IIESL - UAE JOURNAL

Volume 1 - October 2019

INSTITUTION OF INCORPORATED ENGINEERS SRI LANKA
UNITED ARAB EMIRATES

Professionalism beyond boundaries

INSTITUTION OF INCORPORATED ENGINEERS SRI LANKA
United Arab Emirates

IIESL-UAE JOURNAL

VOLUME 1– OCTOBER 2019

https://iiesl.lk

Professionalism beyond boundaries

CONTENTS

Editorial 5

Editorial Committee 6

The Recognition of Incorporated Engineers in Sri Lanka 7
Eng. Anton Peiris
FIEE (SL), MIET (UK), I ENG (UK), I ENG (SL), GCGI (UK)

Zero Energy Buildings – Its Implementation in Sri Lanka 11
Eng. Sisira Walaliyadde
NDT, FIIESL, MICE, MIESL, MCGI (UK), C ENG, I ENG

Coconut Oil as a Lubricant to Optimize Internal Combustion Engine Performance 16
Eng. Jayantha Hettiarachchi
NDT, MSC, FIIESL, MIET, MIMECHE, I ENG, CENG

Engineering Council of Sri Lanka (ECSL) 23
Eng. Shantha Senarath
M.ENG. (LOND), MCGI (LOND), MEG (SL) DTM (USA), FIIESL, I ENG

Administration of Prime Cost Items in Construction Contracts 27
Trinie Anton Fernando
NDT(CIVIL ENG.), BSC (HONS) IN QS&CM, AMIESL

Building Information Modeling (BIM) in Construction Industry 36
Eng. Ranil Wijesingha
NDT (CIVIL ENG.), MSC (CPM), MAIQS, MIIESL

How the Value Engineering Process should Structure to Achieve the Success 41
Samantha Bandara
NDT(CIVIL ENG.), MSC (CPM), MAIQS

Sustainable and Economical Waste Management Practices (WMP) for Building Construction Projects in UAE 45
Manoj Sampath Dissanayaka
MSC(CM), BSC (HONS) (QS & CM), NDT (CIVIL ENG.), MAIQS, CQS, AMIIE, MQSI

Project Management in Construction : A New Approach 50
Eng. Nalaka Kanthiarachchi
MIIESL, MIET (UK), GCGI (UK), PMP, I ENG.

Organizational Strategy Formations 55
Kavindra Jayasooriya
NDT(CIVIL ENG.), MSC(QS), AMIESL, MAIQS, MRICS

Editorial

Dear Readers,

We are pleased to announce the inaugural publication of the IIESL-UAE Journal, a resource overdue and a significance to the Sri Lankan Incorporated Engineers Community in the United Arab Emirates and the professional community at large. The objective of the publication of this journal is to provide a regular channel for our members and other eminent Sri Lankan industry professionals to share their knowledge and expertise which not only benefit themselves, but also the entire professional community.

The journal is designed to encourage the interest in matters relating to the disciplines in construction industry and engineering and the contents of the articles have been valued within aforesaid fields. The articles of this journal have been written by your resourceful peers and highly experienced and qualified industry professionals of today. Articles we receive from the Sri Lankan Incorporated Engineers living and working across the globe, are useful to our entire readership, either personally or professionally.

We wish to thank everyone who has contributed to the journal, the articles are a tremendous pleasure to read. It was with great satisfaction that we observed the outpouring of interest in being a part of the inaugural journal, a satisfaction that we feel certain will be echoed by you as you read the articles it contains.

On a closing note, we ask all of our readers to recall that this journal is your property. As such, the rightful growth of the journal is very much your concern and all feedback on articles are not only appreciated, but an active part of being a member of the IIESL and the professional community.

We anticipate your academic pleasure and hope that you assist us in ensuring it for future readers as well, by providing high-quality articles of your own in our next endeavour.

Editorial Committee
IIESL UAE Journal Volume 1 – October 2019

EDITORIAL COMMITTEE

Eng. Sisira Walaliyadde
NDT, FIIESL, MICE, MIESL, MCGI (UK), C Eng, I Eng

Eng. Anura Jagodage
NDT, MSc, FIIESL, MRICS, FAIQS, CCP

Eng. A.M. Manju Sri Nandana
BSc.(Hons), LLM, FRICS, FAIQS, FIIE(SL) I Eng , MCIArb, AIQS(SL), GCGI (UK)

Mr. Kavindra Jayasooriya
NDT, MSc (QS), MRICS, MAIQS

EDITORIAL POLICY

We, the editorial committee reserve the right to select, reject, edit and excerpt articles at our sole discretion. We will publish no article which, in the opinion of the editorial committee can be reasonably interpreted as insulting or offensive to any individual or group. We will not return unsolicited manuscripts. The opinion expressed in articles contained in this Journal are the opinions of individual authors and not necessarily those of the IIESL UAE Journal editorial committee.

Articles are provided for the general interest of the disciplines in construction industry or engineering community, but the information contained therein does not constitute legal advice and should not be relied on as such. Neither the IIESL UAE nor the individual authors assume any responsibility for the accuracy of information reported. The editorial committee assumes no responsibility for failure to report any matter inadvertently omitted or withheld from it.

The Recognition of Incorporated Engineers in Sri Lanka

Eng. Anton Peiris

FIEE (SL), MIET (UK), I Eng (UK), I Eng (SL), GCGI (UK)

Past President – IIESL (1997 – 1998)
Former Chief Executive Officer of Electro-Serv Pvt Ltd
Currently practicing as an independent consultant in electrical engineering, marketing, management and industrial training.

> *Incorporated Engineers are professional engineers who maintain, manage and apply current and developing technology to achieve cost effective and innovative solutions to everyday problems.*

The concept of engineering has existed since ancient times as humans devised fundamental inventions such as the pulley, the lever, and wheel – all of which are still consistent with the modern definition of engineering.

The forerunners of today's engineers were simple individuals who, proceeded mainly by trial and error. Over time, their tinkering combined with imagination and intelligence, produced ingenious solutions which improved the way we know life as it is today. The name "engineer" originated in the eleventh century from the Latin word ingeniator, used for conceptualisers of ingenious devices such as the Archimedean screw; a clever device to raise water from a river on to the land by Archimedes.

From the eighteenth through to the early nineteenth century, Engineering became a discipline. It became the science and mechanics of adopting a systematic approach to solve practical problems. The laws of motion, formulated by Newtonian physics launched calculus-based mechanics, the fundamentals of most engineering sciences.

Gradually over time, society's perception of engineers changed. They went from being considered and thought of as practical artists to being respected professionals. This was concurrent with the time that technical training shifted to structured engineering schools. Information began flowing in organised meetings and journal publications became a formal means of communicating new findings as professional engineering societies emerged.

College engineering curricula became well established and graduate schools appeared. Workshops turned into to laboratories, tinkering became industrial research, and individual inventions were organized into brilliant innovations.

Engineers however, in order to become leaders in these domains, have had to rebrand themselves in the background; reforming and formalising education programs, expanding research efforts and making every attempt to working collaboratively on an international scale. Intensive engineering research has produced not only new technologies but also bodies of powerful systematic knowledge that has benefited humans on a global scale.

With such globalisation, it became necessary to standardize and regulate the experience and qualifications of engineering professionals by way of accreditation – that is, the process by which engineering programs were evaluated by external

and independent bodies to determine if specific standards were met. This was not only a means of holding engineers accountable for their practises, but it also provided great incentive for engineers to educate themselves further and be recognised, gain respect by equivalent professionals and peers and be properly acknowledged for their contributions to society.

Originally signed in 1989, the Washington Accord is an international agreement between bodies responsible for accrediting Engineering Degree programmes. To complement the Washington Accord, the Engineering Council of the UK pioneered the Sidney Accord which was signed in June 2001, recognizing the equivalency of qualifications for engineering technologists or incorporated engineers in signatory countries. Eventually the Dublin Accord, signed in May 2012, became an international agreement establishing the required educational base for engineering technicians.

In June , 2017 , the Institution of Engineers Sri-Lanka was admitted as a provisional signatory to the Sydney Accord. However as the only professional institution representing the Incorporated Engineers in Sri-Lanka, the IIESL too should also be encouraged to apply to be a signatory to the Sydney Accord. Equally appropriate, if not more so, the newly formed Engineering Council of Sri-Lanka should be persuaded to be a signatory and gain the recognition it deserves.

Looking back in time, we can see how difficult it has been for the Engineering profession in Sri-Lanka to thrive as other professions have. Technical education in Sri-Lanka, originated in the 1890s with the establishment of the Colombo Technical College. Recognised as the most established Technical College in Sri-Lanka in 1893, it was renamed to be the Ceylon Technical College which provided specialized training in the fields of Civil, Mechanical and Electrical Engineering and arranged understudies for the degrees offered by the University of London and examinations of the expert Institutions of Civil, Mechanical and Electrical Engineering. A Junior Technical Officers (JTO) course was inaugurated at the Ceylon Technical College in the late 1940's.

In order to fulfil the need for an increased number Junior technical officers , in 1961 the Institute of Practical Technology was established at Katubedda, Moratuwa with financial aid from Canada, only a few years after the Hardy Regional Technical Training Institute was founded in Ampara.

In 1967, soon to be converted to a University - the Ceylon College of Technology was established with resources from IPTK. The Ceylon College of Technology developed a world-class three-year Engineering program called the National Diploma in Technology (NDT) in par with HNDE, UK. The National Diploma in Technology provided students with skills and drive to push the boundaries of discovery in the fascinating field of engineering, providing accessible, flexible and efficient technological education and skills training to meet the needs of society and the industry.

Since this time, several other recognised Diploma-level Engineering programmes such as National Diploma in Engineering Science (NDES), Higher National Diploma in Engineering (HNDE), and Diploma in Technology (Dip Tech), have been established in Sri-Lanka.

It is noteworthy that while the University of Moratuwa was well established in the process of issuing their National Diploma in Technology (NDT), UK's equivalent HNDE program was converted to a 3-year BEng Degree, representing a more prestigious target for prospective students and qualifying graduates. Unfortunately, for reasons unknown, Sri Lankan Authorities were unwilling to do the same here.

As per Engineering Council UK, "Professional registration provides a benchmark through which the public, employers and their clients can have confidence and trust that registered engineers and technicians have met globally recognised professional standards". As such, professional titles

such as CEng, IEng and EngTech in the UK are only awarded by the Engineering Council and not by any other professional institution. This is in stark contrast to the current practises in Sri-Lanka, where the professional title CEng is awarded by the Institution of Engineers, Sri-Lanka, while the title, IEng is awarded by the Institution of Incorporated Engineers, Sri-Lanka. Unfortunate situations such as this have arisen due to unjust social recognition issues that stem from the lack of equal educational opportunities available to all, and a number of short-sighted solutions implemented over the years.

Unfortunately, the disparity in society between one profession and another, or even between titles within one profession stem from small but significant injustices that are embedded in the core of our education system. At present, up to 40% of available places each year in the universities are reserved for students who are selected based on all island merit (of Z scores). Of the remaining 60% of available places, up to 55% are selected on the district quota and the remaining 5% of available university places are allocated for what is referred to as the 'educationally disadvantaged districts'. There are major flaws with this system which we, as educated individuals should recognise and voice our concern towards.

There is no agreement that those who enter university through the 'educationally disadvantaged' quota must return to their area of schooling after graduation. There is no accountability, no moral obligation or encouragement for these students to return to the 'backward areas' from which they applied from and give back to the community which will progressively eliminate such backwardness. Moreover, the mark up for some districts is so high that once the students do enter university, the disparity between students is unduly large so Universities also struggle to impart knowledge and educate the future professionals.

As a consequence of the manner in which the tertiary education system operates in Sri-Lanka, socio-economic division and social segregation are not only encouraged, but to some extent, enforced or regulated. It is not surprising that those who are selected into prestigious engineering faculties feel superior and belittle their peers who are not offered university places, despite the fact that their peers are potentially equally or some times more intelligent and capable of further study in the discipline.

For these very reasons, there have been attempts to tarnish the image of the NDT programme from its inception. Being a member of the 1st batch, I clearly recall the struggle we endured in order to establish ourselves as Incorporated Engineers due to a lack of recognition and respect from the industrial sector. Purely based on our performance and drive, and standing in solidarity, we were able to achieve much success, especially in the private sector.

It was only in 1977, that the All-Ceylon Engineering Diplomates Association was formed to establish due recognition & look after the interests of the Engineering Diplomates in Sri-Lanka. The ACEDA was later, in 1992, transformed into the Institute of Engineering Diplomates and in the year 2000, in keeping with the international standards of professional engineering societies of similar nature, IEDSL was renamed to what's currently known as the Institution of Incorporated Engineers, Sri-Lanka by an Act of Parliament.

During the past 42 years, the Institution has made rapid progress and achieved great success due to the team work, commitment, sacrifice and hard work of all Past Presidents, Council Members and the general membership.

IIESL as the Professional Body of Incorporated Engineers, who manage & operate Engineering Technology in Sri-Lanka, have the mandate to develop professionalism among the members. During the present time of rapid economic & global changes, we find ourselves challenged to maintain our professional integrity and standards of conduct in professional and business activities.

After many years of deliberations, in 2017, the

Registration of Engineers Act was passed in the Parliament of Sri-Lanka.

Members of The Institution of Incorporated Engineers, Sri-Lanka and those aspiring to gain its membership should be proud in the knowledge that the establishment of the Engineering Council Act which came into fruition, came with significant struggle. Thanks to these efforts, the position of 'Incorporated Engineer' is now a recognised title in Sri-Lanka. Despite this favourable result, much needs to be done for proper implementation of the Act which has to be jointly coordinated with the Institution of Engineers, Sri-Lanka.

This Act, unlike similar Acts in other countries, is oriented more towards recognising academic qualifications of Engineers and not purely based on the demonstration of professional abilities and practical experience. Unlike the three professionally recognised engineering categories in the UK, the new Act in Sri-Lanka acknowledges and awards a total of six categories for the Engineering profession.

To its credit, the IIESL has been successful in signing several reciprocal membership arrangements with multiple international professional organisations and bodies. Hopefully in the near future, Sri-Lanka too will give the due recognition to Incorporated Engineers.

On another pleasing note, we are happy to note the Curriculum revisions of the engineering diploma programs are being carried out in Sri-Lanka to keep abreast with the latest developments in technology. For example, as we understand, the recent conversion of the NDT curriculum to a semester system has already occurred. This makes the NDT meet the credits and attributes required by the general needs of the country and world at large while meeting the requirements of international Accords such as the Sydney Accord.

One can confidently state that the name of the Engineering Diploma programs have no bearing to the present Diplomas or Higher Diplomas mentioned in various qualification frame work systems such as IVQ ,NVQ or SLQF. These names are preserved and guarded to date by all stakeholders of the programs due to their significant acceptance in both the local and international markets as valuable brand names.

Further, when Sri-Lankan Incorporated engineers travel outside of Sri-Lanka, they are respected and held in high regard – this, I can say from experience. There is a certain prestige associated with being able to understand a problem, identify a solution and resolve it using high-level, acquired knowledge.

Living by example is the best means of drawing out professionalism in a culture and practice where it is often overlooked.

Someone unknown once said, "To the optimist, the glass is half full. To the pessimist, the glass is half empty. To the incorporated engineer, the glass is twice as big as it needs to be."

> *"The life work of the engineer consists in the systematic application of natural forces and the systematic development of natural resources in the service of man."*
>
> *Harry Walter Tyler*

Zero Energy Buildings – Its Implementation in Sri Lanka

Eng. Sisira Walaliyadde

NDT, FIIESL, MICE, MIESL, MCGI (UK), C Eng, I Eng

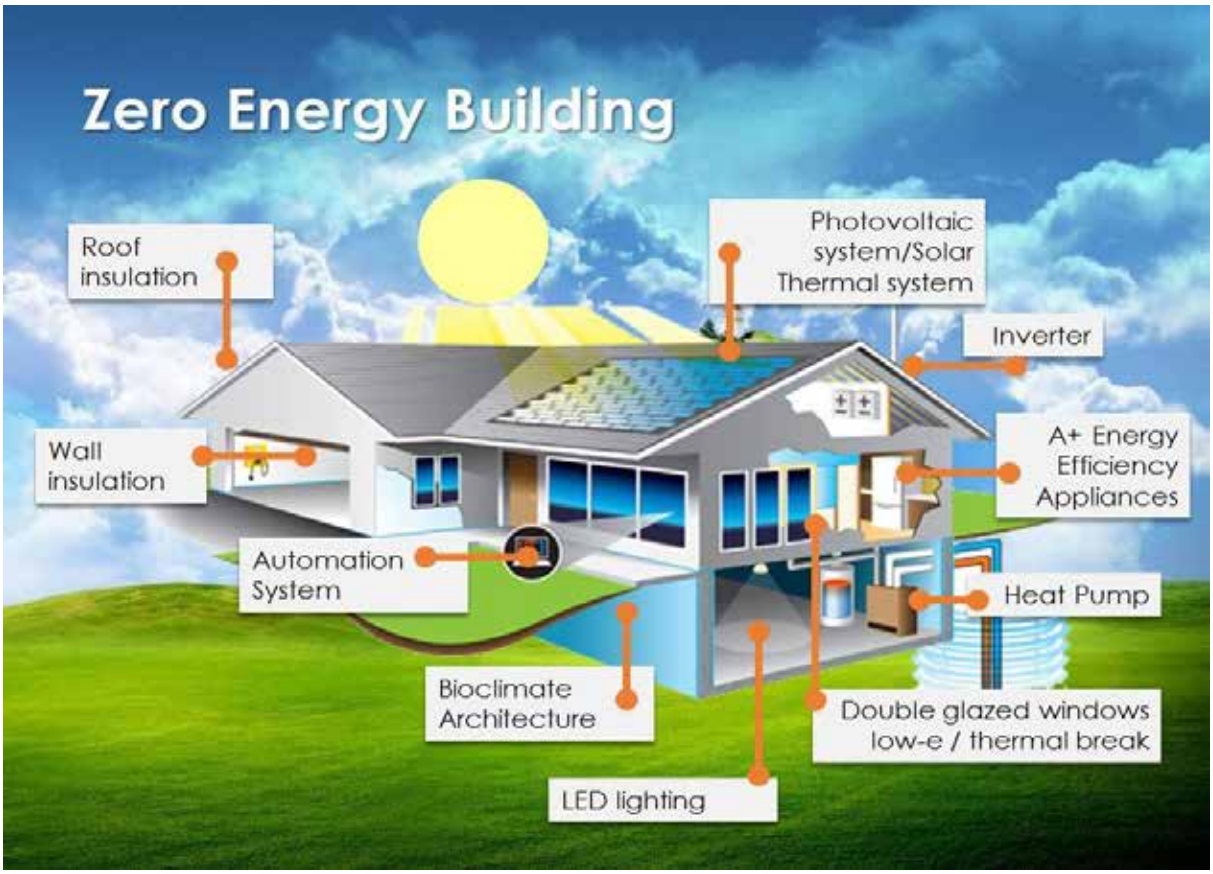
Past Chairman, IIESL UAE Branch
Associate Director, WSP Middle East Ltd, United Arab Emirates

WHAT IS A ZERO ENERGY BUILDING, YOU MAY ASK?

A Zero Energy Building (ZEB) is also known as a Zero Net Energy Building (ZNEB) or Zero Carbon Building (ZCB). In simple terms a Zero Energy Building is, one that could generate (at site) as much power (renewable energy) as it consumes over a given period, usually one year. The energy consumption can also include renewable energy from sources elsewhere. The energy required for the day today use of a building could be generated from various sources; the main sources are solar, wind and geothermal.

A ZEB on the other hand should conform to;

- Efficient use of energy. When it comes to energy consumption there is an emphasis on smart building techniques, materials and technologies to minimize heat losses and improve energy efficiency.
- Consequently, less contribution of Green House Gas to the atmosphere than similar non-Zero Energy Buildings.



For the world to sustain, technologies are being developed to replace the depleting natural energy sources, based on renewable energy. To achieve this target, it requires a system based approach through local and national based policies of a country to transform the existing energy demand, storage, and supply of delivery systems. Not only construction of new buildings complying with these requirements, the existing buildings should also be retrofitted with replacement of fossil fuel use with renewable energy; without which national targets for Green House Gas emission reductions will not be achieved. Net Zero Energy Buildings offer a way of resolving this transformation.

The term "zero energy" has no common definition or a common understanding among its experts.
Definitions:

- Most zero net energy buildings get half or more of their energy from the grid, drawing power at night or during sunless days and returning power to the grid when the sun is shining. That would not only cut the net energy use and net carbon emissions to zero, but also lower cost of ownership and enhance the quality of life of their occupants and return the same amount at other times. Buildings that produce a surplus of energy over the year may be called "energy-plus buildings" and buildings that consume slightly more energy than they produce are called "near-zero energy buildings" or "ultra-low energy buildings ".

Traditional buildings consume fossil fuel (coal, oil, petroleum and natural gas) energy;

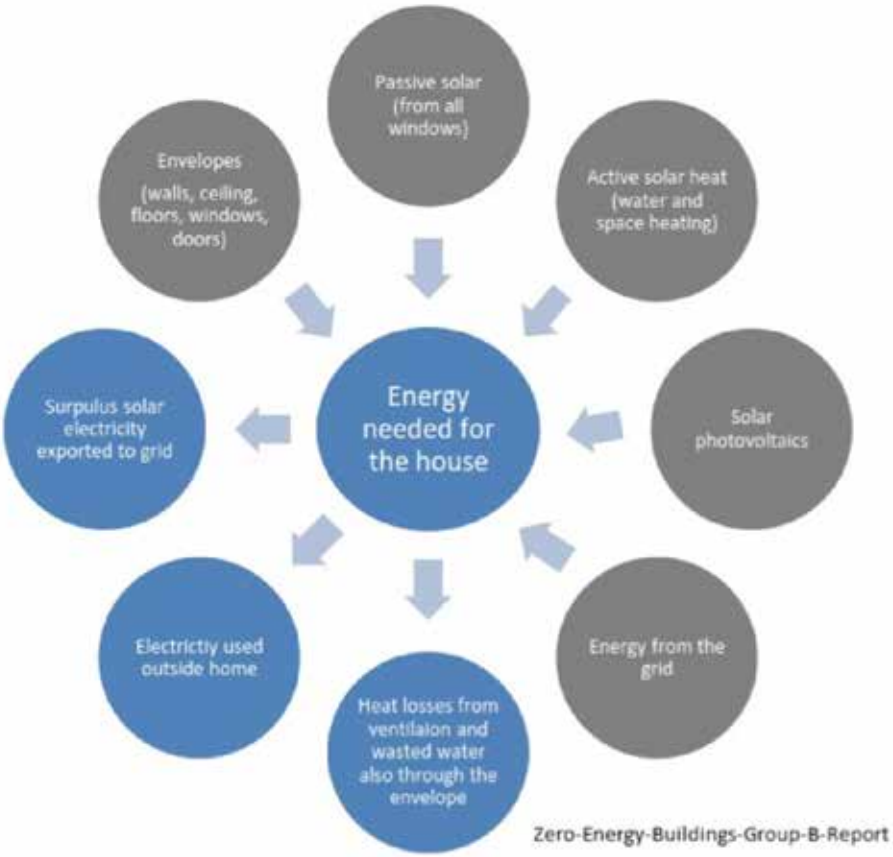
- Approximately 40% in the US and European Union
- Over 50% in Sri Lanka.

These countries among others are significant contributors of greenhouse gases. The zero-net energy consumption principle is viewed as a means to reduce carbon emissions and reduce dependence on fuels. Although zero-energy buildings remain uncommon even in developed countries, they are gaining importance and popularity.

Most zero-energy buildings use the electrical grid for energy storage but some are independent of the grid. Overall use of energy can be reduced with highly efficient Heating, Ventilation and Air Conditioning (HVAC) and lighting technologies. The zero-energy goal is becoming more practical as the costs of alternative energy technologies decrease and the costs of traditional fossil fuels increase.

The development of modern zero-energy buildings became possible largely through the progress made in new energy and construction technologies and techniques. These include highly insulating spray-foam insulation, high-efficiency solar panels, high-efficiency heat pumps and highly insulating low-E triple-glazed windows. These innovations have also been significantly improved by academic research, which collects precise energy performance data on traditional and experimental buildings and provides performance parameters for advanced computer models to predict the effectiveness of engineering designs.

Zero-energy buildings can be part of a smart grid. A smart grid is an electricity network based on digital technology that is used to supply electricity to consumers via two-way digital communication. Some advantages of this system are;



Zero-Energy-Buildings-Group-B-Report

- Integration of renewable energy resources
- Integration of plug-in electric vehicles – called vehicle-to-grid
- Implementation of zero-energy concepts

Although the net zero concept is applicable to a wide range of resources such as energy, water and waste. Energy is usually the first resource to be targeted, because:

- Energy, particularly electricity and heating fuel like natural gas or heating oil, is expensive. Hence reducing energy use can save the building owner money. In contrast, water and waste are inexpensive.
- Energy, particularly electricity and heating fuel, have a high carbon footprint. Hence reducing energy use is a major way to reduce the building's carbon footprint
- Well-established energy saving techniques significantly reduce the energy use and carbon footprint of buildings.
- There are government sponsored subsidies and tax breaks (In some parts of the world) for installing these techniques greatly reduce the cost of getting to a net-zero energy building for the building owner.

To determine the most cost effective technology to get to zero energy for a new ZEB, the architect, engineer, HVAC specialist, general contractor and the building energy consultant should work together reviewing and selecting from among the following energy saving technologies, some of which have been discussed above;

- Insulation: Increasing the insulation for the floors, walls and roof/ceilings.
- Air Sealing: Eliminate air leaks from the building structure itself and from around windows, doors, electrical outlets, plumbing fixtures and all other building penetrations.
- Heating and Cooling: Using effective energy efficient technologies for heating and cooling.
- Lighting: Using natural light by using properly oriented windows and louvers. Using LED lights which reduce energy use and costs while increasing lighting quality and using automatic lighting controls.
- Windows: Double and triple pane windows are available with low-emissivity coatings that help capture or reject solar heat.
- Shading Systems: Optimize natural lighting using roof overhangs or fixed awnings/shelters.
- Water Heating: Use thermal solar systems, electric heat pump technology or a well-insulated standard electric water heaters.
- Energy Efficiency Appliances: Appliances, such as dish washers, dryers, and stoves, should be selected for the highest energy efficiency at the lowest cost, using those with ENERGY STAR ratings when possible.
- Ventilation: An efficient heat recovery ventilation system is required to provide fresh filtered air to a ZEB as it is so airtight.
- Solar Photovoltaic Systems (PVS): Use suitably designed PV system after all the energy saving measures for the building have been determined.
- Dual Use of Energy: Including that from white goods (large domestic appliances). For example, using a refrigerator exhaust to heat domestic water, ventilation air and shower drain heat exchangers, office machines and computer servers, and body heat to heat the building.

Experts' opinion is that, once the energy use of the building has been minimized to a limit, it can be possible to generate all that energy on site, using roof-mounted solar panels.

To summarize, the advantages of constructing a Zero Energy Building can be broadly noted as;

Zero Energy Construction Costs: It is common that the energy saving features and photovoltaic systems increase the cost of construction. However, in accordance with the Office of Energy Efficiency and Renewable Energy (EERE, USA), zero energy commercial buildings can be built within typical construction budgets. To achieve these goals in large projects, Energy Performance Based Procurement guidelines, based on energy modelling, can be followed.

Return on Investment in Monitory Terms: Even when zero energy building costs are higher, they will cost less to own, because the added cost for the energy improvements over and above the costs of a similar standard building, when rolled into the mortgage, will lead to a smaller additional monthly mortgage cost than the savings on energy each month. Overall, the home owner gets the benefit of return on investment.

Return on Investment in Quality of Life: Another important return on investment is in quality of life. Zero energy buildings have fresh, filtered, quality indoor air, are draft free, have even temperatures, and are better lighted and quieter—all of which improve the health and well-being of the occupants. The wellbeing of employees is a significant benefit to the bottom line of owners. All the technology for zero energy buildings is currently available and in wide use. Cost of constructing a zero energy building would be less than a similar standard building, the advantages being; enhance the quality of life of the occupants and meeting the world's climate goals.

CAN THE ZEB CONCEPT BE PRACTICALLY IMPLEMENTED IN SRI LANKA?

It is encouraging to see that a few buildings: residential and commercial are being designed and built in Sri Lanka, conforming to ZEB concept. However, the initiative from the authorities to educate and encourage the public on ZEB concept and providing necessary assistance is lacking.

An article appeared in media says that an apparel factory located in Batticaloa, in eastern Sri Lanka, has become the world's first manufacturing facility to achieve "Net Zero Carbon" status and Si Lanka's first Multi-Family Residential Building has come up in Kandy receiving the award, LEED Gold certification by the US Green Building Council (USGBC). New housing projects are also being built in various parts of Sri Lanka under foreign aids/assistance complying to ZEB concepts. It is encouraging to observe that a few Sri Lankan Contractors, registered in higher categories are paying more attention in incorporation of ZEB concept in their constructions.

It becomes the responsibility of the government authorities, professional institutions, built environment professionals etc. to develop a framework proposing probable and appropriate construction methods/systems in accordance with government rules and regulations and take the initiative in educating and assisting the public and the industry to implement them in new and existing buildings to go for Zero Energy Buildings, for a sustainable future in Sri Lanka.

REFERENCES:

- Article from ASA/ ANZAScA 2012, Griffith University
- Zero-Energy-Buildings-Group-B-Report – Helsinki Metropolia University
- Global Zero-energy Buildings Market Insights, Forecast To 2025-MarketInsights Reports
- Sundaytimes.lk/030824/ft/7.html and several online articles

> *We shape our buildings, thereafter they shape us.*
>
> *- Winston Churchill*

Coconut Oil as a Lubricant to Optimize Internal Combustion Engine Performance

Eng. Jayantha Hettiarachchi

NDT, MSc, FIIESL, MIET, MIMechE, I Eng, CEng

Past Chairman of the IIESL-UAE for three consecutive years from 2015.
Currently serving as the Maintenance Manager, Al Naboodah National Plant & Equipment LLC, Dubai, UAE

1. OVERVIEW

It is a known fact that the mankind used bio-lubricants; fatty acids or animal fats as media for lubrication before inventing bitumen from mineral crude oil as a lubricant. In contrast, today the scientists are in search for alternatives to replace or minimize the usage of mineral based lubricants as a remedy for growing environmental concerns. Because, the world consumes 40 million metric tons of lubricants annually according to the United Kingdom Lubricant Association1, approximately 90% of which could be replaced with bio- lubricants. Bio-lubricants are a good approach because of their superior biodegradability, low toxicity, higher viscosity index and renewable compared to mineral based lubricants. Nevertheless, they exhibits substandard low temperature characteristics; higher pour point, wax formation, and low oxidative stability are the attributes in need of improvements[2,3]. There are many bio-lubricants including plant oils or animal fats in use, which have similar molecular composition; triglyceride molecules, which consist of two main parts; glycerol part consist of three linked hydroxyl groups and fatty acid (FA) part consist of long chain saturated and unsaturated FAs connected to each hydroxyl group as illustrated in Figure [12.] There are three types of natural FAs found in vegetable oils noted by Syahir

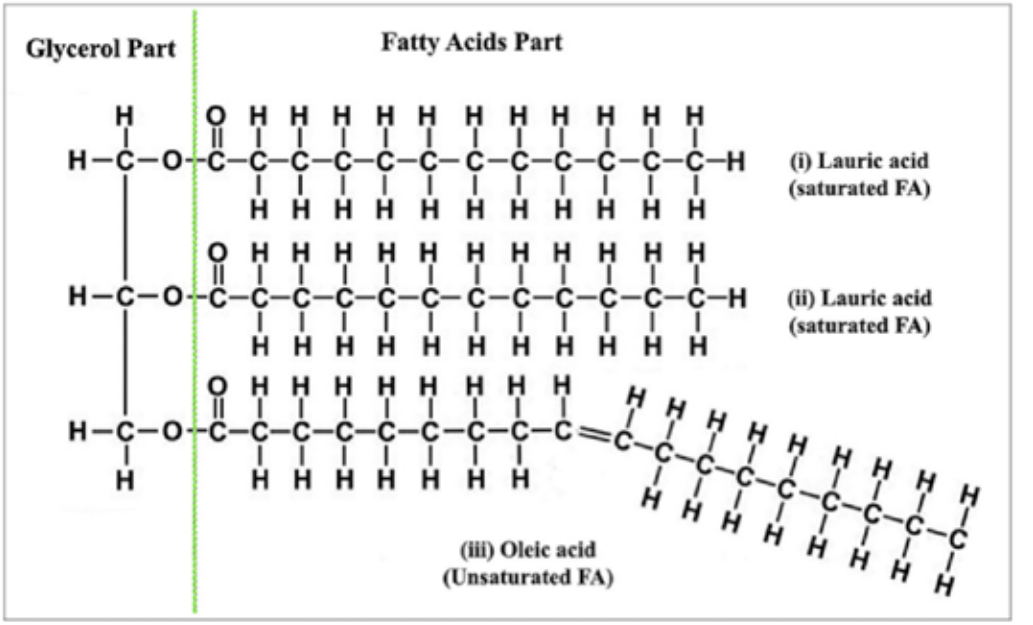


Figure 1; Typical illustration of triglyceride molecule[2]

et al.[2,] such as; saturated, monounsaturated and polyunsaturated as illustrated in Table 1. However, coconut oil (CCO) has been selected in this study because of the availability in the geographical region (south Asia; India, Sri Lanka).

Zinal, et al.[4,] documented that long chain length, linear chain, low unsaturation and high polarity are the key factors for a better lubricity of a lubricant. Also, noted that CCO been used as a lubricant in scooters in South India had shown improved engine pickup, less smoke, improved mileage over conventional lubricants. From the Table 1 it is observed that CCO is constitute with 83.4%, 7.8% and 8.8% of saturated FAs, unsaturated FAs and unknown elements respectively. However, low unsaturated FA composition signifies better oxidation stability, albeit less long chain molecules,[4] high pour point (21^0 C)[2,4] are the drawbacks, regardless of its superiority over other qualities of conventional lubricants. Nonetheless, this situation could be improved. For example, Syahir, et al.[2], Zainal et, al.[4], utilized procedures such as; addition of additives, emulsification, and chemical modification; transesterification, epoxidation and hydrogenation. Moreover, Mehic[5] and technical committee of petroleum additive manufactures in Europe[6] acknowledged that, polyalkylacrylate, polyalkylmethacrylate and zincdialkyldithiophosphates (ZDDPs) could be added as pour point dispersants (PPD) and antioxidants respectively.

1.1 THE AIM

In view of the above, the aim of this study is to examine the tribological effects of CCO on internal combustion engine (ICE) components. Emphasis will be placed on piston ring cylinder liner interface to reduce friction and wear, with the ambition to increase fuel economy and reduce emissions. Thus, optimizing the ICE performance, saves energy and reduces the imports of crude oil to Sri Lanka.

2. EXPERIMENT METHODOLOGY

With the above intentions, many concentrations of untreated CCO were blended with treated mineral based lubricant; 15W40, with the use of Oleic acid (OA) as a surfactant to have stable homogeneous solution[7,8.] The mixed designs were blended using

	Saturated fatty acids (%)									Unsaturated fatty acids (%)									
	C8:0	C10:0	C12:0	C14:0	C16:0	C18:0	C20:0	C22:0	C24:0	C16:1	C17:1	C18:1	C18:2	C18:3	C20:1	C20:2	C22:1	C22:2	C24:1
Safflower	–	–	–	0.10	6.70	2.40	–	–	–	0.08	–	11.50	79.00	0.15	–	–	–	–	–
Grapeseed	0.01	–	0.01	0.05	6.60	2.40	–	–	–	0.08	–	14.30	74.70	0.15	0.40	–	–	–	–
Silybum marianum	–	–	0.01	0.09	7.90	4.50	2.60	–	–	0.05	0.03	20.4	63.3	0.88	0.15	–	–	–	–
Hemp	–	–	–	0.07	6.40	2.60	–	–	–	0.11	–	11.50	59.4	3.36	16.5	–	–	–	–
Sunflower	–	–	0.02	0.09	6.20	2.80	0.21	–	0.31	0.12	–	28.0	62.2	0.16	0.18	0.09	–	–	0.39
Wheat germ	–	–	0.07	–	17.40	0.70	–	–	–	0.21	–	12.70	59.7	1.20	7.91	–	–	–	–
Pumpkin seed	–	–	–	0.17	13.10	5.70	0.47	–	–	0.12	–	24.90	54.2	0.12	1.08	–	–	–	–
Sesame	–	–	–	–	9.70	6.50	0.63	0.14	–	0.11	–	41.5	40.9	0.21	0.32	–	–	–	–
Rice bran	–	–	–	0.39	20.0	2.10	–	–	–	0.19	–	42.70	33.1	0.45	1.11	0.11	–	–	0.38
Almond	–	–	0.09	0.07	6.80	2.30	0.09	–	–	0.53	–	67.2	22.8	–	0.16	–	–	–	–
Rapeseed	–	0.01	–	–	4.60	1.70	–	–	–	0.21	–	64.7	19.60	1.20	9.10	–	–	–	–
Peanut	–	–	–	0.04	7.50	2.10	1.01	–	1.66	0.07	–	71.1	18.20	–	–	–	0.12	–	–
Olive	–	–	–	–	16.50	2.30	0.43	0.15	0.06	1.80	–	66.4	16.40	1.60	0.30	–	–	0.05	–
Extra virgin olive	–	–	–	–	8.70	3.47	0.46	0.13	0.05	0.51	0.25	76.34	8.64	0.75	0.34	–	–	0.19	–
Coconut	7.60	5.50	47.70	19.90	–	2.70	–	–	–	–	–	6.20	1.60	–	–	–	–	–	–
Borage seed	–	–	–	0.06	8.75	3.46	0.22	0.30	0.11	0.29	0.07	16.52	38.47	22.97	4.05	0.35	2.23	–	2.09
Canola	–	–	–	0.06	3.75	1.87	0.64	0.35	0.27	0.21	–	62.41	20.12	8.37	1.54	0.11	–	–	0.26
Corn	–	–	–	–	10.34	2.04	0.44	0.31	0.26	–	0.05	24.23	60.38	0.99	0.28	–	–	–	0.20
Cottonseed	–	–	–	0.77	21.87	2.27	0.26	0.36	0.12	0.47	0.11	16.61	56.35	0.33	0.14	0.10	–	–	0.16
Evening-primrose	–	–	–	0.04	5.47	1.83	0.30	0.31	0.09	–	0.06	7.50	74.00	9.76	0.24	0.14	–	–	0.19
Linseed		–	–	0.05	4.81	3.03	0.20	–	0.01	–	0.12	21.42	15.18	54.24	0.40	0.39	–	–	0.10
Soybean	–	–	–	0.06	9.90	3.94	0.41	0.48	0.21	0.08	0.08	21.35	56.02	7.15	0.22	–	–	–	–
Palm	–	–	–	1.12	42.70	4.55	0.39	0.58	0.06	–	0.06	39.37	10.62	0.21	0.17	–	–	–	0.06
Palm kernel	3.43	3.23	46.14	16.17	8.65	2.27	0.15	–	0.30	–	–	16.46	2.76	–	0.17	–	–	–	0.27
Castor bean	–	–	–	–	1.30	1.20	–	–	–	–	–	89.70	7.30	0.50	–	–	–	–	–

Table 1; Fatty acid composition of common bio-lubricants[2]

a magnetic stirrer hot plate for consistent solutions. Conventional diesel engine oil 15W40 was selected as the reference oil to compare outcomes and the details of sample concentrations are given above with the Table 2.

Material; reference oil "CEYPETCO SUPRA – 15W40" and OA were purchased from a local market and virgin coconut oil was procured from a local mill, all from Sri Lanka.

test parameters such as; constant reciprocating frequency of 20 Hz with 10 mm stroke, thus average sliding velocity of 0.4 ms-1, with 120 N load at a temperature of 100^0 C, after aligning test specimens axially and laterally to avoid mismatch of curvatures.

Moreover, basic physicochemical properties of blends such as; kinematic viscosity, viscosity index (VI), pour point (PP), flash point (FP), were scrutinized with the guidance of ASTM D7279,

Sample S/N	Base oil		Solvent (OA)	Additives	
	Composition	Concentration v/v%	Concentration v/v%	Composition	Concentration v/v%
Sample 1	15W40	100	N/A	N/A	N/A
Sample 2	15W40	88.00	2.00	CCO	10.00
Sample 3	15W40	74.00	2.00	CCO	24.00
Sample 4	15W40	49.00	2.00	CCO	49.00
Sample 5	CCO	74.00	2.00	15W40	24.00
Sample 6	CCO	88.00	2.00	15W40	10.00

Table 2; Elemental composition of blended lubricants

Subsequently, all the lubricant formulations were tested utilizing "DUCOM TR-282" linear reciprocating tribometer (LRT) for their tribological performances using new piston ring and cylinder liner segments as test specimens to mimic a real-time engine operation. The test rig configured with top and bottom specimen holders having, sliding and static positions respectively. A crank mechanism driven by an electric motor, connected to the upper specimen holder generates the required reciprocating motion. The static bottom specimen holder, which was fitted on machine bed under the upper sliding arm was equipped with heat cells for acquiring anticipated test temperatures, piezoelectric pressure transducer and temperature sensor for transferring generated data via proportional integral derivative (PID) controller to a pc for evaluation and to control the test parameters as desired. LRT tests were done following ASTM G181-11 standards with the ASTM D2270, ASTM D97-12, ASTM D92-12 separately, including total base number (TBN), total acid number (TAN), moisture, metal and particle contents of the samples.

3. OBSERVATIONS AND DISCUSSION

LRT tests were performed as per the test design and coefficient of friction (COF) and frictional forces (FF) were recorded at the rate of 10 readings per second. Total test duration for a sample was 1 hour thus, approximately 36,000 readings were collected per sample. Hence, average COF and FF were calculated leaving initial 100 seconds (1,000 readings) as the startup error. From the analysis, the sample 6 with 88% CCO concentration emerged with the best performance showing 31.78% of COF reduction compared to the reference oil; conventional diesel engine oil 15W40 as reveled in Figure 3. Besides all

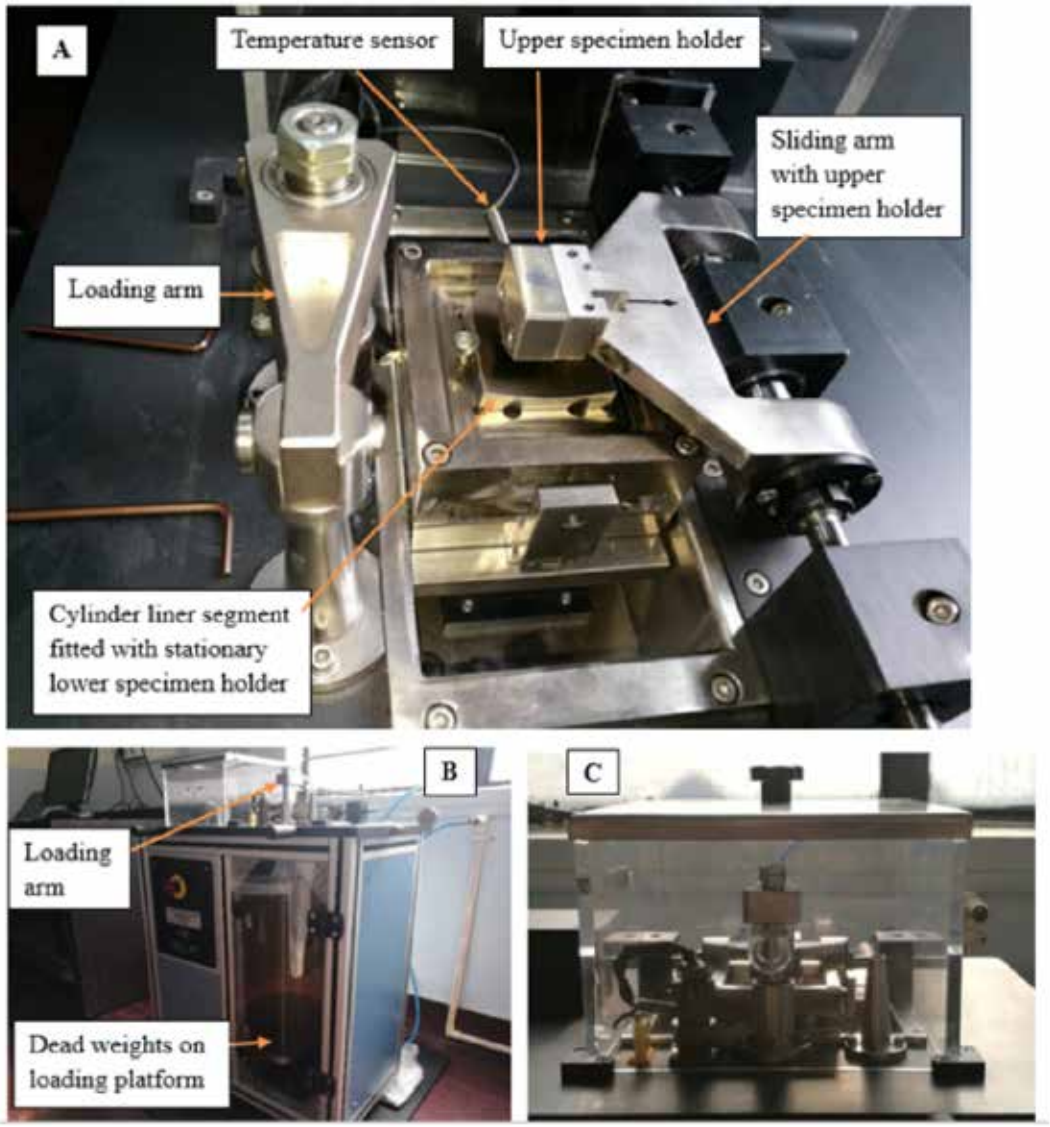


Figure 2; LRT test rig, A) sliding arm, specimen holders and other attachments, B) dead weights and loading arm, C) test rig in action

the samples have illustrated impressive enhancement against 15W40 with 20.63%, 18.61%, 22.33%, 24.84% and 31.78% COF reduction for samples 2,3,4,5, and 6 respectively with the standard error varying from 1.30E-05 to 1.95E-05 (Figure 4a and 4b).

Furthermore, the physicochemical properties of sample lubricants were analyzed as summarized in Table 3. Increase of CCO percentage in 15W40 has indicated mixed results; Figure 5a illustrate the variation of kinematic viscosity of samples @ 40^0C and 100^0C. Thus, increase of VI with increase of CCO percentage is evident with the Figure 5b, in addition to the COF reduction observed with Figure

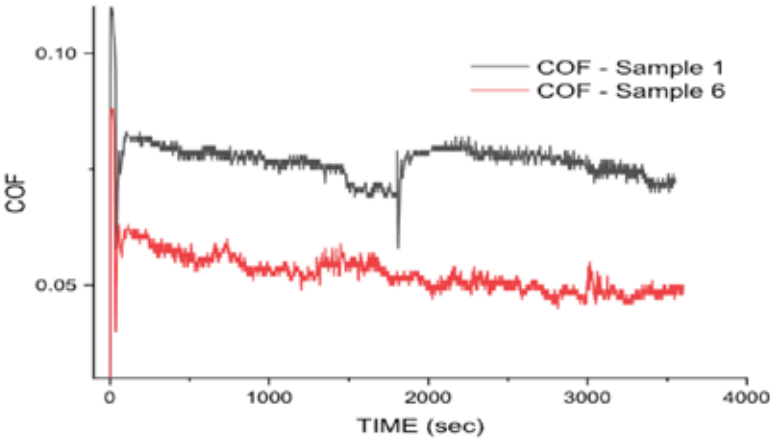
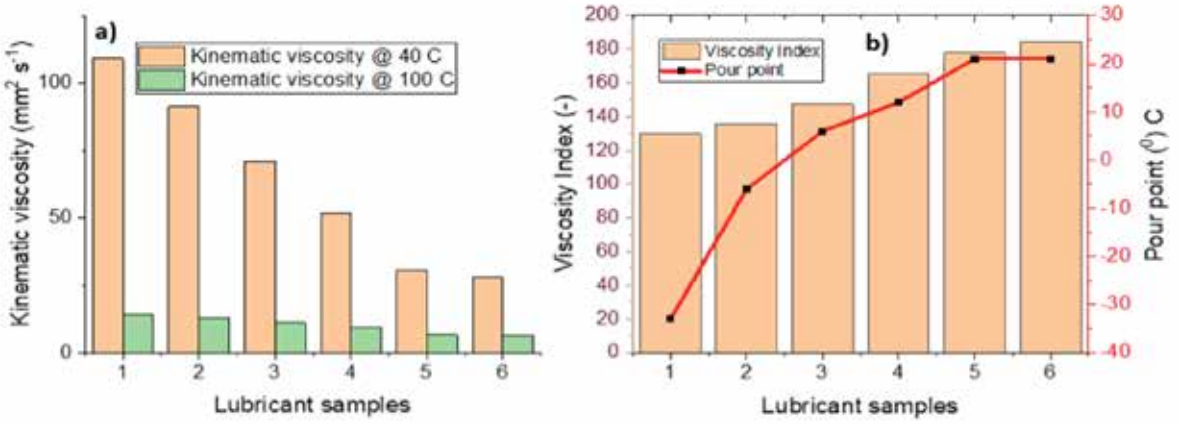


Figure 3; COF vs time analysis for sample 1 and 6



4b. However, increase of pour point with the increase of CCO percentage also evident (Figure 5b) is the drawback as reviewed in the literature, in-addition to TBN and kinematic viscosity at 100^0 C except for sample 2 (Table 3).

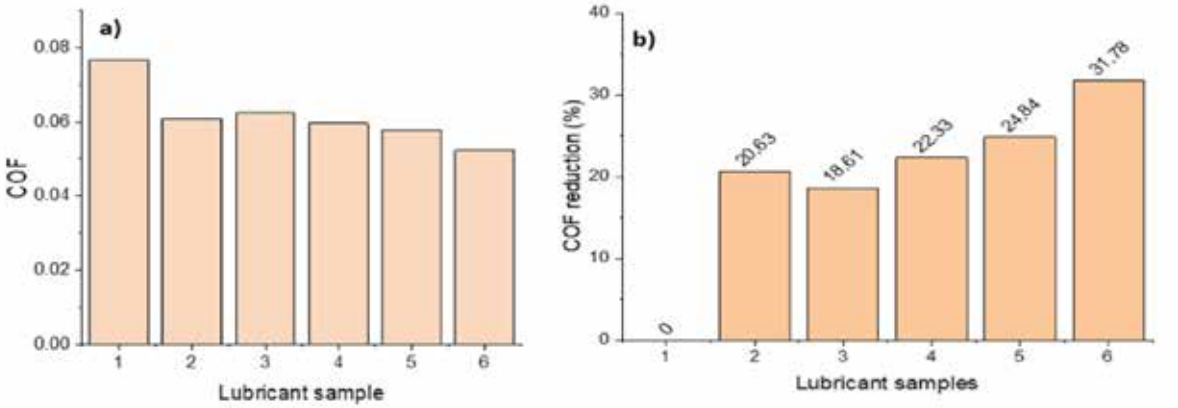
Figure 4; LRT test results, a) COF vs samples and b) COF reduction % vs samples

Figure 5; Physicochemical property analysis of samples, a) variation of kinematic viscosity at 40^0 C and 100^0 C, b) change of viscosity index and pour point with the variation of CCO concentration

With reference to the executed test parameters, the running time or travelled distance of test specimens is equivalent to a one hour or 1440 m, which are not tallying with real-time ICE operation for assessing wear rates for respective lubricants. However, wear loss of test specimens was obtained by measuring weight of test specimens before and after the LRT tests with the use of digital weighing scale. For instance, mass loss for the cylinder liner segments of sample 1 and 6 are equivalent to 0.174 and 0.082 mg individually, all are in microgram (mcg) scale. Thus, it is indicating reduction of mass loss by 92 mcg, compared to the reference oil 15W40.

Sample Number	Concentration % v/v	Kinematic viscosity, $(m^2s^{-1})10^{-4}$ @ 40°C	Kinematic viscosity $(m^2s^{-1})10^{-4}$ @ 100°C	VI (-)	TAN (KOH mg/g)	TBN (KOH mg/g)	PP, (°C)	FP, (°C)	COF reduction, % (-)
2	15W40, 88 + OA, 2 + CCO, 10	91.2	12.7	135.95	1.6	5.9	-6	234	20.63
3	15W40, 74 + OA, 2 + CCO, 24	71.1	11.1	147.37	1.5	3.7	6	240	18.61
4	15W40, 49 + OA, 2 + CCO, 49	107.1	9.6	51.33	1.4	4.5	12	252	22.33
5	15W40, 24 + OA, 2 + CCO, 74	30.8	6.6	177.7	2.5	2	21	272	24.84
6	15W40, 10 + OA, 2 + CCO, 88	28.2	6.3	184.34	3.3	1.5	21	282	31.78

Table 3; Summary of physicochemical properties of 15W40/CC0 concentrations



4. CONCLUSION

All five 15W40/CCO combinations with sample numbers 2, 3, 4, 5 and 6 had shown reduction of COF compared to sample 1; 15W40, with pour points of -6° C, 6° C, 12° C, 21° C and 21° C respectively (Table 3). This indicates that the sample 2 with 10% CCO in 15W40 could utilized as a friction modifier to 15W40 to enhance ICE performance with 20.63% COF reduction, because of its properties are in safe range to operate an industrial ICE. In contrast, sample 6 with 10% 15W40 in CCO had shown 31.78% COF reduction. A pure bio-lubricant with high pour point of 21° C is the negative point. Wear rate also shown inspiring 52.87% reduction in macro scale. Albeit, wear rates, patterns and surface morphologies are to be analyzed for further prediction. Because, the CCO's ability to create low shear strength metallic soap layer (ferric stearate) at boundary regime to reduce friction and repeated formation of soap layer on long run may affect to remove more metal from the surface to reduce friction[2] need to be evaluated.

However, as predicted high pour point and low oxidative stability of bio-lubricants must be resolved in order to achieve a suitable formulation. There are many approaches including but not limited to; surface modification, chemical modification, incorporation of additives. Therefore, PPDs such as; polyalkylacrylate or polyalkylmethactrylate and ZDDPs[5,6] as an antioxidant could be integrated initially or chemical modification or emulsification methods can be utilized. Furthermore, suggests to run a real engine for a period of 250 hours or one month and physicochemical property analyse for all improved samples before and after the test as a feasible remedy. The proposed solution should also be economically viable for the end user.

ACKNOWLEDGEMENT

The author would like to acknowledge the guidance and support extended by the collaboration of prof. Ram Mohan Reddy of BMS College of Engineering and DUCOM Instruments, both in Bangalore, India, for granting permission and arranging to perform LRT tests at IC engine testing laboratory of above institute.

REFERENCES:

1. Ukla.org.uk (2016) Bio – lubricants; understanding the potential and impact of new renewable sources on lubricant technology and application. http://www.ukla.org.uk/wp-content/uploads/bio-lubes-seminar-july-2016-v0-1.pdf
2. Syahir, A. Z., Zulkifli, N. W. M., Masjuki H. H., Kalam M. A., Abdullah, A., Gulzar, M. Khuong, L. S., Harith, M. H., (2017). A review on bio-based lubricants and their application. Journal of Cleaner Production, Vol. 168, pp 997-1016.
3. Murilo, F. T., Luna, T., Cavalcante, J. B., Silva, F. O. N., Cavalcante Jr., C. L., (2019), Studies on biodegradability of bio-based lubricants, Tribology International, vol. 92, pp 301 – 306.
4. Zainal, N. A., Zulkifli, N. W. M., Gulzar, M., Masjuki, H. H., (2018), A review on the chemistry, production and technical potential of bio-based lubricants. Renewable and Sustainable Energy Reviews, Vol. 82(1), pp 80 – 102.
5. Mehic, S. H., (2016), Additives in lubricants: types and chemical composition of lubricant additives. ec.europa.eu/enlargement/taiex/dyn/create_speech.jsp?speechID=37945&key
6. atc–europe.org (2016), Lubricant additives; use and benefits, https://www.atc-europe.org/public/Document
7. Ali, M.K. A., Xianjun, H., Mai, L., Qingping, C., Turkson, R. F., Bicheng, C., (2016). Improving the tribological characteristics of piston ring assembly in automotive engines using Al2O3 and TiO2 nanomaterials as nano-lubricant additives. Tribology International, Vol. 103, pp. 540 – 554.
8. Tadmor, R., Rosensweig, R. E., Frey, J., Klein, J., (2000). Resolving the puzzle of ferrofluid dispersants. Langmuir – American Chemistry Society (ACS) publication, Vol. 16 (24), pp 9117 – 9120.

> *"A good scientist is a person with original ideas. A good engineer is a person who makes a design that works with as few ideas as possible. There are no prima donnas in engineering."*
>
> *- Freeman Dyson*

Engineering Council of Sri Lanka (ECSL)

Past – Present – Future - From its hard beginnings to a successful tomorrow

Eng. Shantha Senarath

M.Eng. (Lond), MCGI (Lond), MEG (SL) DTM (USA), FIIESL, IEng.

Past President and a Fellow Member of IIESL, Sri Lanka.
Member of the Engineering Council of Sri Lanka
Chairman/ Managing Director of Techno Plus International (Pvt) Ltd. Sri Lanka

The long awaited Engineering Council Act of Sri Lanka was enacted at the parliament by Act No. 4, 2017 on 9th March, 2017.

This act will regulate the Engineering Profession in Sri Lanka.

Similar to the Medical Council of Sri Lanka that regulates the Medical Profession in Sri Lanka, the Engineering Council has the sole authority to register and regulate the Engineering Professionals in Sri Lanka.

OBJECTIVES OF THE ECSL

(a) Maintenance of Professional Standards and Conduct of Engineering Practitioners;
(b) Registration of different categories of Engineering Practitioners;
(c) To provide for matters connected therewith or incidental thereto.

COMPOSITION OF THE COUNCIL

- Four (04) Ex-Officio Members consisting of 03 Deans of the Faculties of Engineering or their representatives and the Director - General of Tertiary and Vocational Education Commission (TVEC).
- Thirteen (13) members appointed by the Minister consisting of,

(a) Seven (07) Chartered Engineers representing different engineering disciplines in rotation for every two years, nominated by the Institution of Engineers, Sri Lanka.
(b) Four (04) members representing different engineering disciplines in rotation for every two years, nominated by the Institution of Incorporated Engineers of Sri Lanka.
(c) One (01) Chartered Engineer nominated by the Sri Lanka Engineering Service. (SLES)
(d) One (01) representative from the Engineering Technicians nominated by the Tertiary and Vocational Education Commission (TVEC)

Chairman of the Council

One of the Chartered Engineers from among the appointed members to be the Chairman of the Council, appointed by the Minister

Powers and Functions of the Council

The Council shall be charged with the function of registering engineering practitioners holding such qualifications as set out in the Schedule A of the act, and also-

(a) accept, approve or reject any application submitted for registration.
(b) cancel any registration granted by the Council.
(c) keep, maintain and publish from time to

time the list of the engineering practitioners registered under this Act;
(d) hold inquires on any matter relating to the professional misconduct
(e) determine the remuneration payable to the staff of the Council
(f) make representations to the Government and relevant bodies on matters relating the Engineering Profession

Registration as Engineering Practitioners.
No engineering practitioner shall engage in the practice of engineering profession unless such engineering practitioner is registered under section 15 or 18 of the act:

SECTION 15:
(1) Any engineering practitioner who satisfies the respective qualifications and experience specified in the Schedule A hereto, may apply to be registered as an engineering practitioner
(2) Any engineering practitioner who has duly applied under subsection (1), shall be registered on the payment of the fee determined by the Council by rules made in that behalf.
(3) The Council shall not register any person as an engineering practitioner, other than Engineering Technicians, unless the application for registration has been authorized by the relevant professional body to which such person belongs. All applications should be forwarded through the respective Engineering Institutions Viz. IESL & IIESL.

Designations for Registered Members as authorized by ECSL

(a) a Chartered Engineer, the abbreviated designation - "CEng"
(b) an Associate Engineer, the abbreviated designation - "AEng"
(c) an Affiliate Engineer, the abbreviated designation - "AflEng"
(d) an Incorporated Engineer, the abbreviated designation -"IEng"
(e) An Engineering Diplomate, the abbreviated designation - "EngDip"
(f) an Engineering Technician, the abbreviated designation - "EngTec".

Registration of Foreign Engineers
A foreign engineering practitioners cannot be employed in Sri Lanka unless he has obtained a temporary registration for a period of four months upon payment of a prescribed fee. Such applications should be forwarded through the relevant Engineering Institution Viz.IESL & IIESL.

Registration of any others with local or foreign Diplomas and Degrees not specified in the act

Applications of holders of above certificates should be forwarded through relevant Engineering Institutions Viz. IESL & IIESL after obtaining membership in those institutions.

ECSL Success Story

IIESL made its first proposal for an Engineering Council to the government way back in 1995, when Hon.Bernard Soyza was the Minister of Science and Technology under the coalition government lead by the Hon. Prime Minister, Mrs Sirimavo Bandaranayake. The matter was debated thereafter at different levels for a long period of time due to the differences of opinion of the two Engineering Institutions, viz. IESL & IIESL.

This matter entered a new phase when Hon. Keheliya Rambukwella, took office in 2002 as the Minister of Science & Technology. The minister specifically wanted the two Engineering Institutions to come up with a joint proposal. As a result two powerful committees appointed by the two Institutions had a series of discussions for a period of nearly one year and prepared a comprehensive, very well balanced Joint Proposal. As a faction of members in the IESL vehemently opposed to this proposal the two institutions had to start the deliberations afresh. Thereafter, the two Institutions started working individually with the successive ministers, Hon. Tissa Vitharana, Hon. Rajitha Senarathne, Hon. Wimal Weerawansa and finally with Hon.Patali Champika Ranawaka.

At the request of Hon.Patali Champika Ranawaka the two Institutions once again sat together and drafted a joint proposal which got amended several times. Hon. P.Dayaratne's contributions made to settle the controversies arisen in the proposal is highly commendable.

The final proposal prepared, although not to the 100% satisfaction of both Institutions, was presented to the parliament by Hon. Patali Champika Ranawaka as a Private Member Proposal and the parliament unanimously passed it.

The salient points in the act are as follows:

(1) The Minister in charge of the Engineering Council is H.E.President

(2) Following Engineering Categories have been identified as eligible categories to practice under this act: (a) Chartered Engineers (b) Associate Engineers (c) Affiliate Engineers (d) Incorporated Engineers (e) Engineering Diplomates (f) Engineering Technicians - authorized by the relevant professional bodies to which such persons belong.

(3) Engineering Council comprises 3 Ex-Officio Members nominated by universities,
7 Chartered Engineers nominated by IESL, 4 Incorporated Engineers nominated by IIESL, 1 Chartered Engineer nominated by the SLES and 1 Person nominated by TVEC to represent Engineering Technician category.

(4) No Engineering Practitioner (local or foreign) shall engage in the practice of Engineering Profession in Sri Lanka unless registered as a member of the Council.

Both IIESL and IESL have nominated their members to the Engineering Council with the approval of H.E.President (the Minister in Charge).

The names of the IIESL Members in the Engineering Council are as follows:

- Eng. (Dr.) T.A.G.Gunasekara (Past President)
- Eng. Shantha Senarath (Past President)
- Eng. Pani Kavikeshawa (Past President)
- Eng. K.Ariyawansa (Past President)

The Council has had 2 informal meetings and 15 formal meetings and 2 workshops up to now. The first formal meeting of the ECSL was conducted on 10th August, 2018 under the Chairmanship of Eng (Prof.) S.B.S. Abayakoon.

During the past 14 months the council has been able to complete the following activities:

- Create a website for ECSL (www.ecsl.lk)
- Create two separate registers for the IESL and IIESL members who have already registered with the ECSL.
- Arrangements are being made to issue Certificates to the registered members.
- Create a Bank Account
- Designing a LOGO with Tag Line.
- Publish relevant gazette notices
- Publish in the National News Papers in all three languages (a) Formation of the ECSL (b) Invitation to register as Engineering Practitioners.
- Publish notices to recruit staff.
- Make arrangements to have the ECSL office at the Dept. of Irrigation Head Office Building temporarily.
- Called tenders to procure furniture for ECSL office.
- Had a meeting with department heads of prominent govt. Organizations such as Ceylon Electricity Board, National Water Supply & Drainage Board, Road Development Authority etc. etc. to inform them that all recruitments and promotions in future should be done in line with the ECSL act.
- Conclusion of Code of Ethics for Engineering Practitioners.
- Rules and Regulations and Competencies of different engineering categories are under preparation at present.
- Obtaining budget allocations from the government for ECSL activities. (Please note that ECSL has been operating on two loans received from IESL and IIESL, Rs. one million each, as the govt. funds were received only on 2nd August,2019).
- ECSL has identified that several categories

of engineering practitioners in Sri Lanka are unable to register with ECSL due to the fact that they are unable to get the membership of any of the two Engineering Institutions under their existing bylaws. ECSL will take appropriate action in the future to register these categories with the concurrence of the two institutions, as far as possible.

ENGINEERS DAY OF SRI LANKA

Plans are underway to have a grand Inauguration Ceremony of the ECSL on 17th September, 2019 with H.E. the President attending as the Chief Guest. Several Ministers and Secretaries of engineering related Ministries and all Past Presidents of the IESL and IIESL who were involved in the efforts of establishing the Engineering Council will be invited for this grand ceremony. This ceremony will be held at the Irrigation Head Office auditorium where the ECSL office is located. H.E. the President is also expected to ceremonially open the ECSL Office and declare September 17th as the ENGINEERS DAY OF SRI LANKA. Coincidently, September 17th is the birthday of late Eng. D.J. Wimalasurendra, the first engineer of Sri Lanka.

Formation of an Engineering Council for Sri Lanka is a significant breakthrough for the Engineering Profession in Sri Lanka as well as a turning point for the Institution of Incorporated Engineers, Sri Lanka (IIESL).

"

Engineering is the art of modelling materials we do not wholly understand, into shapes we cannot precisely analyse so as to withstand forces we cannot properly assess, in such a way that the public has no reason to suspect the extent of our ignorance.

Dr AR Dykes

"

Administration of Prime Cost Items in Construction Contracts

Trinie Anton Fernando

NDT (Civil Eng.), Bsc (Hons) in QS&CM, AMIESL

Associate Member of Institution of Incorporated Engineers Sri Lanka
Graduated as a Quantity Surveyor from Sheffield Hallam University-UK
Senior Quantity Surveyor for a Hotel Development Project in Ras Al Khaimah.

INTRODUCTION

Prime Cost (PC) rates are included in the Bill of Quantities (BoQ) very often. Prime Cost rate principal will give the contractors some relief when pricing the tender, when the material price fluctuation is not allowed in the construction contracts. Further, the project's client is also benefited from this principal and will have the opportunity to select the final material (mostly related to aesthetic values/ value engineering etc.) at the post contract stage without delaying the tender process, until the employer and engineer finalized the exact specifications. PC rates are mostly involved in final fixings like floor-wall-ceiling finishes, bathroom accessories, light fittings, etc. But how to administrate the Prime Cost rates in the post contract stage is rarely specified in the contract documents. Therefore, this article focuses on how to administer the PC rate involved items in post contract stage and trying to find out the most neutral and fair method in terms of risk sharing.

PRIME COST RATE DEFINITION

One of Royal Institution of Chartered Surveyors' (RICS) publications, New Rule of Measurement 02 defined the Prime cost sum as "sum of money included in a unit rate to be expended on materials or goods from suppliers. It is supply only rate for materials or goods where the precise quality of those materials and goods are unknown. PC Sums exclude all costs associated with fixing or installation, all ancillary and sundry materials and goods required for the fixing or installation of the materials or goods, subcontractor's design fees, subcontractor's overhead and profit, main contractor's design fees and overheads and profit". But the RICS's previous method of measurement publication, Principal of Measurement (International) (POMI) does not define the PC rates. On the same token, the Civil Engineering Standard Method of Measurements (CESMM 03 and CESMM 04), published by Institution of Civil Engineers (ICE) had defined the Prime Cost items under Section 05.

Prime Cost rates used majorly in two ways in the contracts documents,

- "PC rate for supply" - In this case, PC rate included in the contract (either BOQ or Drawing itself) is an estimated/assumed price for the major (prime) material component of that work item which will be selected later by the employer at the execution stage (employer controls the final material selection).
- "PC rate for supply and install" - In this scenario, PC rate included in the contract (either BOQ or drawing itself) which is an estimated/assumed price for the supply and installation of that work item. (this scenario will not be further discussed in this context and this is more like Provisional Sum principal)

PRIME COST RATE ADJUSTMENT PROCEDURE

When stating the PC rate adjustment procedure in the contract documents, following aspects shall be addressed in order for the contractor to price effectively (with minimum risk premium) and to evaluate at the execution stage by the engineer without disputes:

01. Definition of the PC rate.
02. How to evaluate PC rate adjustment,
- How to reach adjusted unit rate.
- How to reach the final "PC rate adjustment" (BOQ quantity or contract drawing quantity to be used?)
03. Who bears the responsibilities when procuring material and the responsibility matrix?

The above aspects were further elaborated in the below table and some samples were extracted from the contract documents which came across by this author.

Concern	Sample 1	Sample 2	Sample 3	Sample 4
Definition	PC rate shall be deemed to include delivery to site and excludes MC OH&P. Tenderer shall add to the PC rate, the amounts required to cover for profit and overheads, unloading from delivery vehicle to store, loading and transporing from site store, hoisting and lowering, fixing, protecting,.....wastage and all other allowances required to fully fix, install or place the fixed and will not be adjusted against final value of supply rates adopted	PC rate shall be deemed to include delivery to site, excludes MC OH&P. Tenderer shall add to the PC rate, the amounts required to cover for profit and overheads, unloading from delivery vehicle to store, loading and transporing from site store, hoisting and lowering, fixing, protecting,.....wastage	Tenderer shall include in the bill rates for all the cost associate with the purchasing of material, obtaining quotation, samples, taking delivery, unloading, storing, replacing goods damaged, broken, stolen, waste, fixing in position and all OH&P.	Tenderer shall include in the bill rates for all the cost associate with the purchasing of material, obtaining quotation, samples, taking delivery, unloading, storing, replacing goods damaged, broken, stolen, waste, fixing in position and all OH&P.
Evaluation- (how to reach the adjusted rate)	Delivered to site cost plus OH&P shall be inserted in to Contractor's rate following the deduction of the original PC rate.		The quantity in BOQ will not be re-measured but remain the same as BOQ. PC rate replaced with actual rate finalized with NC. Appropriate adjustments to mark-up only. Then new rate multiplied by the BOQ quantity will be the Final amount to be paid to Contractor.	Contract rate shall be adjusted by the difference between the PC rate and the actual cost (including delivery to site and wastage) plus the Contractor's OH&P applied to such difference. (any other material,plant or work element together with OH&P applicable therto shall remain unchanged). BOQ qty multiplied by finalised rate shall be considered by making necessary adjustments to prime cost only
Evaluation-(which quantity to be considered)	not mentioned		BOQ qty	
Evaluation-how to arrive final amount or adjustment	not mentioned	not mentioned	Mentioned as, New rate multiplied by BOQ qty will be the final amount to be paid to Contractor	Mentioned somehow
Procurement (who will procure)	yes	yes	no	no

Table 01 - Few sample descriptions/wordings regarding the PC rates in the contract documents

As per above Table 01 demonstration, each and every sample had not addressed all the aspects. Accordingly, disputes may arise in post contract stage where the parties may have different opinions regarding the administration of each aspect.

This article's focus will narrow down to the aspect No.: 02 (evaluation criteria).

PRIME COST RATE ADJUSTMENT CALCULATIONS

Assume the BoQ provision as follows, for supply and installation of ceramic tiles (PC rate).

For the ease of explanation, it was considered that the BoQ quantity is equal to actual contract drawing quantity and assume "PC rate" is defined as invoice rate of material delivered to site where the contractor to unload, store, protect, handle, install, clean and handover. Wastage, overhead and profit provisions are to be adjusted (which are affected by final selected material rates). Installation and other miscellaneous expenses will not be adjusted since those are not affected by final selected material rate.

Now at the execution stage the employer selected the material with a delivered to site rate of 130 Dhs/m2. Therefore, the PC rate adjustment will be as follows,

Selected Ceramic tiles = 130.00
Wastage (5%) = 6.50
Installation and miscellaneous = 45.00
Subtotal = 181.50
OH&P (20%) = 36.30
Adjusted Tender rate (or New rate) = 217.80
Tender rate = 180.00
Difference between Adjusted rate and Tender rate (unit rate adjustment) = 37.80/m2

Therefore, the final amount adjustment will be,

- Unit rate adjustment x contract drawing quantity = Dhs. 37.80 / m2 x 1,000 m2 = Dhs. 37,800.00

  If the contract drawing quantity is different than BOQ, say 1,200m2 in contract drawing. Then the final amount adjustment will be,
- Unit rate adjustment x contract drawing quantity = Dhs. 37.80 / m2 x 1,200 m2 = Dhs. 45,360.00

Quantities in Prime Cost Adjustments

It is known fact that the BoQ quantities always do not reflect with the actual tender drawings.

Therefore, while tendering in Lump Sum Contracts, the contractor/tenderer assumes the quantity risk and price this risk within his tender. There are three types of lump sum contracts:

Type 1 – Schedule of rates (plus drawings and specifications) and the contractor consider genuine rates.

Type 2 - Employer provide BoQ with quantities and the contractor is allowed to adjust any errors in the quantities. (Contractor will adjust the quantity and consider a genuine rate, if he found BoQ quantities not correct)

Type 3 – Bill of Quantities (plus drawings and specifications) and the contractor is not allowed to adjust any errors in the quantity. (if the contractor found BoQ quantity is different to actual contract drawing quantity, he has to use an "adjusted rate" in order to reach the actual amount to accomplish the contract scope without losses).

Item	Description	Qty	Unit	Rate	Amount	Contractor's Rate built up
A	Supply and install ceramic tile (PC supply rate, 100 Dhs/m2)	1,000	m2		180,000.00	Ceramic tiles = 100.00 Wastage (5%) = 5.00 Installation and miscellaneous = 45.00 Subtotal = 150.00 OH&P (20%) = 30.00 Tender rate = 180.00

Item	Description	Qty	Unit	Rate	Amount	Remark
	Employer provided BOQ					
A	Supply and install ceramic tile A	1,000 (wrong qty)	m2	216.00 (adjusted rate)	216,000.00	Contractor puts 216,000/1000 = 216 Dhs/m2, an adjusted rate in order to reach 216,000 Dhs final amount.
	Contractor's actual					
A	Supply and install ceramic tile A	1,200 (actual qty)	m2	180.00 (genuine rate)	216,000.00	1,200 actual Construction drawing qty, 180 Dhs/m2 genuine market rate inc. expected OHP.

Prime costs rate's final adjustments are associated with above type 01 and type 02. Lump sum contracts are rather straightforward, but it is worth to further discuss these adjustments on above type 03 lump sum contracts.

Following possible scenarios (priced examples) were considered in this respect and the definitions used to clarify the calculations should also be noted.

- Selected Rate - Supply rate of final selected material
- PC Rate - Price included in the BoQ description as PC rate
- BOQ Rate - Total rate put in the BoQ
- BOQ Quantity - Quantity in the BoQ
- Contract Quantity - Quantity in the tender drawing
- Genuine Rate - Actual market (workable) rate including contractor's overhead & profit
- Adjusted Rate - A bogus rate put by contractor in order to achieve the workable total amount (Adjusting the quantity errors between BoQ and tender drawing not allowed)
- Final Account - Final amount received from employer
- Actual Expenses - Amount spend by contractor including overhead & profit.
- Gain (positive) - Amount gain additionally by the
- Pain (negative) - Amount lost by the contractor

Selected Rate higher than PC Rate	BOQ Qty is lesser than Contract Qty	Contractor put Genuine Rate	**Scenario - S1**
		Contractor put Adjusted Rate	**Scenario - S2**
	BOQ Qty is more than Contract Qty	Contractor put Genuine Rate	**Scenario - S3**
		Contractor put Adjusted Rate	**Scenario - S4**
Selected rate lesser than PC Rate	BOQ Qty is lesser than Contract Qty	Contractor put Genuine Rate	**Scenario - S5**
		Contractor put Adjusted Rate	**Scenario - S6**
	BOQ Qty is more than Contract Qty	Contractor put Genuine Rate	**Scenario - S7**
		Contractor put Adjusted Rate	**Scenario - S8**

The detailed calculations associated with above scenarios as follows,

Scenario - S1			
BOQ		Final	
BOQ Qty (not actual)	1000	1200	Contract Qty
BOQ Rate (Genuine Rate)	180	130	Selected Rate
PC rate	100	5%	Wastage
Amount	180,000	20%	OHP
Genuine buildup			
PC rate	100		
Wastage	5%		
Installation & misc. material	45		
OHP	20%		
Genuine Rate	180		
Evaluation			
Unit rate adjustment			
Selected Rate			130.00
PC rate			100.00
Difference			30.00
Wastage	5%		1.50
			31.50
add OH&P	20%		6.30
Unit rate adjustment			37.80
If unit rate adjustment is zero (PC rate = Selected Rate)			
	Qty	Rate	Amount
A) Final Account			
BOQ	1,000	180.00	180,000
PC rate adjustment			0
			180,000
B) Actual Expenses			
Contract Qty x Genuine Rate	1,200	180.00	216,000
			216,000
Gain or Pain (A-B)			-36,000
PC rate is adjusted to Contract Qty			
	Qty	Rate	Amount
A) Final Account			
BOQ	1,000	180.00	180,000
PC rate adjustment	1,200	37.80	45,360
			225,360
B) Actual Expenses			
Contract Qty x Genuine Rate	1,200	217.80	261,360
			261,360
Gain or Pain (A-B)			-36,000
If PC rate is adjusted to BOQ Qty			
	Qty	Rate	Amount
A) Final Account			
BOQ	1,000	180.00	180,000
PC rate adjustment	1,000	37.80	37,800
			217,800
B) Actual Expenses			
Contract Qty x Genuine Rate	1,200	217.80	261,360
			261,360
Gain or Pain (A-B)			-43,560

Table 02 – Calculations for scenario 01

Scenario - S2			
BOQ		Final	
BOQ Qty (not actual)	1000	1200	Contract Qty
BOQ Rate (Adjusted Rate)	216.00	130	Selected Rate
PC rate	100	5%	Wastage
Amount	216,000	20%	OHP
Genuine buildup			
PC rate	100		
Wastage	5%		
Installation & misc. material	45		
OHP	20%		
Genuine Rate	180		
Evaluation			
Unit rate adjustment			
Selected Rate			130.00
PC rate			100.00
Difference			30.00
Wastage	5%		1.50
			31.50
add OH&P	20%		6.30
Unit rate adjustment			37.80
If unit rate adjustment is zero (PC rate = Selected Rate)			
	Qty	Rate	Amount
A) Final Account			
BOQ	1000	216.00	216,000
PC rate adjustment			0
			216,000
B) Actual Expenses			
Contract Qty x Genuine Rate	1200	180.00	216,000
			216,000
Gain or Pain (A-B)			0
PC rate is adjusted to Contract Qty			
	Qty	Rate	Amount
A) Final Account			
BOQ	1000	216.00	216,000
PC rate adjustment	1200	37.80	45,360
			261,360
B) Actual Expenses			
Contract Qty x Genuine Rate	1200	217.80	261,360
			261,360
Gain or Pain (A-B)			0
If PC rate is adjusted to BOQ Qty			
	Qty	Rate	Amount
A) Final Account			
BOQ	1000	216.00	216,000
PC rate adjustment	1000	37.80	37,800
			253,800
B) Actual Expenses			
Contract Qty x Genuine Rate	1200	217.80	261,360
			261,360
Gain or Pain (A-B)			-7,560

Table 03 – Calculations for scenario 02

Scenario - S3			
BOQ		Final	
BOQ Qty (not actual)	1000	800	Contract Qty
BOQ Rate (Genuine Rate)	180.00	130	Selected Rate
PC rate	100	5%	Wastage
Amount	180,000	20%	OHP
Genuine buildup			
PC rate	100		
Wastage	5%		
Installation & misc. material	45		
OHP	20%		
Genuine Rate	180		
Evaluation			
Unit rate adjustment			
Selected Rate			130.00
PC rate			100.00
Difference			30.00
Wastage	5%		1.50
			31.50
add OH&P	20%		6.30
Unit rate adjustment			37.80
If unit rate adjustment is zero (PC rate = Selected Rate)			
	Qty	Rate	Amount
A) Final Account			
BOQ	1,000	180.00	180,000
PC rate adjustment			0
			180,000
B) Actual Expenses			
Contract Qty x Genuine Rate	800	180.00	144,000
			144,000
Gain or Pain (A-B)			36,000
PC rate is adjusted to Contract Qty			
	Qty	Rate	Amount
A) Final Account			
BOQ	1,000	180.00	180,000
PC rate adjustment	800	37.80	30,240
			210,240
B) Actual Expenses			
Contract Qty x Genuine Rate	800	217.80	174,240
			174,240
Gain or Pain (A-B)			36,000
If PC rate is adjusted to BOQ Qty			
	Qty	Rate	Amount
A) Final Account			
BOQ	1,000	180.00	180,000
PC rate adjustment	1,000	37.80	37,800
			217,800
B) Actual Expenses			
Contract Qty x Genuine Rate	800	217.80	174,240
			174,240
Gain or Pain (A-B)			43,560

Table 04 – Calculations for scenario 03

Scenario - S4			
BOQ		Final	
BOQ Qty (not actual)	1000	800	Contract Qty
BOQ Rate (Adjusted Rate)	144.00	130	Selected Rate
PC rate	100	5%	Wastage
Amount	144,000	20%	OHP
Genuine buildup			
PC rate	100		
Wastage	5%		
Installation & misc. material	45		
OHP	20%		
Genuine Rate	180		
Evaluation			
Unit rate adjustment			
Selected Rate			130.00
PC rate			100.00
Difference			30.00
Wastage	5%		1.50
			31.50
add OH&P	20%		6.30
Unit rate adjustment			37.80
If unit rate adjustment is zero (PC rate = Selected Rate)			
	Qty	Rate	Amount
A) Final Account			
BOQ	1,000	144.00	144,000
PC rate adjustment			0
			144,000
B) Actual Expenses			
Contract Qty x Genuine Rate	800	180.00	144,000
			144,000
Gain or Pain (A-B)			0
PC rate is adjusted to Contract Qty			
	Qty	Rate	Amount
A) Final Account			
BOQ	1,000	144.00	144,000
PC rate adjustment	800	37.80	30,240
			174,240
B) Actual Expenses			
Contract Qty x Genuine Rate	800	217.80	174,240
			174,240
Gain or Pain (A-B)			0
If PC rate is adjusted to BOQ Qty			
	Qty	Rate	Amount
A) Final Account			
BOQ	1,000	144.00	144,000
PC rate adjustment	1,000	37.80	37,800
			181,800
B) Actual Expenses			
Contract Qty x Genuine Rate	800	217.80	174,240
			174,240
Gain or Pain (A-B)			7,560

Table 05 – Calculations for scenario 04

Scenario - S5			
BOQ		Final	
BOQ Qty (not actual)	1000	1200	Contract Qty
BOQ Rate (Genuine Rate)	180	70	Selected Rate
PC rate	100	5%	Wastage
Amount	180,000	20%	OHP
Genuine buildup			
PC rate	100		
Wastage	5%		
Installation & misc. material	45		
OHP	20%		
Genuine Rate	180		
Evaluation			
Unit rate adjustment			
Selected Rate			70.00
PC rate			100.00
Difference			-30.00
Wastage	5%		-1.50
			-31.50
add OH&P	20%		-6.30
Unit rate adjustment			-37.80
If unit rate adjustment is zero (PC rate = Selected Rate)			
	Qty	Rate	Amount
A) Final Account			
BOQ	1000	180.00	180,000
PC rate adjustment			0
			180,000
B) Actual Expenses			
Contract Qty x Genuine Rate	1200	180.00	216,000
			216,000
Gain or Pain (A-B)			-36,000
PC rate is adjusted to Contract Qty			
	Qty	Rate	Amount
A) Final Account			
BOQ	1000	180.00	180,000
PC rate adjustment	1200	-37.80	-45,360
			134,640
B) Actual Expenses			
Contract Qty x Genuine Rate	1200	142.20	170,640
			170,640
Gain or Pain (A-B)			-36,000
If PC rate is adjusted to BOQ Qty			
	Qty	*Rate*	*Amount*
A) Final Account			
BOQ	*1000*	*180.00*	180,000
PC rate adjustment	*1000*	*-37.80*	-37,800
			142,200
B) Actual Expenses			
Contract Qty x Genuine Rate	*1200*	*142.20*	170,640
			170,640
Gain or Pain (A-B)			-28,440

Table 06 – Calculations for scenario 05

Scenario - S6			
BOQ		Final	
BOQ Qty (not actual)	1000	1200	Contract Qty
BOQ Rate (Adjusted Rate)	216	70	Selected Rate
PC rate	100	5%	Wastage
Amount	216,000	20%	OHP
Genuine buildup			
PC rate	100		
Wastage	5%		
Installation & misc. material	45		
OHP	20%		
Genuine Rate	180		
Evaluation			
Unit rate adjustment			
Selected Rate			70.00
PC rate			100.00
Difference			-30.00
Wastage	5%		-1.50
			-31.50
add OH&P	20%		-6.30
Unit rate adjustment			-37.80
If unit rate adjustment is zero (PC rate = Selected Rate)			
	Qty	Rate	Amount
A) Final Account			
BOQ	1,000	216.00	216,000
PC rate adjustment			0
			216,000
B) Actual Expenses			
Contract Qty x Genuine Rate	1,200	180.00	216,000
			216,000
Gain or Pain (A-B)			0
PC rate is adjusted to Contract Qty			
	Qty	Rate	Amount
A) Final Account			
BOQ	1,000	216.00	216,000
PC rate adjustment	1,200	-37.80	-45,360
			170,640
B) Actual Expenses			
Contract Qty x Genuine Rate	1,200	142.20	170,640
			170,640
Gain or Pain (A-B)			0
If PC rate is adjusted to BOQ Qty			
	Qty	*Rate*	*Amount*
A) Final Account			
BOQ	*1,000*	*216.00*	216,000
PC rate adjustment	*1,000*	*-37.80*	-37,800
			178,200
B) Actual Expenses			
Contract Qty x Genuine Rate	*1200*	*142.20*	170,640
			170,640
Gain or Pain (A-B)			7,560

Table 07 – Calculations for scenario 06

Scenario - S7			
BOQ			Final
BOQ Qty (not actual)	1000	800	Contract Qty
BOQ Rate (Genuine Rate)	180	70	Selected Rate
PC rate	100	5%	Wastage
Amount	180,000	20%	OHP
Genuine buildup			
PC rate	100		
Wastage	5%		
Installation & misc. material	45		
OHP	20%		
Genuine Rate	180		
Evaluation			
Unit rate adjustment			
Selected Rate			70.00
PC rate			100.00
Difference			-30.00
Wastage	5%		-1.50
			-31.50
add OH&P	20%		-6.30
Unit rate adjustment			-37.80
If unit rate adjustment is zero (PC rate = Selected Rate)			
	Qty	Rate	Amount
A) Final Account			
BOQ	1,000	180.00	180,000
PC rate adjustment			0
			180,000
B) Actual Expenses			
Contract Qty x Genuine Rate	800	180.00	144,000
			144,000
Gain or Pain (A-B)			36,000
PC rate is adjusted to Contract Qty			
	Qty	Rate	Amount
A) Final Account			
BOQ	1,000	180.00	180,000
PC rate adjustment	800	-37.80	-30,240
			149,760
B) Actual Expenses			
Contract Qty x Genuine Rate	800	142.20	113,760
			113,760
Gain or Pain (A-B)			36,000
If PC rate is adjusted to BOQ Qty			
	Qty	*Rate*	*Amount*
A) Final Account			
BOQ	*1,000*	*180.00*	180,000
PC rate adjustment	*1,000*	*-37.80*	-37,800
			142,200
B) Actual Expenses			
Contract Qty x Genuine Rate	*800*	*142.20*	113,760
			113,760
Gain or Pain (A-B)			28,440

Table 08 – Calculations for scenario 07

Scenario - S8			
BOQ			Final
BOQ Qty (not actual)	1000	800	Contract Qty
BOQ Rate (Adjusted Rate)	144	70	Selected Rate
PC rate	100	5%	Wastage
Amount	144,000	20%	OHP
Genuine buildup			
PC rate	100		
Wastage	5%		
Installation & misc. material	45		
OHP	20%		
Genuine Rate	180		
Evaluation			
Unit rate adjustment			
Selected Rate			70.00
PC rate			100.00
Difference			-30.00
Wastage	5%		-1.50
			-31.50
add OH&P	20%		-6.30
Unit rate adjustment			-37.80
If unit rate adjustment is zero (PC rate = Selected Rate)			
	Qty	Rate	Amount
A) Final Account			
BOQ	1,000	144.00	144,000
PC rate adjustment			0
			144,000
B) Actual Expenses			
Contract Qty x Genuine Rate	800	180.00	144,000
			144,000
Gain or Pain (A-B)			0
PC rate is adjusted to Contract Qty			
	Qty	Rate	Amount
A) Final Account			
BOQ	1,000	144.00	144,000
PC rate adjustment	800	-37.80	-30,240
			113,760
B) Actual Expenses			
Contract Qty x Genuine Rate	800	142.20	113,760
			113,760
Gain or Pain (A-B)			0
If PC rate is adjusted to BOQ Qty			
	Qty	*Rate*	*Amount*
A) Final Account			
BOQ	*1,000*	*144.00*	144,000
PC rate adjustment	*1,000*	*-37.80*	-37,800
			106,200
B) Actual Expenses			
Contract Qty x Genuine Rate	*800*	*142.20*	113,760
			113,760
Gain or Pain (A-B)			-7,560

Table 09 – Calculations for scenario 08

SUMMARY

The summary of the outcome of above tables (table 02 to table 09) as follows,

Scenario	Column A	Column B	Column C
	Adjustment (Nil; PC rate = Selected rate)	Adjustment to Contract Drawings Quantity	Adjustment to BoQ Quantity
Scenario 01	(36,000.00)	(36,000.00)	(43,500.00)
Scenario 02	0.00	0.00	(7,560.00)
Scenario 03	36,000.00	36,000.00	43,560.00
Scenario 04	0.00	0.00	7,560.00
Scenario 05	(36,000.00)	(36,000.00)	(28,440.00)
Scenario 06	0.00	0.00	7,560.00
Scenario 07	36,000.00	36,000.00	28,440.00
Scenario 08	0.00	0.00	(7,560.00)

Table 10 – Summary of possible scenarios

Most of the time in the construction contracts, the PC rate in the BoQ and actual rate later on the execution will not be the same. Therefore, the figures in the above column "A" can be ignored and this discussion can be diverted towards the outcome on column "B" and column "C". There will be either Gain or Pain towards the contractor throughout the column "C" but column "B" figures suggested a neutral and fair position towards the contractor as well as to the employer. Whenever the Contractor had used "Adjusted rate", which is the correct way of pricing of above Type 03 lump sum contract, it is observed that no gain or pain to the contractor (Scenarios 02,04,06,08). Therefore, it is always best option to use contract drawing quantity in arriving PC rate adjustment in terms of risk sharing among the employer and the contractor.

CONCLUSION

Prime Cost in the construction contracts gives somewhat relief to the contractor as well to the employer but it is very essential that the tender documents to specify the procedures of PC rate operation. If not the parties will come with different arguments and opinions and will lead imbalance to the commercial agreements. It shall be discussed in the pricing preambles and if possible with some sample calculations.

Further, above demonstrations had justified the importance of considering the contract drawing quantities for Prime Cost adjustments and such an approach will be a risk sharing among the employer and the contractor. The author wishes to suggest further discussions on this subject matter such as variations related to prime cost items, prime cost items and FIDIC 1987 Sub-clause 52.3-adjustments..etc..

REFERENCES

- Continues Professional Development (CPD) session carried out by Prof. Indrawansa Samaratunga on Tender Documents, Provisional Sums, PC Rates and Contract Administration,
- Continues Professional Development (CPD) session carried out by Mr. Sivakaran Kanagaratnam on Administration of Provisional Sum / Prime Cost Sum and PC Rates.

Building Information Modeling (BIM) in Construction Industry

Eng. Ranil Wijesingha

NDT (Civil Eng.), MSc (CPM), MAIQS, MIIESL

Graduated from Heriot Watt University, MSc in Construction Project management
Senior Quantity Surveyor in a leading developer

INTRODUCTION

BIM is the current star player in the construction industry. Despite this technology has been around for about a decade, a lot of talks has been created about BIM in the recent years. What is BIM really? It is the process spanning the generation and management of the physical and functional information of a project. The output of the process is what we refer to as BIM or building information models which are ultimately digital files that describe every aspect of the project and support decision-making throughout a project cycle.

BIM can support to improve various types of business practices in the construction industry. Architecture, engineering, construction (AEC) and facility management sectors can gain their benefits in lifecycle of the project. Benefits are generally categorized as pre construction benefits, design benefits, construction benefits, fabrication benefits and post construction benefits (Eastman et. al., 2011).

BUILDING INFORMATION MODELLING IN CONSTRUCTION INDUSTRY

Recently the construction industry has received wide spread attention for Building Information Modelling (BIM) together with the technological information development in the construction industry. The BIM technology can be used in construction of digital buildings by way of virtual models. These models are supported in every design phase, providing accurate analysis and control very different from traditional manual processes. Completed computer generated models contain precise geometry and information which is highly supportive for procurement activities, construction and fabrication throughout the project's design, construction and maintenance periods.

Hardin (2009) explains BIM as a software and process which can improve the design and construction processes with all members engaged in a collaborative working environment. Designers use BIM to quickly separate virtual perspective view and digital animation to a better communication process with project owner or government bodies. Engineers use BIM to apply their structural, electrical, mechanical designs, etc. and evaluate how the service systems will perform in accordance with their requirements.

BIM applications are mainly used for visualization, drawing production, fabrication, forensic analysis, code reviews, cost estimating, space planning and facilities management in building lifecycle (Azhar, Hein and Sketo, 2008). In addition to that each and every activity of the project can be successfully integrated with BIM and can be used by owners, architects, engineers, facility managers, contractors, subcontractors, fabricators and suppliers (Eastman et. al. 2011).

The BIM benefits are divided into quantitative and qualitative benefits according to the type of objectives. Quantitative benefits are numerically

measurable benefits (resulting the measurable quantity) and qualitative benefits are disciplines or behavioural benefits (Deutsch, 2011).

Alliance for Construction Excellence (2008) attributed the main benefit of utilizing BIM influence in the design and construction phase. According to Eastman et. al. (2011) BIM benefits are identified with several sections which are pre construction benefits to the owner, design benefits, construction and fabrication benefits and post construction benefits. These benefits are explored further more in detail as below.

Pre-construction benefits:
- Feasibility, concept and design benefits
- Increase in building quality and performance
- Intergraded project delivery collaboration

Design benefits:
- More accurate and early visualization of the design
- Earlier collaboration platform of multiple design disciplines
- Easy verification and corrections of design intent
- Cost estimation is extracted during the design stage
- Improved energy efficiency and sustainability

Construction and fabrication benefits:
- Design model is used to fabricate components
- Identification of design errors before construction
- Design and construction planning synchronization
- Lean construction technologies application

Post construction benefits:
- Handover facility management information and improve commissioning
- Improve the facilities management and operation

BIM MODEL DEVELOPMENT

Model Development Methodology

Model development level is associated with selected model element breakdown structure and model's needs. Working group can gain benefits from the following through each element and visualization of the element (The Computer Integrated Construction Research Program, 2012). Model development is divided into different categories and level of development (LOD) for BIM model components (State Of Ohio BIM Protocol, 2010).

Model Development Categories

Model categories are established with a minimum level of BIM model development for each project. The State of Ohio BIM Protocol (2010) categorized four model development categories, I, II, III and IV, described as follows:

Category I: This model supports project planning, volume illustration and site positioning.

Category II: This model reflects an increased level of development, involving supported documentation, clash detection and coordination, system review and as built formats.

Category III: This model incorporates all benefits and model requirements. In addition, it contains additional details for occupancy and facility management of the building.

Category IV: In addition to incorporating the benefits of Category III above, further highly detailed logistical, estimation efforts and scheduling are also included for development of this model.

Level of Development

Level of development (LOD) is established with model content criteria and described in five specific development levels, as shown on figure 1.0 (AIA document E202, 2008, The Computer Integrated Construction Research Program, 2010, State of Ohio BIM Protocol, 2010)

Figure 1.0: Level of development

Level of Development	Description
LOD 100 Schematic Design Model	Overall building massing indicative of area, height, volume, location, and orientation may be modeled in three dimensions or represented by other data.
LOD 200 Design Development Model	Model Elements are modeled as generalized systems or assemblies with approximate quantities, size, shape, location, and orientation. Non-geometric information may also be attached to Model Elements
LOD 300 Construction Documentation Model	Model Elements are modeled as specific assemblies accurate in terms of quantity, size, shape, location, and orientation. Non-geometric information may also be attached to the Model Elements.
LOD 400 Construction Model	Model Elements are modeled as specific assemblies that are accurate in terms of size, shape, location, quantity, and orientation with complete fabrication, assembly, and detailing information. Non-geometric information may also be attached to Model Elements.
LOD 500 Record Model	Model Elements are modeled as constructed assemblies actual and accurate in terms of size, shape, location, quantity, and orientation. Non-geometric information may also be attached to modeled elements.

(Source: The Computer Integrated Construction Research Program, 2012)

BIM IN PROJECT EXECUTION

The Project Execution Process

The project execution process is defined after BIM uses are identified. According to the goals and uses of BIM, the project team can be developed during the implementation process throughout the project life cycle. This execution process accomplishes well developed processes, defining information exchange within multiple participating disciplines. The process maps were developed to portray information deliverables to multiple parties utilizing BIM. The process maps are divided into two stages, BIM 'Overview Map' and 'Detailed BIM Use Process Map' for clear identification and performance implementation.

BIM OVERVIEW MAPPING PROCEDURE

BIM overview mapping procedure consists with potential BIM users, project sequences, and information exchanges. Aouad et. al. (1998) posited process mapping procedure supports and encourages integration and better coordination between various disciplines within a construction project. In the first stage, potential BIM uses are identified and listed according to the priority level. Once the team has identified BIM users, process can be mapped by adding each use or process in the map. In addition, it's important to understand BIM uses in several process locations often connect and influence the project life cycle (The Computer Integrated Construction Research Program, 2010).

After the establishment of BIM process by project team, deliverables have to be co-ordinated with the project sequence, throughout the project. In this stage, the main focus will be on the BIM users within the planning, designing, construction and operation phases to implement the process team which will include a BIM deliverable schedule aligned with BIM disciplines.

In the next stage, the project team will identify the responsible parties for each process. The most important aspect of this stage is the process of team member selection to successful completion the task. Information exchange is the most critical in this process. It is most important to reflect a clear process flow from one party to another.

INFORMATION EXCHANGE METHODS

BIM project information exchange methods are most important for project implementation. To define the information exchange between each party, the project team needs to understand that the required information needs to be delivered to each BIM user. It is important to define which model components are necessary for implementation.

REQUIRED INFORMATION FOR EACH EXCHANGE ACTIVITY

Basically each information exchange, model receiver and model file type need to be included for better communication. Model receiver's identification is given for the identification of the receiver and the information. Every project team member has to update information inputs and outputs for future BIM users. Generally, output exchanges shall be by the project model designer or the architect.

The model file type is explained within specific software applications to develop the model. It further highlights the interoperability between exchanges between each party.

Information levels are highly important for BIM implementation. This information can be structured and the project team has to regularly consider input versus output in the information exchanges. Once the information requirements of processes are defined, it is necessary to discuss information inputs and outputs requested. If any discrepancy of the information exchange is identified by the project team, corrective actions have to be taken to overcome the inadequacy.

STRATEGIES FOR SUCCESSFUL BIM IMPLEMENTATION PROCEDURES

BIM Training

Most BIM implementation trainings are conducted relating to a specific software system or process. Training strategies are established to include the following:

- Objective of the training
- Who needs what training
- What training methods are most suitable

Firstly, necessary training subjects are listed to identify the most required software system or process. Secondly, identify who needs software training and training on BIM processes. Generally upper management needs to only understand the process of BIM. Middle management needs extensive education and induction training on different software packages. The implementers need extensive process and software training to obtain the maximum use of the system. However, the organization has to identify the specific requirements to use the BIM designed for them to manage within their budgets. Often software vendors train the BIM users based on the training needs which vary and depend on the organisation size and the scope of BIM adoption (The Computer Integrated Construction Research Program, 2012).

BIM training is usually conducted by IT specialists on system configuration training, which involves hardware selection, network access, server setup, setup of libraries and plotting. In addition, company specific system requirements can be addressed during this training. BIM training for staff is focused on modelling and drawing production, including model object libraries.

Hardin (2009) suggested BIM manager identification is an important factor in successful BIM implementation. In addition, BIM managers are trained on BIM software which the company would use to manage their systems. The company has to train the BIM manager to manage their system and continuously update his with the

specific updates of the system and new methods, new technologies and resource handling.

Deutsch (2011) attributed the training strategy as most critical for professional BIM implementation development and follow up trainings help BIM's successful adoption. He suggested various factors to make BIM training successful, such as:

1) Create a feedback loop to improve performance
2) Senior management support before, during and after training
3) Change the attitude of trainee explaining willingness, important openness and curiosity
4) Explaining the big picture how training is fit into goals of organization and how learning objectives are aligned with organization objectives
5) Trainer presentation consists with knowledgeable, well organized, most important, excited about BIM process
6) Quality of learning materials
7) Arrange suitable environment to conduct the training

Factors leading to failure of BIM training:

1) Not understanding the training due to poor trainee selection
2) Not being prepared, motivated and ready to learn
3) Falling behind the allocated time for behavioral change
4) Unable to set expectation and compare results
5) Misidentifying the right people to train
6) Failing to create targeted
7) Not undertaking a need's assessment.

CONCLUSION

Building Information Modelling can provide the industry with consequential opportunities to raise the quality of the industry to a much higher and sophisticated level. Having the capacity to simulate a range of data options with real-time cost advice and carry on throughout the detailed design, construction and operational stages. BIM will surely place construction practices at a higher value.

REFERENCES

- Alliance for Construction Excellence (2008) Building Information Modelling. An Introduction and Best Methods Approach [online] available from <http://www.ace4aec.com/pdf/Introduction%20&%20Best%20Methods%20Manual%202008.pdf> [21 September 2012]
- Aouad, G., Hinks, J., Cooper, R., Sheath, D.M., Kagioglou, M. and Sexton, M. (1998) 'An IT map for generic design and construction process protocol.'
- Azhar, S., Hein, M. and Sketo, B. (2008) 'Building Information Modelling (BIM): Benefits, Risks and Challenges.'
- Deutsch, R (2011) BIM and Integrated Design. New Jersey: John Wiley and Sons.
- Eastman, C., Teicholz, P., Sacks, R. and Liston, K. (2011) 2nd edn. BIM Handbook. New Jersey: John Wiley and Sons.
- Hardin, B. (2009) BIM and Construction Management. Indiana: Wiley Publishing.
- Smith, D.K. and Tardif, M. (2009) Building Information Modelling. New Jersey: John Wiley and Sons.
- State Architect's Office (2010) State of Ohio Building Information Modelling (BIM) Protocol [online] available from <http://www.buildingsmartalliance.org/client/assets/files/bsa/state_of_ohio_bim_requirements.pdf>
- The Computer Integrated Construction Research Program at The Pennsylvania State University (2010) BIM Project Execution Planning Guide. US: The Pennsylvania State University.

How the Value Engineering Process should Structure to Achieve the Success

Samantha Bandara

NDT(Civil Eng.), MSc (CPM), MAIQS

Contract Administrator graduated from Heriot Watt University –Dubai Campus - 2013
Member of Australian Institute of Quantity Surveyors
Senior Quantity Surveyor, M/s.Jouzy Consulting Engineers

INTRODUCTION

Value Engineering (VE) is a systematic approach in which function of the activity, equipment, services, systems or facilities are analyzed and assigned the effective function at the lowest life cycle cost without compromising the required performance, quality, safety and reliability. It means implementation of VE increases the performance, quality, reliability, durability, effectiveness, safety or other desirable characteristics. However, the real objective of VE is value improvement which is not an immediate cost cutting phenomenon.

VE is an organized thinking method which is looking at functional improvement of an item or process. This VE can be applied wherever functions performed by products, services, equipment, component, procedure etc. anything that can be converted to money. It removes the non-adding value items and make modification to improve the functionality of a particular object or process.

Mansour (1991) describes the VE as a systematic approach that achieves an optimum value through a functional analysis without compromising the performance level of a product design, engineering concept or construction approach with a multi-disciplinary team. Further it maintains or improves quality, safety and maintainability.

VE is a procedure that examines the cost and function of an aspect. It investigates every item of a system or subsystem including the very existence of the item itself without degrading the required performance or function level (Brahtz,J., 1978). This article will focus how the Value Engineering process should structure in order to achieve desirable objectives.

VALUE ENGINEERING PROCESS

Jergeas, G., & Revay, S., (1999) contend that the VE study must be launched day one of the design process, if the benefits of the VE is to be fully realized and it should be not limited to later stage constructability process. The best opportunity for optimizing the value, exists in the design stage and end users gain the maximum benefits if the VE study starts at the design stage (HM Treasury, 2007a). It allows design teams to brainstorm and hunt the alternatives when it uses the primary method of VE. This process requires time and cost and concept will not worth if there is a belief or influence to award the design work to the lowest bidder (Jergeas, G., and Revay, S., 1999). SAVE (2007) clarifies that VE study can be applied any stage of the project and its maximum benefits can be achieved during the conceptual design stage before major design criteria have been committed.

According to the Kelly & Male (1993), all VE authors agree that there is maximum cost reduction potential in early in the briefing / design process. This cost reduction potential methodically reduces with the development of the design process and it can be identified as the medium level cost saving potential at the construction stage as illustrated in the following Figure 01.

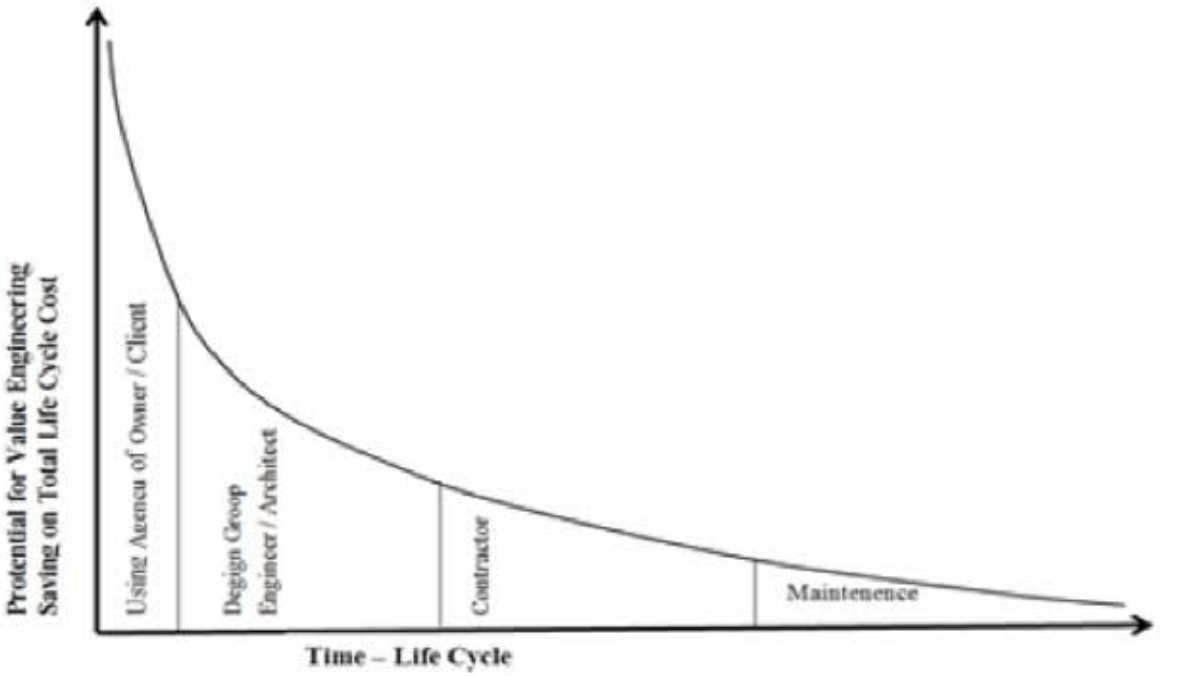


Figure 01

HM Treasury (2007a) notes that repeated VE application at various stages refine the benefits. But it points out that the implementation cost of the VE studies will be increased, in fact it should not be allowed further design changes after the final design as the lost due to wasted time and material can be increased.

Mainly two factors are considered when the VE study applies at the correct time which are a maximum return on VE investment and consideration of the application possibilities (Davis, 2004). The greatest results are shown on projects where VE studies were conducted at the early design stage when the around 20% of design development has been achieved. It is difficult to realize the savings once the design has fully completed in terms of redesign cost, delays and conflicts in the project (Coffield et al 1999). On the other hand Fletcher and McClintok follow the optimum time to put on a VE study when the design development has reached to the 25% and 35% of the design.

The success of the VE process is highly dependent on the VE job plan which is to focus on essential needs, criteria, problems, issues, objectives and concerns of the project (Davis,K., 2004). Further Davis, K., (2004) stated that the typical VE job plan can be described as follows.

DEFINITION PHASE

The goal of the VE process is clearly defined during this phase and boundaries are outlined. It should be ensured that the purpose of this process is to manage the efforts within the scheduled time frame.

INFORMATION PHASE

The selected VE team captures the information as much as possible about the project background and budget during this phase. In this phase, an overview of the design is presented by the designer with its development, typically. The following information is collected to improve the design and construction.

- Design criteria
- Operational requirements
- Codes related to environment, zone, etc.
- Schedule of the project
- Constructability measures
- Project budget
- Construction or building codes.

FUNCTIONAL ANALYSIS

The VE practical application is commenced during this phase. Functions and function-logics are used to describe the elements of the project at its simplest way. It is forced to think in new ways and outside the box within this functional analysis. Two-word function is used to describe every element of the project and those functions are arranged in a decision-logic diagram. This helps to identify the basic needs and wants in delivering a project.

CREATIVITY PHASE

This phase is opened to create ideas, methods or processes in line with the previously defined functions. The brainstorming process is typically deployed to accomplish this phase. The critical success factor of this phase is opening the mind to any and all possibilities. It doesn't allow for critical judgment or comments that might prevent the creative thoughts during this phase. Especially it focuses on the quantity of ideas, not to the quality of them. The ideas such as substitution of materials, standardizing customized items, relaxing tolerances, combining elements and alternatives to construction sequence should be considered.

EVALUATION PHASE

The ideas generated in the previous phase are evaluated at this stage. The aim is to inspect the ideas that have the greatest possibility to implement and each idea is examined individually as to cost, feasibility and value gained. These ideas are tested within the established criteria and limitations. Also, Life cycle cost analysis, economic analysis, sensitivity analysis and tradeoff analysis are performed to enhance the value of the ideas. Further ideas can be ranked on reliability, safety, maintainability, aesthetics and other non-economic criteria.

DEVELOPMENT PHASE

During this phase, the selected ideas from evaluation phase are developed into workable value engineering recommendations. These recommendation proposals help to take the necessary decisions based on the information provided in the proposal. A typical recommendation proposal describes the cost of the proposal, advantages and disadvantages, supporting data like life cycle cost comparison, calculations, sketches and product data sheet.

PRESENTATION PHASE

It presents an informal VE process presentation giving the results for decision makers. And also this stage gives the opportunity to clarify any confusions between the VE recommendations and project requirements.

IMPLEMENTATION PHASE

Any or all VE recommendations are implemented upon approval of the owner. The progress monitoring system may be required to ensure the implementations are properly done by the Engineer or Architect.

SUMMARY

VE study is a part of Value Management (VM) process and it improves the value of a project without compromising the performance level through a multidisciplinary team approach and application of systematic process. The right time for the possible VE studies to gain maximum value is during the concept design and the possibility of achieving the value is reduced respectively with the development of the design. The investment on the VE study normally accounts for between 16 and 30 internal rate of return. During the design stage the control of the project is under the client and designer and

there is a low possibility to involve the contractor at the possible VE studies that mostly depends on the characteristics of the procurement route and the conditions of contract that are used to deliver the project.

REFERENCES

- Brahtz,J., 1978. Value Management for construction. Canada: Wiley-Interscience.
- Coffield, D., et al., 1988. 'Valua Engineering A No Risk Investment'. Transactions of the American Association of Cost Engineers".
- Davis, K., 2004. 'Finding Value in the Value Enginering Process'. Cost Engineering, 46(December 2004).
- Fletcher, T., & McClintock, S., 2004. Intergrating Value Engineering into Quality Management Framework. Milwaukee, American Society for Quality.
- HM Treasury, 2007a. Design Quality: Achieving Excellence in Construction, Procurement Guide No.07, London: HM Treasury (OGC).
- Jergeas, G., and Revay, S., 1999. An intergrated Value Management Approach. s.l., AACE International Transaction.
- Kelly,J., & Male,S., 1993. Value Management in design and construction. London: E&FN Spon.
- Mansour,F., 1991. 'Value Engineering in Engineering/Construction'. Transaction of the American Association of cost Engineers".
- SAVE , 2007. Value Standarad and Body of Knowledge. Dayton, SAVE International.

"

Go for civil engineering, because civil engineering is the branch of engineering which teaches you the most about managing people. Managing people is a skill which is very, very useful and applies almost regardless of what you do.

- Sir John Harvey Jones

"

Sustainable and Economical Waste Management Practices (WMP) for Building Construction Projects in UAE

Manoj Sampath Dissanayaka

MSc(CM), BSc (Hons) (QS & CM), NDT (Civil Eng.), MAIQS, CQS, AMIIE, MQSi

Diploma in Civil Engineering, Institute of Technology, the University of Moratuwa, Sri Lanka – 2006
BSc (Hons) in Quantity Surveying and Construction Management, Sheffield Hallam University, UK – 2012
MSc. in Construction Project Management, Gordon University in UK Surveyor (CQS),
Cost Manager, Gleeds Gulf Engineering and Cost Consultancy Services, Dubai

INTRODUCTION

This article discusses about what other people have written about the construction waste, including type of waste, reasons for the waste and economical and environmental impacts due to waste in building construction projects in the UAE. Further, this article investigates different types of waste evaluation and waste management methods and identifies sustainable and economical waste management strategies.

WASTE IN THE CONSTRUCTION INDUSTRY

According to Formoso et al. (1999) waste can be defined as 'Any losses produced by activities that generate direct or indirect costs but do not add any value to the product from the point of view of the client'. Materials or resources discarded without proper use or management for its maximum benefits to the development can be described as "waste of the construction industry". A construction waste can be categorized based on their nature (solid, liquid or gaseous), characteristics (inert, combustible, bio-degradable, hazardous or nuclear) and origin (processing, household, emission treatment, construction & demolition or energy conversion).

As described by Olusanjo et al (2014), the construction waste can occur from design, manufacturing, logistics, and physical construction processes. Reduction of waste should not be the sole responsibility of the construction team, because, as identified, around 33% the site waste is related to design issues. One of the main risks involved in many construction sites is that actual material waste percentage is usually higher than the estimated. Further, waste reduction in the entire life cycle of the project and recycling is affecting the economy and sustainable development.

CONSTRUCTION WASTE EVALUATION

Evaluation of construction waste is important to identify the cause of waste and to manage the waste properly in the construction site. Blue Stream Environmental Technology managing director Mr. Suvarna Jeetandra stated that "Here the construction waste is not usually recycled, instead it gets disposed into landfills". As per him, reduce and re-use of waste is not an easy task due to the reasons that recycling is an expensive process. Contractors prefer, to dump the waste in empty lands in the UAE, paying for dumping cost as minimum rather than paying for sorting bins and greener building materials. Therefore, evaluation of construction waste is more important for the UAE construction industry rather than the comparing with short term economical comparisons (Blackman, 2009).

ECONOMIC IMPACT OF THE WASTE

As stated by Mr. Kez Taylor, Managing Director of Al Jaber LEGT Engineering & Contracting "There has been a very quick impact in terms of waste management, if we can recycle all the waste it does not end up a landfill, that has a huge economic effect". Further, he add comments about the materials we use on a project should be either recyclable or sustainable sources, because choice of materials has become hugely important for tracking the economic philosophy of the project. (CW Guest 2011)

According to the Olusanjo et al. (2014) construction wastes had incurred negative impact to the project by contributing additional cost to construction due to replacing the cost of wasted materials. The construction managers must explore mitigating actions on waste, which include reduction, recycling, and proper disposal of wastes.

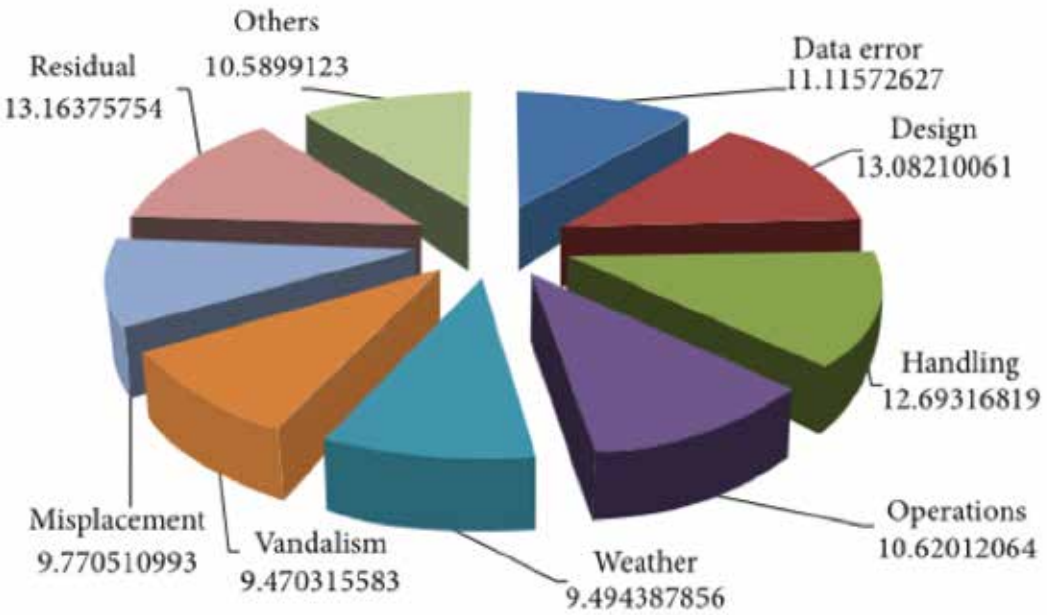
IMPORTANCE OF WASTE MANAGEMENT PLAN TO CONSTRUCTION SITES IN UAE

As per the research done by the waste management companies, in terms of the environment and authority regulations, the future of the construction companies is uncertain due to poor waste management plans of the projects, because, most of the companies are tight with the financial crisis. As a result, spending money on recycling of waste is the least priority.

Dulsco stated that more effort needs to be made by the construction industry to help the environment, even if it is only a basic task. The new technologies need to be implemented to make recycling and reducing on-site waste for the construction sector to overcome the future issues (Blackman, 2009).

Because of rising construction activities, waste management arena became a leading topic in

Figure 01: Construction waste contribution of the project



Source: Rate of Construction Waste available from: constructionweekonline.co

the UAE. It is confirmed, the growing scope of opportunities in the UAE's waste management sector and need for facilities to support anticipated demand for services such as collection, recycling, and energy generation (CW Staff 2017).

WASTE MANAGEMENT PRACTICES

According to the Formoso et al (1999), waste management in the construction industry has been the subject of many research projects around the world in recent years. As per the researches and studies done by them waste can be managed successfully as follows:

1. Treatment of construction waste to reduce the landfill and avoid or reduce environmental impacts
2. Proper storage and handling of construction materials
3. Proper flaws of construction materials spicily in the building project
4. Concern the experience and qualification of workers
5. Implement a measure of the effectiveness and efficiency of utilization of resources
6. Implement a measure in quality of perform of works and specification
7. Monitoring the productivity in term of cost and programme
8. Ability of creative adaptation process of product and services

WASTE MANAGEMENT PRACTICES IN THE UAE CONSTRUCTION INDUSTRY

With the Emirate's goal of becoming a green city, the Dubai Municipality (DM) launched a program for the waste management, in 2014. Accordingly, the UAE Ministry of Climate Change and Environment (MOCCAE) to establish waste facilities in Umm Al Quwain, Ajman, and Fujairah with the participation of government and private sector. As stated by Madhumohan, the waste management has become a growing industry in the Gulf in 2017 (Fatima, 2017).

As a part of the Abu Dhabi waste management master plan, the Centre of Waste Management System will soon come up with a regional standard for construction and demolition (C&D) waste reduction. As per the experts in waste management, recycling C&D waste can save raw materials, energy, water, reduce the production of greenhouse emissions and preserve natural resources. Further, it is possible to support the local economy by recycling. Further, as stated by the Mr. EisaSaif Al Qubaisi, General Manager of Tadweer, municipalities across the GCC are recognizing the need for strong strategies to minimize the negative impact of large amounts of C&D waste due to massive upcoming developments in the region. Therefore, the waste management master plan being developed includes studies about the best practices, laws and policies and the best cost-efficient waste processing solutions (Anon, 2015c).

As detailed by Alison (2010) in the construction week magazine, many waste management firms are actively involved in managing the construction waste in the UAE as follows,

1. Dulsco's was the first waste management firm in the UAE to be, integrated management system (IMS) certified. They collect and dispose hazardous and non-hazardous solid waste in construction and demolition works and provide treatment facilities in compliance with the Municipality's Environment and Safety regulations.
2. Envac is a global leader in the automated waste collection, treating of municipal and commercial waste, which comprise fully automated, safe and environmentally friendly solutions in the UAE.
3. Mohammed Tayyeb Khoory & Sons treat water, electricity, roads, transport and construction sector's waste management in the Middle East.
4. Trashco is based in Dubai for the collection of domestic, commercial and hazardous waste. The firm also offers recycling and industrial cleaning services.

REGULATIONS FOR WASTE MANAGEMENT IN THE UAE

As per the investigation performed by Alison (2010) and published in Construction Week magazine, knowing of what is required by law and how firms are tackling the issue is important to the drive for sustainable building in the Middle East under the 'green' credentials. The following rules and regulations are implemented in the UAE for the proper waste management approach:

- Dubai Municipality (DM) has allocated a dump site for construction waste in Jebel Ali, with a clear set of guidelines for the same (Local Order No 7 of 2002 on the Management of Waste Disposal Sites in the Emirate of Dubai).
- The construction companies must get a permit from the DM to transport the waste under designated guidelines and fees for the type of waste disposal.
- As per the federal law Nr. 24 (series 1999) for environmental protection and development cover the overall sustainable development and methods of waste management, disposal and recycling.

As published by CW Guest (2011) in the UAE, implementing effective regulations for environmental responsibility is slightly difficult than other regulations due to the effect of the natural environment and each emirate has its own sets of rules and regulations. However, as stated by the Emirates Green Building Council (EGBC) vice-chairman Mr. Saeed Alabbar "The regulations on environmental issues have become stricter in all the emirates". Such regulations are as follows,

1. All the contractors to prepare and submit an environmental management plan for how they are planning to mitigate impacts, including waste management.
2. Every new project must obtain a permit from the Environment Protection Agency, which needs that environmental effect assessments done before project starting, to identify any potential concerns that may affect from the work.
3. All the contractors must follow the environmental and waste management plans on site as a part of regulation in the UAE.

According to the governing law of the UAE, and regulations protecting public facilities under Article 56, Abu Dhabi City Municipality (ADM) has launched the campaign to track and monitor the illegal dumping of construction and sewage waste carrying in Abu Dhabi's industrial areas. During the campaign, ADM's inspection teams had issued fines for seven offenses relating to the illegal dumping of construction and sewage waste, amounting of approximately AED 700,000 in total. Officials have called on this campaign to encourage the construction and waste management companies to deposit their disposal loads in designated locations (James, 2017).

CONCLUSION

According to the above findings, it could be summarized that the UAE construction industry is identified as a fast moving and rapidly growing industry by contributing more than 8% of the GDP of the country. Due to numerous construction activities, consumption of the natural resources and producing of waste materials also slightly increased. As monitored and reported by the government authorities and private organizations, the impact of the natural environment due to the construction waste is a growing issue in the UAE. Further, as per the information founded, the construction waste is effecting the construction cost and time overrun as well.

The main causes for construction waste are lack of attention of involvement by parties to manage the waste, poor site coordination and planning, issues on supply chain management and lack of knowledge about the waste management strategies, etc. But many of the causes can be avoided or minimized, however, for some cases it is difficult

to find reasonable or successful solutions, such as authority regulation changes, global economic crisis, unexpected weather conditions, etc.

The Author suggest to continue this topics on the aspects such as solutions to reduce waste in the building construction industry in the UAE and the involvement of parties to apply various solutions in different stages to manage this issue.

REFERENCES

- Alarcon, L., 1994. Tools for the identification and reduction of waste in construction projects.
- Alsehaimi, L.K., 2008. Critical evaluation of previous delay studies in construction.
- Anon.,2015c. How about recycling construction waste.
- Alison. L.,2010. Wasted Elements. [online] Article from construction week online.com.
- Blackman, S.,2009. UAE's building waste dilemma.
- CW Guest.,2011. Construction pollution.
- CW Guest.,2017. Waste investments buoy UAE construction sector.
- Fatima. D. L.,2017. UAE to develop radioactive waste management policy.
- Formoso, C. et al.,1999. Method of Waste Control in the Building Industry. University of California, Berkeley, CA, USA.
- James. M.,2017. ADM cracks down on illegal dumping of construction waste.
- Olusanjo, O. at all.,2014. Quantitative Analysis of the Sources of Construction Waste.

"

The well being of the world largely depends upon the work of the engineer. There is a great future and unlimited scope for the profession; new works of all kinds are and will be required in every country, and for a young man of imagination and keenness I cannot conceive a more attractive profession. Imagination is necessary as well as scientific knowledge.

Sir William Halcrow

"

Project Management in Construction : A New Approach

Eng. Nalaka Kanthiarachchi

NDES, MIIESL, MIET (UK), GCGI (UK), PMP, I Eng.

Secretory, Institution of Incorporated Engineers, Sri Lanka, UAE Branch
Treasurer, Sri Lanka Professionals Association, UAE
Currently working as the Manager Electrical Services at the American University of Sharjah UAE

1. INTRODUCTION

Organizations need change in order to sustain, grow and thrive in businesses. Vision of an organization is translated into values and to strategic goals. Projects are means of achieving these strategic objectives by bringing about changes & adding value to the business. Construction projects give the means for the businesses to expand and grow.

Some of the most knowledgeable, skilled, experienced and highly certified project practitioners are working in construction project teams worldwide. Well experienced project managers lead these teams. Yet most projects are anyway destined to fail from the inception. Construction industry has one of the height project failure rates among all the industries. Failed construction projects have over the years wasted enormous amounts of time and resources. Whilst not all projects face the same challenges that are discussed here, the project managers and teams would agree that majority of failed projects has seen a fair share similar issue in them.

2. STATISTICS AND EVIDENCE

Research and surveys done by various professional organizations worldwide give a good insight to the performance of projects. Questions are asked to find if these projects complete on time, under budget and bring about the expected benefits to the businesses? "PMI's Pulse of the professing report 2016" says that 16% of the projects were deemed as projects failed and 38% failed to meet the business intent. "PMI's Pulse of the profession report 2017" says that while the project success rates are rising, approximately 10% of projects deemed failed. 30% failed to meet the business intent.

APM's research report "Conditions for project Success" says that almost 12% failed to meet the budget. Only 22% were found successful.

COIB's report in 2009 "Managing the Risk of Delayed Completion in the 21st Century" highlights that many construction projects failed to meet timely completion causing cost overrun.

"The century's most troublesome construction projects" an article by Stewart Wilks on COIB Global Construction Review says that only 14% of projects use a fully linked network/schedule to manage time, and only 2% use an independent reviewer to check viability.

The evidence suggest that construction projects has failed to deliver the expected benefits, despite of the technological advancements and modern project management methodologies.

3. WHAT'S WRONG

Traditionally, the project managers strive to manage the triple constraints scope, time and cost. Whilst achieving these objectives are important, often the other aspects such as usability, completeness,

functional relevance, technical performance, sustainability and life cycle cost are overlooked.

a. Complete project as per scope.
The project scope of works and the product specifications gives the requirements to which the project should to be built. In short it says what to do, how to do and with what material. The project scope includes the project scope document, product specifications and the construction drawings. But most projects fail because of:

- Poorly defined project scope.
- Project scope documents are either too generic and or too complex.
- Incomplete construction drawings.
- Project technical performance requirements are not clearly defined.
- Most project scope documents are copied from previous projects or made using specification software frameworks such as CSI.

b. Complete project under budget.
This is the priority of most construction projects. Project teams strive to complete the projects within the budget. But in many projects the allocated budget often is insufficient to complete the project within the expectations and meeting the levels of technical performance. This is because of the erroneous estimations due to:

- Not gathering all project requirements prior to defining scope.
- Not defining the expected outcomes clearly.
- Insufficient and / or incomplete information used in estimating budgets.
- Not allowing enough contingencies for the risks.
- Inherently optimistic approach of project professionals in estimating.
  When the estimated budgets are inaccurate it is inevitable that the projects end up with claims for cost variations to complete with in the expected technical performance.

c. Complete project ahead of schedule
All project teams strive to complete the projects ahead of schedule. But many project schedules are based on incomplete information and optimistic time estimates due to:

- Incomplete project scope of works.
- Not identifying all activities and the time to complete them.
- Not taking risk contingencies into account.

d. Complete project within acceptable quality
Whilst quality is one of the important aspects, it is usually not given the same prominence as scope, cost and time. Projects fail to achieve the quality requirements because:

- Incomplete project scope definition.
- Not defining the expected quality levels clearly.
- Not having a proper quality assurance mechanism.
- Not employing sufficiently experienced, qualified and skilled workforce in all areas of expertise and through all stages of a construction project.

Balancing scope, cost, time and quality constraints is challenging. It's more challenging to complete the scope keeping to the expected quality, when the project has cost and time overruns.

4. TRADITIONAL APPROACH

It seems there is a serious problem with the approach taken in defining, planning, exciting and managing construction projects.

4.1 Approach to defining projects seems:

- Using a one fix solution without resolving the problem in hand.
- Designing with the highest technical specifications but not to optimize the performance.
- Building a 100 Ton chiller plant when we really want a comfortable living space.
- Using the most sophisticated control system when we really want simplicity and ease of control.

- Building a complicated building when we really want is a good living space.
- Providing space lighting to meet a generic guideline, when the requirement is to illuminate a space, appropriate for the use.

4.2 Approach to planning projects usually end up with:

- Creating a lengthy complicated schedule using an expensive software, when we really want a simple plan that is realistic, understood and executable.
- Producing unrealistic overconfident milestones just to satisfy stakeholders, which are destined to fail and waste time and resources.

4.3 Approach to project execution goes wrong because:

- Trying to manage and control individuals without leading teams.
- Strive to achieve unrealistic deadlines when what is required is to complete the project (deadline management instead of project management).
- Engineers, Suppliers, Contractors work in silos to maximize their profits.
- Work to a wrong plan simply because it the contractually agreed plan.

4.4 Wrong approach to monitoring and controlling:

1. Most project control systems try controlling cost and time.
2. Reactive problem solving instead of proactive prevention of problems.
3. Not having a project wide quality assurance scheme used by all stakeholders from the inception to handover.
4. Not using the technology and data available to predict problems.

4.5 Wrong approach to closeout:

1. Thinking that the project is completed when all installations are completed. Not enough importance is given for commissioning of building services.
2. Partial handover and substantial completion.
3. Using the defect liability period as an extended construction and commissioning period.

5. A NEW APPROACH

Statistics and evidence suggest that the traditional approach to construction projects has been a failure. It is time that the construction project professional takes a leaf out of the other industries and learn how they minimized the wastage and increase the success of projects. Construction industry needs a paradigm shift in thinking and approach towards projects.

5.1 A Strategic Business Approach to Construction Project Management

Traditionally the business strategies were made for a period of 5 years or more. But today the business environment has become volatile, uncertain, complex and ambiguous. Therefore, the strategies are made for shorter periods. Although the vision, mission and values of a business may not change the strategies to get there, may change with the fast-changing to business environment.

Construction projects are part of a business strategy of an organization. The businesses exist to optimize the value and maximize returns. All projects should be aligned with the organizational business strategy. If the strategy changes the projects should also change their direction or cancelled all together. Projects should aim to provide successful strategy implementation and delivery of optimum business value over strict scope, time and cost control.

How can construction projects adopt to this fast-changing business environment and new challenges? The IT projects adopted an agile project management approach few decades ago, and was able to drastically reduce waste and project failures. Can the construction projects adopt an agile approach? In "The Project Management Book of Knowledge," sixth edition, the Project Management Institute suggest applying agile principles into project management.

5.2 An agile Approach to Construction Project Management

In the year 2001 the leaders in software industry introduced Agile Manifesto with four guiding values:

1. Individuals and Interactions over Process and Tools.
2. Working Software over Comprehensive Documents.
3. Customer Collaboration over Contract Negotiations.
4. Responding to Change over following a plan.

Whilst the manifesto acknowledges the values on the right, it emphasizes and values those in left more. Agile approach shares the lean concepts of focus on value, small batch sizes and eliminating waste. The end goal is not to be agile for the sake of it, but to deliver value to customers for a better business outcome.

With some minor changes in item 2 these principals can be adopted to the construction project management as well:

1. Individuals and Interactions over Process and Tools.
2. Functioning and Performing Buildings / Infrastructure over Comprehensive Documents.
3. Customer Collaboration over Contract Negotiations.
4. Responding to Change over following a plan.

Construction projects traditionally employed a predictive lifecycle. Predictive lifecycles are best for projects that has:

- Fixed requirements.
- Activities which are performed once for the entire project.
- A single delivery.
- Manage cost as the primary goal.

A construction project may take six months to ten years for completion, depending on the size and complexity. Usually larger projects are done in phases which are easily manageable. A medium size construction project might take one to two years from inception to execution and another two to three years for the construction to complete. In today's terms this is a long period where the technologies, methods, material, products and cost can change considerably.

Therefore it is no longer viable to manage construction projects using a predictive only approach. Project Management Institute suggest a use of a hybrid approach based on both predictive and agile approaches. There are many activities that can be done with a predictive approach, such as:

- Architectural, civil and structural building design.
- Design of MEP services and design of IT infrastructure.
- Preliminary design of building controls.
- Site preparation and excavation.
- Foundations and structure.
- The construction of building core and shell.

But an agile iterative approach may be more suitable for the following activities:

- Specifying of IT and ELV system equipment.
- Final selection of building controls equipment.
- Specifying and selection of luminaires.
- Specifying and selection of furniture.
- Specifying and selection of final finishes.
- Installation of electrical final circuits.
- Installation of final data cabling and outlets.
- Testing and commissioning of MEP systems.
- Testing and commissioning of IT & ELV systems.
- Testing and commissioning Building controls.

For the hybrid approach to be successful;

- The project teams need to change the mind set and the behavior. It's a new project culture,
- Project managers, architects, engineers, construction professionals, suppliers, system integrators and commissioning teams should

be involved in the projects from the inception to the end,
- Complex designs and documentation should be replaced with simple yet practical solutions,
- The teams working in silos should be replaced with one team of professionals from many organizations working together,
- Require simple and flexible contracts,
- Shift priority from cost and time management to performance and delivery of value to customer and
- Project governance should be transparent and ethical.

Many professional organizations in construction industry have suggested integrative project management approach which is more collaborative and agile. The professional organizations, companies and leaders in construction industry should revisit the construction standards, guidelines, practices and approaches to change the way the projects are done, giving the priority to the performance of the end-product and delivery of business value. A hybrid approach tailored for each project with a whole new mindset will help the construction projects to be profitable as well as deliver value to the businesses.

> *Engineers are not superhuman. They make mistakes in their assumptions, in their calculations, in their conclusions. That they make mistakes is forgivable; that they catch them is imperative. Thus it is the essence of modern engineering not only to be able to check one's own work but also to have one's work checked and to be able to check the work of others.*
>
> *Henry Petroski*

Organizational Strategy Formations

Kavindra Jayasooriya

NDT(Civil Eng.), MSc(QS), AMIESL, MAIQS, MRICS

Diploma in Civil Engineering, University of Moratuwa, Sri Lanka
MSc. In Quantity Surveying, Heriot Watt University, Dubai
Contracts Manager for Modern Executive Systems Contracting LLC in Dubai, UAE

INTRODUCTION

"We all are blind men and our elephant is the strategy formation" (Minitzberg,1998). Since we all are blind men, once we grabbed a part we may have thought that this is the strategy, completely ignoring or without concentrating the other consequences. All of us know about the pace of change in the businesses today. So, grabbing only one part will not help to sustain in this competitive market. This article is an attempt to discuss the strategy and organizational strategy formation in wider context and the content wishes to pay more attention on resource based view on strategy.

WHAT IS STRATEGY?

There were lots of arguments / researches on this topic but it is very difficult to find a collective definition for this matter. To this writer's point of view, it varies from strategy as positioning, as aspiration, as action and as visioning. As per Markides (2004), "how I could achieve my company's objectives" will be the definition for strategy from the practicing executive's point of view. Furthermore, Markides believes that technically above statement is correct but practically it is meaningless. This writer also agrees with Markides because when we implement a strategy practically it is not only the company's objective. We have to consider a number of facts such as business direction, scope of the market, competitive advantages / disadvantages, company resources / stakeholders, business environment etc. Junnonen (1998) described the strategy as the primary pattern of planned and present using of resource effectively and interactions with the environment that gives an indication about the achieving of organization's objectives. Furthermore Minitzberg (1998) exchanged his views on strategy stating it cannot be identified in a single definition and of course this word strategy is used in different ways. Basically, strategy is equipped with three contents. Those are the organizational activities scope, deployment of organizational resources and the normative character. Strategy will indicate us about the general notion of organization's business (Ansoff, 1991). That statement will support the above concept one. Strategy is having collective qualities to rule or control with authority and coordinates towards certain actions (Junnonen,1998). This will give us a better understating about the above concept three, normative character.

STRATEGY AS RESOURCE BASED VIEW

Strategy as a recourse based view is one of the prevailing views on strategy during the past decade. This scenario, based on the concept on economic rent and the organization as a collection of abilities. Kotelnikov (2007) suggested that the intelligible, articulate and integrative roles of this scenario placed well above with comparing to other mechanisms of decision making strategies. If we consider the traditional strategy models, for example Michael Porter's five forces model discuss only about the external environment of the organization and not

having an enough consideration about the inside of the organization. But when it comes to strategy as a resource based view, it stresses on organizational fit between its internal strengths and external environment. If we put this approach in other words we can conclude that this view considered inside-out approach. Barney (2001) emphasized that organizations are a collection of capabilities and resources and that is the basis for its strategy and the basic source of company's return. These resources may firm attributes, company processes, all assets, capabilities, knowledge, information etc.

STRATEGY PROCESS

"It is generally recognized that effective strategy formation processes consist of central planning activities orchestrated at the corporate strategic apex as well as emerging strategic decisions influenced by empowered managers within the organization"(Torben, 2004). And as per Junnonen (1998) company's strategy is the last possible outcome of the process of strategy formation over a period of time. We can identify three main elements in the strategy process or strategy formulation. Those are strategic analysis, strategic choices and strategy implementation. The firm's purpose defined under the strategic analysis. Some companies expressed this purpose in their mission statement and some firms identified values which they want to achieve. When identifying the purpose, it is really important to understand the current position of the company and this can be done with a proper analysis of a firm weakness and strengths. This is called the environment analysis and basically through this part identified where we are now? The second wave of the strategic process is the strategic choices. Through this phase, companies will critically examine the facts like objectives (Where do we want to be?), strategies (How are we going to there?) and option analysis (Are there any alternative methods or routes?). When merging, the internet service leader (AOL) and the multimedia firm giant (Time Warner) both chief operating officers from the respective companies prepared well comprehensive strategic vision for the proposed future company. This writer wishes to bring this as a best example for objective settings.

STRATEGY PROCESS IN TEN STEPS AND TOOLS ASSOCIATED WITH STRATEGY PROCESS

Furthermore, we can identify the strategy process in ten steps. Phase one is the strategic thinking and it consists three steps, process of conception, formal process and analytical process. In other words, we can put it as an idea, plan and explanation. Phase two will be the strategic vision and it concludes the processes of visionary, mental and emergent. Our previously discussed example of merge between AOL and Time Warner, can be included under this phase. Phase three is the strategic and operational plan where it is having essential features of process of negotiation and collective process. Final phase is the strategic implementation and monitoring. Discussing about the tools associated with the strategy process, ashridge mission model will be useful to identify organizational vision, mission and objectives. From the SWOT analysis we can identify organizational strengths, weakness, opportunities and threats, balance scorecard will be helpful for goals and mission settings, McKinsey 7S will be associated with strategy implementation and finally balance scorecard will be helpful again for evaluation, monitoring and controlling, feedback and reviews. In addition to above tools such as competitor analysis, gap analysis, PEST analysis, portfolio analysis and resource audit will be applicable during the different phases of the strategy process (Price, 2003).

STRATEGY AND STRATEGY PROCESS TO CURRENT BUILT ENVIRONMENT PRACTICES

As we all know over the past twelve to twenty-four months, many countries around the globe faced a huge financial pressure and only a very few countries have been able to stand strong to this economic downturn. Many companies do not have proper strategical plans to sail through this muddy water of economic downturn and end up with losses and bankruptcy. To this writer's opinion these periods gives greater opportunities for companies to find out the realities and possible results in the current

environment to expend their earning in the safest manner. Not only that, these periods give rise greater opportunities to companies to shift or capture new markets and new customer bases. Australian writers Kajewski and Weippert highlighted that the construction companies should be matured and equipped with financial and technical resources to meet with the challengers happening in the current market. Furthermore, Kuklis (2009) states organizations should be smart enough with their strategies and strategic management processes in order to face global challengers and changing environment against economical, political and social changes. This writer believes that protecting the core assets of the organization, especially during the periods of recession is very vital. Rigby (2001) pointed out that strengthening organizational core aspects will stand strong during the recessions and weak businesses are always having threats with comparing with the strong ones. Another important fact to be considered in strategic planning during these periods; choosing a holistic approach, more attention to the employees and bridging and strengthen the loyalty bond among the customer base. Vann (2009) states that developing a strategic plan in the recession is not that much different than that of economic boom but we can apply an approach with nuances and that will enhance the chances of building a performed strategy during recession period.

RESOURCE BASED VIEW TO BUILT ENVIRONMENT ORGANIZATIONS

We have discussed, strategy as resource based in earlier paragraphs. Now, let us see how this resource based view is applicable to the built environment practices. As we all know the construction industry operates its activities within a highly competitive and turbulent market, but very few companies are going through with the formal processes when it comes to the formation of organizational long term strategies. (Price, 2003). For catering these companies it requires distinctive capabilities, market positions and individuals. To sustain in the dynamic, ever changing and very competitive construction industry environment, people with the power and authority should rely on the initiatives and the imaginations of the employees. Built environment practices contain full of resources with different capabilities and skills and these full of talent packages can be used to develop a comprehensive strategy for the sake of business's success and achieving its desired objectives and goals. Taipei 101 project is a fine example for using resource based approach successfully to building project teaming strategies (Dzeng, 2005). It was 508m in height, giant sized project and considered as the highest building in the world in year 2004. The owner applied the resource based view and identified the resource gaps and employed additional sub contractors for filling this gap.

CONCLUSION

As we all know if the building is having a strong foundation it will resist natural disasters like earthquakes, storms etc. If we compare a building with a business and the foundation to well developed strategy plan, then the business will stand tall to all the events happening around the business environment. This writer believes that the smooth and effective strategic plan is the best investment of a company. More importantly well planned strategy will bridge the organization's internal capabilities and the external environment, giving a competitive advantage to the company, enhancing its performance. Prosperous strategies implemented by the opportunities and possibilities, which will occur in the future, rather than restrictions happen on the past (Feurer and Chaharbaghi, 1997).

This writer wishes to state that as per above discussions the resource based approach will provide wider context to the organization to plan and implement its strategy. Comparing the resource based approach with traditional theories on strategy is not up to the mark on both the content and process. Han et al (2007) states that the "construction contractors are sustained by the positive momentum of the expanding construction market, but also are faced with threats as market

conditions change rapidly". Furthermore, to achieve the firm's profit, resources will lay a good foundation and this is the most important source for the capabilities of the organization (Grant, cited in Dzezg, 2005). Considering all the facts discussed above and all the quotations from different scholars, this writer wishes to conclude that the resource based approach on strategy will gives organizations related to build environment practices more competitive edge, specially during economic downturn periods.

REFERENCES

- Markides, C. (2004). 'What is Strategy and How Do You Know If You Have One?'. Business Strategy Review.
- Junnonen, J.M. (1998). 'Strategy Formation in Construction Firms'. Engineering, Construction and Architectural Management.
- Mintzberg, H. and Waters, J.A. (1985). 'Of Strategies, Deliberate and Emergent'. Strategic Management Journal.
- Ansoff, H.I, Mintzberg, H.1991, 'Critique of Henry Mintzberg: The Design School: Reconsider', Strategy Management Journal.
- Barney, J.B. (2001). 'Is the Resource-based "View" a Useful Perspective for Strategic Management Research? Yes'. The Academy of Management Review.
- Alimin, I.I., Haslinda, A., Jegak, U. and Raduan, C.R. (2009). 'Management, Strategic Management Theories and the Linkage with Organizational Competitive Advantage from the Resource-Based View'. European Journal of Social Science.
- Altman, G 2000, 'The changing nature of strategy development –supporting management thinking' paper presented to the International Conference on Systems Thinking in Management 2000.
- Porter, M.E. (1996). 'What is Strategy?'. Harvard Business Review, November-December 1996.
- Chinowsky P S and Meredith J E, 2009 Journal of Construction Engineering and Management, Vol.Jan-Feb.
- Kajewski, S and Weippert A. (2000) 'Online Remote Construction Management Literature review,' Queensland University of Technology.
- Kukalis, S (2009) "Survey of Recent Developments in Strategic Management: Implications for Practitioners', International Journal of Management Vol.26, No. 1, California State University Long Beach.
- Price, A.D.F. (2003). 'The Strategy Process within Large Construction Organisations'. Engineering, Construction and Architectural Management

"

What we usually consider as impossible are simply engineering problems… there's no law of physics preventing them.

Michio Kaku

"

INSTITUTION OF INCORPORATED ENGINEERS SRI LANKA

UNITED ARAB EMIRATES