrose formation.

In general, though Ethiopia has a suitable climatic condition for cane agriculture, it was not possible to optimally utilize the prevailing natural potential of the country. In line with this, field assessment result indicated that a number of technical factors are involved in the spectacular decline in cane and sugar productivity. The major factors include:

- Lack of improved sugarcane varieties;
- Increased prevalence and effect of diseases and pests;
- Reduced land productivity;
- Rise of soil and water management problems such as salinity and water logging;
- Lack of low cost sugar and/or sugarcane production technologies and
- Low technological backup due to weak institutional capacity of the Research and Training.

The Research Unit's Organization and Contribution

Research endeavor in the sugar sub-sector of the country has been started since 1950 with the establishment of the first sugar factory. In the earlier times, research has been working as an integral part of the sugar estates. Consequently, the research organization has passed the following phases, namely, the pre-nationalization of the sugar estates period (until mid 70's) which had the following features; Ethiopia Sugar Corporation period (1976 – 1991); Period following dissolution of Ethiopian Sugar Corporation (1991 – 1998); Period of Ethiopian Sugar Industry Support Center

Share Company (1998 – 2007); Ethiopian Sugar Development Agency Period (2007 – 2010); and the Sugar Corporation Period (as of 2010)

In the pre-nationalization period of the sugar estates, the research unit was organized in such a way that the headquarter was situated in Amsterdam with few onsite staff at Wonji and Metahara to undertake applied research. All agricultural operations were guided based on the onsite-developed research results and recommendations were continuously revised based on annual/intermediate research findings. However, in the later periods (after mid 1970's), because of organizational instability and lack of qualified manpower, the research units' contribution to the sugar industry was in general unsatisfactory. Besides, the research undertaken used to focus on tackling immediate and minor shortcomings encountered in the production system rather than to be innovative, which would have brought radical change to the sector. Consequently most of the existing production systems/recommendations of Wonji and Metahara are as old as each estate; whereas most of the recommendations of Finchaa sugar estate are not established based on *in-situ* research output but adopted from the experience of older estates. Nevertheless, assessment report of the service delivery of the research unit indicated that most of the released research outputs and advisory services were not implemented because of the shortcomings they have had (ESCRT, 2011).

Besides, the research unit has some contribution in project document evaluation and scaling-up the cane production technologies of the pioneer sugar factories to the new development areas during the establishment of the sugar factories, in the expansion of the existing sugar factories and installation of new sugar factory. Taking these facts into consideration, the role of the research unit in the country's sugar sub-sector development seems limited. However, internationally, different sugar industries exploit their research unit with regard to productivity and are now using their noble technologies to reduce cost of sugar production by use of factory by-products, diversifying production, use of improved production technologies (Li and Wei, 2006; YSRI, 2006; Hassan and Nasr, 2008; MSIR, 2008; SASA, 2010; Nair, 2011). Thus, while the government of Ethiopia is undertaking huge sugar development endeavors, our industry is constrained due to limited use of improved technologies. Therefore, the research unit is expected to develop and adapt or adopt improved technologies that can enhance sugar productivity with minimum cost.

Experiences of other Countries

Experience of other sugar producing countries indicates that with the use of improved technologies developed through research, production and productivity are increased by 20 to 100% (with the use

of improved cane variety through breeding) and 25 to 80% (use of improved sugar/sugarcane production technology). Some of these sugar producing countries have faced a number of strategic problems, but they were able to address their problems through research and consequently emerged as a world best sugar producer. Among these, China, India, South Africa and Mauritius are countries to be mentioned as they have a number of contextual similarities with that of Ethiopian sugar industry. These countries have the following research capabilities, strategic issues/ goals, strategies and historical achievements.

China: the Chinese sugar industry has five sugar research institutes and 15 stations. One of these institutes is affiliated with university and capacitated to award MSc. and PhD degrees, as well as host post-doctoral workers. Moreover, to centralize the management of scientific research and avoid duplications at low levels, the system is divided into two levels and guided by the National Sugarcane Industrial Technology Research and Development Center. With the use of the above-mentioned research strategies, a number of sugarcane and sugar technologies have been released and commercially implemented. With the commercial use of these technologies, China was able to increase its cane productivity by 52 t ha^{-1} (from 24 to 76 t ha^{-1}) in 50 years time (217% increase); the recent five years mean increment being 63.3 t/ha (Rukai and Yuan, 2010). The research goal and strategies followed to achieve the targeted goal are indicated in Table 5.

India: India is endowed with an effective research and development network to adequately cater the need of sugarcane growers and sugar industry in the country. It has two central research institutes fully devoted to sugarcane improvement and cultivation and one institute for sugarcane processing (Yadav et al, 2009). Besides, every sugarcane growing state has its own sugarcane research and development wing. In the non-governmental sector, two institutes are also in operation meeting the immediate need of associated farmers and sugar mills.

Table 5: China sugar Industry research goals and strategies (After Rukai and Yuan, 2010)

Research Goal	Strategies
1.Sustainable development	• Introducing creative management • Environmental protection concerns (water recycling and conservation in sugar factory and green chemistry approach to sugar production: recycling of agro-industrial residues of sugar industry) • Sugarcane based energy program (breeding of energy cane varieties and processing technology for energy cane)
2.Increasing sugar quality	• Innovative technologies in cane production (drought management strategies, introduction of drip irrigation system in upland areas, efficient and specialized cane husbandry practices under drought conditions, sugarcane varietal improvement programs with the application of genetic transformation technology) • Improving pretreatment, juice extraction, decolorization and clarification techniques
3.Decreasing cost and increasing efficiency	• Healthy seed cane production emphasis on biological nitrogen fixation in sugarcane • Chemical ripening to improve cane quality • Efficient planting and harvesting methods

Organized research through varietal improvement in sugarcane geared up from 1930 onwards in the country. Since this time, the Indian sugarcane research institutes have been working towards the upliftment of cane agricultural in the country, in terms of quality, productivity, management practices and various policy issues. As a result, cane productivity in the country was improved from 32 to 72 t ha^{-1} in 55 years time (125% increase) with the implementation of sugarcane technologies in large scale. Besides, the recent five years mean cane productivity is 70 t ha^{-1}, which is projected to be 88.5 t ha^{-1} in 2020 (Nair, 2011).

Table 6: Indian Institute of Sugarcane Research goals and strategies (After Yadav et al., 2009)

Research Goal	Strategies
1. Improving level of cane yield and sugar recovery	• Increasing the levels of cane yield and sugar recovery (introgression of untapped genes in the parental gene pool; enhancing selection efficiency through marker aided selection; improving sink strength and source efficiency; enhancing productivity of ratoon cane);
2. Reducing cost of cane cultivation	• Reducing the cost of cane cultivation (nutrient efficiency through rhizospheres engineering and INM technology; water use efficiency through micro-irrigation; land use efficiency through companion cropping; reducing cost of pesticide use in an eco-friendly manner through bio-intensive IPM and IDM; mechanizing sugarcane farming); and
3. Improving the factor productivity	• Arresting the decline in factor productivity (soil biological and nutritional dynamism; carbon sequestering through cropping system).

Mauritius: The principal crop in Mauritius is sugarcane, a factor that is reflected in the institutional structure of the nation's agricultural research and development system. The Mauritius Sugar Industry Research Institute (MSIRI) is the country's largest agricultural research agency, accounting for more than one-third of total agricultural Research and Development staff and expenditures in 2008 (Food and Agricultural Research Council, 2010). MSIRI was established by sugarcane producers in 1953 as a private, non-profit agency to promote the technical progress of the sugar industry through research (Kee Kwong, 2005). Accordingly, MSIRI contributed for improvement of cane productivity from 66 to 79 ton/ha in 16 years (20% increase), the recent five years mean being 72 t/ha (MSIRI, 2009).

Following world trade globalization and the reform of the European Union sugar regime, up to 36 % price reduction was imposed on sugar export of Mauritius to the European Union; besides, the industry has a number of strategic issues of which loss of cane lands in recent years, scarcity of

labor, and increased cost of production are the major ones. Strategies in Mauritius are embodied in the 2006–2015 Multi Annual Adaptation Strategic Plan prepared by the government of Mauritius in partnership with all the stakeholders of the sugar industry (MAAS, 2006). In the strategy, MSIRI is expected to focus on increasing total sugar production at national level, reducing costs of production, maximizing utilization of sugarcane by-products as well as diversifying within sugar, diversifying with other crops, monitoring environmental issues and improving transfer of technology and development (MSIRI, 2009).

South Africa: The South African sugar industry has two research institutes namely: South Africa Sugarcane Research Institute (SASRI) and South Africa Sugar Milling Institute. The Sugar Milling Research Institute (SMRI) is the central scientific organization involved in research work and technical services for the southern African sugar manufacturing/milling industries. It was founded in 1949 and is located on the Durban campus of the University of KwaZulu-Natal. The SA Sugarcane Research Institute is the leading sugarcane agricultural research institute in Africa; and it is world-renowned for its research into the development of new sugarcane varieties, and improved crop management and farming systems that enhance profitability, effective delivery of new knowledge and technology make a significant contribution to the sustainability of the industry (SID, 2011).

Research at SASRI is clustered to address the industry's strategic issues namely insuring profitability and sustainability of the industry, improving efficiency in variety development, and optimizing utilization of resources (Snyman et al., 2008; SASRI, 2010). Accordingly, SASRI has organized its research unit into four multi-disciplinary programs namely Variety Improvement, Crop Protection, Crop Performance and Management, and System Design and Optimization research programs.

Research conducted by SASRI contributes to the profitability and sustainability of the industry whilst encouraging environmentally responsible farming practices. Outputs from the various research programs at the institute are transformed into practical knowledge and technology products. Consequently, with the use of these research outputs, South Africa improved cane productivity from 61 to 75 t ha^{-1} in 15 years (23% increase), the recent five years mean yield being 64 t ha^{-1} (Meyer, 2007; Synamas et al, 2008; SID, 2011). Moreover, the Extension Service provides essential link between SASRI researchers and farmers through consultation and feedback.

Its primary role is to facilitate the adoption of technology and best management practices that encourage responsible and sustainable land use and deliver optimal productivity and profitability. A range of services are being provided to the industry on a user-pays basis, including Specialist Advice on growers' problems and soils and leaf analyses through the Fertilizer Advisory Service. Short courses in Sugarcane Agriculture at the junior and senior levels are held annually. SASRI also operates the only sugarcane quarantine facility in South Africa (SID, 2011)

Comparison of Ethiopian Sugar Industry Performance with other Countries

As indicated in Table 7, Ethiopia seems better in cane productivity than that of China, India, South Africa and Mauritius; however, the cane management practices employed in these countries indicated that the cane productivity of 5 to 6 t $ha^{-1}mon^{-1}$ is mainly obtained from rain fed cane agriculture as opposed to Ethiopia. Hence, this productivity is attributed to the use of improved technologies in cane agriculture released from their respective research institutes. Conversely, the current cane productivity of Ethiopia is even below its once attained potential of 10 $t^{-1}ha^{-1}mon$ (ESDA, 2010). This indicates that though the country has a good natural potential for cane agriculture, it is not yet optimally utilized. On the other hand, China and South Africa showed best performance in sucrose content and overall sucrose recovery.

In terms of total plantation area and sugar production, Ethiopia will be almost at par with South Africa in the year 2014. Moreover, literature indicates that the South African sugar industry is one of the world's leading cost competitive producers of high quality sugar (ISO, 2010). The key driver for this best performance of the South African sugar industry being its world-renowned agricultural and industrial research platform (SID, 2011). In addition, international experience indicates that almost all the world best sugar producing countries such as Brazil, India, China, Australia, South Africa, etc have a well established research capacity to ensure their industry competitiveness in an international market. Hence, the research unit of Ethiopian sugar industry can take these countries' research institutes in general and SASRI in particular as benchmarks to cope with the existing and future sugar development goals of the country. Thus, the existing sugarcane and sugar research system of the country should be revisited in line with the government development plan taking into account the world-renowned sugarcane and sugar research experience in to consideration.

Table7: Sugar production, consumption and some technical performance indicators of the sugar industries of Ethiopia and selected countries

No.	Description	Unit	China	India	South Africa	Mauritius	Ethiopia	
							Current	long term
1	Cane area	10^6 ha	1.521	4.229	0.44	0.069	0.04	0.44
2	Sugar production	10^6 t	12	21	2.3	0.57	0.3	2.25
3	Cane productivity	$t^{-1}ha^{-1}mon$	5.3	5.9	5.5	6.0	8.6	
4	Sucrose content	%	14.07	ND	13.47	10.52	13.48	
5	Overall sucrose recovery	%	85	88	89.4	86	85	
6	Ethanol production	10^6 l	5000	1300	ND	ND	20	181

Conclusion

The Ethiopian sugar industry uses limited improved technologies due to lack of capacity in the research unit to develop new technologies. Moreover, though high productivity were recorded in the three sugarcane plantations during some years, the overall productivity was inconsistent over milling seasons and even it was not possible to maintain the highest productivity achieved. Conversely, with the use of improved technologies developed through research, sugar producing countries have increased their production and productivity. Thus, to realize the sugar development endeavors of the government and ensure the industry's competitiveness in the international arena, use of improved technologies developed through research is crucial. Besides, bridging of the existing gap between the potential yield and the yield level achieved at present should be the primary focus of the research unit. On the contrary, the research unit is behind technological advancements in the industry. Moreover, the existing Sugarcane and Sugar Research Directorates have weak institutional capacity to fulfill the government's sugar development plan. The current level of resource both in human and physical facilities is also inadequate for high level research undertakings.

Noting the importance of the sugar industry to the country's economy and the opportunities in developing the sector to exploit local as well as international market, the research unit's institutional capacity should be in par with the sugar development program of the country. Cognizant of the role of research and training in the sugar industry, Sugar Corporation has

carried out benchmarking study and reformed the research and training unit (ESCRT) based on experience of Brazil and India. Following the reform, the industry's strategic issues have been clearly identified, namely, decline in cane and sugar productivity, scarcity of improved technologies and increase in the cost of production are the major ones. Strategies to address these issues, ESCRT has produced a five year (2010–2015) Strategic Plan, which is prepared in partnership with all the stakeholders of the sugar industry. In the strategy, ESCRT defines its role to focus on increasing sugar and cane productivity at national level, reducing costs of production, maximizing utilization and diversification of sugarcane co-products, monitoring environmental issues and improving transfer of technology and development. On this account, in order to address these issues, ESCRT is organized into three multi-disciplinary directorates which include:

- **Sugarcane Variety Development Research: by** using both conventional breeding and modern molecular technologies seeks to breed and select varieties having high productivity, tolerance to biotic and abiotic stresses, better water and nutrient use efficiency, multiple ratoonability and wider adaptability. Besides, it collects, characterizes, maintains, evaluates, conserves and utilizes sugarcane genetic resources.

- **Sugarcane Production Research** aims at establishing agronomic standards, production systems, minimizing the impact of weeds, pests and diseases on crop yields in environmentally sustainable ways. Emphasis is placed on the integrated use of management practices on biosecurity issues through the development of proactive countermeasures and threat-specific incursion plans. Focus on enabling production of high quality cane through optimal choice of varieties, appropriate use of ripeners, herbicides and fertilizers for enhanced soil sustainability as well as efficient use of water and improved sugarcane harvesting practices.

- **Sugar Technology Research** is directed towards investigating and developing innovative systems that optimize sugar and co-product production through process optimization research, technology design and fabrication systems and co-product utilization research approach.

Development of appropriate technology transfer tools and practices is recognized as fundamental to improved adoption of research advice and sustainable sugarcane/sugar production. Moreover,

the Extension Service provides essential link between ESCRT researchers and factory/project operation staff through consultation and feedback. Its primary role is to facilitate the adoption of technology and best management practices that encourage responsible and sustainable input use and deliver optimal productivity and profitability. Hence, through all these concerted efforts, the existing research system in the industry will work hand in hand both with national (EIAR, OARI, AARI, Jima University, Welega University, Addis Ababa University, Semera University) and international institutes and pave the way forward for technological advancement.

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Session 4

Technology, Development and Industrialization

Technical Tour to Turkish Textile Factory

Harnessing ICT for hastening Africa's catching up: Lessons from India

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Introduction

The emergence of Information Communication Technology (ICT) revolution and related innovations may be considered as one of the most important contributions in the field of technology by the last century to the present century and beyond. The world thus today is in the midst of a new technological revolution driven by the ICT, which is so ubiquitous and the accompanying innovations qualify it as a general-purpose technology. It has been argued that ICTs are key inputs for building competitiveness, economic growth and development. It offers opportunity for global integration while retaining the identity of traditional societies and can also increase economic as well as social wellbeing of poor people and enhance the effectiveness, efficiency and transparency of the public sector, including the delivery of social services (World Bank, 2002). In order to harness ICTs for growth and development today an increasing number of developing countries are undertaking various policy initiatives and institutional interventions. Here Africa is no exception as almost all the sub-Saharan African countries are committed to harness ICT as a short cut to prosperity. Thanks to these initiatives, use of ICT in Africa is picking up at a faster rate. However the famous statement made by Thabo Mbeki – "half of the world population has never ever made a telephone call" - almost a decade ago, continues to be relevant in many of the African countries as we can find a stark difference in ICTs access in Africa in comparison to other developing countries. In this context it may be inspirational for developing countries in general and those in Africa in particular that a developing country like India has acquired significant capabilities in ICTs and has immensely profited from its production, export and use. Hence an important issue of immense relevance for informed policy making and implications for south –south cooperation arises; Are there any lessons from India for the African countries aspiring to catch up by harnessing ICT. This is the central issue that this paper intends to address.

The remainder of this paper is organised as follows. The second section presents the analytical background by highlighting the role of innovation systems and trade and investment in promoting the production and use of ICT. The second section highlights Indian experience with respect to ICT production and use. The last section, drawing from the Indian experience, highlights the lessons for the aspiring African countries in general and Ethiopia in particular from the perspective of south-south cooperation.

2. Analytical framework: Facilitating ICT for development

In order to understand the issue at hand, one need to have proper understanding on the ways ICTs contributes to the economy and society. Analytically the link between ICT and development could be viewed at two, different but interrelated, levels; (a) on account of the growth of ICT sector and (b) on account of ICT diffusion/use. The former refers to the contribution in output, employment, export and other direct contribution to the economy on account of the production and exchange of ICT related goods and services and are often more visible than those from use. The latter refers to ICT induced development through enhanced productivity, competitiveness, growth and human welfare on account of the use of this technology by the different sectors of the economy and society (Kraemer and Dedrick 2001, Joseph 2006).

There is enough empirical evidence, both from the developed and developing world, at the firm, industry and at the economy wide level indicating that ICT could contribute significantly to productivity and growth (Pohjola, 2001; Link and Siegel, 2003; UNCTAD, 2003; Indjikian and Siegel 2005. The US Department of Commerce (2000) has shown that in the US, wherein the macroeconomic benefits of IT revolution are already apparent, ICT industries accounted for about 8.3 percent of the GDP and nearly a third of GDP growth between 1995 and 1999. IT production also contributed to lower inflation rates since a growing proportion of economic output has been in sectors marked by rapidly falling prices[5]. Benefits from IT production have not been confined to the US alone. IT industry has shown to be a major source of economic

[5] The report argues that actual inflation fell by 0.5 per cent points a year from 1994 to 1998 due the effect of declining prices of IT goods. Also IT industry, including telecommunications, employed 7.4 million workers in 1998 and this accounted for 6.1 per cent of the total employment with an annual wage rate more than 1.5 times that for all private employees. A cynic may argue that to sustain such growth in employment, output and wages in developed countries, the diffusion of ICT in developing countries need to grow at higher rate and not production.

output, exports and job creation in countries like South Korea, Singapore, Taiwan, Malaysia, Finland and so on. A country could benefit not only from the production of ICT goods also from ICTs services. For instance India, with its large pool of skilled manpower, has emerged as a major exporter of IT software and related services like Business Process Outsourcing (BPO). Also, on account of the availability of highly skilled manpower at low cost, India has emerged as preferred low cost site for R&D outsourcing and as of now more than 750 foreign companies have set up their R&D centres in India. In fact, India is not the only country being benefited from opportunities offered by BPOs. Countries like China, Philippines and Costa Rica among others are also emerging as providers of BPO services to the developed countries

Also, there are numerous cases across the world demonstrating that the developing countries could benefit from increased use of new technology as much as the rich countries to address various development issues like enhancing competitiveness, empowering people, improving social service provision and poverty alleviation. For instance case studies of Gambia, Chile and Bangladesh have highlighted how ICTs are being used in improving different development indicators like health, education and employment to local men and women. In Indonesia too ICTs are enabling the local citizens' groups to monitor complaints with environmental standards (DOI 2001). A study on the use of ICT in four villages in northern Thailand (as quoted in World Bank, 2002) also has similar conclusion to offer. In the Indian context there are numerous ICT projects initiated at the instance of Central and state governments along with non-governmental organizations and private are shown to have helped harnessing ICT for varied developmental issues. The UID project initiated by the central government, *Gyan Doot* programme in Madhya Pradesh, Internet Kiosks set up by MSS Foundation in Tamil Nadu and *Bhoomi* Project implemented in Karnataka, e-choupal project by ITC and various other rural ICT projects stand as a testimony to the positive benefits that ICT could impart to poor countries (Singh 2002, Government of India 2001, Joseph 2012).

In case of Africa, if the evidence presented by recent studies is any indication, ICT has immense potential for facilitating socio economic transformation. By exploring the link between ICT, growth and employment generation in case of Senegal Oumy Laye (2011) has shown that 10 per

cent investment in ICT in informal sector generate much more revenue and concluded that ICT investment has significant bearing on growth, employment generation and poverty reduction.

Waema and Okinde (2011) argues that in case of less developed countries like Kenya ICT is not just computers and internet and the old ICTs like radio plays a crucial role. A study of tele centres in Tanzania tends to suggest that ICT impact is greater in case of users in the rural areas who are more educated, underlying the bearing of initial conditions for getting benefited from ICT. The telecenters are increasingly being used for information sharing and help socio-economic development (Ulanga Peter 2011). Study on ICT use in printing and publishing industry in Nigeria (Adeoti et. 2011) and cassava value chain by Tiamiyan et. al 2011) also have reported the positive benefits of ICT[6]. In general the developing countries are actively looking for ways to speed up the transition towards an more inclusive information society UNCTAD 2012).

However, the focus of policy initiatives and other institutional interventions, mostly at the instance of international institutions, have been on promoting ICT use and only limited attempts have been made towards integrating the policy towards ICT production and diffusion/use. The most notable initiative in this context is the Information Technology Agreement of WTO**,** which came into force in 1997 and required the elimination of tariffs and other duties and charges on the goods covered by the ITA in maximal four stages until 2000. However, developing countries could opt for extending their staging until 2005[7]. The participants are required to abide the Most Favored Nations (MFN) principle. Hence, the benefits of zero tariffs are extended to those WTO members who did not sign the ITA. While ITA is open to non-WTO members, it is not mandatory on the part of WTO members to sign it. ITA till today is solely a tariff cutting mechanism, as the review of non-tariff barriers has not yet come to any conclusion. It is assumed that ITA will help reducing the prices of ICT goods and thus promote the wider use of ICT (Joseph and Parayil 2008).

Facilitators of ICT production and use[8]

Trade and Investment

[6] For a more detailed discussion please see the special issue of *African Journal of Science, Technology, innovation and Development*, vol 3. No.3, 2011.

[7] The exact text of the ITA, including the product coverage, can be found at http://www.wto.org/english/docs_e/legal_e/itadec_e.htm

[8] For detailed discussion please refer to Joseph (2006)

Analytically, it could be argued that the trade policy reforms, among others, play a dual role as they could be instrumental in promoting both use and production of ICT by operating from both demand and supply sides. From the demand side, as argued by Kraemer and Dedrick (2001) one of the best ways to promote IT use is to not create barriers to use. Needless to say, any government policy that makes electronic goods more expensive, especially in countries wherein affordability is a crucial issue, will discourage its use and reduce the possible benefits from IT. Thus trade policy reforms in the form of lowering taxes and tariffs and dismantling non-tariff barriers could have the effect of promoting demand and use through reduced prices and increased access. Trade policy reforms also have the effect of easing the domestic supply constraints and creating a more competitive environment leading to lower prices and better quality products, thus promoting the use of IT.

Innovation System

It is by now recognized that an economy's ability to bring about industrial transformation especially by harnessing knowledge and skill intensive sector like electronics in particular in a sustained manner depends, to a great extent, on the National System of Innovation (NSI). While the historical roots of the concept of NSI could be traced back to the work of List (1841), the modern version of this concept was introduced by Lundvall (1985) in a booklet on user-producer interaction and product innovation. Freeman (1987), while analyzing the economic performance of Japan, brought the concept to an international audience. He defined National Innovation System as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (p.1). The concept of NSI, as defined by Freeman, highlights the processes and outcomes of innovation. Since then there has been burgeoning literature (Lundvall 1992; Nelson 1993; Freeman 1987; Edquist 1997)[9] focusing on different dimensions of the innovation system.

3. India's Achievement in ICT production and use

Production and export

In the light of the above discussion, it may be paradoxical that a developing country like India has been able to successfully participate in the global division of labour in ICT sector and

[9] Here the readers are referred to the large number of papers presented in the different GLOBELICS conferences available at www.globelics.com

emerged as a leading player in the export of IT software and services *inter alia* by taking advantage of the opportunities opened up by new technologies that increasingly splintered off services from its providers. As a result, in the service sector induced turnaround in India's GDP growth and remarkable performance of the external sector observed since 1990s the role of software and IT enabled services, has been substantial. The export performance has attracted the attention of researchers and well documented in the literature (Schware 1992; Arora et. al 2001, Joseph 2002; Joseph 2009; Joseph and Harilal 2001; Kumar and Joseph 2005 to list a few). The performance of India in software and IT enabled service sector during the last two decades has been remarkable by any standard. During the years since 1990-91 total production of software and services increased by 26 fold; from a little over $200 million in 1990-91 to US $5.5 billion, recording an annual average growth rate of over 44 per cent. With a total production of about $75 billion in 2010-11, the observed high rate of growth during 1990s was sustained since 2000 recording an annual average rate of growth of over 35 per cent. More remarkable has been the performance with respect to exports. Total exports increased from $ 110 million 1990-91 to nearly $ 4 Billion in 1999-00 recording an annual average growth rate has been about 50 per cent in the 1990s. Going by the available evidence, with a total export of $ 57.6 billion in 2010-11 the observed rate of growth was as high as 38 per cent since 2000.

While it has been argued that Indian firms operated mostly at the low end of the software value chain, recent evidence tends to suggest that with increased participation in product development and other skill intensive activities, Indian firms are moving up the value chain (Joseph 2012).

On ICT use: The case of telecommunications

Along with the vibrancy in the software sector, the ICTs use has been significantly increased across the different sectors of the society and segments of the society during last few decades and the change has taken place mainly due to communication sector. The telecommunication sector, which was earlier under the state monopoly, has major process of transformation through significant policy reforms, particularly beginning with the announcement of National Telecommunication Policy of 1994 and was subsequently re-emphasized and carried forward under NTP 1999. NTP 1994 ensured the availability of telephone on demand, (in a context of huge pent up demand) provision of world class services at reasonable prices, improving India's competitiveness in global market and promoting exports, attractive FDI and stimulating domestic

investment, ensuring India's emergence as major manufacturing / export base of telecom equipment and universal availability of basic telecom services to all villages. With the entry of private service providers brought with it the inevitable need for independent regulation. Hence the Telecom Regulatory Authority of India (TRAI) was established with effect from 20th February 1997 by an Act of Parliament to regulate telecom services, including fixation/revision of tariffs for telecom services which were earlier vested in the Central Government.

Reforms initiated by NTP 1994 were carried forward by New Telecom Policy in 1999. NTP-99 laid down a clear roadmap for future reforms, contemplating the opening up of all the segments of the telecom sector for private sector participation. It clearly recognized the need for strengthening the regulatory regime as well as restructuring the departmental telecom services to that of a public sector corporation so as to separate the licensing and policy functions of the Government from that of being an operator. It also recognized the need for resolving the prevailing problems faced by the operators so as to restore their confidence and improve the investment climate.

Another major step was to set up the Universal Service Obligation Fund with effect from April 1, 2002. The Fund is to be utilized exclusively for meeting the Universal Service Obligation. Under this initiative, 7387 mobile infrastructure sites are being rolled out, in the first phase, across 500 districts and 27 states of India. This scheme will provide mobile services to approximately 0.2 million villages which where hitherto deprived of the same. As on 30th June 2010, 7183 shared towers have been set up under the First Phase of the scheme. The Universal Service Obligation Fund (USOF) of Department of telecommunication has proposed to set up about 10,128 additional towers in order to extend the mobile coverage in other uncovered areas under the Second Phase of the Scheme.

As a result of these reform measures and institutional interventions, India's telecom service sector has emerged as the third largest and one of the cheapest in the world. As per the data available from the department of telecommunications[10], the Tele-density in the country increased from 5.11% in 2003 to 77.57% in January 2012. By January 2012, there were 936 million telephone subscribers of which only 32.3 million are fixed lines. In the rural area teledensity

[10] For details please visit http://www.dot.gov.in/osp/Brochure/Brochure.htm

increased from 1.49% in Mar 2003 to 38.08 % in January 2102 and in the urban areas it is increased from 14.32% in March 2003 to168.44 per cent in January 2012. Though this indicates a rising trend in rural access, the sharp urban rural divide remains to be addressed.

The weak link: lagging hardware sector

The weaker link in India's IT performance relates to hardware. Though India is one more the pioneering developing countries to evolve institutional interventions and policy measures to promote a balanced electronics industry as early as in late 1960s its performance both under the control regime and liberalized regime was less remarkable. To be most specific, the annual average growth of electronics production was only at 12% during post 1995 period with total production reaching a level of little over $27 billion in 2010 of which $8.8 billion was exported indicating a less vibrant domestic production base. In a context of liberalized trade regime, adherence to the Information Technology Agreement of WTO in a context of booming domestic demand has led to substantial increase in the import of IT equipment. As per the data obtained from WITS (UNCTAD) total import for the year 2010 amounted to over $20 billion. Thus viewed, there is some merit in the argument that, the absence of a vibrant electronic sector would have acted as a drag on India's effort towards harnessing IT for development.

The draft electronics policy (2011), notes that IT demand in India for the year 2008-09 is estimated at $45 Billion and is expected to reach $ 400 Billion by 2020. Domestic demand is expected to be driven by growth in income levels leading to higher off-take of electronics products, automation demands of corporate sector and the government's focus on e-governance. The domestic production in 2008-09 was about $ 20 Billion. However, the actual value-addition in the domestically produced electronic product is very low, ranging between 5 to 10 per cent in most cases. At the current rate of growth, the domestic production could cater to a demand of $100 billion in 2020 as against a demand of $ 400 billion and the rest would have to be met by imports. This aggregates to a demand supply gap of nearly $ 300 billion by 2020. Unless the situation is corrected, it is likely that by 2020, the electronics import may far exceed oil imports. Hence, the draft electronics policy (Government of India 2011) envisages transforming India into a global hub for electronics system design and manufacturing (ESDM) so as to meet the growing domestic and global demand.

NIS and India's IT sector

Various studies have explored the factors that led to India's success in ICT sector and it has been argued that India's performance has not been the handiwork of the market but has been an outcome of the innovation system built up over the years mostly at the instance of state[11]. In a sense India's success owes largely to the cumulative investments made by the government over the past five decades in building what is now termed National Innovation Systems (NIS). These include a system of higher education in engineering and technical disciplines, creation of an institutional infrastructure for S&T policy making and implementation, building centres of excellence and numerous other institutions for technology development, setting up of software technology parks and provision of venture capital and export finance, among other initiatives. The Indian government recognized the potential of the country in computer software way back in the early 1970s and started building necessary infrastructure for its fruition, in particular, for training of manpower. The government also facilitated technological capability building with investments in public funded R&D institutions and supporting their projects, by creating computing facilities, and developing infrastructure for data transfer and networking. The patterns of clustering of the software development activity in select centres provides a further evidence to the contention that public funded technological infrastructure has crowded in the investments from private sector and foreign firms in skill intensive activities such as software development. While Government interventions laid the foundations, the industry could take off only with high growth in world demand *inter alia* on account of the Y2K problem and greater participation by the private sector (Kumar and Joseph 2005; Joseph 2009).

4. Towards a perspective: the lessons and an agenda for S-S cooperation

In the light of the foregoing discussion let us reflect if there are any lessons from Indian experience for developing countries in Africa in general and Ethiopia in particular?

To answer this issue it is important to have an understanding on where does Sub Saharan Africa and Ethiopia stands with respect to the approach towards ICT and the present level of production and use. It needs to be noted that as in many other African countries over the last decade, ICT has become an integral part of Ethiopia's development programmes. ICT has been explicitly

[11] See for details Joseph (2006) Kumar and Joseph (2006) Balakrishnan (2006) also A K Sen "looking beyond the traditional domain", *The Hindu*, 16, February 2007, Chennai,

recognized as one of the key components of the Sustainable Development and Poverty Reduction Program (SDPRP) of the Ethiopian government in the Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) that has been implemented during 2005-10. This is evident from the ICT sector policy of the Ethiopian government developed in 2006 by the Ethiopian ICT Development Agency (EICTDA) which aimed at

- developing ICT as a globally competitive industry, and as an engine of national growth; creating the necessary conditions for the rapid development of ICT within the economy and society to accelerate Ethiopia's socio-economic development process;
- promoting and facilitating extensive use of ICT in support of key sectors of the economy including agriculture, industry and the services sectors;
- transforming Ethiopia into a knowledge and information-based society and economy; and
- promoting the use of ICT for modernising the civil and public service to enhance its efficiency and effectiveness for service delivery, to promote good governance and reduce wastage of scarce resources.

To achieve the above objectives, the government has come up with programmes that aim at

- creating an enabling policy, regulatory and legal environment for the growth and utilization of ICTs;
- developing the necessary ICT human resources, infrastructure, rural access, ICT standards, and local content;
- strengthening the capacity of public institutions to facilitate the mainstreaming of ICTs for socioeconomic development; and
- facilitating the use of appropriate technologies for development of applications and content for rural development, good governance, and service delivery in priority sectors.

Highly appreciable policy initiatives notwithstanding, the available evidence with respect to IT production is disappointing because Africa is yet to get a position in the world electronics and ICT production map. When it comes to IT use – as indicated by the use of mobile, internet, broad band and computers - the picture is not very encouraging either (see table 2). To be more specific, when it comes to indicators of ICT use in Ethiopia and Sub Saharan Africa like internet (0.75, 11.25) broadband (0.004, 0.18) fixed telephone (1.09, 1.42) the gap between Ethiopia and Sub Saharan Africa is much wide. However, the use of mobile has recorded a remarkable increase during the last decade both in sub Saharan Africa and Ethiopia (see table 2). The present level of mobile diffusion in Ethiopia (8.26 per 100 population), however, is at a much lower level as compared to Sub-Saharan Africa (44.9 per 100 population) notwithstanding the higher rate of growth in Ethiopia as compared to sub Saharan Africa recorded during the last

decade. Yet the current level mobile density (8.26%) has to be compared with 78 per hundred population in the whole world and 107 for OECD countries and 33, 72 and 84 for the lower middle income, middle income and upper middle income countries respectively. This tends to indicate that both sub Saharan Africa and Ethiopia need to travel a long distance to reach even the world average. There are also evidence to suggest that, as in many other developing countries, the intra-national digital divide is perhaps more acute than international digital divide. To be more specific, in case of mobiles, while national mobile intensity in Ethiopia is 8.3, much of it is in three administrative regions - Addis Ababa (81%) Hareri (67%) and Dire Dawa (50%) with all other eight administrative regions having mobile density at one digit level with three of them having mobile density as low as one per cent.

Adam (2010) reports that access to communication services in Ethiopia is characterised by a high pent-up demand. The waiting list for fixed-line communication increased from 13,579 in 2007 to 19,013 in 2008 and thereafter declined marginally to 18,548 in 2009 possibly as people substituted mobile for unavailable fixed services. The waiting list for mobile services is also extensive, with over a quarter of the population of 80 million (20 million users) waiting for their first mobile SIM cards. The cost of mobile call is found to be much higher than in India and exorbitant when compared to the low per capita income of the country. The cost of the SIM card is another barrier to subscription to mobile services, particularly to those with low incomes. Although the cost of SIM cards has come down dramatically from US$42 in 2006 to US$13 in 2009 and US$5 in 2010, the price is still high when compared to many African countries where SIM cards can be obtained for as little as US$2, or even for free as part of a subscription.

Table 2: ICT diffusion in Ethiopia and in comparison with Sub-Saharan Africa
(per 100 population)

Year/ Indicator	Mobile		Internet		Broadband		Fixed Telephone		Computer
	Ethiopia	SSA	Ethiopia	SSA	Ethiopia	SSA	Ethiopia	SSA	Ethiopia
2000	0.027	1.715	0.015	0.512	-	-	0.354	1.378	0.092
2001	0.041	2.491	0.037	0.658	0	0	0.421	1.402	0.111
2002	0.072	3.577	0.072	0.901	0	0.001	0.512	1.437	0.145
2003	0.072	4.961	0.105	1.208	0	0.004	0.572	1.484	0.212
2004	0.214	7.402	0.155	1.6	0	0.012	0.667	1.513	0.309
2005	0.552	12.039	0.219	2.325	0	0.029	0.821	1.46	0.402
2006	1.14	17.793	0.311	3.521	0	0.082	0.954	1.509	0.568
2007	1.554	23.262	0.37	4.109	0.001	0.083	1.132	1.495	0.676

2008	2.46	32.086	0.45	6.456	0.001	0.097	1.129	1.448	-
2009	4.991	37.794	0.54	9.389	0.004	0.133	1.127	1.516	-
2010	8.263	44.907	0.75	11.25	0.004	0.177	1.095	1.423	-

Source: ITU and WDI

Lessons for African countries

The first and foremost lesson from India is that, the development of software sector and building up of capabilities cannot be accomplished simply by the magic of market – the state has a key role to play. The strategy needs to walking on two legs – promoting both production and use. For evolving a domestic production base and to attract investment, there is the need for a liberal trade and investment policies that facilitate the inflow of inputs into and output out of the economy. To attract FDI, along with liberal trade regime, there is, among others, the need for developing human capital. A large pool of skilled manpower is also a primary condition for developing a software production base. Here the strategy needs to be one of pooling together the resources of different actors like Civil Society Organizations, private sector and other stakeholders. But with the operation of different stakeholders for generating human capital, there is also the risk of generating human capital which is not employable. Hence, there is the need for a system of accreditation for the manpower training centres and promoting greater interaction with the industry.

Also, the strategy should be not one of spreading thinly the resources across the country, instead the investment needs to be undertaken in such a way as to take advantage of the agglomeration economies. This might be possible through the setting up of Technology Parks wherein, built up space, communication infrastructure and others, which are beyond the reach of an individual entrepreneur is provided along with a "single window clearance" system so that the prospective investors need to have only limited interaction with the bureaucracy. Such technology parks needs to be close to and have constant interaction with the centres of learning such that mutual learning and domestic technological capability is built up in the long run.

Since the software sector consists of different activities that call for varying levels of skill intensity, the developing countries with skill deficit could make their entry point with ITES or software services. But there is the need for conscious efforts towards skill empowerment such that the sector does not get locked up in low technology activity and an upward movement along the value chain is facilitated.

In a less developed economy it might be possible that the business may not be e-ready to have large domestic demand. While it is possible to develop a software production base using the export market, a domestic market is definitely an added advantage. Hence an appropriate policy framework that creates a vibrant domestic market base is likely to help development of a vibrant software service industry.

To promote IT use, it is important to ensure that the telecom and other services are priced in such a manner that it is affordable to people at large. This is likely to happen in a competitive structure than under monopoly. Hence there is the need for promoting competitive environment in the telecom and other IT services sectors, of course in a regulated environment, as has been accomplished by India by establishing the Telecom Regulatory Authority. There is no guarantee that the private sector, driven by profit motive will ever be induced to thinly populated rural areas. Here much could be learned from India's strategy of establishing the universal access fund.

South-South Cooperation in ICT and Software

Paradoxically, during 1970s and 1980s when the developing countries had only their poverty to share, South-South cooperation has been much debated among the developing countries[12]. The issue seems to have taken a back seat during the last decade as the developing countries were increasingly experimenting with trade and investment liberalization under Globalization. But today, with increasing disenchantment among developing countries with globalization and creation of substantial technological capabilities in the South which in turn has contributed to southern development solutions, the South-South Cooperation is gaining momentum (Joseph 2006).

In a sense, the potential of IT in general and software in particular to contribute to the socio-economic transformation of the developing world through South-south cooperation emanate from the fact that while the western world held monopoly over the earlier GPTs, in case of software, the capabilities are more diffused with capabilities in the South. While Japan and South East Asian countries used to hold leading position in the manufacture of ICT goods (Ernst 1993), China of late has joined the league. In the field of ICT software and services while India has emerged as a major player in the world market going by the available evidence, China also has established a sound software development base. Though there have been apprehensions about Indian software firms

[12] See in this context among others, RIS (1987) and South Commission (1990)

focusing on low end of the software value chain, the present study presented evidence to suggest that India's software sector has been moving up the value chain. Further there are a number of ICT innovations from India addressing issues specific to developing country like affordability, illiteracy and last mile connectivity (see box 2). Therefore, unlike the developing countries of 1950s and 1960s that had to resort to

Box 2
CorDECT: An Answer to Last mile Connectivity at Affordable Cost?

Despite living in this Information Age, people in most developing countries can not afford to spend much on telecom. In a country like India, where over 65% of the billion plus population hails from the rural hinterland with low income and affordability levels the key issue in the provision of telecom services remains that of affordability. To be precise, the income levels of most rural households hover around $40-$60 and the amount that they can spend on communications can be no more than $2-$3 in a month. This calls for the development of a technology that has a very low capital expenditure, one such technology being the WiLL (wireless in local loop).

CorDECT WiLL, developed by the TeNeT Group of IIT Madras and Midas Communications in Chennai, (a company incubated at IIT Madras in India). DECT stands for "Digital Enhanced Cordless Telecommunications", a radio technology suited for voice data and networking applications. It is a low-cost fixed wireless access technology aimed at connecting primarily homes and small offices in rural areas and small towns. CorDECT provides two lines to each subscriber, a voice line and a 35 kbps dedicated Always-ON Internet connection (a premium rate at 70 kbps). Capable of being used in both rural and urban areas, its cost effectiveness is highlighted better in the rural case where using the Relay Base stations it can serve users in a radius of 25-30 km. Such rural deployment costs less than $300 per line, making CorDECT the lowest cost connectivity solution.

Apart from India, CorDECT is already being used in over 10 other countries including Egypt, Tunisia, Brazil, Argentina, South Africa, and Iran.
Source: Joseph (2005)

the difficult task of importing and adapting technologies from the North, for today's developing countries that are lagging behind in the sphere of ICT, there are many a "ready to use" innovations from the ICT technology shelves of emerging countries in the South. Hence these countries have the less risky and less costly option of transferring technologies from other countries in the south to hasten their catching up process.

While China is known for its hardware production capabilities, recent evidence tends to suggest that China is also emerging as a major producer of software and much of it has been used domestically which in turn could have been instrumental in increasing the efficiency and competitiveness of other sectors of the economy. India and China are not isolated success stories in the South. A number of non-G7 countries have developed capabilities in the field IT and software (Arora and Gambardella 2004 Ojo et al 2008) and a new generation of countries like Philippines, Morocco, Costa Rica and others have joined the bandwagon (UNCTAD 2003).

Thus ways and means by which these countries have managed building up software capabilities and ways in which it has been harnessed for addressing various development issues might offer very valid lessons for countries in Africa and Ethiopia in particular. This becomes all the more relevant when we consider the fact that the elements and priorities of national ICT strategies are shown to vary between developed and developing countries. While issues like basic telecommunication, affordability, local content, human capital and other related issues are the central concerns of developing countries, the developed countries are preoccupied with issues relating to IT security, privacy, cross-border certification and other related issues (UNCTAD 2003, Koanantakol 2002).

Thus the need for South-South cooperation is obvious because of the existence of IT capabilities in the South and marked divergence in the IT interests of developing and developed countries. Going by the available evidence cooperation in the sphere of ICT has emerged as a major agenda in many of the regional cooperation agreement starting the e-ASEAN framework agreement. India is very active in South-South cooperation in ICTs (Joseph 2005; Joseph and Parayil Joseph and Parayil 2008). Some of the existing cooperation agreements involving CIBS as reported by Ojo et al (2008) include:

- India's bilateral agreements with over 30 countries in the area of e-government, computerization of government offices, and FDI in software industries of countries such as Sri Lanka, Mauritius, Vietnam, and Senegal. India has also been involved in trilateral relationships with Mexico and Venezuela.
- South Africa plays a prominent role in a few major regional economic frameworks such as the Southern African Development Community (SADC), Common Market for Eastern and Southern Africa (COMESA) and the African Information Society Initiative (AISI). These regional initiatives involve cooperation in the area of e-applications (such as e-learning and e-government).

- China has supported several developing countries through its technology cooperation programme, largely in the form of training. China also has some 130 technical cooperation agreements including SSC in science and technology with major players in the north, particularly the EU and the US.
- Brazil, as a member of Economic Commission of Latin America and the Caribbean, is involved in the development of regional information systems with other members.
- The India-Brazil-South Africa (IBSA) Economic Cooperation agreement includes: (i) facilitation of trade among the three countries, (ii) sharing of experience in the field of e-governance and (iii) mutually strengthening capabilities in free and open source software.

But, what is at present missing is an institutional arrangement for promoting the same with research backed by theory and empirics to sustain it. In this context there is the need for initiatives to make the ball rolling by bringing together the countries in the South under the umbrella of an e-South Framework. The Agreement shall aim at bridging the digital divide, developing software capabilities and harnessing ICT for development through an integrated development of ICT Sector in the developing countries. Towards achieving this objective, the Agreement, in tune with the Information Technology Agreement of WTO should facilitate free trade in ICT goods and services. At the same time, drawing from the e-ASEAN Framework Agreement the e-South Agreement should be instrumental in building capacity both for production and use. Given the paramount importance of human capital in developing ICT production and promoting ICT use, special focus may be given to developing IT manpower wherein there is the need for relaxing the restrictions on the mobility of skilled manpower across the developing world. In general the Agreement should facilitate an integrated development of the ICT sector wherein both production and use are promoted instead of the ongoing lop-sided approach towards making many a developing countries passive adopters of technology. South-south cooperation, however, should not be construed as a substitute for the ongoing initiatives at promoting North-South, bilateral and regional cooperation or country-specific policies.

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Industrialization through the Introduction of Venture Capital – Considering the Experiance of Emering Economies

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Abstract

The purpose of this study is meant for the introduction of venture capital as a means of finance for revitalizing the feeble Small and Medium Enterprises (SMEs) and developing viable business ideas which are deemed to be the springboard for industrialization. Accordingly, the team has employed multiple methods of data collection instrument such as documentation, observation, and interviews. Subsequently, the team has found out that more than 90% of SMEs and innovative business ideas are not well functioning up to their intended purposes due to the lack of venture type financial intermediaries. The team also identified that there is no encouraging legal environment for the introduction of venture capital business. It is also found out that there is no culturally encouraging environment and systematically organized institutions for taking high risk of financing entrepreneurship and revitalizing the feeble SMEs in Ethiopia.

The practical implications of this study are to introduce venture capital business in Ethiopia and to propose suitable type of venture capital model from the experience of other emerging economies. Furthermore, the study team has encourages doing further research in this area. On top of this, the study is to the best of the team's knowledge and the first to provide introductory conceptual framework on venture capital business and proposes the introduction of such business in Ethiopia in order to accelerate the progress of industrialization.

Key Words: Venture Capital, Small and Medium Enterprises (SMEs), Industrialization, and Innovative Business Ideas.

1. Introduction

The economic growth trend of the world has now shifted towards the developing countries and many have started to register double-digit growth annually (Economic Watch, 2010 and 2011). However, this growth is highly constrained by the scarcity of capital. In particular, the development of SMEs and new business ideas, which are the springboard for industrialization and economic growth, are critically affected by lack of finance. To solve this problem, many developing countries are working towards improving access for finance to those innovative businesses with high economic benefits. One of the major sources of fund recommended for financing such types of enterprises is Venture Capital. Venture capital is a kind of finance provided for early-stage, high potential, high risk, growth startup companies having no truck record[13]. This study, therefore, explores the conceptual understanding of venture capital, assesses its contribution for industrial development, and draws lessons to be learned from other developing countries with a view of adapting to the Ethiopian environment. Accordingly, the objectives of this study are;

- To create the conceptual understanding of what is venture capital all about;
- To draw lessons from the experiences of emerging countries with the view of adapting to the Ethiopian environment;
- To assess the potential ground for venture capital business in Ethiopia
- To identify the missing for the introduction of venture capital in Ethiopia

The scope of the study is limited to introducing the concept of venture capital based on lessons drawn from some emerging countries and to make potential assessment on its effect with regard to the development of entrepreneurships and SMEs.

1.1 Statement of the Problem

This study considers that absence of venture capital for the revitalization of SMEs and innovative businesses as one of major causes for the slow progress of industrialization in Ethiopia. It can

[13] http://www.mbaknol.com/business-finance/stages-of-venture-capital-financing/; Retrieved on 12/3/2012

also be taken as an impending force for the growth of the SMEs and creates a retarding repercussion on entrepreneurial innovation and subsequent industrial development.

1.2 Research Design and Methods

This study has a simple descriptive and exploratory nature. It is partly descriptive because it describes the existing attitudes towards venture capital business. The study is also partly exploratory in nature for the mere fact that it is undertaken to explore an area where little is known in our situation. The study has also assessed secondary data concerning the experiences of emerging economies in relation to venture capital and industrialization. On top of this, the team has conducted an interview to a sample of 86 registered SMEs, 12 intellectual property right owners, fifty university students, and four representatives of banks to look into the potential for venture capital business in Ethiopia. The team has also used the documentations of the target group for creating more understanding about the subject matter of the study.

With regard to data collection, both primary and secondary data were used to support the research. Primary data were collected mainly through interview and observations. Secondary data were collected from literatures written on venture capital business in emerging economies and documentations of the Federal Small and Micro Enterprises Agency and Ethiopian Intellectual Property Right Office. Therefore, Documentation, observation, and interview were also the major techniques used for data collection. The study has employed statistical software that is suitable for the study. The results of the data have been organized in tables and graphs. The frequency distributions and percentages ratios are used to summarize the output of the study pictorially.

2. Venture Capital and Industrialization – Literature Review

2.1 Concept of Venture Capital

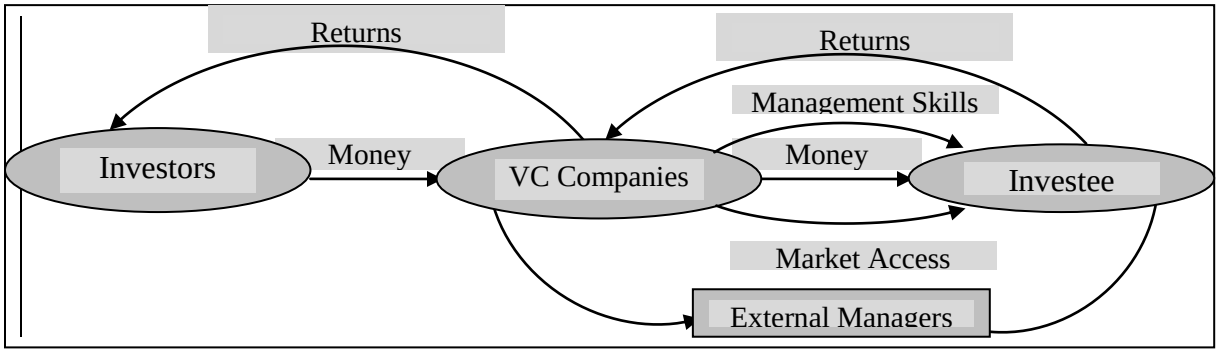
Venture capital commonly refers to the provision finance for seed, start-up, and first stage businesses.[14] It also refers to the provision of financial support for the expansion of companies that have already demonstrated their business potential. Venture capitalists provide equity capital that enables young and growing businesses to take risks, build plants, develop technology and implement their long-term strategies to compete on a global basis. Thus, Venture capitalists are

[14] http://www.mbaknol.com/business-finance/stages-of-venture-capital-financing/; Retrieved on 12/3/2012

mainly engaged in: (1) Financing new and rapidly growing companies; (2) Assisting the development of new products or services; (3) Adding value to a company through active participation; and (4) Taking higher risks with the expectation of higher rewards.

The venture capital business had its origin in the offices that managed the wealth of financially successful individuals in the late 19th and early 20th century.[15] Venture capitalist finances innovations and ideas, which have potential for high growth but not proven. This makes it a high risk, high return investment (Figure 1).

Figure 1: The Operational System of Venture Capital Business



Source: http://www.scribd.com/doc/49880098/VENTURE-CAPITAL, Retrieved on 23/02/2011

Unlike Banks, venture capitalist is a business partner, sharing the risks and rewards, and provides strategic, operational and financial advice to the company.In order to increase the likelihood of success; venture capitalists typically assist the company's development in four stages.[16] These are (1) **Idea generatio**n, where ideas are supported by feasibility study and business plan and can then be sold to interested investors, firms, and interested parties for a lump sum or a management contract, as agreed; (2) **Start-up**, is a company or a temporary organization designed to search for a repeatable and scalable business model; (3) **Ramp-up**, describes the period between product development, and maximum capacity utilization, characterized by product and process experimentation and improvements; and (4) **Exit,** a means of leaving one's current situation, either after a predetermined objective has been achieved or as a strategy to mitigate failure.

[15] http://kannanpersonal.com/content/mutual-fund/vc-2.html; Retrieved on 5/4/2012
[16] http://www.banknetindia.com/finance/vcapital.htm;Retrieved on 7/7/2012

2.2 Venture Capital and Industrialization - Experiences of Emerging Economies

Developmental programs in many developing countries have come with many challenges due to differences in cultural, economic, and legal systems.[17] This has led to unrealized developmental goals of countries and ever-widening financing gaps for Small and Medium Enterprises (SMEs). Venture capital (VC) encourages and advances the creation and development of entrepreneurship and SMEs in emerging economies. Evidence from some of the major emerging countries suggests that venture capital is an important player in their industrialization and technology transfers.

Table 1: Number of Venture Capital firms and the Contribution of Industry to GDP

Emerging Economies	**Number of Venture Capital Firms**	**Industrial Contribution to GDP**
China	528	**44.8%**
Brazil	400	**28.3%**
India	350	**26.5 %**
Ghana	5	**25.0%**

Source: World Bank, 2011 and Associations of Venture Capital respective countries

The above evidence suggests that the higher the number of venture capital firms in a given economy, the higher the share of the industrial sector in the GDP, which may suggests the influence of venture capital businesses on the development of the industrial sector. New developments in science and technology are the key competitive edge in the advancement of industrial economies. In order to observe the contribution of VC for industrial development in emerging economies, the team has attempted to give a brief overview of venture capital industry of China, India and Brazil.

2.2.1 Venture Capital Business in China

In China, the development of VC industry was intensified after 1998, when the Chinese government established a governing body and adopted policy schemes to promote venture investment in the country (Batjargal, B., and M. Liu, 2004). In the same period, the State Council issued the decision to develop High-technology businesses through Innovation and

[17] Dossani, R. & Kenney, M. (2002). Creating an Environment for Venture Capital in India *World Development 30 (2), pp. 227–253.*

Industrialization. This decision calls for the cultivation of capital markets and establishing a venture capital regime, which considers that:[18] (1) High-tech industries as key the drivers for the growth of an information-based economy; (2) IT, biotechnology, technologies on new materials, and advanced manufacturing technologies were set as the priorities of future investment; (3) Establishing and developing a venture capital industry to support technological innovations of small and medium enterprises (SMEs).

Under the guidance of the central government's macro-policies, local governments were zealously pursuing policies and regulations that would spur the growth of venture capital industry. Because of these efforts, four distinct types of venture capital firms were organized to operate in China: (1) foreign firms, (2) government firms, (3) university firms, and (4) corporate firms, (White et al., 2005). Each of the different types of venture capital firms has experienced some successes and some difficulties. However, in 2005 alone, an estimated amount of $1.17 billion was raised by venture capital firms to invest in China, up from $325 million in 2002 (Balfour, 2006). The larger portion (nearly 60%) of this fund is used to finance high-tech and manufacturing sector of the country followed by service. At the end of 2006, the total number of venture capital and private equity firms operating in China reached more than 500 and this number was expected to continue its steady growth as venture capital firms continue to move into the China market (Liu et al., 2006). All the above efforts have raised the economic contribution of venture capital and lead to the rapid growth of the Chinese industrial sector. Consequently, China started to become one of the fastest growing markets for venture capital investment in the world.

2.2.2 Venture Capital Business in Brazil

The venture capital business in Brazil began to show rapid growth after the first half of the 1990s, following the implementation of a new legal framework that brought about investment structures, which are close to those used in the USA. In order to help startups and SMEs to surpass the valley of death, venture capitalists of Brazil not only provide funding but also a whole package of strategic resources that help the invested companies to succeed. While Brazil has a potential for early-stage investment in innovative SMEs, it also has a growing VC industry capable of selecting and financing promising business projects. In 2004, the industry received

[18] http://www.oycf.org/Perspectives2/18_093002/Economy_Venture_China.htm retrieved on 7/7/2012

more than 3,600 investment proposal and invested in 35 of them. During the process, 840 were full examined by VC professional and 140 reached the due diligence stage; only 25% of those underwent the due diligence process received investment in the same year.[19]

Table 2**:** Number of Firms at Different Stages of Investment financed by Venture Capital

Stage of Investment	Number of Firms	Share in %
Seed Capital	36	17.6
Start up	72	35.3
Expansion	96	47.1
Total	**204**	**100.00**

Source: http://www.mvcc.mx/wp-content/uploads/2010/04/Brazilian-VC-and-SMEs.pdf; Retrieved on 7/5/2012

The VC industry of Brazil managed a portfolio with 204 companies. Of these, 36 received their first round of VC financing at the seed stage and 72 as start-ups. In general, The Brazilian institutional environment has also become supportive of early-stage entrepreneurial activity. The recent developments in this area include; the introduction of new corporate and bankruptcy law, acknowledgement of arbitration, and liberalization of pension fund to participate in venture financing.

2.2.3 Venture Capital Business in India

In India, the concept of venture capital has evolved because of the gap created between the demands for financial resources and funding availed from banks and other financial institutions. The first origins of modern venture capital in India can be traced to the setting up of a Technology Development Fund in the year 1987/88, through the levy of access on all technology import payments (IVCA, 2000). The Technology Development Fund was started to provide financial support to innovative and high-risk technological programs through the Industrial Development Bank of India. Subsequently, the Government of India gave the procedures that can be used for starting venture funding. The purpose of this procedure was to deliver venture capital service to Indian businesses.

As a result of the above initiative, there are now more than 400 venture capital funds in operation on different sectors with more than USD 16.5 billion at the end of 2010/11.[20] Yet, there were

[19] ibid

about 300 venture capital funds active at the end of 2008. The VC industry has shown a steep upward curve from investments of about USD 0.5 billion (56 deals) in 2003 to USD 14 billion (439 deals) in 2007. In the year 2008, the venture capital industry mobilized around USD 11 billion (382 deals).

2.3 Lessons from Venture Capital Contribution in Emerging Economies

- The concept of venture capital emanated from the chronic problem of finance for early stage, high risk, and high return investments, such as SMEs and innovative business ideas.
- SMEs and innovative business ideas are the springboard for industrialization and economic growth.
- The presence of greater number of venture capital firms has helped to increase the contribution of industry to GDP.
- The development of venture capital investment needs adequate legal and institutional framework as preconditions for its efficient and effective operation.
- Policy directions of the government, especially in providing adequately attractive business environment, can also be taken as cornerstone for the advancement of venture capital business in emerging economies.
- There are different types of venture capital financing businesses at different stages of development.

3. Ground for the Introduction of Venture Capital in Ethiopia

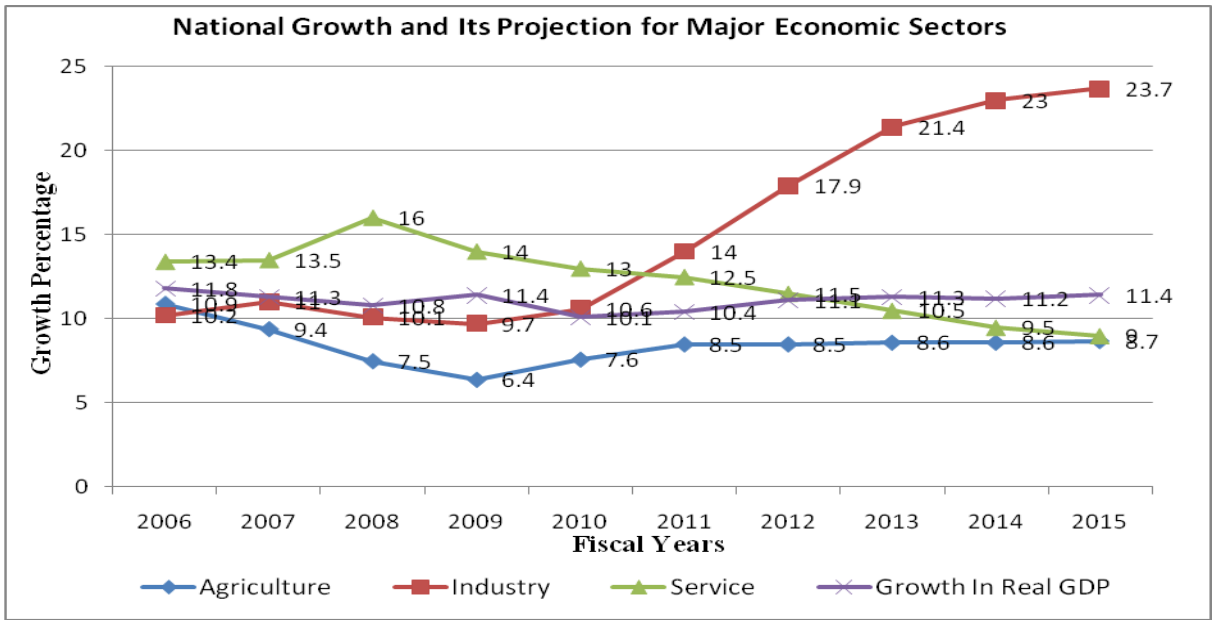
3.1. Overview of Industrial Development in Ethiopia

The past eight years were very remarkable in the history of the Ethiopian Economy. During this period Ethiopia registered an average growth rate of around 11% (MoFED, 2011). The recent five-years Growth and Transformation Plan (GTP), 2010/11 – 2014/15, envisages an achievement of an annual real GDP growth of at least 11.2% and at best 14.9%. Most importantly, the GTP envisaged strengthening of the industrial sector to become the leader of the economy. Accordingly, the growth projection for industrial sector by the end of the

[20]http://www.ey.com/Publication/vwLUAssets/Globalizing_venture_capital_Global_venture_capital_insights_and_trends_report_2011/$FILE/Globalizing_venture_capital_Global_venture_capital_insights_and_trends_report_2011.pdf

transformational plan is 23.7 percent, which is an ambitious task compared to the current industrial base of around 14% (Figure 2).

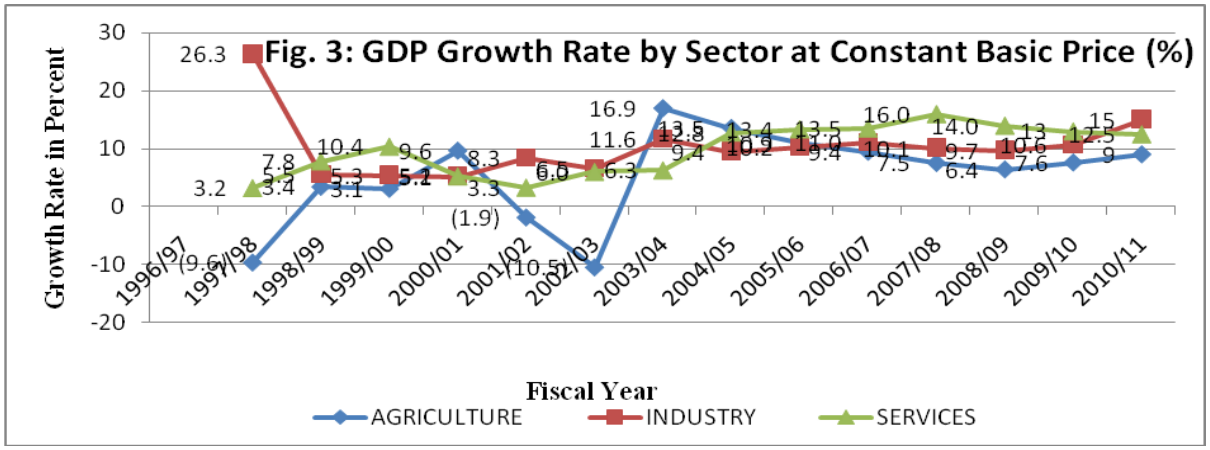
Figure 2: Ethiopian Economic growth and its Projection for major Economic Sectors



Source: Ministry of Finance and Economic Development (MoFED)

Though the industry is expected to grow faster than the rest of the economic sector in the years to come (Figure 2), the actual industrial growth performance of the country still require more effort to bring about a structural shift in the economy.

Figure 3: GDP Growth rate by sector at constant basic price (%)



Source: Ministry of Finance and Economic Development (MoFED)

The achievement of industrial development would require support for entrepreneurial skill, which in turn requires easy access to financial resources through a well functioning financial

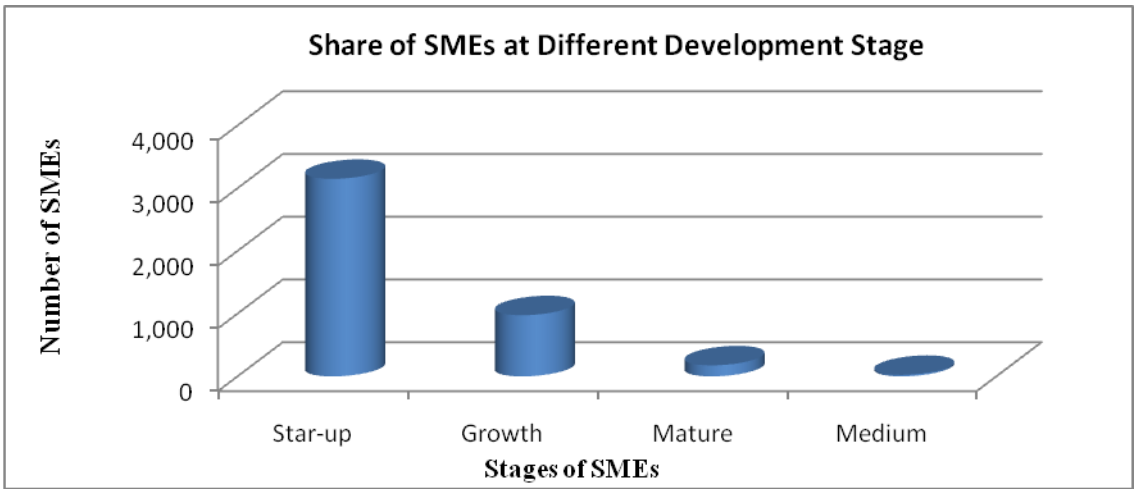
system. In general, lack of access to financial resources has been one of the major challenges in the process of starting and sustaining business in Ethiopia. Therefore, apart from banks and microfinance institutions, it is essential to establish various forms of financing mechanisms that help to support the development of industry to encourage innovation and raise efficiency to ultimately result in the envisioned industrial development.

3.2 Potential Assessments on the Need for Venture Capital Business in Ethiopia

3.2.1 Potential Assessment Result in Relation to SMEs

The number of SMEs operating in Addis Ababa reached around 4,314 as of June 2012. These enterprises are found under different stages of operation and the major share, which accounted for more than 77% of these enterprises are classified under startup stage. On the other hand, 0.4% of them have been transformed to medium scale enterprise. This indicates that the number of SMEs developing from start up to a stage of medium level is very negligible (Figure 4).

Figure 4**:** Share of SMEs at different Stages of Development



Source: Federal Micro and Small Enterprise Development Agency (FeMSEDA)

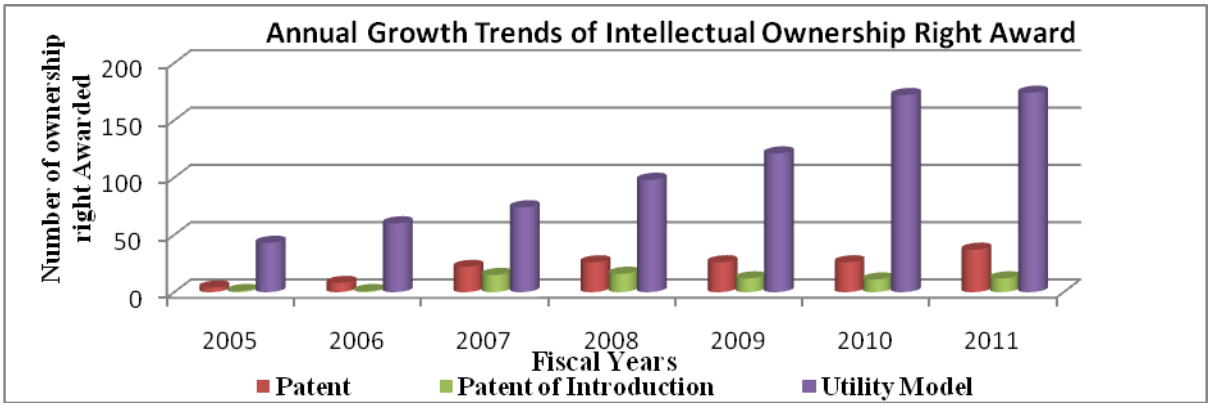
In order to assess the basis for the problem a random sample of 86 SMEs, which is 2% of the population, were taken and interviewed and learned that more than 82% of them were unable to function up to their intended purposes due to financial constraint. Around 13% of the sample indicated that they are unable to proceed further because of financial constraint and market problem for their product. The remaining 5% of the sample selected revealed that lack of training and advice is the major challenge to expand their operation. From this analysis, it is possible to

conclude that one of the major reasons for the very low transformational rate of SMEs to medium and large-scale industries is lack of adequate finance to support their operation.

3.2.2 Potential Assessment Result in Relation to Entrepreneurship

Considering the importance of innovation for industrialization, assessment is made on the number of intellectual property right awarded by the Ethiopian Intellectual Property Office. In 2005, only 48 intellectual property rights were granted by the Office. However, this number was increased to 223 at the end of 2011 by registering a higher rate of growth (Figure 5).

Figure 5: Trend of registered Intellectual Property Right



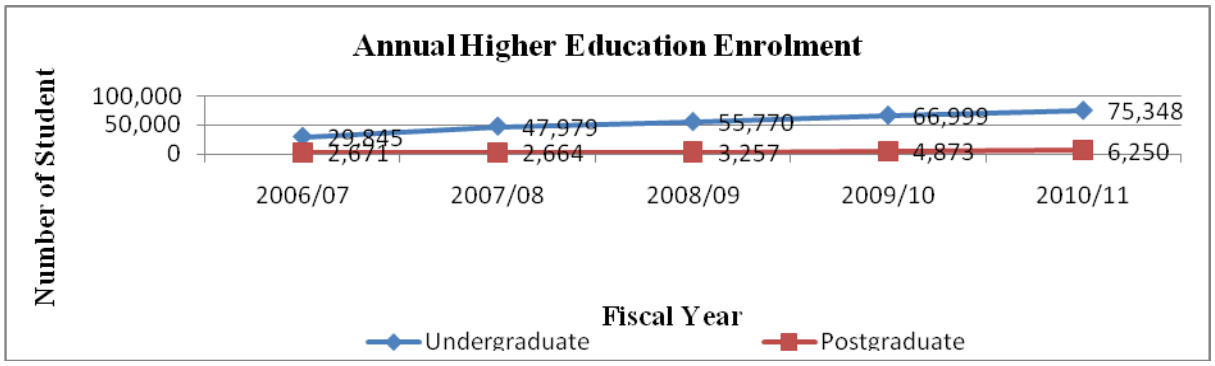
Source: Ministry of Science and Technology, 2011

Most of the registered Intellectual Property right owners have not yet started operation. While assessing the problems, it is found out that 63% of the sampled intellectual property right owners stated lack of finance as the chronic constraint to start operation and the remaining cited problem of both finance and operation area as their obstacle.

Higher education is another key element to the development of knowledge-based sectors of the economy. The current expansion of higher education within the country has increased the number of students joining the universities to more than 80,000 per annum. The total number of university students' has been increasing significantly during the past five consecutive years. It was around 210,456 in 2006/07, and this figure increased to 467,843 by 2010/11.[21] This change definitely enhances the overall innovation and knowledge creation potential in the economy (Figure 6).

[21] Student enrolment level; Ministry of Education, Ethiopia (http://info.moe.gov.et), Retrieved on 23/04/2012

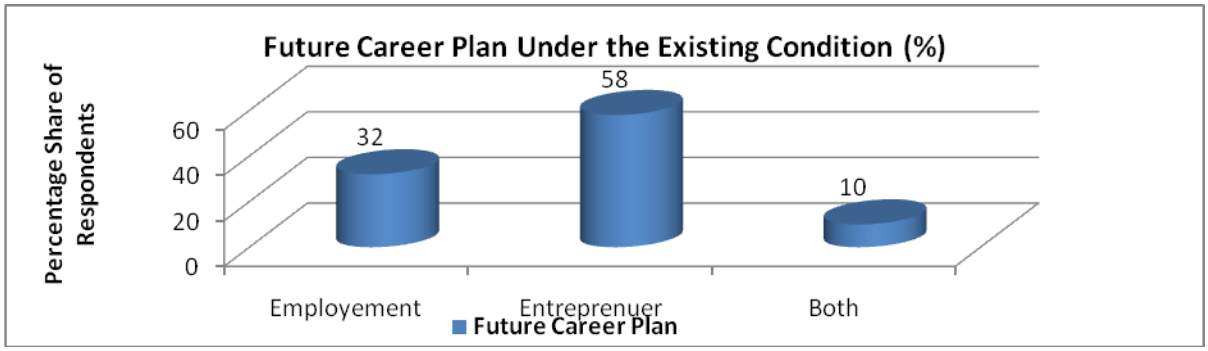
Figure 6: Trend of Higher Education Enrolment



Source: Ministry of Education, Ethiopia. (http://info.moe.gov.et/est.shtml)

To observe the attitude of university students towards the option of being employee or entrepreneur and to predict their future career inclination. The team has interviewed randomly about fifty students of the Addis Ababa University and learned that, under existing condition, around 58% of the samples opted to be entrepreneur and 32% of the samples prefer to be employed. The survey also revealed that the remaining 10% of the sample have an interest to become both employee as well as entrepreneur as the chance provides them.

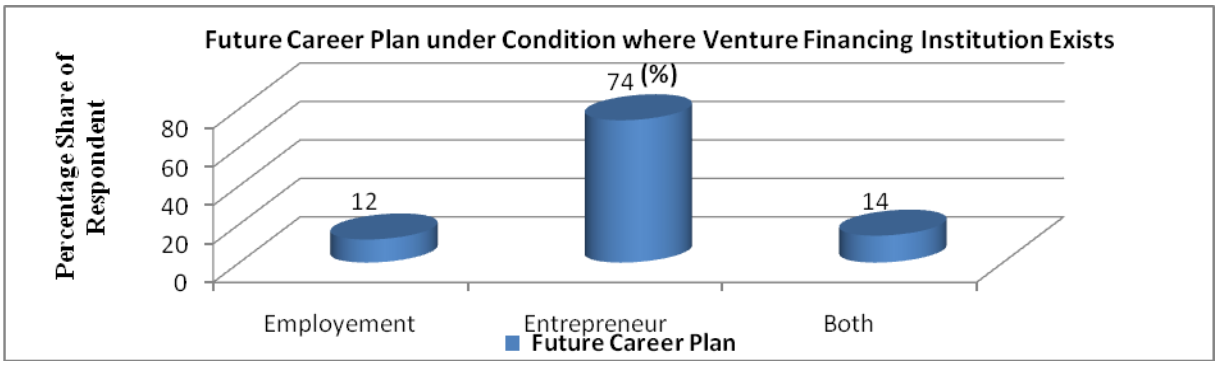
Figure 7: Students inclination towards Entrepreneurship



Source: Sample Survey Result

With the assumption that venture type of financing institution exists within the finance system of the country, the study revealed that more than 74% of the sample prefer to do their own business and 14% of the sample have an interest both to be employed as well as undertake their own operation as the condition allows them to do so. The remaining 12% of the sample have selected the option of being employed.

Figure 8: Students inclination towards financed Entrepreneurship



Source: Sample Survey Result

This fact indicates that the introduction of venture type of financing help to encourage innovation and contributes for the development of the private sector, which is an engine for industrial development. The development of the industrial sector in turn enhances the employment opportunities of the youth and promotes s the growth of the national economy.

3.2.3 Ethiopian Diaspora as Potential Source of Venture Capital Business in Ethiopia

The experience of most emerging economies shows that Diasporas have started to become the major sources of fund and playing a significant role in the transfer knowledge. Like other developing countries, there are large numbers of Ethiopian Diaspora, who have been exposed to different culture, ideas, and knowledge, and which might be considered as potential for venture capital business. Therefore, it is essential to consider Diaspora while introducing venture business as a means to foster entrepreneurship ideas and to revitalize the feeble SMEs.

3.3 Findings from the Potential Assessments of Venture Capital Business in Ethiopia

- The assessment revealed that more than 90% of the sampled SMEs in Addis Ababa have failed to operate up to the expected level because of chronic financial constraint. The remaining associated their failure with market problem and lack of training and advice. Concerning their growth status, more than 77% of the SMEs in Addis Ababa are found at their startup stage while 0.4% of them have been transformed towards medium scale enterprise.

- The assessment made on property right owners indicated that 63% of the sampled intellectual property right owners has failed to start operation due to lack of finance and the remaining cited problem of both finance and operation areas as their main obstacle.
- The potential assessment made on some university students in Addis Ababa have showed that around 58% of them have an interest to become entrepreneur and the remaining have an interest to be employed. With the assumption that venture type of financing institution exists, around 74% of the sample prefers to do their own business and 14% of the same sample have an interest to be employed or undertake their own operation as the condition allows them to do so.

3.4 Missing Elements for the Introduction of Venture Capital Business in Ethiopia

The experience of other countries suggests that Venture capital business requires an environment having certain important elements that are critical for its introduction and cultivation. Some of the major missing elements necessary for this business are:

- Policy direction and legal framework that facilitate the operation of Venture Capital;
- Adequate incentive packages which are geared towards Venture Capital Business;
- Well organized institutions operating on Venture Capital Business; and
- Legally well established entry and exit mechanisms for Venture Capital Business.

4. Summary of Major Findings and Recommendation

4.1 Summary Major Findings

The overall analysis result of the study revealed that venture capital has a greater contribution for the development of SMEs and entrepreneurship, which are the springboard for industrialization and sustainable economic growth. The major findings of this study are:

- The concept of venture capital was emanated to give solutions to the chronic problem of finance for high risk innovative business ideas and SMEs;
- The experiences of emerging economies indicated that the presence of greater number of venture capitalists in a given economy encourage the development of SMEs and innovation and speed up technology transfer for industrialization;

- As compared to traditional banking system, venture capital in emerging economies has become the best financial instruments for the development of entrepreneurship and SMEs, which is deemed to be the cornerstone for industrialization;
- The situation of Ethiopia indicates that more than 90 percent of the SMEs have been unable to operate up to the expected level greatly because of financial constraint. Similarly, more than 80% of the sampled intellectual property right owners have failed to start operation due to lack of risk oriented financial support;
- Looking at the growth potential for entrepreneurship, larger proportion (more than 85%) of university students have had a preference to become an entrepreneur than to be employee, unless there is finance constraint for their business; and
- Absence of systematically organized institutions operating on the establishment of the venture capital firms and lack of legal framework for undertaking such business has contributed for the absence of venture capital business in Ethiopia.

4.2 Recommendations

- The experience of venture financing business in emerging economies should be considered while introducing the venture capital business in Ethiopia.
- It is important to acknowledge the significance of venture capital business for the development of SMEs and expansion of entrepreneurship, which is a springboard for industrialization;
- It is recommended to start introducing and cultivating venture financing culture among business community and population of Ethiopia.
- The ground for venture capital business should be properly established through introducing policy framework and regulation.
- It is also crucial to build a rapport with the International Venture Capital firm's management team to share the experiences of the business.
- The team has also recommended the university community of Ethiopia to undertake basic and applied research concerning venture financing industry and its significance to the rest of economic sector, namely agriculture and service.

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Global Standards and Education

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Abstract

Global standards are a driving force for the success of industry business and higher education in academia as well. We are living in IT convergence world, and technology innovation for new products in industry and new ideas in academia come from innovative and creative education for young and smart university students. In many university campuses globally, mobile internet-based campus networks are popular these days, and these new internet-oriented IT technologies easily allow to implement so called, "open online education" and video conferencing lectures connecting many remote regional university campuses.

In Africa, with less telecommunication infrastructure available than other advanced regions, it will be a great benefit and advantage to adopt new global standards-based mobile communication technologies for fast and economic infrastructure buildup. This will be the best way to implement the higher education reform, to narrow the technology gap between Africa and other regions, and to eventually bring a bright economy outlook for African region.

Key words: *global standards, internet, convergence, education*

Regional Disparities in Establishment of Large and Medium Scale Manufacturing Industries in Ethiopia: Panel Data Analysis

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Abstract

In this study, I explore factors that determine large and medium scale manufacturing industries establishment disparities over time across regions in Ethiopia. To do so, the linear panel data regression models viz fixed effects (FE) model and random effects (RE) model are used. I present theoretical arguments and secondary empirical evidence as to why we should have strong expectations about finding a positive relationship between the explanatory variables (i.e. labor productivity, which is proxy for agglomeration economies, and availability of market) and the dependent variable (i.e. establishment of large and medium scale manufacturing industries) and negative relationship between the explanatory variable (i.e. average wage) and the dependent variable. However, establishment disparity across regions overtime in Ethiopia was found to be positively and significantly related with all the three explanatory variables.

Key Words: **Agglomeration Economies, Establishment**, **Large and medium scale manufacturing firms**

Abbreviations and Acronyms

CSA= Central Statistical Authority
DD = Dire Dawa region
estab = Establishment
EFY = Ethiopian Fiscal Year
LMS = Large and Medium Scale
LMSM = Large and Medium Scale Manufacturing
LMSMI = Large and Medium Scale Manufacturing Industries
nom = Percentage of Firms with No Problem of Market
pro = Productivity
SNNP = Sothern Nations, Nationalities and People Region
wsppe = Wage and Salary Paid Per Employee
VA = Value Added
GVP = Gross Value of Product

1. Introduction

1.1 Background of the Study Area

The introduction of the manufacturing industry in Ethiopia dates back to about a century. The emergence of central government, the prevalence of political stability and construction of the Ethio-Djibouti Railway was among the main factors that facilitated the emergence of the manufacturing industry. Up to the takeover of the military government in Ethiopia in 1974, 273 medium and large scale industrial enterprises had been established among which 65% were wholly or partially owned by foreigners (Enquobahrie, 2004).

The military regime nationalized the industrial enterprises which were under the ownership of both nationals and foreigners. Under the centralized command of socialist economic management, private sector participation was highly restrained and had adverse effects on the contribution of the sector to industrial development in Ethiopia. Capital ceilings were imposed on new investments and expansion of facilities. The system introduced discriminatory policies against the private sector which took the form of restrictions on the supply of foreign exchange, price control, allocation of skilled manpower and credit, high tax rates as well as tedious and bureaucratic red-tape procedures for acquiring licenses. The socialist system of managing the economy emphasized on public sector development and did not consider the private sector as an important partner of socio-economic development. Such a scenario weakened the significant potential that the private sector could have played in the expansion and development of the manufacturing industry.

However, the establishment of the Transitional Government of Ethiopia in 1991 brought with it some policy measures that facilitated the creation of enabling environment for the development of the sector. The measures comprised of reforming the public enterprise sector, introduction of freely accessible and partly liberalized foreign exchange market, lifting of government intervention in market and price control, measures related to encouragement of private investment in the sector and adjustment of taxes and tariffs. Nevertheless, employment in large and medium manufacturing showed only small improvement over 2.

The pre-reform situation mainly because of retrenchment from public enterprises (ibid.).

1.2 Statement of the Problem

In the world, where information asymmetry is common, concentration of large and medium scale manufacturing industries in some areas of a country favor (in terms of access to employment opportunities and urbanization) only those who are located nearer to the industries, ceteris paribus.

The manufacturing sector's contribution to the absorption of the large unemployed workforce that could have been the potential contributor of development in the manufacturing sector is not that significant. As a result, the efforts of the Ethiopian Government to implement its poverty reduction strategy in the face of increased unemployment in urban areas would be a serious challenge (Enquobahrie, 2004).

According to the 2010 annual survey of the Central Statistical Authority of Ethiopia on large and medium scale manufacturing industries, Addis Abeba city shares 41% of large and medium scale manufacturing industries in Ethiopia. In contrast, the average share of number of large and medium scale manufacturing industries of emerging regions namely Afar, Harari, Gambela and Dire Dawa City is less than 1% (i.e., 0.56%) of Ethiopian large and medium scale manufacturing industries. Moreover, the average share of Tigray, Amhara, Oromiya and SNNP regions is only 13.51% of Ethiopian large and medium scale manufacturing industries. This indicates how LMSM firms, which are sources of employment and income, are unfairly distributed in the country.1

1 The 2010 regional distribution of LMSMI is fond under appendix 2. Moreover, according to Teshome (2007), regional distribution of investment projects shows rather worrying prospects. He added, Addis Abeba enjoyed the largest share (about 71%) of approved projects with investment capital of around Birr 8 billion, which is 67 % of the total investment capital of the country. It is worrying because establishment disparity can be directly associated with income disparity across regions in Ethiopia, which can be a source of conflict if existing factors for disparity are allowed to continue. 3 Spatial units that have industrialized are more productive and have higher incomes than spatial units that have not industrialized or have industrialized less. In other words, geographical variation in industrialization is a primary cause of geographical variation in average income in developing nations (Chakravorty, 2005).

Considering these and the like facts, it is natural to ask why huge establishment disparity exists among regions in Ethiopia. In other words, this paper tries to answer why establishment of large and medium scale manufacturing industries are unevenly distributed among regions in Ethiopia.

1.3 Objective of the Study

The general objective of the study is to envisage image of regional establishment disparity in Ethiopia to any stakeholders for proper remedial action. More specifically, the objective of this study is to identify the significant variables that determine establishment disparities among regions in Ethiopia.

1.4 Significance of the Study

According to the 2010/11-2014/15 Growth and Transformation Plan of Ethiopia, the government plans to exert effort to develop large and medium scale manufacturing industries to ensure economic development objectives of the country (GTP: PP 64). So, this paper can be an input to indicate the priority areas of focus to improve and fill establishment disparities among regions in Ethiopia. Moreover, indicating the problems that cause the disparities and acting against them might have a meaningful result in reducing unemployment, poverty level of the regions and hence avoid regional development imbalance. Moreover, the research can be an input for any interested researchers who wish to conduct research on similar thematic areas. 4

1.5 Scope and Limitations of the Study

The scope of the study is limited to dealing with factors that can affect LMSMI establishment disparities across six regions in Ethiopia viz Tigray, Amhara, Oromiya, SNNP, Dire Dawa and Addis Abeba. Despite the study is conducted on the six regions, inference can be made for all regions in Ethiopia as firms in the sample regions constitute 97% of the total LMSMIs in Ethiopia.

As a limitation the study didn`t consider the following points:

- The research didn`t disaggregate which agglomeration economies are relevant for higher industrial labor productivity.

- The research didn`t consider capital variation of the LMSMI rather variation in number of establishment.

Finally, the next parts of this paper are organized in four chapters. The second chapter viz the literature review part constitutes three important topics viz important definitions, theoretical literature, empirical literature and LMSMIs in Ethiopia. In chapter three of the paper; data type, data source, sampling method, model specification, hypothesis and estimation procedures are incorporated. In chapter four of the paper; findings from descriptive and econometrics analysis will be discussed. In the last and the fifth chapter of the paper, we will have conclusion and recommendations of the study. 5

3. Literature Review

2.1. Important Definitions

Incorporating important definitions facilitate easily understanding of terms used in the paper. As important definitions terms like establishment, paid-up capital, large and medium scale manufacturing firms, economies and diseconomies of agglomeration are incorporated. Definition of each term is stated as follows.

2.1.1 Establishment

Establishment is defined as the whole of the premises (land and building) under the same ownership or management at a particular address (CSA, 2006/07). In other words, to be considered as an establishment there should be working and legal manufacturing firm owned by an individual or group at a particular place.

2.1.2 Paid-up Capital

Paid up capital is that part of the issued capital of an establishment that has been paid by the shareholders or the individual owner (CSA, 2006/07).

2.1.3 Large and Medium Scale Manufacturing Firms

Defining large and medium scale enterprises (LMSEs) is an area of major concern in the literature due to the huge variation in definition given to this area of business. The numbers of employees, annual turnover, annual balance sheet, paid up capital amount, etc are some of the parameters used to define the enterprises (MTI, 2006). Ethiopia uses the number of employees and paid up capital to define firms. While the Ministry of Trade and Industry (MTI) use paid up capital, the Central Statistical Authority uses number of employees. 6

Using number of employees, the Ethiopia Central Statistical Agency (CSA 2006:2) used the following definition during its survey of small scale manufacturing enterprises in 2005/6:

i) Large and Medium Scale Manufacturing Establishments, engaging 10 or more persons and using power -driven machines.

ii) Small Scale Manufacturing Establishments engaging less than 10 persons and use power -driven machines.

iii) Cottage/Handicraft Manufacturing establishments performing their activities by hand (i.e., using non -power driven machines).

But the Ministry of Trade and Industry (MTI, 2006) has defined the enterprises using amount of paid up capital as follows:

Micro Enterprises are those small business enterprises with a paid-up capital of not exceeding birr 20,000, and excluding high technology consultancy firms and other high technology establishments.

Small Enterprises are those business enterprises with a paid-up capital of above 20,000 and not exceeding birr 500,000, and excluding high technology consultancy firms and other high technology establishments.

Firms with paid up capital of more than birr 500,000 are classified under medium and large enterprises.

2.1.4 Economies and Diseconomies of Agglomeration

Economies of Agglomeration

The term economies of agglomeration are used in urban economics to describe the benefits that firms obtain when locating near each other ('agglomerating'). This concept relates to the idea of economies of scale and network effects.

Simply put, as more firms in related industries cluster together, costs of production may decline significantly (firms have competing multiple suppliers, greater specialization and division of labor result). Even when multiple firms in the same sector (competitors) cluster, 7 there may be advantages because that cluster attracts more suppliers and customers than a single firm could alone. Cities form and grow to exploit economies of agglomeration (http://en.wikipedia.org).

Diseconomies of Agglomeration

Diseconomies of agglomeration refer to the opposite case. Additional competition drives down pricing power. Large cities attract problems of crowding and congestion. It is this tension between economies and diseconomies that allows cities to grow, but keeps them from becoming too large. Agglomeration economies are most closely associated with economies of scale and these network effects as stated above. It is important to understand the possible ultimate outcome of agglomeration economies, only if the benefits outweigh the disadvantages. The ultimate end to agglomeration economies is the formation and growth of a city (ibid.).

2.2 Theoretical Literature Review

Theoretical literature review is considered to be crucial to roughly understand the cause and effect relationship between/among variables. Moreover, hypothesis can be derived from exiting theoretical explanations.

2.2.1 Krugman`S Core-Periphery Model

Whilst localization and urbanization economies as well as their sources are crucial to sustaining agglomeration economies and cities, it is important to understand the long term result of the function of agglomeration economies which relates to the core-periphery model. The core-

periphery model basically features an amount of economic activity in one main area surrounded by a remote area of less dense activity. The concentration of this economic activity in one area (usually a city center) allows for the growth and expansion of activity into other and surrounding areas because of the cost minimizing location decisions of firms 8 within these agglomeration economies sustaining high productivity and advantages which therefore allow them to grow outside of the city (core) and into the periphery. A small decrease in the fixed cost of production can increase the range of locations for further establishment of firms leading to the loss of concentration in the city and possibly the development of a new city outside the original city where agglomeration and increasing returns to scale existed (http://en.wikipedia.org/w/index**)**.

In a nutshell, if localization economies were the main factor contributing to why cities exist with the exclusion of urbanization economies then it would make sense for each firm in the same industry to form their own city. However, in a more realistic sense cities are more complex than that; which is the reason for the combination of localization and urbanization economies to form large cities (ibid.).

2.2.2 Conditions for New Business Development

Analyses of the dynamics of geographic concentration may contribute to a number of often discussed topics. For example, Arthur and Krugman emphasize that with increasing returns, industry locations today could potentially be the result of historical accidents in the distant past. This creates scope for government action and has implications for understanding such questions as how the industrial structure of Europe may change with integration (Guy Dumais, 2002).

A second active discussion concerns the conditions that favor new business development. Here, the first view (associated with Marshall, Arrow, and Romer and some- times referred to as the MAR model) emphasizes the importance of increasing returns to scale and learning by doing and suggests that firms benefit from being located in industry centers (ibid.).

The other view (associated to Jacobs) is that the most fertile areas for new plant births are areas with a diverse set of related industries. The Jacobs view suggests that industries may be fairly mobile and that startup activity may be high away from industry centers (ibid.). This indicates how firms can benefit from concentration. 9

The agglomeration of related economic activity is a central feature of economic geography. In a given location, limitations on resources can result in diminishing returns. This can lead to convergence in economic activity (employment, income, productivity) across regions over time (Mercedes Delgado, 2011).

Economists have highlighted at least three distinct drivers of agglomeration: input-output linkages, labor market pooling, and knowledge spillovers. Though conceptually distinct, each of these mechanisms is associated with cost or productivity advantages to firms that result in increasing returns to geographically proximate economic activity. Over time, an extensive literature has incorporated additional agglomeration drivers, including local demand, specialized institutions and the structure of regional business and social networks (ibid.).

Agglomeration may arise from the specialization of a region in a particular industry where firms share common inputs or knowledge so called localization economies. At the other extreme agglomeration may be the result of exploiting the overall diversity of industries in an entire regional economy so called urbanization economies (ibid.)

While convergence forces may prevail at the region-industry level, we argue that the important agglomeration forces are due to the presence of clusters of related industries (ibid.).

2.2.3 Weber`S Theory of Industrial Location

Weber (1990) formulated a theory of industrial location in which an industry is located where it can minimize its costs, and therefore maximize its profits. Weber's least cost theory accounted for the location of a manufacturing plant in terms of the owner's desire to minimize three categories of cost:

I. **Transportation:** the site chosen must entail the lowest possible cost of moving raw materials to the factory, and finished products to the market. This, according to Weber, is the most important.

II. **Labor:** higher labor costs reduce profits, so a factory might do better farther from raw materials and markets if cheap labor is available. 10

III. **Agglomeration:** when a large number of enterprises cluster (agglomerate) in the same area, they can provide assistance to each other through shared talents, services, and facilities.

The pulls which the agglomerative factors possess to attract an industry to a particular point are mainly dependent on two factors. Firstly, on 'the index of manufacture' (the proportion of manufacturing costs to the total weight of the product) and secondly, on the 'locational weight' (the total weight to be transported during all the stages of production). Then a "co-efficient of manufacture" which is the ratio of manufacturing cost to locational weight is deduced. Agglomeration is encouraged with high co-efficient of manufacture and deglomeration with low co-efficient of manufacture and these tendencies are inherent in their nature (ibid.).

With regards to transport, we need to consider first whether to locate an industry in the raw material or market location. If there is no weight loss or weight gain in production, you site your factory at either location, because the transport costs are the same each way. As transport costs are not identical for raw material and manufactured (finished) goods a relative weighting (i.e., material index) must be calculated (ibid.).

Material index = Total weight of materials used to manufacture the product Total weight of the finished product

If the product is a pure material its index will be 1. If the index is less than 1 the final product has gain weight in manufacture, thus favoring production at the market place. The weight gain is most likely to come from the addition of ubiquitous materials, like water, that we can expect to occur anywhere. Such a product would be a drink, soft drinks or beer, where a small quantity of usually dried materials are added to water and bottles to make a much heavier and more fragile final product. Most products lose weight in manufacture, such as a metal being extracted from an ore. Thus their material index will be more than 1, thus favoring the raw material site. The significance of the material index is in calculating precisely by the difference between the unit transport costs of raw materials and finished products (ibid.). 11

2.2.4 Agglomeration

2.2.4.1 Advantages and Disadvantages of Agglomeration Economies

Advantages

When firms form clusters of economic activity, there are particular development strategies that flow in and throughout this area of economic activity. This helps to accumulate information flow of new and innovative ideas among firms for the achievement of what economists call increasing returns to scale. With the establishment of a firm, there is always a fixed or average cost of production for the firm based on (supplies needed, labor, capital, rent etc.) for the production of the firm. When this average cost of production falls as the result of the increased total output of a product, here indicates a presence of economies of scale; increasing returns to scale and economies of scale may be used interchangeably. Increasing returns to scale or economies of scale, is internal to a firm and may allow for the establishment of more of the same firm outside the area or region. Economies of scale external to a firm are the result of spatial proximity and are referred to as agglomeration economies of scale. Agglomeration economies may be external to a firm but internal to a region. It is important to note that these increasing returns to scale are a major contributing factor to the growth of cities. Agglomeration economies exist when production is cheaper because of this clustering of economic activity. As a result of this clustering it allows for the establishment of other businesses to take advantage without joining any big organization. It helps to urbanize areas as well (http://en.wikipedia.org/w/index**)**.

Disadvantages

Referring back to the growth of cities and that the existence of them can only persist if the advantages outweigh the disadvantages, it is important to know that agglomeration economies may also lead to congestion, pollution and other negative externalities caused by the clustering of a population of firms and people and that this may lead to diseconomies of scale. As stated above, these factors are what decrease the pricing power of firms because of the many competitors in the area as well as a shortage of labor and lack of flexibility among 12 firms to move their laborers around. Large cities experience these problems, and it is this tension between agglomeration economies and agglomeration diseconomies that may contribute to the growth of the area, control the growth of the area, or cause the area to experience a lack of growth. The

ways of maintaining a stable outcome for agglomeration economies is for clustering to create "knowledge spillovers" that prevail over these negative externalities (ibid.).

2.2.4.2 Types and Sources of Economies

There are two types of economies that are considered large-scale and external economies of scale; **localization and urbanization economies**. Localization economies arise from many firms in the same industry locating close to each other. There are three sources of localization economies: the first is the benefit of labor pooling which is the accessibility that firms have to a variety of skilled laborers, which in turn provides employment opportunity for the laborers. The second benefit is the development of industries due to the increasing returns to scale in intermediate inputs for a product and the third source is the relative ease of communication and exchange of supplies, laborers and innovative ideas due to the proximity among firms (ibid.).

From the localization of firms labor market pooling emerges. Large populations of skilled laborers enter the area and are able to exchange knowledge, ideas, and information. The more firms there are in this area, the greater the competition is to obtain workers and therefore results in higher wages for the workers. However, the fewer firms there are and the more workers there are at a location the lower the wage becomes for those workers.

The second contribution towards localization economies is the access to specialized goods and services provided for the clustering firms. This access to specialized goods and services are known as intermediate inputs and provides increasing returns to scale for each of the firms located within that area because of the proximity to available sources needed for production. If intermediate inputs are tradable, there forms a core-periphery notion that will have many firms locate near each other to be closer to their needed sources. If there are tradable resources and services nearby but no related industries in the same area, there are no networking linkages and therefore makes it difficult for all firms in the area to obtain resources and increase production. The decreased transportation costs associated with 13 clustering of firms leads to the increase in likelihood to a core-periphery pattern; where the result of this will be more intermediate inputs will be focused at the core and therefore will attract more firms in related industries.

The third source relating to localization economies is technological spillovers. One final advantage of this source is that clustering in specific fields leads to quicker diffusion of ideas or adoption of ideas. In order for production to be at its maximum and sell their products, firms require some sort of feasible access to capital markets. New forms of technology can create problems and involve risk; the clustering of firms creates an advantage to reduce the amount of uncertainty and complications involved with the use of new technology through information flow. The industry of capital flow and technology are concentrated within specific areas and therefore it is to the advantage of the firm to locate near these areas. This technological impact specifically in the communications field will provide and dismiss the barrier between firms in the same industry located further away as well as nearby which would lead to a greater concentration of information flow and economic production and activity. Furthermore, technological spillovers may be more beneficial to smaller cities in their growth than larger cities because of the existing informational networks in larger cities that already helped them to form and grow (ibid.**)**.

2.2.5 Critical Factors of Industrial Location Decision

According to Badri (2007), a comprehensive set of fourteen theoretical critical factors influencing industrial location decisions are developed through a process that involved the identification and synthesis of the critical requirements that have been prescribed by practitioners and academics from various disciplines. The critical factors for industrial location are classified as regional factors and international factors. The regional factors and international factors are illustrated in the following table 6 and 7 respectively. 14

Table 1: Regional Factors for Industrial location Decisions

No.	**Critical Factors**	**Explanation of Critical Factor**
1	Transportation	Pipeline facilities. Airway facilities. Highway facilities. Railroad facilities. Trucking services. Waterway transportation. Shipping cost of raw material. Cost of finished goods transportation. Availability of postal services. Warehousing and storage facilities. Availability of wholesale outlets.
2	Labor	Low cost labor. Attitude of workers. Managerial labor. Skilled labor. Wage rates. Unskilled labor. Unions. Educational level of labor.

		Dependability of labor. Availability of male labor. Availability of female labor. Cost of living. Worker stability.
3	Raw Materials	Proximity to supplies. Availability of raw materials. Nearness to component parts. Availability of storage facilities for raw materials and components. Location of suppliers. Freight cost.
4	Market	Existing consumer market. Existing producer market. Potential consumer market. Anticipation of growth of markets. Shipping costs to market areas. Marketing services. Favorable competitive position. Income trends. Population trends. Consumer characteristics. Location of competitors. Future expansion opportunities. Size of market. Nearness to related industries.
5	Industrial Site	Accessibility of land. Cost of industrial land. Developed industrial park. Space for future expansion. Insurance rates. Availability of lending institutions. Closeness to other industries. Community industrial development projects. Attitude of financing agents.
6	Utilities	Attitude of utility agents. Water supply, cost and quality. Disposable facilities of industrial waste. Availability of fuels. Cost of fuels. Availability of electric power. Cost of electric power. Availability of gas. Adequacy of sewage facilities. Availability of coal and nuclear facilities.
7	Government Attitude	Building ordinances. Zoning codes. Compensation laws. Insurance laws. Safety inspections. Nuisance and stream pollution laws.
8	Climate	Amount snow fall. Percent rain fall. Living conditions. Relative humidity. Monthly average temperature. Air pollution.
9	Tax structure	Tax assessment basis. Industrial property tax rates. State corporate tax structure. Tax free operations. State sales tax
10	Community	

Assessment of Climate Change Impacts on Cascade Reservoirs Operations: A Case Study on Gibe Hydropower Schemes, Ethiopia

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Abstract

This research focuses on assessment of climate change impact on hydropower development project in Upper Omo-Gibe River Basin of Ethiopia. The study specifically aims to evaluate the impacts of climate change on cascade hydropower reservoirs Operations of the current functional power plant; Gilgel Gibe-I and Gilgel Gibe-II; and currently under construction power plant, Gibe –III.

This study presents three steps for analyzing climate change impacts on hydropower cascade reservoir operation. The first step is construction of climate change scenarios. The climate change impact studies on water availability of Upper Omo-Gibe basin were done based on the outputs of the Regional Climate Model (RegCM3 forced by ECHAM5 GCM model output) for global emission scenarios of A1B.

The second steps of study is to generate future runoff into each reservoir systems for each constructed climate scenarios by HEC-HMS hydrological model .The HEC-HMS model was first calibrated and validated using historically observed daily climate data and stream flow data by incorporating different watershed characteristics of the sub basin. Then, HEC-HMS model uses the future constructed climate scenarios as input to generate future stream inflows to each reservoir systems.

Finally, Gilgel Gibe-I,II,III cascade hydropower plant reservoirs are simulated using HEC-ResSim model in baselines period and the future constructed climate scenarios by incorporating different physical characteristics of dam, reservoir system, power plants, river reach etc. Then, impacts of climate change on future hydropower reservoirs operations of Gibe cascade power plant under future climate scenarios are assessed.

The generated climate results suggest that the climate in most of the Upper Omo-Gibe River Basin is likely to become warmer (increase in temperature) and wetter (increase precipitation) in 2030s (2031-2040) and 2090s (2091-2100). Potential evapo-transpiration rate is also increase in future climate scenario. The future generated stream inflows to each reservoirs system shows slightly decrease in climate scenarios of 2030s and increase somewhat in 2090s. The results of decreasing trend inflows to each reservoir in 2030s are due to the higher increase rate of potential evaporation than precipitation. The hydropower energy generation in each power plant shows a slightly decrease in 2030s and somewhat increase in 2090s as the trend of inflows to each reservoir systems.

Key words*: climate change, hydrological modeling, Omo-Gibe River Basin, Cascade Reservoir systems, hydropower energy generations.*

Martyrs Square

Adma Wind Farm 1