Sustainability in Construction: Reduce, Reuse and Recycle for a Greener Qatar

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ABSTRACT

In this paper, an innovative Engineering Sustainability Policy (ESP) and a new Sustainable Engineering Index (SEI) is proposed on the basis of testing results obtained within the context of the DN16 project in the State of Qatar, the largest project of the existing C2 Programme which represents the biggest sewage, drainage, and roads development programme worldwide. The ESP has been developed through a joint effort and active participation by the authors from Ashghal (PWA), the government entity, Arcadis, the consultant (acting from a design and site supervision perspective) and contractor (CCC). The policy refers to the general pillars for sustainable engineering defined by the Institution of Civil Engineers (ICE), which are environmental, financial, and social. Also, it fully aligns and complies with Ashghal and Qatar Vision 2030 regarding sustainability. The proposed policy takes into account a number of areas and aspects across all distinct phases of a project life-cycle, from master-planning to the design phase, from construction to handing over phases. During the testing phase for both the policy and index, the project's CAPEX and OPEX have been monitored throughout and, by adopting the new proposed approach, a decrement of the overall costs has been observed. The new proposed policy and index shall comply with international regulation over sustainable engineering, however they have been primarily designed to integrate existing Ashghal policies and procedures based over the on-going interaction process between major parties involved. Next step will be to define a refined calibration of the suggested SEI using data from a wider pool of projects from a holistic perspective, i.e. from concept to the handing over phase. The newly proposed SEI may be used as an initial effective tool to monitor the sustainability status of every project by means of qualitative interviews with key project people and managers.

Keywords: Sustainability; Sustainable engineer; Sustainability index; Environmental policies; Engineering sustainability policy

1 INTRODUCTION

Looking at most common and recently developed policies and procedures present in the literature in terms of sustainable engineering, the proposed Engineering Sustainability Policy (ESP) and Sustainable Engineering Index (SEI) aim at factoring in theoretical and practical solution elements for sustainable designing and construction used as part of the C2 Programme, in particular for the DN16 Project.

Extrapolating data and information for the DN16 project, the SEI intends to provide a synthetic measure for the overall project sustainability, and it has been developed and calibrated based on interviews and a factor comparison with the teams from Ashghal (Ashghal, 2017), Arcadis and CCC on a joint effort and participation basis.

Given the substantial index independency from any country reference and project type and specifications it can be used globally as well. After a testing phase over the above mentioned C2 programme, a summary log for the key follow-up actions brought to define a new policy (the ESP) that aims at integrating Ashghal Corporate Environmental and Sustainability Policy (1).

Ashghal policy provides statements and guidelines to establish, deploy and maintain a robust and viable environment and sustainability management system across PWA that is compliant with local and international regulations. The purpose of existing Ashghal policy is in fact to provide clear directions to the senior management team and ensure that compliance with local and international standards is achieved and maintained.

The existing Ashghal policy must be followed by all Ashghal team and engaged parties, affairs, projects, PMC, GEC, contractors and subcontractors.

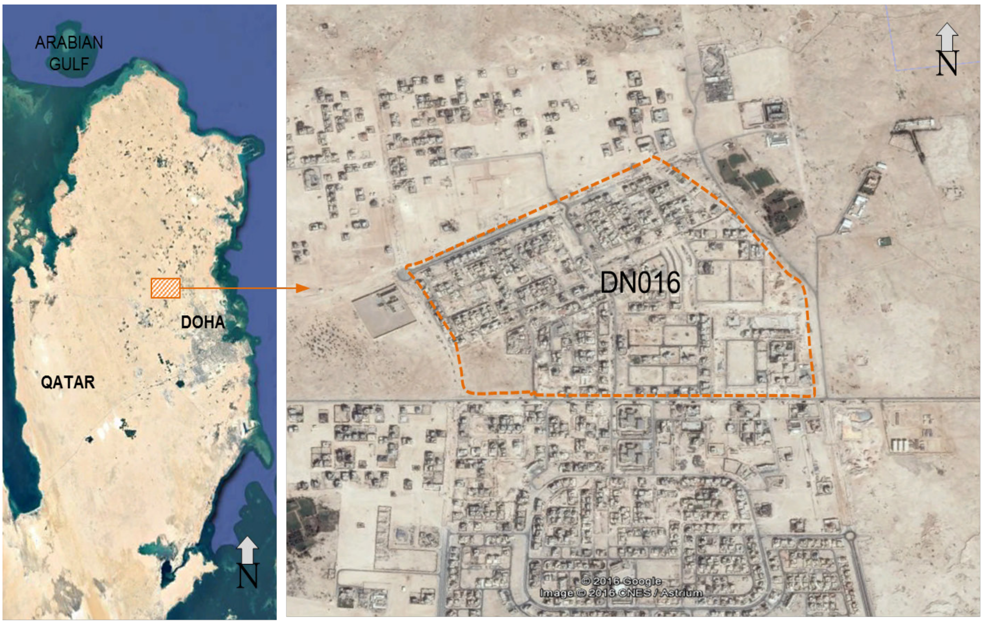

Figure 1: Qatar, Doha- Ashghal DN016 Project, located north east of Celebration Road

2 SUSTANABILE ENGINEERING IN DESIGN SOLUTIONS

Best practices framework and innovative design solutions have been implemented and adopted to maintain the main pillars of sustainable engineering looking at both environmental, economic and social issues (ICE, 2005). The framework provides options and specific action drivers for both installation and on-going maintenance across different areas.

Arcadis has developed the following design principles meant at supporting the highest level of sustainable engineering from a holistic perspective within the project design phase:

1. Sustainable and innovative design based on value engineering fundamentals, with no major design changes associated.
2. Since master-planning stage, minimized design changes over existing utilities and roads in order to minimize noise and disruption for the residents.
3. Reduced material quantities and preferential usage of locally produced or sourced materials in line with Qatar Sustainability Vision 2030 (Qatar Vision, 2008).
4. Optimized water usage across the overall system (focusing on drainage and sewage in particular) minimizing dredging and micro-tunneling structures, and adopting selected open cut solutions and shallower drainage system.
5. Use of gravity systems wherever possible, in order to reduce wide energy consumption.
6. Adopting cost efficiency and optimization tools for roads design and sewage drainage aiming at implementing green design elements whenever / wherever possible, subject to Ashghal design standards.
7. Use of recycled materials, again subject to Ashghal standards.

3 SUSTANABILE ENGINEERING IN CONSTRUCTION

CCC, the contractor, defined the following areas and action points to be referenced to increase sustainability across the project construction phases:

1. Energy efficiency and conservation.
2. Water, wastewater systems and re-use (site has a re-using structure for sewage grey water).
3. Green building (contractors are using sustainable materials on site where cost does not increase, as ecological concrete, low VOC paint, bamboo flooring).
4. Waste reduction and recycling (full paper / paper printing recycling policy on site).
5. Climate-friendly air circulation (air conditions on site are eco-friendly).
6. Renewable energy & low carbon fuels (using sustainable distances and recyclable material).
7. Efficient transportation.
8. Land use and community design (open spaces adopted) and carbon emissions/CO2 offsetting.
9. Common and individual behavior (sustainability and innovative design with value engineering exercises, subject to no major design changes).

In particular, in DN16 the following initiatives are being implemented aimed at maximizing development sustainability and overall programme efficiency during the various project phases, which also enable significant cost savings. Amongst them:

1. Energy savings (installation of solar flashing lights, traffic signs; units and offices being provided with high density insulation to save HVAC units; fully synchronized power houses for energy and power savings).
2. Water and wastewater systems (use of ground water for testing the water structures; use of gravity water supply by building water towers for office premises).
3. Use of air test instead of water test wherever possible.

4. Waste reduction and recycling.
5. No printing on Thursdays.
6. All internal correspondences via e-mailing.
7. Pool transportation.
8. Use of green pickups to reduce carbon emissions.
9. Smart planning for extended hour requirements.

From Table 1, an example of CO2 reduction, using recycled material, has been extrapolated. “Road – general filling to make up levels” has been evaluated. Two options were studied:

1. Using new material imported from Oman.
2. Crushing and recycling the excavated material directly from the same site DN16.

It is worth mentioning that 140,482 m3 of filling materials for the road levels corresponds to 224.771 tons (t). Using crushing and screening CO2 factor equal to 0.003, and considering 12km transportation between DN16 and the plant, emissions of CO2 was calculated as 998 t CO2.

Using completely new materials from Oman, the CO2 emission was much higher, as it was calculated at 2303 t CO2. This resulted in a 1367 T CO2 saving, or 60% of CO2 reduction. This example is used to promote the use of recycled material and/or locally produced abnd sourced materials.

4 THE SUSTAINABLE ENGINEERING INDEX (SEI) AS A KEY ENABLER

In agreement with all parties involved, a Sustainable Engineering Index (SEI) has been developed with matrices and weights for each area in scope (from design to construction) to standardize the quantification of the sustainability value of each project.

Data were calibrated by testing the index in several DN projects, aiming at ensuring robustness and effective validity for the tool, and the objectiveness and efficiency of the tool itself go along its interconnected lines with the Engineering Sustainability Policy (ESP).

A holistic strategy was adopted, new policy elements have been factored in and a scorecard like structure and design used as a starting point with maximum score to be assigned for full sustainable project standing at 100.

Table 1: Qatar, Doha- Ashghal DN016 Project: Minimization example of surplus material on site

Project	Excavated Materials			Fill Materials (IFC Drawings)		Remarks
	Suitable (IFC drawings)			Filling (m3)	Excess Material to be disposed (m3)	
	Disposed of Site (m3)	To be Disposed (m3)	Total (m3)			
DN016						
Roads		68,232	68,232			Road Works Quantities
Utilities for Trenches		198,077	198,077			SWD, FWD & TSE Quantities
Attenuation Tanks		44,194	44,194			Attenuation Tanks
Manholes		44,433	44,433			Manholes, Shafts & Chambers for SWD, FSD & TSE
Roads - General Filling to Make up levels				140,482		Road Works Quantities
Filling for Replacement of Subgrade Material				Included in General Filling above		
General Backfilling in trenches				31,362		Net volume of Filling for All Trench Works
General Backfilling around Manholes				13,384		Net volume of Filling for All Manhole Works
General Backfilling around Attenuation Tanks				8,035		Net volume of Filling for All Attenuation Tanks Works
Filling used for the specified bedding and Surrounds				99,849		
Filling used for the specified granular filling around Manholes				10,951		
Filling used for the specified granular filling around Attenuation Tanks				9,271		
			A	**B**		
			354,936	**313,334**		
				(A - B)	**41,602**	**Surplus Materials On-site**

Table 2: Sustainable Engineering Index (SEI): Structure and design

	AREA	Weight	PWA	Ar-cadis	CCC	Partial Score	Client	Con-sultant	Con-tractor	Partial Index Green
1	Design phase	8	7	7	6	53.33	10	10	10	80
2	Sustainable Design	10	8	9	6	76.67	10	10	10	100
3	Innovative Design	7	6	6	6	42	10	10	10	70
4	Value Engineering in design	9	7	7	6	60	10	10	10	90
5	Design of site office	6	6	6	6	36	10	10	10	60
6	Working remotely	6	6	6	6	36	10	10	10	60
7	Using local resources	10	10	7	6	76.67	10	10	10	100
8	Land use and Community design (Open spaces) Carbon Emissions	5	7	7	6	33.33	10	10	10	50
9	Dust suppression and irrigation water	6	7	7	10	48	10	10	10	60
10	Energy efficiency and Conserva-tion	6	6	6	8	40	10	10	10	60
11	Water and Waste water re-use	7	7	7	10	56.00	10	10	10	70
12	Green building Ecological con-crete, low VOC paint, bamboo floor)	7	7	9	9	58.33	10	10	10	70
13	Waste reduction and recycling (paper recycling policy on site)	9	7	7	7	63	10	10	10	90
14	Climate-friendly air circulation	5	7	6	6	31.67	10	10	10	50
15	Renewable energy & low carbon fuels (using sustainable distances and recyclable material)	7	7	6	8	49	10	10	10	70
16	Efficient transportation	5	7	6	8	35.00	10	10	10	50
17	Common and individual behavior	7	7	7	7	49	10	10	10	70
18	Energy Savings	7	9	9	9	63	10	10	10	70
19	Solar flashing lights and traffic signs	6	6	6	6	36	10	10	10	60
20	high density insulation	6	8	8	6	44.00	10	10	10	60
21	Fully synchronized power houses	6	6	6	6	36	10	10	10	60
22	Use of gravity water supply by building water towers for office	7	6	7	8	49	10	10	10	70
23	Use of air test instead of water test if possible	6	7	7	9	46	10	10	10	60
24	Waste Reduction and Recycling	9	9	9	9	81	10	10	10	90
25	No printing on Thursdays	6	6	8	6	40	10	10	10	60
26	Internal correspondence by email	5	7	6	6	31.67	10	10	10	50
27	Pool transport	5	6	9	6	35.00	10	10	10	50
28	Use of green pickups to reduce Carbon Emissions	6	7	9	9	50	10	10	10	60
29	Smart Planning for extended hour requirements	5	7	7	8	36.67	10	10	10	50
30	Value engineering in construction	8	9	9	9	72	10	10	10	80
		202				48.81				67.33
	Sustainability index =	**72.49**								
		0-39	40-69	70-100						

The SEI is based upon 30 factors that influence the most sustainability engineering objectives and drivers. This applies to the specific DN16 project but ultimately to all other projects in Qatar, and eventually worldwide, given the independence from country risk / country specifications.

The factors were selected and reviewed based on the best practice largely in use across the DN16 project. Each party (i.e. Ashghal, Arcadis, CCC) was interrogated first of all over the weight to assign to each factor and driver, and, in order to make the process as easy as possible, the correspondent scores were set within a 0 to 10 range, and calibrated on a subsequent stage to a “perfect” project where all scores were supposed to be 10.

In such a way, the weights of the factors were set, and they should remain fixed, subject to further enhancement for the scoring formula that can be achieved through recalibrating the tool with a larger data / projects set. After that, at the presence of the all three parties involved, it was assigned a score (that can be changed for each phase of the project, or if any major change will be happening) to Ashghal, Arcadis and CCC for each factors line.

Results ranging from 70 to 100 would assign a Green status / flag to the project as it was the case in this particular testing.

5 CONCLUSION

In summary, using data collected from the DN16 Project as a starting point and a scorecard like approach, a Sustainable Engineering Index (SEI) was developed, and a new Engineering Sustainability Policy (ESP) defined to integrated current guidance embedded in Ashghal policy and standards.

Input from many parties engaged in the project across its al life-cycle was factored in and current industry best practices and local and international regulations and standards, together with cost management aspects, adopted as a reference for both.

DN16 project had a resulting SEI score of 72.49 demonstrating that DN16 is in the range of Green projects, this mainly, thanks to the number of initiatives adopted during the design and construction project phases as to consolidate and sustain sustainable engineering throughout.

Future step would be testing the index on other C2 projects and double check if there is any need for extending or recalibrating the model in terms, for example, of factor weights and score aggregation criteria.

The SEI is meant to provide a high-level quanti-qualitative based measure to evaluate any civil project and mark main sustainability factors to be referenced through the project development and deployment phases.

Moreover, Ashghal is developing an advanced software to capture the reduction in CO_2 emission per activity, tailor made for the Middle East, which could also be integrated as part of the proposed index.

REFERENCES

Ashghal QSD03 Corporate Environmental and Sustainability Policy (2017). PWA, Doha, Qatar.

ICE Sustainability Pillars (2005). ICE Institution Civil Engineers, London, the UK.

Qatar Vision 2030 (2008). Doha, Qatar.

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