“IT” APPROACH TO SUSTAINABLE ARCHITECTURE

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"IT" APPROACH TO SUSTAINABLE ARCHITECTURE

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ABSTRACT

Nowadays, we cannot avoid decreasing of availability of non–renewable energy resources, particularly fossil fuels, and environmental degradation, consequently. Sustainable Architecture, respectably answered those conditions by streamlining architecture as system. Beneficially, Information Technology (IT) has all potencies needed to simplify Life Cycle Analysis (LCA), instrument for assessing sustainable product that considered as being too complicated. Streamline computer software LISA, stands for LCA in Sustainable Architecture, offering an instrument to those extents particularly in regard with construction process. Besides simplifying the process, LISA will help reducing energy, cost and environmental impacts that will be spent and occur along the so-called process.

Keywords:

Sustainable Architecture, LISA, Energy, Cost, Environmental Impact.

1.0 INTRODUCTION

As intentionally mentioned on the topic, this paper will illustrate the effectiveness of application of streamline computer software LISA, stands for LCA (Life Cycle Analysis) in Sustainable Architecture (courtesy of BHP Australia), in streamlining architecture as system, to be precise architectural process particularly phase of construction, on purpose to achieve Sustainable Architecture.

2.0 SUSTAINABLE ARCHITECTURE

Based on global state of mind, architecture at present not any longer architecture merely known as building design, but architecture that based on cradle to grave paradigm known as well as from source to sink to Malaysian Architect Ken Yeang.

With the intention that, similar to product in general, architecture should always be sensible in using various resources by keep maintaining their availability, to be exact sustanability of the resources particularly non–renewable energy resources such as fossil fuels.

To those extents architecture should be considered as system (Handler, 1970) that includes:

- Design process
- Construction process
- Operational and Maintenance Process
- Human Bionomic Process

Furthermore, according to Building Life Cycle in Figure 1, building as enclosure of architecture should be deal with,

- Cradle (i.e. Birth) Stage: Material acquisition that will need energy and cost besides will cause environmental impacts.
- Similar to material acquisition, products manufacture transportation will need energy and cost besides will cause environmental impacts, and this will occur as well to the consecutive:
- Construction and fitting out,
- Operation and maintenance, and
- Grave (i.e. Death) Stage: Renovation and demolition.

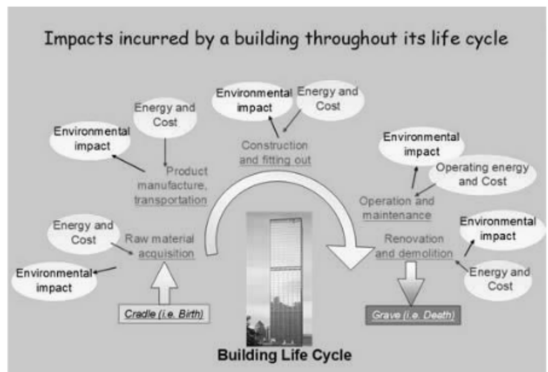


Figure 1: Building Life Cycle

From the coverage mentioned above, Sustainable Architecture can be understood as architectural system that nothing other than streamlining process of resources usage, mostly non–renewable energy resources. The process is the entire architectural process that embraces processes of design, construction, operational and maintenance, human bionomic and last but not least the demolition and/ or recycle process at the end of building life.

However, architectural processes able to remain produce designs that are related to the creation of value or meaning, intentionally to affecting user's emotion and sensitivity. In view of the fact that sustainable architecture offering designs that associated with quality and reliable issues.

3.0 STREAMLINE

Streamline, in general, known as make more efficient or make more simple. In regard with architecture, streamlined process actually has come up several times. The earliest occurred ever since the shifting of design method, from traditional into modern design method, or from trial and error into design by drawing method. The latter can simplify the making of corrections besides; enable the process to carry out some fast track actions that is paralleling several sub processes that can be accomplished in the same time or simultaneously.

Sustainable Architecture that based on cradle to give paradigm, subsequently streamlining the energy usage, cost, and environmental impacts that will be spent and occur along architectural process. Nevertheless, in order to achieve sustainability, architecture needs a kind of instrument that similar to LCA, instrument to assess sustainability of products in general.

On the other hand, currently LCA methodologies too complicated and not widely accessible to designers and quantity surveyors, besides detailed study of LCA divert attention from the key environmental issues and tend to focus attention on inter–material competition rather than optimum construction systems (LCA – BHP Australia, 2003).

Beneficially, Information Technology (IT) has all potencies needed to simplify Life Cycle Analysis (LCA) including for architectural process that recently considered as being too complicated. Streamline computer software LISA offering an instrument for those extents particularly in regard with construction process. Besides simplifying the process, LISA will help reducing energy, cost, and environmental impacts as well that will be spent, and occur along the so–called process.

4.0 LISA (LIFE CYCLE IN SUSTAINABLE ARCHITECTURE)

As users' friendly streamline computer software, particularly for construction process, LISA has an attractive, informative, and comprehensive interface, Figure 2. LISA contends with the entire computation concerning:

- Specification
- Construction
- Fit Out
- Utilization
- Repair/ Maintenance

That supported by Decommissioning and Material Transport.

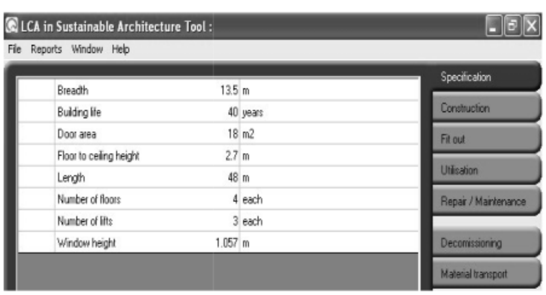


Figure 2: LISA Interface

4.1 LISA APPLICATION

For illustrative purpose, the following coverage will show application of LISA on the Construction Process of an Office Building.

LISA	LISA SUB SYSTEMS	DECOMMISSIONING	MATERIAL TRANSPORT
DESIGN PROCESS			
Specification	▪ Building Breadth ▪ Building Life ▪ Door Area ▪ Floor to Ceiling Height ▪ Length ▪ Number of Floor ▪ Number of Lift ▪ Window Height	–	–
CONSTRUCTION PROCESS			
Construction	▪ Structure ▪ Walls ▪ Windows	NO	YES
Fit Out	▪ Air Conditioning ▪ Finishing ▪ Installation ▪ Stair	NO	YES
OPERATIONAL PROCESS			
Utilization	▪ Heating ▪ Lighting ▪ Office Equipment ▪ Other Electrical Appliances ▪ Water Heater	–	–
Repair/ Maintenance	▪ Air Conditioning ▪ Finishing ▪ Installation ▪ Structure ▪ Walls ▪ Doors	–	YES

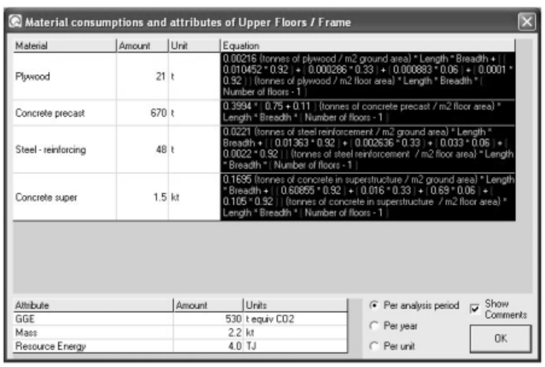
Figure 3: Structure of Construction Process of an Office Building according to LISA.

Problem structure of Construction Process of an Office Building according to LISA that stated on Figure 3, shows the items of respective design process, construction process, and repair/ maintenance process. Even though as mentioned before that LISA particularly used for construction process, in fact we cannot avoid the related processes that will influence, and will be influenced by the construction process.

At the Design Process stage, will be produced design and specification that furthermore will determine the type of structure, walls, and windows and fitting out components. In comparable way, Operational Process will be influenced by specification and the equipments needed will be built and assembled within construction process.

Construction Process of An Office Building, Figure 4, shows details of specification of consecutive structural items, Upper Floors/ Frame, Substructure, Roof Structure that consists of respective specifications that followed by decomissioning and material transport remarks. Each items of specifications has respective LCI (Life Cycle Information) data.

LCI data on Figure 5 below shows material consumptions and attributes of Upper Floors/ Frame: Number of floors – 1. Each used material has respective equation. Notes: GGE = Greenhouse Gass Emissions stated in t equiv CO_2, Mass stated in kg, t. Resource Energy stated in TJ. GGE calculation including IPCC weighting factors (global warming potensials) such as CH_4 dan N_2O.


Material consumptions and attributes of Upper Floors / Frame

Material	Amount	Unit	Equation
Plywood	21	t	0.00216 (tonnes of plywood / m2 ground area) * Length * Breadth + ((0.010452 * 0.92) + (0.000286 * 0.33) + (0.000883 * 0.06) + (0.0001 * 0.92)) (tonnes of plywood / m2 floor area) * Length * Breadth * (Number of floors - 1)
Concrete precast	670	t	0.3994 * (0.75 + 0.11) (tonnes of concrete precast / m2 floor area) * Length * Breadth * (Number of floors - 1)
Steel - reinforcing	48	t	0.0221 (tonnes of steel reinforcement / m2 ground area) * Length * Breadth + ((0.01363 * 0.92) + (0.002636 * 0.33) + (0.033 * 0.06) + (0.0022 * 0.92)) (tonnes of steel reinforcement / m2 floor area) * Length * Breadth * (Number of floors - 1)
Concrete super	1.5	kt	0.1695 (tonnes of concrete in superstructure / m2 ground area) * Length * Breadth + ((0.60855 * 0.92) + (0.016 * 0.33) + (0.69 * 0.06) + (0.105 * 0.92)) (tonnes of concrete in superstructure / m2 floor area) * Length * Breadth * (Number of floors - 1)

Attribute	Amount	Units
GGE	530	t equiv CO2
Mass	2.2	kt
Resource Energy	4.0	TJ

Figure 5, Material consumptions, and attributes of Upper Floors/ Frame.

4.2 REPORTS

Under reports button on horizontal bar of LISA Interface provided information of,

- Impact Chart, Figure 6 on the next page, shows total investigated environmental impacts that will occur along the process, for instance energy consumption that will be used by the building, GGE (Greenhouse Gas Emissions), NO_x, SO_x, NMVOC (Non Methane Volatile Organic Compounds), SPM (Suspended Particular Matter), and Water consumption. The left vertical bar indicate base example and the right bar indicate edited example, if the environmental impacts exceed the base one so the right bar will be higher, and vice versa.

CONSTRUCTION		SPECIFICATION	DECOMISSIONING	MATERIAL TRANSPORT	
STRUCTURE	Roof Structure	Pitched Roof, Concrete Slab	No	Railway	No
				Highway	Yes
				Sea	No
	Substructure	Foundations, slab, and groundbeam.	No	Train	No
				Highway	Yes
				Sea	No
	Upper Floors/ Frame	Celullar beams and composite slabs.	No	Train	No
		Composite beams and composite slabs.			
		Precast hollow concrete core units.		Highway	Yes
		Reinforced concrete slabs.			
		Precast beam and floor slab.		Sea	No
WALLS	External Wall	Concrete blocks with brick face.	No	Train	No
				Highway	Yes
				Sea	No
	Internal Wall	Concrete blocks, timber studs, plasterboard lining.	No	Train	No
				Highway	Yes
				Sea	No
WINDOWS	Windows	UPVC frame, doubled glazed.	No	Train	No
				Highway	Yes
				Sea	No

Figure 4: Construction Process of An Office Building

- Bill of Materials, Figure 7 on the next page, shows the amount of each material needed. For instance, Upper Floor/ Frame item of Construction Stage that consists of following components, Concrete Block, Timber, and

Material Transport, and respective component consists of various materials. The amount of materials including material transport will be calculated for each component.

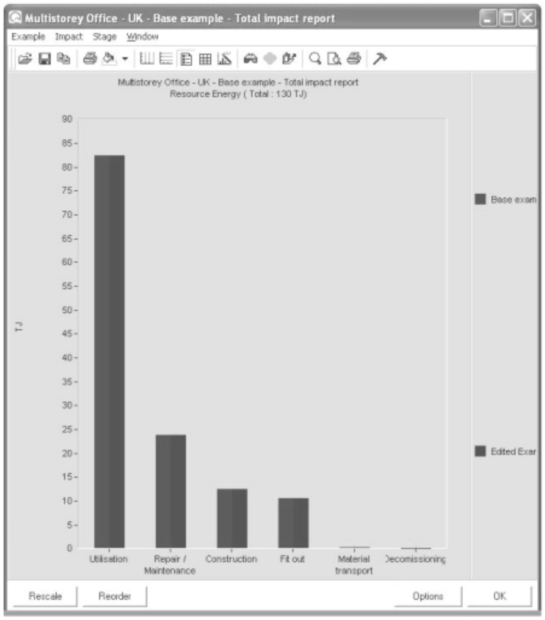
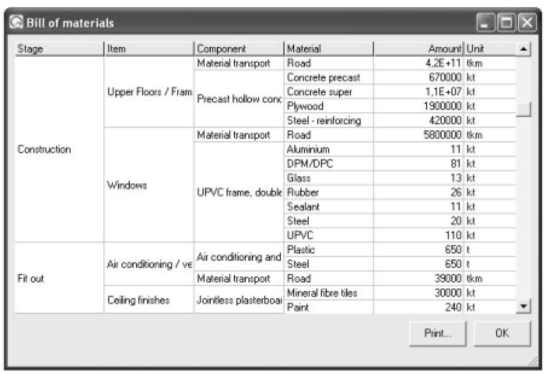


Figure 6: Total impact reports



Bill of materials

Stage	Item	Component	Material	Amount	Unit
Construction	Upper Floors / Fram	Material transport	Road	4,2E+11	tkm
		Precast hollow conc	Concrete precast	670000	kt
			Concrete super	1,1E+07	kt
			Plywood	1900000	kt
			Steel - reinforcing	420000	kt
	Windows	Material transport	Road	5800000	tkm
		UPVC frame, double	Aluminium	11	kt
			DPM/DPC	81	kt
			Glass	13	kt
			Rubber	26	kt
			Sealant	11	kt
			Steel	20	kt
			UPVC	110	kt
Fit out	Air conditioning / ve	Air conditioning and	Plastic	650	t
			Steel	650	t
		Material transport	Road	39000	tkm
	Ceiling finishes	Jointless plasterboar	Mineral fibre tiles	30000	kt
			Paint	240	kt

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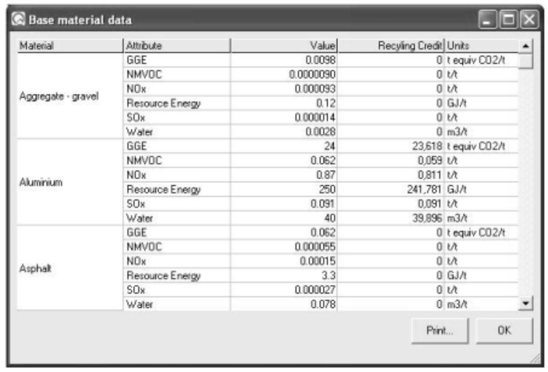
Figure 7: Bill of materials

- Base Materials Data, Figure 8, provide data base information of base materials, such as Aluminium and Asphalt, concerning environmental impacts attribute for instance GGE (Greenhouse Gas Emissions), NMVOC (Non Methane Volatile Organic Compounds), NO_x, Resource Energy, SO_x, and Water, that followed by their respective value and recycling credit.

4.3 LISA APPLICATION CONCLUSION

Project : Office Building
Stage : Construction
Item : Upper Floors/ Frame.



Base material data

Material	Attribute	Value	Recyling Credit	Units
Aggregate - gravel	GGE	0.0098	0	t equiv CO2/t
	NMVOC	0.0000090	0	t/t
	NOx	0.000093	0	t/t
	Resource Energy	0.12	0	GJ/t
	SOx	0.000014	0	t/t
	Water	0.0028	0	m3/t
Aluminium	GGE	24	23,618	t equiv CO2/t
	NMVOC	0.062	0,059	t/t
	NOx	0.87	0,811	t/t
	Resource Energy	250	241,781	GJ/t
	SOx	0.091	0,091	t/t
	Water	40	39,896	m3/t
Asphalt	GGE	0.062	0	t equiv CO2/t
	NMVOC	0.000055	0	t/t
	NOx	0.00015	0	t/t
	Resource Energy	3.3	0	GJ/t
	SOx	0.000027	0	t/t
	Water	0.078	0	m3/t

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Figure 8: Base materials data

Components : Material Transport and Precast Hollow Concrete Core Units.
Materials : Road, Concrete Precast, Concrete Super, Plywood, Steel Reinforcing.

According to Sustainable Architecture that based on cradle to grave paradigm, which is subsequently streamlining the energy, cost and environmental impacts that will be spent and occur along the architectural process, particularly construction process, LISA application can be wrapped up as follow:

- Energy – Sensibility of energy resources usage noticeable provided by LISA, by means of Impact Chart report and LCI data of each item of each stage.

- Cost – Sensibility of cost usage noticeable provided by LISA, by means of Bill of Materials report, Decommissioning and Material Transport of each stage, item, component, and material.

- Environmental Impacts – Sensibility of investigated environmental impacts noticeable provided by LISA, by means of Impact Chart report of:
  1. Energy Resources,
  2. GGE (Greenhouse Gas Emissions),
  3. NO_x,
  4. SO_x,
  5. NMVOC (Non Methane Volatile Organic Compounds),
  6. SPM (Suspended Particular Matter),
  7. Water Consumption.

  On each stage, each item, each component, and each material.

In regard with Grave (i.e. Death) Stage, that embrace renovation and demolition furthermore recycle process, as crucial part of cradle to grave paradigm, LISA sensibly manage them by giving recycling credit to environmental impacts attribute of each base material, Figure 8: Base materials data. Besides intrinsically the building should be designed based on consideration to be renovated, recycled, and furthermore easy and economical to be demolished at the end of building life.

5.0 CONCLUSION

Beneficially, IT (Information Technology) has all potencies needed for streamlining architectural system to be precise architectural process in regard with sustainable architecture, that require sensibility of the process in using various resources, principally in relation to the sustainability of the resources that mostly non–renewable energy resources.

In fact, architectural process has changed consecutively into streamlined one since the shifting of design method from trial and error method into design by drawing method, and since the coming up of sustainable development issues.

However, architectural process in relation to sustainable architecture needs a kind of LCA instrument to assess the sustainability of building. On the other hand, the instrument currently considered to being too complicated and not widely accessible to designers and quantity surveyors besides detailed study of LCA divert attention from the key environmental issues and tend to focus attention on inter–material competition rather than optimum construction systems (LCA – BHP Australia, 2003).

To those extents, streamline computer software LISA offering instrument to simplify the process without avoiding the fundamental objective of sustainable architecture that is constantly concern of energy, cost, and environmental impacts that will be spent and occur along the architectural process that based on cradle to grave paradigm, to be precise along the building life cycle.

As mentioned in the coverage of LISA application conclusion above, besides enabled the architectural process to make occurrence streamlining, LISA enabled the process to reduce the use of energy and cost, and minimize the environmental impacts as well.

6.0 REFERENCES

Abioso, Wanita Subadra (1999), *Kriteria Rancangan Arsitektur Dalam Konteks Pembangunan Berkelanjutan*, Program Magister Teknik Arsitektur, Program Pasca Sarjana, Institut Teknologi Bandung.

BHP Australia (2003), *LCA (Life Cycle Assessment) in Architecture LISA*.

Handler, A. Benjamin (1970), *Systems Approach to Architecture*, New York: American Elsevier Publishing Company, Inc..

Http://buildlca.rmit.edu.au/: *Greening the Building Life Cycle*, *Life Cycle Assessment Tools in Building and Construction*.

Steele, James (1997), *Sustainable Architecture, Principles, Paradigms, and Case Studies*, New York: McGraw–Hill Inc.

Sustainable Architecture and Building Design (SABD), http://arch.hku.hk/research/BEER/sustain.htm

Yeang, Ken (1994), *Designing With Nature, the Ecological Basis for Architectural Design*, New York: McGraw–Hill Inc.

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