Sustainable Supply Chain in Hydropower Development – A Case Study of a 10.5 MW Run-off Scheme

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Introduction

In today's current pace of globalisation, there exist a higher awareness and concern among organizations embracing the notion of sustainability. Environmental and social concerns, together with the effects of global warming and carbon footprints have pushed business organizations to incorporate sustainable agenda in their corporate business strategies.

Sarawak Energy (SE), being an organisation that envisions to be a regional powerhouse and provider of renewable energy for the ASEAN region, has taken steps forward in the sustainability movement particularly embracing the International Hydropower and the United Nations' Sustainable Development Goals (SDG).

The case study outlined in this paper will be focused on the Kota 2 mini hydropower project (HEP), a pilot project undertaken where the best practice initiatives were embedded within the supply chain. The main initiatives within the supply chain are guided by the Hydropower Sustainability Assessment Protocol (HSAP) and related SDGs, namely the SDG 07- Affordable and Clean Energy, SDG-08 Decent Work and Economic Growth, and SDG-13 Climate Action (Figure 1).

Figure 1: Sustainable Development Goals contributing to the Global Sustainable agenda

1. Background

Before going into details on the improvement adopted for the supply chain, it is essential to understand the organisation's project model whereby the initiatives are introduced at different phases of the project, although the total effect of these initiatives will be covered throughout the whole project delivery supply chain.

Given that more than 70 percent of the electricity generation mix is sourced from hydropower, SE has partnered up as a platinum member with the International Hydropower Association (IHA) and has committed to be guided by the HSAP. In 2014 an overview mapping of the HSAP and SE's Project Model (SPM) was conducted at the project development level (Figure 2). The aim was to identify the protocol topics and locate them to the relevant project stage - Initiation, Concept, Pre-Engineering and Execution. (Figure 3). This would also result in the streamlining of the role and responsibilities, key activities and deliverables of different stages. This was one of the many initiatives conducted to improve the corporate sustainability performance of SE.

Also in 2014, SE rolled out its first sustainability report in efforts to be more open with its governance practices and its business strategies towards the commitment to sustainability; it is worth mentioning that the sustainability reporting for SE is done on a voluntary basis.

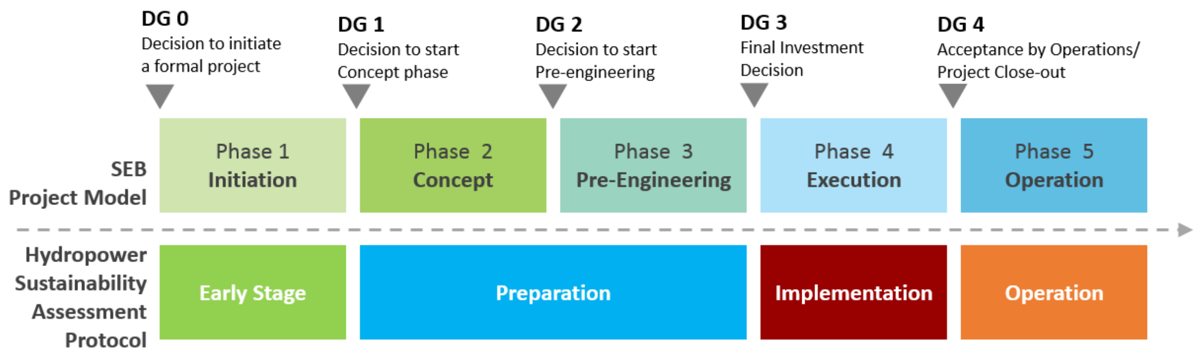

Figure 2: Overview Mapping of the HSAP and SPM

Protocol Assessment Tools	Early Stage	Preparation Stage		Implementation	Operation
Activities under SPM	**Initiation**	**Concept**	**Pre-Engineering**	**Execution**	**Operation**
Engineering Works*	ES1, ES2, ES3, ES4, ES5, ES6	P3, P4, P6, P7, P8, P15, P17, P19, P20, P22, P23	P3, P4, P7, P8, P19, P20, P22, P23	I5	-
Site Investigation	ES2, ES7, ES8	P1, P4, P7, P15, P17, P19	-	-	-
Project Control	-	P6	P6, P22	I1, I2, I4, I7, I8, I10, I13, I16, I17, I18, I19, I20	-
Land Issues	-	P4		I11	-
Permitting	-	P2	P6	-	-
Social & Environment	-	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P17, P18, P19, P20, P21, P22, P23	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P17, P18, P19, P20, P21, P22, P23	I3, I9, I15	-
Contract Planning & Strategy	-	P4, P8, P12, P16, P18, P19	P6, P12	I8	-
Health, Safety & Environment	-	P4, P8, P16, P18	P4, P8, P16, P18	I12, I14	-
Financial Analysis	-	P3, P9, P11	P3, P9, P11	I6	-
Business Case	ES1, ES2, ES3, ES4, ES5, ES6, ES7, ES8	P3, P4, P6, P7, P9, P10, P11	P3, P4, P5, P6, P7, P9, P10, P11, P13, P14, P15, P17, P18, P19, P20, P22, P23	-	-
Hydropower Plant Operation	-	-	-	-	O1, O2, O3, O4, O5, O6, O7, O8, O9, O10, O11, O12, O13, O14, O15, O16, O17, O18, O19

Figure 3: Identified HSAP topics against the activities under SPM

2. Main Drivers within the Supply Chain

A Supply Chain Management is commonly understood as the process of having materials, services and information exchanged in the pursuit of product delivery. In the case of SE's project, this translates to the complex collaboration between the many members ranging from consultants, contractors, suppliers, vendors, governmental bodies and the organisation's internal departments (within the chain) that starts from project identification to the delivery of the product at the end of the project execution phase.

In the effort to enhance the sustainability and added value creation within the project supply chain, the management embarked in making improvements in 3 main areas: Procurements, Social and Environmental Impact Study and the capacity building agenda (Figure 4).

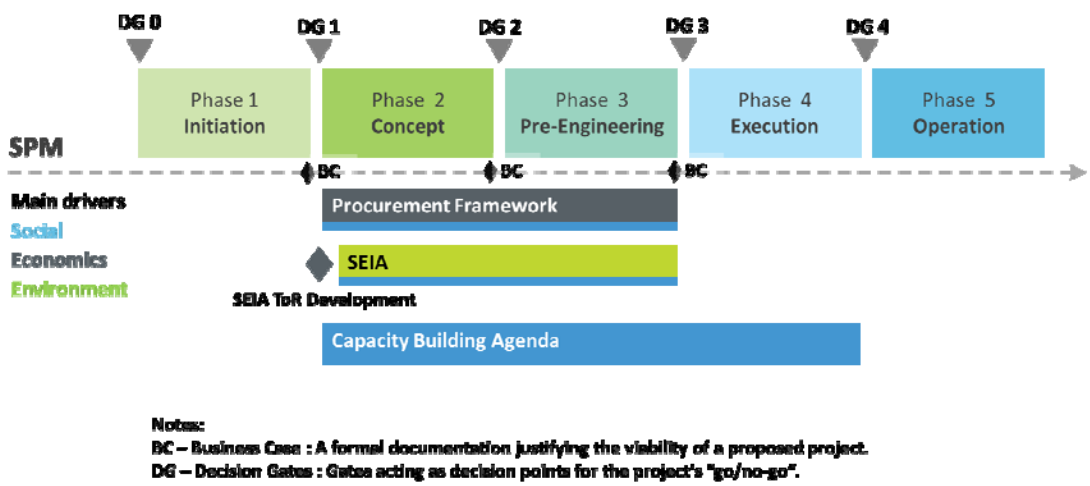

Figure 4: The main drivers throughout the different phases of the SPM

These three initiatives, acting as the main drivers within the project model, streamlines the decision making in regards of the economics, environmental and social aspects of projects.

2.1 Procurement Framework:
One of the first initiatives adopted in the supply chain was introducing a more robust procurement framework that was developed by the organisations 4 main procurement guiding principles, namely, Best Value for Money, Open and Effective Competition, Impartiality and Transparency of Process and Enhance Opportunity for Local Content. The enhanced procurement process was to ensure sustainability was captured at the early stages from developing strategic procurement techniques to the execution of the deliverables of the project which integrates all the requirements and specifications that revolves around aspects of economics, social and environmental.

The development of the procurement framework is also aligned with SDG #08 Decent Work and Economic Growth in which SE could play its role in stimulating the local economy, by opening up opportunities to the local contractors. It is well intended that this initiative would provide job creations to the locals and at the same time a platform to drive the economic development in a more environmental-friendly manner.

2.2 Social and Environmental Impact Studies Terms of Reference (ToR):
Guided by international standards, mainly the HSAP, a high level Terms of Reference for the Social and Environmental Impact Assessment was developed to be used for all hydropower projects. The newly developed ToR drew on the lessons learned from SE's previous hydropower project, and also the organisations past and recent environmental and social experiences. In addition, the purpose of the ToR is to ensure that the social and environmental considerations are identified at the earliest stage, and integrated in a timely fashion when necessary.

The mainstreaming of the ToR for all the hydropower projects also meant to be a step forward in the process of developing a more comprehensive SEIA framework that would provide information and analysis to a more integrated platform, thus assisting future environmental and social assessments, plans and policies, in view of the diversity arising from individual projects of different localities.

2.3 Capacity Building Agenda:
SE recognises that the challenge it faces in pushing for sustainability in the supply chain is with the complex relationship between all the stakeholders within the chain. Being the forefront organisation in pushing for sustainability, SE has committed to ensure a growth in capacity building as a way to address the common understanding and expectation from various parties, in regards to the sustainability aspect.

Through this effort, SE will be able to contribute to the SDG #08 target where it is intended to promote development-oriented policies that support productive activities. Higher productivity can be achieved by investing more resources into human capital, from having training programmes for the employees and workshops with the external parties such as the contractors and consultants.

3. A case study of the Kota 2 Mini HEP, Lawas, Sarawak, Malaysia.

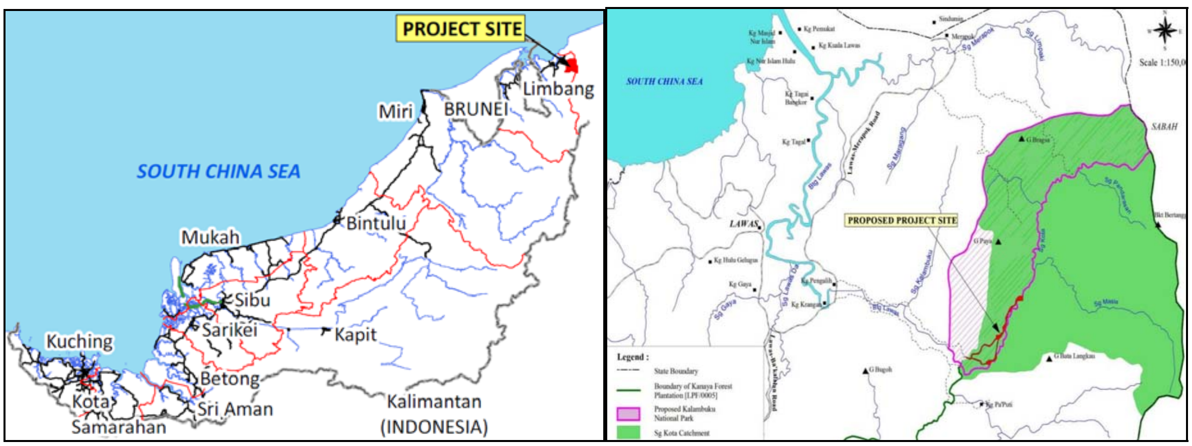

Figure 5. Map showing the location of Kota 2 HEP

The Kota 2 Mini HEP is one of the many hydropower generation projects embarked upon by Sarawak Energy with a capacity of 10.5 MW and a weir height of 5 meters located on the Sungai Kota, a branch of the Batang Lawas, within the Lawas District, Sarawak, Malaysia. With reference to Figure 5, the site is located approximately 17 kilometers (in a straight line) and 25 kilometers by road east-south-east of the Lawas town. The project consists of a run-of-river scheme with a 3 x 3.5MW surface power station, supplied from the low weir and an above ground waterway of 4.5 km long.

The key business case in pursuing Kota 2 Mini HEP is to displace costly diesel generation for the Lawas Town and its surrounding region, with a less expensive, cleaner means of generation. Hydropower was chosen as the most viable option not only as it was a renewable energy source, it was also a decision to contribute to the reduction of greenhouse gasses and carbon footprint, aligned with the SDG #13. The usage of the renewable energy for power generation is also aligned with the Malaysian Federal Government's fuel diversification Policy, National Green Technology Policy, the Third Outline Perspective Plan for 2001 – 2010 (Opp3) and the 11th Malaysia Plan which promote greater usage of renewable energy for generation of power and by industries. This is also an initiative from SE to support Malaysia's obligation as a party of UNFCCC, where Malaysia is committed in combating climate change by voluntarily reducing its emission intensity by up to 45%, based on year 2005 levels, by 2030 (Ministry of International Trade and Industry, 2017).

The Kota 2 HEP project was chosen as a case study for this write-up given its standing as the first HEP in SE to utilise the new contract and procurement process, SEIA ToR and the agenda for knowledge transfer and capacity development. In comparison to other mega generating projects, Kota 2 was best fit as a pilot study as the simpler stakeholder relationship and the smaller size of the project meant that it was simpler to cover the end to end process of the supply chain.

3.1 Economics of the Project

As discussed previously, the 10.5 MW Kota 2 HEP's primary function was to offset the diesel generation for the isolated grid of Lawas town, which is in combination with the existing 2 mini hydropowers, for a medium term of about 15 years. There will be further plans to connect Lawas to the main grid through the Northern Agenda Transmission plan, as well as considerations for a larger capacity hydropower within the region. The customer load demands at Lawas have been suppressed by the limitations of the existing diesel generating stations supplying electricity to the town. Lawas town is currently experiencing a peak load of approximately 7.5MW, and the current generation mix is as follows:

- Diesel; fuel cost of RM 21.5 million to generate an average 4.2 MW
- Mini hydropower 1 contributing an average of 0.6 MW
- Mini hydropower 2 contributing an average of 0.6 MW

The Kota 2 Hydro Project is found to provide the lowest cost additional energy to displace the diesel consumption with a very competitive levelised cost of energy, aligning to the SDG #07. Given the longer term plans to connect the town to the main grid, it was imperative that the project be fast tracked, to optimize the savings generated from displacing the diesel usage. Not only was it a strategic decision financially, to proceed with the project, in line with the commitments to the sustainability agenda, the amount of diesel displaced would mean a large amount of CO_2 reduction. This is again coherent to the SDG #13 Climate Action where increasing the current generation mix which is heavily reliant on diesel plant, to hydropower, marking one of the roles SE plays in reducing impact contributing to climate change.

Studies have shown that the average annual potential diesel savings is calculated to be a little over 30 million Malaysian Ringgit. By assuming this and an average diesel price of RM1.85 per litre, translated to a reduction of about 16 million litres of diesel being consumed. It is anticipated the displacement of diesel could reduce up to 44,548 tonne of CO_2 per year thus able to reduce the CO_2 intensity for the Lawas Grid which is currently running at 0.66tCO_2 eq/MWh (based on data as of 2016)

3.2 Implementation of the main drivers within the project

3.2.1 Design Optimisation and Value Engineering

Optimisation of design and value engineering within the supply chain is crucial as it helps in realising not only cost improvements, material optimisation and waste reduction but also enhances the project best value.

For the case of Kota 2 HEP, a concept study for the HEP was completed in 2013 which delved into three different options along Sungai Kota. It was finalised within the Concept study that the current location for the Kota 2 HEP was best fit technically, given that there were no significant differences in terms of environmental and social impact compared to the other two options. The project then went on to the pre-engineering stage, of which the works were mainly to finalise the tender design, drawings and specifications as input to the Contract documents.

The concept design initially marked the project to be of a 23 meter high dam, with a live storage of 321,300 m^3.

Following this, the Owner's Engineer proceeded to do a value engineering of the final design and proposed a river run-off design maintaining the same generating capacity but with lower weir height of 5 meters.

Incorporated within the new Contract document is also a clause on Value Engineering for Contractors. This clause serves as platform for the Contactor to propose variations to the tender design to which they see value in terms of cost, schedule and quality of the project.

The Main Contractor for Kota 2 took the opportunity of the value engineering clause and proposed a few design changes to the project, having conducted a detailed Site and Soil Investigation works. The changes included the following:

- Road re-alignment – Although there were differences in the total distance, the Contractor has managed to reduce a large amount of excavation and minimised embankment fill works through the re-alignment.
- Weir and Powerhouse location – The Contractor has proposed for the weir and subsequently the powerhouse to be located further upstream to which also resulted in less excavation works.

The decision was strongly supported by the local authorities, as it was considered unfavourable to construct by creating massive cut in the steep hills for locations within or close to the river. The optimisation in the slope works and the reduction in excavation had a positive impact towards the environmental aspect, as it meant less deforestation and less potential erosion entering the Sungai Kota.

3.2.2 Procurement Process and Strategy

3.2.2.1 Project Delivery and Contract Strategy

It is vital that the successful delivery of the project is guided by the most optimal contract model. Given the fast track expectations for the project to meet it strategic needs, an Engineering, Procurement, Construction (EPC) strategy was adopted. The single EPC contract for both the design and construction was to avoid complex interfacing issues between contractor parties.

3.2.2.2 Procurement Process

Incorporating, at that point of time in 2014, a newly rolled out tender process and format, the project went through the main stages of design development, tendering and evaluation. It was decided very early that due to the nature and size of the project, a mini hydropower will be open tendered specifically to attract Sarawak based Contractors who would meet a certain set of requirements which included experience in completing works relevant to mini hydropowers. This was also in efforts to increase the local contractors' portfolio, for future hydropower works within the State. Building up the capacity of the contractors would mean building up the list of viable local contractors and not relying on external workforce in the future.

Prior to the development of the tender documents, Sarawak Energy appointed an international Consultant to fill up the role of an Owner's Engineer, where the responsibility would range from conducting the concept design (pre Decision Gate 2), which were main elements in the tender documents, to the due diligence on the technical evaluation stage.

The tender went on to receive a good number of local bidders and the process proceeded with a 4 stage evaluation session, explained as follows:

Stage 1 – Initial Screening
The Initial Screening stage is conducted mainly to screen through the tenderer's submission which includes a completeness checking of documentations and requirements.

Stage 2 & 3– Detailed Evaluation
The 2nd and 3rd stage of the evaluation involved a more detailed review of the technical & financial review, questionnaire preparation, clarification meeting, field audit and also the shortlisting of the recommended tenderers to be submitted to the SE Higher Management for endorsement and approval.

Stage 4 – Final Clarification
The last stage in the process, and is aimed at finalising the commercial aspects of the tendered bid, and also for the Contract Award with the recommended and approved tenderer.

The whole process were conducted with pre-determined evaluation criteria and expectations, in view to determine the tenders that represent the best of value for the project aligned with the procurement process guiding principles.

3.3 Job creations

One of the main intentions of the project was to also stir job creations for the locals especially during the construction stages of the project. The execution of the Kota 2 has proven this as a few areas has had higher local contributions, namely in the following areas:

- **Construction material supply** – Despite not being able to have the materials fully supplied from within Sarawak, there was still a high percentage of the supply of ready mixed concrete, raw sand materials and stones from the local suppliers.
- **Local Manpower** – Locals have been employed for site works, which included the works of lorry and heavy machinery operators, security, as well as supervision works.
- **Sub-contractors** – Local sub-contractors were also taken for the smaller packaged works, under the Main Contractor. 10 out of the 12 appointed subcontractors are locally based within Sarawak.
- Food supply – Local food vendors were taken in to supply raw food materials for the duration of the project construction.

During the current peak period of construction, the project records not less than 300 employees on-site, and with Lawas being only 25-km away, the increase in population will stir more economic activities within the town itself.

3.4 Social and Environment Impact Assessment

Kota 2 Mini HEP adopted the hydropower SEIA Term of Reference (ToR), which was mainly guided by the HSAP. The integrated ToR linked the current format required for EIA, which was limited to only complying to the state legislative requirements, to the applicable assessment topics of the Protocol. 23 applicable preparation stage assessment topics from the HSAP was embedded into the ToR and was aimed to assist SE in assessing, planning, mitigating impacts, and providing a basis for the monitoring plans during the construction stage. An accredited third party reviewer was then brought in to review the findings of the SEIA in comparison to the Term of References, and the feedback review were to be adopted as necessary by the consultant. One of the major product of this integration was the determination of the downstream flow criteria, which was not identified within the previous EIA format.

3.5 Capacity Building

Despite the size of the project when compared to other mega hydropower developed by SE, the transfer of information and services within the Kota 2 project still poses a challenge, especially in the organisation's move for a more integrated information flow within the supply chain. Managing a number of stakeholders would involve ensuring that everyone was on the same understanding and expectation.

Within Kota 2, the main participants of capacity building within the supply chain are the first tier members, of which are mostly new to the idea of sustainability and management of the supply chain. These members are identified as follows:

- Sarawak Energy Inter departments – consisting of the project team, and other functional departments, i.e. Environmental, Corporate Sustainability, Legal, Corporate Risk etc.
- Main EPC Contractor
- Consultants – SEIA Consultant and the Owner's Engineer

A shift in culture and mindset is essential when organisations roll out new agendas. To address the different participants of the chain, and to ensure clear expectations are communicated, efficient knowledge transfer and capacity building throughout for Kota 2, Sarawak Energy embarked on various initiatives.

- **Internal training** – Internal capacity building is of utmost importance as the employees will be the front liners when dealing with the other participants of the supply chain, as well as moving the sustainability agenda forward. A team of internally trained assessors was formed that came from various background cross-functionally within the organisation. The assessors were mainly trained to understand and undertake the embedded best practices which would subsequently contribute to the enhancement of the supply chain.

- **Workshops and Third Party Reviewers** – To address the awareness and the knowledge gap with the SEIA Consultants and Design Consultants, workshops were conducted to clarify objectives or to communicate strategies in ensuring that the parties were of common understanding. In the case of the SEIA, in efforts to be aligned with the best practices (guided by IHA protocol), a certified third party reviewer was brought in to review the findings of the SEIA study and to comment on their framework and methodology, reviewing the alignment against the required Terms of Reference.

- **Knowledge Transfer** – The main knowledge transfer was aimed for the Contractor that had limited experience in constructing hydropower projects. It was decided to extend the services of the Owner's Engineers from the initial scope of concept and tender design, which included the services for technical evaluation in the procurement process, design review and verification during construction stage. This would create a platform for the Contractor to build up their capabilities learning from a Consultant that had extensive experience in hydropower construction. Given the Contractor's experience in the hydropower field, it was supported that they partner up with an experienced international Mechanical and Electrical supplier, which then created a whole new platform for knowledge transfer as they collaborate in delivering the project outcome.

3.7 Risks and Opportunities Management

All construction projects in Sarawak Energy goes through the decision gate process by which their validity and maturity is checked prior to approval. At different gates, the project will be screened for both its risk and opportunities. As of the case of Kota 2, it was very clear to proceed with a project that displaces the expensive diesel usage with a hydropower option. Through the screening process, together with the organisation's agenda of adopting sustainable projects, a decision was made to leverage on the opportunity of building up the experience of local contractors as well as job creations through this project.

Risk and opportunity management commences during the development of the project proposal and continues throughout the project cycle until project delivery (Figure 6). This was also made compulsory to the Contractor through the specifications within the new Contract format. Apart from having monthly risk meetings, it was also a requirement for the Contractor to develop their risk management plan and to update the plans as necessary. The monthly meeting sessions with the Contractor was used as a platform to identify any opportunities that can be acted upon.

Figure 6: Managing Risks and Opportunities process in the project cycle

3.8 Findings and Challenges

Having embedded three main initiatives and improvements throughout the execution of the Kota 2 Mini HEP, it can be summarised that the challenges are of the following common issues:

- **Sustainability Awareness** – Whilst there seem to be an improvement in the awareness in regards of sustainability and the participants' general role within the chain, it has become clear that the knowledge and practicality of embedding sustainability is still low and certain decisions that tends towards upholding sustainability are still met with reluctance, as the mind-set of 'cost-savings only'' is still quite strong.

- **Contractor's Experience** – The Kota 2 Mini HEP was a first full hydropower package undertaken by the Main Contractor, and they experienced some issues co-ordinating between their internal designers, equipment manufacturers and their on-site construction workers.

- **Working Culture** - Kota 2 Mini HEP was categorised as a fast track project, as it was imperative to leverage on the diesel displacement as soon as possible. The issues faced on site such due to geological and weather conditions, led to the need of working in shifts, rather than the typical 8-hour per day which is widely practiced by the local construction industry, hence one of the manpower issues faced by the Contractor.

- **Capacity building framework** – Setting up the internal training, workshops and the knowledge transfer platform was a good move towards capacity building however findings have shown that the lack of continuity and a well-integrated framework to keep the momentum of the initiative was one of the reasons that the initiative was not fully satisfied.

4. Conclusion and Lessons Learned

- Learning from the case study of Kota 2, it is vital to create a common and broader understanding not only within the organisation itself, but also to the other stakeholders within the chain. The lessons learnt from this project also highlighted the need of having a performance measurement indicator system, that can be utilised to quantify and gauge the company's performance when adopting various best practices.

- SE took the bold step of creating the opportunity for local contractors to construct the project, with the knowledge of having contractors with limited hydropower project experience. Regardless, the journey of capacity building is of essence in which the local Contractors and Consultants have benefitted from the exposure and would move forward to improve their standing in relevance to being part of sustainable projects. It has to be engrained in all the participants in the supply chain that sustainability is not just about being 'green' as any decision made throughout the chain would have cause and effects.

- The sustainability supply chain in SE will continue to perform comprehensive assessments with consideration of risk and opportunities in maximising project benefits and lessons from this pilot project will be fed back into the system and be built upon for incoming projects. The organisation will also continue its journey to strive for the optimal alignment of embedding sustainability into its core business strategy and implementation, which will be streamlined with all other departmental functions.

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Mohd. Firdaus graduated in the Bachelor Degree of Civil Engineering and Corporate Masters in Business Administration from the University Malaysia Sarawak, Malaysia. He is currently being stationed on site as part of the project management team for the construction of a 10 MW HEP, and is in charge of the quality control and assurance of one of the project work packages. His experience includes involvement in different phases of hydropower progress, such as planning, tender design, as well as feasibility studies for other hydropower projects.