



Addis Ababa University,



New Mexico State University,



FDRE Metals & Engineering
Corporation

A Report on the Course of Action of:
Advanced Systems Engineering Training

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List of abbreviations

AAiT – Addis Ababa Institute of Technology

AAU – Addis Ababa University

AS – Availability of Services

CIG – Confidence in Government

CHP – Cultural Heritage Preservation

DEJEN – (unique name of the place that the industry is found)

EWB – Economic Well-Being

HIV – Human Immunodeficiency Virus

HH – Human Health

HOMICHO – (unique name of the place that the industry is found)

HR – Human Rights

METEC – Metal and Engineering Corporation

NMSU – New Mexico State University

R&D – Research and Development

SMART – Specific, Measurable, Actionable, Realizable, and Time-bound)

TB – Tuberculosis Bacteria

UNESCO - United Nations Educational, Scientific, and Cultural Organization

USA – United States of America

Executive Summary

*The term quality of life (QoL) refers the general well-being of individuals and societies. Citizens in any part of the globe demand to have improved quality of life. Governments also strive to satisfy citizens by enhancing their quality of life. In such instances, government officials need to consider tens of thousands of variables to create a system or policy portfolio which enables them offer the best to citizens. Complex systems have dynamic behaviour whose characteristics are difficult to anticipate. According to the discussions made on the collaboration among NMSU, AAU, and METEC, training on Complex Systems Engineering was offered by NMSU to experts from both higher education institution and industry. The main objective of the training was to enable trainees recognize the variant of systems and apply classical systems engineering in formulating apt policy portfolio relevant to Ethiopians' QoL. Through the training, participants identified core national objective. That was **“Quality Driven, Rapid Development at the National Level through Resource Utilization and Optimization.”** After making prudent discussions, participants identified Vital Issues and QoL dimensions pertinent to the objective.*

The QoL dimensions were human health, cultural heritage preservation, human rights, economic well-being, availability of services, and confidence in government. Champions and counterpoints were assigned to each QoL dimensions. Trainees made elevated discussions on these dimensions. Trainees also identified four Vital Issues suitable for enhancing the QoL of Ethiopians. These are: quality education, brain drain, business start-ups, and agricultural productivity. For trainees to be capable of designing and analyzing optimal systems for decision making, detailed lectures were delivered on the following topics: Systems Thinking, System Characterization, System Reductionism, Bumps, Complex Systems, Adaptive Systems, Intelligent Systems, Wicked Systems, Systems with Emergent Behaviour, and System of Systems. Methodologies leading to modelling and analysis of Bumps and expected ethics from engineers and scientists were also lectured.

In general, the training was impressive since it was conducted through interactive discussions and presentations by trainees and coached by trainers who were good to deliver the subject matter. Trainees, being from both academics and industry, were flavour of the training.

Introduction

Globalization intensifies the competition among firms, countries, and even among individuals. The way individuals react to such scenarios differs significantly from country to country. The perception for what we call 'life' is not the same in developing economies and developed once. Therefore, the measurement should consider the development level and need of citizens in respective countries. In this regard, the needs and perceptions of citizens can be measured as a function of the Quality of Life dimensions. Quality of Life is a measure or degree of fulfilment for the needs of citizens.

Systems are commonly known as black boxes which use inputs and transform these in to outputs. Complex systems have dynamic behaviour whose characteristics are difficult to anticipate. Examples of such systems may include: human body, manufacturing firms, service industries, nations, etc. Systems Engineering helps to design, model, and analyze such complex systems. To that extent, training was offered by New Mexico State University to experts of industry and higher education institution from July 15 to July 26, 2013.

The training was the outcome of the discussions held at a meeting on November 7, 2012 at New Mexico State University, Goddard Hall, in Las Cruises, New Mexico, USA. The meeting was called by Dr. Ricardo Jacquez, dean of College of Engineering, New Mexico State University (NMSU). The discussion was aimed on the collaboration among New Mexico State University, FDRE Metal and Engineering Corporation, and Addis Ababa University. Participants in the meeting were:

1. Dr. Ricardo Jacquez – Dean of the College of Engineering – NMSU **Chairman**
2. Dr. Tilahun Adera – Dean of Health and Social Services – NMSU
3. Dr. Sonya Cooper – Associate Dean of College of Engineering – NMSU
4. Dr. Edward Pines – Chair of Industrial Engineering – NMSU
5. Dr. Peter T. Martin – Chair of Civil Engineering – NMSU
6. Dr. Daniel Kitaw Azene – Visiting Professor at NMSU – AAiT **A/Secretary**

Agendas of the meeting were:

1. NMSU collaboration with Metal Engineering Corporation (**METEC**) - Ethiopia
2. NMSU collaboration with Addis Ababa University – Addis Ababa Institute of Technology (**AAiT**)
3. Way forward

As a result of the discussions, the collaboration was launched and training on Complex Systems Engineering was offered to instructors and PhD candidates from AAU and to higher officials from METEC. Objectives of the training were:

- ❑ To enable trainees recognize the variant of systems;
- ❑ To make trainees familiar with modeling tools that are helpful in analyzing complex systems;
- ❑ To make participants learn on how to apply classical systems engineering techniques for modeling and analyzing complex systems;
- ❑ To learn how to be vigilant about Meta problems that will inevitably be introduced by solutions;
- ❑ To apply the applications of Systems Engineering concepts to formulate appropriate policy portfolio relevant to Ethiopians' Quality of Life.

In the training, a national system model has been developed using Systems Engineering approaches so as to identify and prioritize the dimensions of Quality of Life of Ethiopian citizens. In addition, Vital Issues were identified for designing the most favourable policy portfolio which is thought to enhance the Quality of Life of Ethiopian citizens.

Target Group

Participants relevant to the training were systematically selected from both academics and industry. Among the trainees, twenty three participants were selected from the enterprises under the umbrella of Federal Democratic Republic of Ethiopia Metal and Engineering Corporation (METEC). Since the enterprises under METEC take the highest pledge of the country's transformation by leading the industrial sectors' development. In addition, 10 participants were selected from the academics, School of Mechanical and Industrial Engineering of Addis Ababa University. The mix has intentionally been done so as to strengthen the University-Industry-Linkage to heighten the industrial development of the country jointly.

Thus, in the first session, training on VIP was given to participants from Addis Ababa Institute of Technology (AAiT) on (July 15, 17, and 19). List of these VIP participants is presented in table 1.

Table 1: List of VIP participants (July 15, 17, and 19)

S.N	NAME	FATHER	ORGANIZATION	Position
1	ABEBE	BEYENE	AAiT	Lecturer
2	AMEHA	MULUGETA	AAiT	PhD Candidate
3	EPHREM	GIDEY	AAiT	PhD Candidate
4	ERMIAS	TESFAYE	AAiT	PhD Candidate
5	ESHETIE	BERHAN	AAiT	Assistant Professor
6	KASSU	JILCHA	AAiT	PhD Candidate
7	MESERET	ALEMU	AAiT	Lecturer
8	NETSANET	JOTE	AAiT	PhD Candidate
9	SHEWIT	W/GEBRIEL	AAiT	PhD Candidate
10	YITAGESU	YILMA	AAiT	PhD Candidate

In the second session of the training, participants from both institutions were selected. The training was held from July 22–26, 2013. Names of participants and their respective institutions are presented in table 2.

Table 2: List of participants (July 22–26)

S.N	NAME	FATHER	ORGANIZATION
1	ABEBE	BEYENE	AAiT
2	ABDURHAMAN	KEDIR	METEC
3	ALEMU	SIRNA	METEC
4	ALGAWERASH	ABADI	METEC
5	AMEHA	MULUGETA	AAiT
6	BEHAILU	TAYE	METEC
7	BELETE	H.MARIAM	METEC
8	BIRHANE	DESALEGN	METEC
9	BIRHANU	BESHAH	AAiT
10	BIRUK	GEBREMESKEL	METEC
11	DESTALEM	KAHSAY	METEC
12	EPHREM	GIDEY	AAiT
13	ERMIAS	TESFAYE	AAiT
14	ESHETIE	BERHAN	AAiT
15	ESKINDER	GIRMA	METEC
16	HAILU	TADESSE	METEC
17	HAILU	TIRFE	METEC
18	KASSU	JILCHA	AAiT
19	MELESE	MASRESHA	METEC
20	MELKU	SETNSIE	METEC
21	MESERET	ALEMU	AAiT
22	MOHAMMED	BESHIR	METEC
23	NETSANET	JOTE	AAiT
24	SENAY	HAILESELASSIE	METEC

25	SERKALEM	FEKADU	METEC
26	SHEFERAW	SORSA	METEC
27	SHEWIT	W/GEBRIEL	AAiT
28	TADELE	AEMIRO	METEC
29	TILAHUN	BIRHANU	METEC
30	WOGAYEHU	GIZAW	METEC
31	YARED	MEKONNEN	METEC
32	YITAGESU	YILMA	AAiT
33	YOHANNES	BERHE	METEC

Expected Results

Since the training has been targeted in modelling and analysis of complex systems through advanced Systems Engineering approaches, trainees were expected to acquire knowledge and skills that enable them design and develop alternative policy options and generate guidelines for policy options that can significantly enhance the QoL of Ethiopians. Moreover, trainees were expected to assist their supervisors in directing how complex systems can be modelled at national level.

Deliverables of the Training

The training had five basic sessions. The first session had been on basic terminologies, definitions, and concepts to be used throughout the training. These include: system, reductionism, system types, and the importance and testing of definitions. This session also introduced participants about the basics of Classical Systems Engineering. How to define a problem, how to design, develop, and build the system solution were discussed in detail.

The second session was giving an overview on modeling, decision theory, sequential decision making, game theory, social movement theory, and the Second Law of Systems. The third session covered about engineering ethics, system dynamics, discrete-event/Monte Carlo simulation, Agent-Based modeling, and Model Federation. The fourth and fifth sessions were basically focusing on class projects, team meetings, review of class project deliverables, and final presentations. The tools and approaches used for the training were power point presentations, experience sharing by the trainers, and group discussions.

Themes in detail

Day-1: Training on the basics of system engineering for policy modelling and analysis

Activities

Participants have been highlighted on how policies can be designed, modelled, and analysed. In doing so, the process of identification of Vital Issues have significance in designing systems. Vital Issues (VIs) were summarized as anything that adds value to the quality of life of citizens. Two approaches were introduced which can be utilized: qualitative (synthesis) and quantitative (analysis). Participants were then made to brainstorm on what VIs are and what these could be to Ethiopian citizens' context.

Basics of policy portfolio options have been introduced by trainer-1; the considerations when identifying policy options were also highlighted. These are regulations, information and education, inter/intra organizational relations, etc. Portfolio of policy options that enhance the quality of life of citizens were identified and discussed; some of them include:

- Agricultural-Led Economy would be better substituted by Industry-Led Economy
- Technology transfer and productivity improvement
- By considering the input output relations, attaining rapid development of the nation, and etc.

Trainer-1 asked a question whether trainees have considered measures like NPV. The trainer also encouraged participants to think broadly on the issue and gave an example on overheating effects of the economy. Participants added giving higher focus to education spread as another portfolio of policy option. Objections were also raised such that education spread should not base on compromised quality of education. After tremendous discussions, participants were requested to forward main themes that are favourable for Ethiopian existing overall conditions.

A participant forwarded a national issue, 'National Growth and Development through Resource Optimization', to be the main concern for policy formulation. Other participants were encouraged to comment and forward their suggestions on the theme selected. A participant suggested that 'optimization should be replaced by utilization' for a reason that Ethiopia is a developing country. We need to utilize our resource for national development. Trainer-2 commented on the term 'optimization' and reflected as the theme could be 'Accelerated Growth and Development through Effective and Efficient Use of Resources'.

Another participant argued that since development and growth are being used synonymously these days, we need to focus only on the Development issue rather than both. He also added that the national development should be based on Quality-Driven. Participants reached in to a consensus and agreed the core objective to be:

“Quality Driven, Rapid Development at the National Level through Resource Utilization and Optimization”

Participants were then briefed on the basics of Quality of Life Dimensions. These were measures to evaluate the satisfaction of citizens on the way they lived. At the first glance, seven provisional options of QoL dimensions were forwarded; these were:

1. Human Health
2. Cultural Heritage Preservation
3. Human Rights
4. Economic Well-Being
5. Environmental Quality
6. Availability of Services
7. Confidence in Government

Trainer-2 persuaded participants to disseminate the dimensions of QoL to others around them and translate in to Amharic in a way that others can simply understand them. Participants were also made free to add other dimensions or reduce from the listed ones by considering Ethiopia’s existing Vital Issues. Some participants criticized on the significance and applicability of the dimension ‘Environmental Quality.’ It has been added that Environmental Quality wouldn’t be a critical concern for developing countries like Ethiopia while there are so many issues affecting the QoL of citizens. Others also commented on the insignificance of ‘Cultural Heritage Preservation-CHP’ to impact QoL of Ethiopian citizens. However, objections were forwarded which stressed the significance of CHP for QoL in Ethiopia.

Trainer-2 asked whether there are QoL dimensions that could be combined into one dimension in Ethiopian context. After making intense discussions, participants reached at an accord to combine Human Health and Environmental Quality. Doubts were also forwarded not to combine the two. And finally, all participants agreed to remove Environmental Quality dimension from the list as it is somehow covered by other quality dimensions. Six QoL dimensions were then approved. The selected dimensions were:

1. Human Health (HH)
2. Cultural Heritage Preservation (CHP)
3. Human Rights (HR)
4. Economic Well-Being (EWB)
5. Availability of Services (AS)
6. Confidence in Government (CIG)

Tainer-1 requested participants to take a champion and argue on its significance for QoL in Ethiopia over the other counterpart dimensions. Participants were made to prioritize their interest to be champion with their highest interest dimension; i.e. participant gave 6 points to the dimension they felt most important. They gave 1 point to the dimension they felt least important out of the six dimensions. As a result, the following matrix was developed showing the priority made by participants (P₁ through P₈). Dell made

Table 3: Weighs given to Quality of Life dimensions

Participants	HH	CHP	HR	AS	CIG	EWB	Comment
P ₁	2	5	6	4	3	1	Champion for EWG & counterpoint for HR
P ₂	1	6	5	3	2	4	Champion for HH & counterpoint for CHP
P ₃	1	4	3	5	2	6	Counterpoint for EWB
P ₄	2	3	4	6	1	5	Champion for CIG
P ₅	3	5	6	2	4	1	Champion for AS & counterpoint for CIG
P ₆	5	6	2	1	3	4	Champion for HR & counterpoint for HH
P ₇	4	6	5	3	2	1	-
P ₈	1	2	6	5	3	4	Champion for CHP & counterpoint for AS

As shown in table 3, champions and counterpoints were assigned based on the precedence of their interest. The quantification process was then conducted as follows: champions presented the advantages and significance of the QoL dimension they stand for. Counterpoints were then made to forward queries that they doubted on the QoL dimension under-consideration and criticized it by stating reasons they felt appropriate. Arguments among panellists also contributed for creating good understanding in the basics of QoL dimensions. Supports, criticisms, and different opinions forwarded by participants added good flavours for the training session, which made participants to rationally weigh the dimensions with respect to the QoL of Ethiopians.

To ensure the operationality of arguments, trainers informed participants to follow the SMART (Specific, Measurable, Actionable, Realizable, and Time-bound) principle. The elucidations, supports, or criticisms forwarded by participants on each dimensions are presented as follows:

a) Human Health, HH

Champion: “prioritizing HH enhances life expectancy and labor productivity. In developing economies life expectancy is too low due to HIV, Malaria, TB, and etc”. It was stated that productivity of workable labor can significantly decrease as a result of diseases and high mortality rate existing in developing economies. Due to the high mortality rates, youth dependency is also rising. Therefore, it is important to create a system for enhancing human health for the sake of national development. To that end, the governments should set goals to have a productive human labor at national level. The champion also emphasized that the other dimensions of QoL are directly related with human health. They cannot exist without human health.

Counterpoint’s criticism: the counterpart asked the champion to clarify the existing health condition in Ethiopia in relation to the other dimensions. A participant also asked on how cultural heritage preservation can depend on human health. The champion responded as human health is the basis for everything else. It can stabilize and create a healthy society. A supporter participant also argued that cultural medicines as cultural value of the society have positive impact on human health. It can also serve for certain community as income source and medication, and reduce the mortality rate in the country.

Additional questions were also raised by participants; ‘have you noticed how human health is directly interact with the other dimensions of QoL such as economic well-being and increased health services? Do you really think it can be prioritized first’? It can be prioritized first so as to advance the other dimensions of QoL; this is the main issue that our country is badly demanding” the champion responded. A supporter also added that human health not only focuses on the recovery from illness of patients, but also the safety and protection of citizens is a requirement for Quality of Life of citizens which is one part of the human health dimension. Queries then rose on how each individual can be protected from injuries for the requirement of human safety. A supporter responded as all these requirements can be gradually fulfilled.

As the discussions made by the participants were not specific and consumed time, trainers informed participants to be specific and time-bounded. Due to these time-overriding discussions, the trainer informed participants to be specific and time-bounded.

b) Cultural Heritage Preservation, CHP

Champion: the champion first expressed his gratitude to be the champion for CHP and exemplified how Ethiopian people were happy when Axum Obelisk returned back from Italy and when Conso was registered as the ninth Ethiopian Cultural Heritage by UNESCO. He stated as he believe the other dimensions can be achievable. But, the champion argued that if we could not focus on CHP, the other dimensions cannot be met.

Counterpoint's criticism: after stating his appreciation for the way of presentation of the champion, the critique commented as he could not see any link with the other dimensions. The champion responded, 'before we start to think of development, we need be able to state ourselves and our culture. Trainer-1 asked the champion to forward examples and stated his country's cultural icons. The champion stated that we Ethiopians have own alphabets derived from the Sabian family. The trainer asked as 'how can CHP be utilized to motivate the other dimensions of QoL.'

c) Human Rights, HR

Champion: stated as follows: "after having access to services and infrastructures such as education, health, water, road, etc., citizens should be given the right to equally access them". Then, this would be an opportunity to exploit the potential of all people for the country's development.

Counterpoint's criticism: if citizens are satisfied with the basic needs, is HR the basic issue for development? Champion responded that after fulfilling the basic needs, citizens can easily be initiated to work more and more for continuous change. Criticisms were also forwarded by participants saying that human right can be achieved not by focusing on it but by realizing the other dimensions of QoL. A question was raised from trainer-2, "on what basis is the implication of human rights? Could it be freedom of speech, freedom of writing, or freedom of publicizing personal thoughts?" The champion supported the forwarded suggestion.

d) Availability of Services, AoS

Champion: “this dimension is the most important to Quality of Life”, the champion stressed. She exemplified the provision of education; she stated, education is the backbone of every development. An educated society is thought to support families in particular and its nation in general. The provision of health services is also vital to the QoL of citizens. Transport services are able to facilitate economic activities of a country.

Counterpoint’s criticism: “it is very challenging to realize the availability of services without having ample economic well-being of citizens. The first thing to be realized should be improving economic well-being of citizens before trying to fulfil all required services. A participant noticed that service types should have to be prioritized. Trainer-2 said that unavailability of services can lead to conflicts. A participant also stressed as this dimension should be basic over the others.

e) Confidence In Government, CIG

Champion: the champion stressed that a good government can build a country whereas a bad government can destroy a country. If citizens could not have confidence in the government, there would be a high probability of embarking conflicts. As a result, none of the other dimensions could be realized. Creating an adequate confidence of the government from the society determines the consciousness on the other Quality of Life dimensions.

Counterpoint’s criticism: the counterpart argued that if citizens have good economic well-being, there is no reason for them not to have a confidence in the government. As a result, this dimension couldn’t be a basic issue for QoL. The champion replied that whatever economic well-being citizens have, if the government is not flexible and capable to enhance the country’s growth and development, there is always a conflict to eliminate such type of governments. And in such moments, economy of the country can significantly be affected. A participant opposed the idea forwarded by the champion in that the stated elucidations do not represent confidence in government but represent good governance. The champion replied that good governance is a result of good government. Hence, citizens will only have confidence in government if there is good governance from the government.

f) Economic Well-Being, EWB

Champion: he noticed as all dimensions are important to QoL. However, economic status is the key to get advanced needs. He compared the conditions in developing and developed economies. Economic well-being is required to create a difference. Education beyond the basic need can be realized through strong economy. Service level to be obtained and advanced technologies can be utilized only through the availability of economic well-being. In view of that, economic well-being is mandatory to minimize brain drain and other migrations.

Counterpoint's criticism: the counterpart argued that economic well-being is not a priority; good governance determines to have economy. If culture is kept, the economic well-being is sure to come. Economy will not come simply, we should pass through the other dimensions like human health; economic well-being is the last issue to determine Quality of Life of citizens. The champion replied that economic well-being would be a concern after all the other basic needs are fulfilled. A criticism against this dimension was also forwarded from a participant saying that EWB should not be an agenda for our country's case; fulfilling the basic needs such as education and health should first be fulfilled than economic well-being”.

Then, participants have submitted their ratings on the Quality of Life dimensions. Trainer-1 gave homework assignments on Ethiopian Vital Issues which is thought to be a significant problem or concern the resolution of which is essential to improve the QoL of the citizens of Ethiopia. Participants were requested to prepare one-slide presentation for each dimension and the impact of one on the others. They were told to think about the dimensions with respect to the objective function stated at the beginning of the session for improving QoL of citizens.

Wednesday July 17, 2013

Briefings were made on what has been discussed in the previous session – by trainer-1 and by the rapporteur. A lecture was also delivered on System Engineering Principles and Components. The end result expected from the session was also displayed to participants; i.e. ***“a consistent, non-conflicting, synergistic composite policy portfolio addressing issues that are vital to Ethiopia.”***

Results of previous weights on QoL dimensions, given by participants, were displayed. The result showed that Human Health dimension scored the highest; then (CIG, EWB, and AoS)

scored the same and ranked second. HR followed and CHP scored the least. Champions were requested to present their justifications for the selected dimensions. Trainer-2 highlighted how dimensions should be selected to meet the main objective. Moreover, after hypothetical Vital Issues were presented by trainer-1. Participants within each group were requested to brainstorm on Ethiopia's Vital Issue; these were:

- Insufficient number of trained health care professionals per capita
- Inadequate manufacturing base
- Excessive inflation
- Inequitable distribution of wealth
- Inadequate power

Meta-criteria for individual issues and collections of issues were presented. The SMART guideline was highlighted again. After making prudent iterations, each participant identified Vital Issue. The first four VIs were given the opportunity to present, discuss, or argue with the rest of the participants. These presenters are simply labelled as P₁, P₂, P₃, and P₄.

P-1: *there is no locally adopted quality education at all levels.* The problem identified was quality education. Counterpoint stated his disagreement with the issue identified. A sensible argument has been made on how it affects the QoL of Ethiopian citizens.

P-2: *Business start-ups*: this was first proposed as 'Job creation' from a participant with the following elucidations: there are inadequate businesses in the country; problems in business start-ups are abandoning the Ethiopian youth not to succeed in running micro and small enterprises. Counterpoint questioned about the realization of start-up capital requirements. The champion indicated that awareness creation should be made at family level and other modalities should be identified by the government to support the youth. Trainer-2 asked whether there are inhibiting policies in Ethiopia for job creation. "Though there are no prohibitive rules that hinder job creation, there are no clear-cut policies that address the stated limitations of short lived businesses", the champion replied.

Trainer-1 wanted to know if there are policies that incentivize enterprises which recruit youth in the age range of 18-25. Champion replied as there are no such initiatives in Ethiopian job market. A participant then argued as business start-up is not a problem in Ethiopia. The champion defended that the main problem is on the survival rate or life cycle of the business. Though micro and small enterprises are started up, they failed to survive after 2 to 5 years

according to some researches made on the area. Some of the problems include: shortage in working capital, poor business management, business plan limitations, and etc. Lastly, participants came to a consensus that this problem is the Vital Issue for Ethiopians to improve their QoL.

P-3: “*low agricultural productivity improvement effort in quality and quantity of outputs.*”

The economic base of 80 percent of the country’s population who lives in the rural areas is basically traditional agricultural system. Improvement of living standard of this population of the country is vital in achieving better quality of life as a nation. Starting from improving the income of farmers to better input for export oriented companies increases the effective resource utilization experienced by the sector and thus the nation. To that end, agricultural productivity improvement should be one major area of concern to formulate policy direct. Hence, mechanisms should be devised to help the rural society so as to enhance both quality and quantity of outputs from the agricultural sector which indirectly can boost the overall economy of the country.

Counterpoint asked for how can this issue be addressed without having adequate technology. “The government should take the initiative to enhance productivity of the agricultural sector” the champion replied. A criticism was raised from participants that this issue should not be the vital issue of the country because it failed to work for the past 2 decades. The participant added as no productivity improvement has been achieved yet. The best way is to provide the arable land to investors since farmers were not able to sustain themselves till recently.

The champion replied that the counterpoint indirectly supports the core issue to be a problem for the QoL of citizens (low land productivity). “There should be initiatives and supports to enhance productivity of each arable land in the country” the champion stated. A question was also raised on where should be the focus, whether on the existing land which is owned by the farmers or on the available arable land not yet utilized. “Is it recommended to keep 80% of the population in the rural areas and remain there for years to come?” trainer-2 asked. The champion argued that it is very important and of course mandatory to improve the QoL of citizens in the rural area by improving the productivity of their farm land. A counterpoint participant asked for how can productivity be improved when people are migrating from rural to urban areas. He added where the focus area should be whether in productivity of farmers or that of pastoralists.

The champion defended that by making use of available productivity improvement approaches and using same inputs, productivity of both farmers and pastoralists can be enhanced. Trainer-1 has asked on how quality and productivity improvement can be realized in the agriculture sector and where should the focus be for improvement (local or export-oriented products).

P-4: *Minimizing Brain Drain for sustainable development:* brain drain is greatly affecting the economic development of the country. Though participants came to agreement with the significance of addressing the problem, they recommended to give higher focus to specific areas of professions such as medicine, engineering, etc. On the other hand, participants have argued on the issue in a way that whether there is brain drain in the country or not. Some said, graduates should be free to work abroad since there are excessive graduates from universities and colleges in the country. Based on this idea, criticisms were then forwarded whether policy of the government to generate enormous graduates to the market is ill-planned. Trainer-1 highlighted experiences of different countries to identify the themes for respective country. The vital issue was then rephrased as follows: *“the Brain drain in the Country is too great to Support Sustainable Development.”*

An assessment matrix/table was distributed to participants and requested to rate their weights with respect to each Quality of Life dimension. Trainer-1 briefed participants on how they can make the pair-wise comparison of each Vital Issue with respect to each QoL dimension.

July 19, 2013

The basic concept, steps, and applications of Systems Engineering (SE) were discussed. The two stages of SE for policy formulation were displayed. The first part of SE is to define the problem and the second stage is to devise methodologies for solutions. Measures were required to identify appropriate solution options. To reach at the end result expected from the session, participants were requested to look for the existing regulations, fiscal incentives, technological development and deployment, inter organizational relations, and related enforcements are considered as measures to evaluate the identified Vital Issues and their effect on the QoL of citizens.

July 22, 2013

Objectives of the course were highlighted to new participants listed in table 2. “What the course is and what the course is not” were also introduced. Participants were also informed

that there would be an executive level seminar on July 31, 2013. All participants then introduced themselves.

A lecture was given on ‘Systems Thinking.’ Science and technology were contrasted. Engineering stages and associated dynamics were introduced. The science of systems was introduced. A lecture on System Characterization was also provided. An assignment was then provided to work on Systemic Characterization of a system with which participants were engaged in. Voluntary participants were requested to present their System’s Characterization and respective dimensions: domain, dynamic, and external dimensions. Participants also identified system commodities of the industries they are working for.

In the afternoon, briefings were made on the concepts of “Reductionism and Reverse Reductionism”. Based on the System Characterization that teams have already performed, a third assignment was given to work on System Reductionism in a way that they can relate both systematically and to indicate the worth of Reverse Reductionism to understand the characteristics of the overall system. 10 minutes were given to frame a response and 2 minutes to provide feedback on their results. The following participants have got the opportunity to present their findings. For simplicity, the four presenters are labelled as P-1, P-2, P-3, and P-4.

P-1: a participant from HOMICHO Ammunition Industry, one of the enterprises under the umbrella of METEC, replied that though System Reductionism can be practiced and focused in the enterprise, Reverse Reductionism made workability of the system complicated and it doesn’t have any significance at all.

P-2: another participant from METEC – DEJEN Aviation Industry stated that disassembled components are first received and then repair requirements are performed. Then assembly functions are carried out and airframe becomes the final product. In this case, Reverse Reductionism was not recommended to be feasible.

P-3: a third participant from METEC R&D department identified 7 major functions as elements of System Reductionism.

P-4: the fourth participant was from Addis Ababa Institute of Technology, School of Mechanical and Industrial Engineering noticed that the Reverse Reductionism approach best fits to research and academic institutions so as to analyze the whole educational system in the school, in the institution, and in the overall University as well.

Hoping that teams would come to a consensus of weighing the Vital Issues for each QoL dimensions, four teams have been established for each Vital Issue. Teams were made to discuss about their Vital Issue on the tea break. Briefings were then made on the progressive sessions. Teams presented their respective topics about the Vital Issues for Ethiopia's development. As a result of the ratings given by participants, Quality of Education ranked first on its impact on the QoL dimensions. Participants then presented their elucidations via the champions selected from each team. After that, participants were requested to work on the followings:

- Identify means of verification that could be used to determine if progresses are made with regards to the identified QoL dimensions;
- Determine the time frame for observing significance progress towards the resolution of their respective Vital Issues;
- Identify policy options that are currently in place that have some impact on the Vital Issues;
- Identify the impact of these existing policy options on the attainment of the overall objective previously defined;
- Identify any of the existing policies that would be eliminated; and
- Identify any policy options to add.

July 23, 2013

Trainer-1 summarized System Reductionism by taking METEC's 16 enterprises as examples. Later on, a lecture was provided on the basic types of systems by characterizing what commonly are known as '*Bumps*'. A detailed lecture has been provided on Systems with the following features: complex, adaptive, intelligent, wicked, systems with emergent behaviour, and system of systems. Bumpy terminology space was also defined. As a result, fourth assignment was given for participants to determine where the system they characterized lies within the Venn-diagram representing the natures of systems. 15 minutes were given to participants to frame their response and 2 minutes to provide feedback. Participants from METEC and AAiT presented Bumpy terminology space with respect to the system they are working in.

A lecture was then delivered on the importance and test of definitions. Denotative and connotative definitions were elaborated. Rules for evaluating the success of connotative definitions were also forwarded. In doing so, participants were coached to give higher focus

for essential features, to avoid circularity, to capture the correct extension, to avoid figurative or obscure languages, and to make definitions affirmative than negative. To this end, a 5th assignment was given for participants to apply Copilcohen rules for evaluating the success of connotative definitions to test the definition of “System of Systems” given in the lecture. Participants presented the results of their findings. The concepts and definitions of Systems Engineering were then lectured. And lastly, new comers were requested to sign up as members in the eight teams previously identified. New participants were made to be involved with the existing teams so that they can catch up with previously covered sessions.

Trainer-1 highlighted again on the two basic stages of Systems Engineering applications in complex systems: defining the problem and defining the solution space. Representatives of each team were invited to present the basics of their Vital Issues and their impact or contribution to the QoL dimensions. Presenters discussed in concretizing their issues by taking some more time. Lectures were then conducted on system thinking. And then, sixth assignment was delivered. Each team discussed on its issue and presented it.

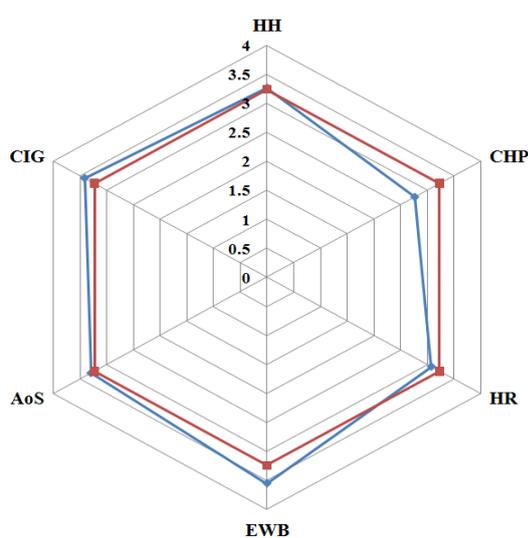
After presentations were completed, an overview was delivered on the basic concepts in modelling and analysis of decision making and ‘Modelling tools’. Policy modelling and analysis should be done in a way that designed policies would enhance QoL of citizens at national level. Considering SE approaches, policy modelling can be approached through the classical SE. In doing so, Vital Issue Processes should be clearly identified in a way that anything that adds value should contribute to the QoL of citizens. Subsequently, 7th assignment was given in seeking the resolution capability of teams towards each Vital Issue and to identify the problem types that must be solved. Teams identified the number of domains and their respective categories.

July 24, 2013

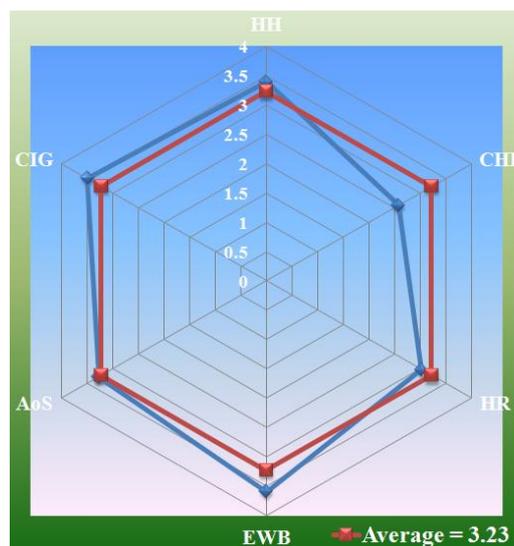
Trainer-1 delivered the answers to the 7th assignment and detailed discussions were made on how the example raised can be related to policy portfolio formulation. Afterwards, a lecture was offered on ‘Methodologies leading to modelling and analysis of Bumps’. Moreover, an overview to decision theory was delivered. Then after, 8th assignment was given to participants and they were requested to practice on the application of decision theory on the systems they are involved in. An overview to game theory was lectured. In addition, the Social Movement Theory was introduced. Then, 9th assignment was given to think the resolution of each Vital Issue. And finally, each team presented its assignment.

In the 2nd shift of the day, trainer-2 has presented an intensive and extensive lecture on Ethics for Engineers and Scientists. The lecture included three basic topics: fundamental principles, fundamental duties and rules of practices. Elements of the fundamental principles are: being honest & impartial, maintaining the highest integrity, increasing competence & prestige, and supporting professional institutions & societies. Components of the fundamental duties are: accepting responsibility/commitment, proactively mitigating unsafe practices, managing risk by whole system, and promoting prudence of System Engineering measures. The rules of practices were reflected in terms of the following elements: respecting intellectual properties of others, honoring all legal contracts & agreements, treating all constituents fairly, giving prudent advice, providing diligent & competent services, respecting granted trust & privileges, and avoiding conflicts of interest.

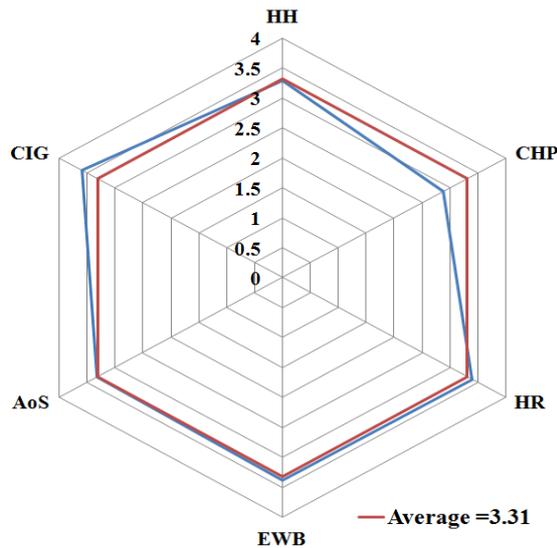
And then, participants were given assignments to rate their attitude on the components of the fundamental principles, fundamental duties, and rules of practices of ethics with respect to the QoL dimensions. After participants completed their weighting, they made prudent discussions. Lastly, they were requested to consider and practice them in their daily activities and even in the training they were attending. Based on the ratings given by participants, cultural heritage preservation part of the QoL dimensions was less affected by the fundamental principles, fundamental duties, and rules of practices of professional ethics as shown in figure 1.



a) Fundamental Principles



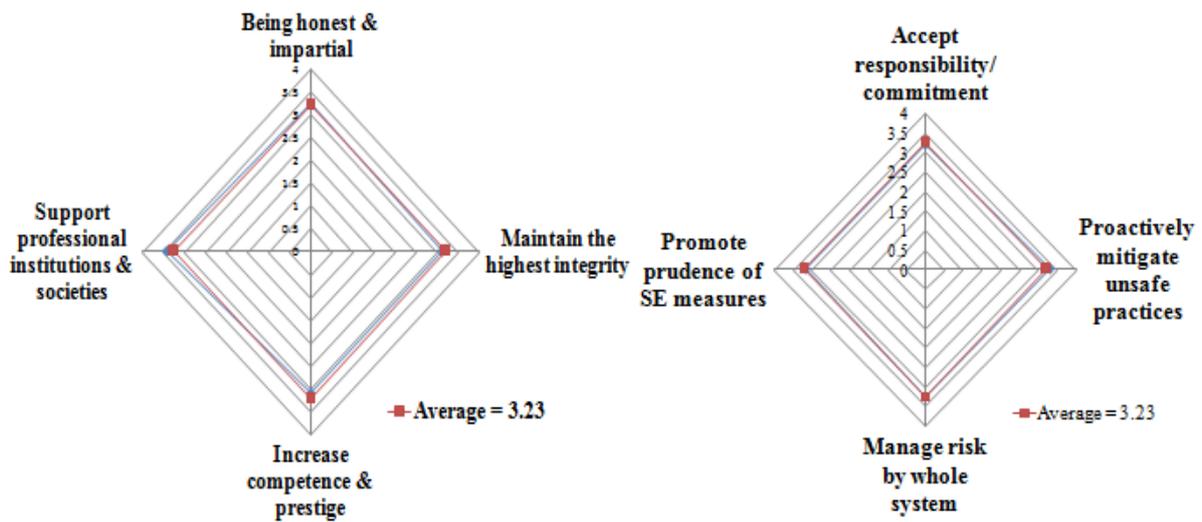
b) Fundamental duties



c) Rules of Practices

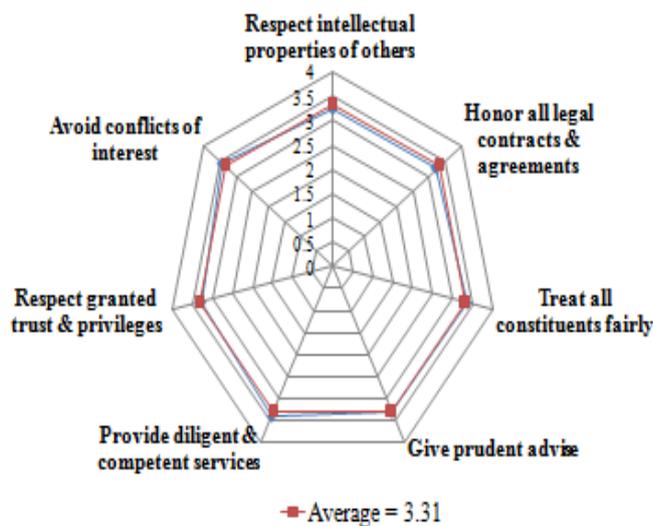
Figure 1: the effect of engineers and scientists ethics on QoL

Surprisingly, Economic Well-being and Confidence in government dimensions of QoL are greatly affected and determined by the principles, duties, and practices of professional ethics as shown in figure 1. Moreover, each part or component of the principles, duties, and practices of engineers and scientists ethics equally contributes to or affects for the QoL of citizens as shown in figure 2.

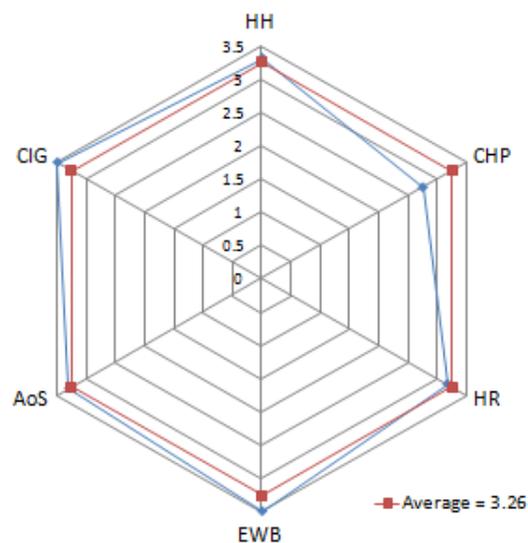


a) Fundamental Principles

b) Fundamental duties



c) Rules of Practices



d) Ethics of Engineers and Scientists

Figure 2: effect of each part of the principles, duties, and practices of engineers and scientists ethics to QoL

July 25, 2013

A lecture was provided on Dynamic Simulation and its applications for policy formulation. In this regard, System Dynamics, Discrete-event Simulation, Monte Carlo Simulation, and Agent-Based Modelling were discussed. Demonstrations of complex system design and simulation were provided using AnyLogic software package. The first demonstration was for bank service system by a discrete-event simulation. A second demonstration was made on the product diffusion model. Participants practiced these demos the whole day. As an approach of integrating different modelling methodologies, the concept of Model Federation was also introduced.

July 26, 2013

Group discussions on modelling of the Vital Issues as systems were conducted the whole day. Lastly, all teams presented their works in the same day. The works and performances of teams were commented and valuable suggestions were forwarded by trainers so as to make the presentations and deliverables of high quality. As a result, teams' representatives or champions presented their results for executives from both participating institutions, AAiT and METEC on July 31, 2013. Eventually, trainers acknowledged participants and the institutions for being enthusiastic of such a priceless training for engineers and scientists of

the institutions. Trainer-2 also requested participants to work jointly so as to have a concrete University-Industry-Linkage in Ethiopia.

Conclusion

In almost all the training days, intensive lectures have been delivered and full-fledged group works or exercises have been done. Team members have also been discussing eagerly. In each session, participants were presenting their findings and conclusions for respective Vital Issues. The composition of participants being from both institutions (academics and industry), made the session too attractive and a learning process. Participants have enjoyed all the moments and have been dedicated in practising the subject matter.

All participants were impressed to make use of the concept of Systems Engineering in their work position. Especially, PhD students seemed to be highly interested to link their dissertation studies with the concepts and tools that they acquired in Systems Engineering. Participants from METEC also approved to institutionalize the concept in the respective METEC enterprises. At last but not least, higher government officials or decision makers have been recommended to have continual trainings for professionals on such high level and state-of-the-art courses.