A Conceptual Framework to Analyzing and Optimizing the Environmental Input – Output Value Chain; a Case Study: Public Water Supply System in Hilla City

Ahmed Talib Sahib Auda
E. Mail: ahmedts61@yahoo.com
Lecturer - Environment Department - College of Engineering - Babylon University

Abstract

Value chain analysis has been increasingly recognized in recent years as an important tool in development and environmental research. It has dramatically changed over time, and has expanded due to the internationalization and globalization process. Question is a complex issue involving problems of natural resources conservation as well as general issues.

To evaluate the system different kinds of factors and methods collected and compared to measure the macro impact level for public water supply in Hilla city. Questionnaire data permit objective assessment of larger scale pattern, trends and relationships, focus on the actions and activities to check the reliability to formulate decisions on environmental problems. Preliminary assessment during 2012 indicated that no adverse impacts on public health or environment were observed. Interrelationships produced a nonmathematical model which show that environmental value chain of water supply of 86 %, with impact 14 % in the survey level, over a period of one year. Five factors incorporated in optimizing water supply chain operations to cost less and be more effective, represent by: Quality (85 %), Accessibility (95 %) , Feasibility (85 %), Flexibility (74 %), Current time and future (78 %).

Keywords: Value chain analysis; Water supply; Input – Output; Framework; Impact assessment; Optimize.

المفاهيم الهيكلية لتحليل وتحسين مراحل القيم البيئية للمداخل والمخارج

منطقة الدراسة : نظام ماء الشرب في مدينة الحلة

أحمد طالب صاحب عودة

مدرس , قسم البيئة – كلية الهندسة – جامعة بابل

الخلاصة

تحليل تسلسل القيمة استخدمت بشكل متسارع حاليا كأداة مهمة في التطور والبحث , وقد تغيرت وتمددت كثيرا مع الوقت نتيجة تدويلها عالميا. والتقصي قضية معقدة تشمل مشاكل الحفاظ على الموارد الطبيعية والقضايا العامة.

لتقييم النظام مختلف أنواع المعايير والطرق جمعت وقورنت لقياس المستوى العياني لماء الشرب العام في مدينة الحلة , فاستعملت استمارة الاستبيان للتقييم الهادف لنموذج ذو قياس كبير ، الاتجاه والعلاقة , مركزةً على ماذا يجب ان نفعل لفحص الفعالية لصياغة القرارات لمشاكل البيئة. التقييم التمهيدي خلال عام 2012 أظهر عدم وجود تأثير معاكس على الصحة العامة أو البيئة. والعلاقات المتبادلة أنتجت نموذج غير رياضي ذا تسلسل قيمة بيئية لماء الشرب تعداده 86 % , بتأثير 14 % على

مستوى المسح لعام كامل. وان تجمع خمسة عوامل يساعد في تحسين تشغيل اولويات ماء الشرب لتقليل الكلف وزيادة الكفاءة تتمثل: بالنوعية (85 %), سهولة الوصول (95 %), الملائمة (85 %), المرونة (74 %), الزمن الحالي والمستقبلي (74%).

Introduction

Production and consumption activities create waste that is costly to handle and environmentally damaging (Masters, 2005; Sincero and Gregoria 2010). Since the last two decades there has been an increasing effort to examine better approaches and logistics systems to reduce congestion, conserve natural resources and reduce emission (Canter and Kamath, 1995; Henry and Gary, 2009). Before the First World War, rapid industrialization and urbanization in western countries was causing rapid loss of natural resources. This continued to the period after the Second World War giving rise to concerns for pollution, quality of life and environmental stress (OECD, 1996). Almost 20% of the papers published in the field of value chains in 2009 were directly related to the environment. In the past, the conventional analysis of value chains focused mainly on calculating the value added and its distribution on different value chain actors (Michelle, 2001; Anja et al., 2011).

Questions in the Value chain analysis (VCA) requires additional valuation techniques estimating environmental costs and benefits. These developments have strong implications on the choice of analysis method or physical flows of natural resources (Grote et al., 2007; Henry and Gary, 2009; Anja et al., 2011). Methods for environmental VCA have been designed to measures input-output flows that provides a very good basis for identifying the right methodologies for answering urgent questions around environment (Bair, 2005; Anja et al., 2011).

The present study aims to getting a tool that can be used to develop a conceptual framework that can present a methodology for formulating and analyzing environmental value chain at the system level, based on modeling techniques to safeguard the environment in any development, which applied as a case study for public water supply in Hilla city.

Environmental value chain analysis

Value chain defined as a description of “the full range of activities, which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), be delivered to final consumers, and final disposal after use” (Kaplinsky and Morris, 2002). Awareness of the often conflicting, goals and objectives allows for the appropriate values to be placed to minimize waste, make profits or limit costs (Ishii, 2000).

Environmental VCA emphasize on physical accounting in contrast to economic VCA (Finnveden and Moberg, 2005). There are several limitations to the implementation and interpretation of value chain analysis. Methods to evaluate a potentially harmful output of a value chain or its negative or positive impact on the environment are highly demanded in recent years. The input and output chains comprise more than one channel and these channels can also supply more than one final (Pacifica, 2007; Henry and Gary, 2009). Value chain analysis is neither an exact science nor is it easy, it is more art than preparing precise accounting reports. Despite the calculation difficulties, value chain analysis can yield firms invaluable information on their competitive situation, cost structure, and linkages with suppliers and customers. Value chain thinking requires a shift in emphasis, away from supply chains to value chains and the thinking that goes with it (Shank and Govindarajan, 1993).

Environmental impact assessment

Environmental Impact Assessment (EIA) can broadly be defined as a study of the effects of a proposed project, plan or program on the environment (Pacifica, 2007), also is a activity designed to identify and predict the impact on the biogeophysical environment and on human health and well-being (Henry and Gary, 2009). Impact assessments are carried out to assess the consequences of individual projects. The principle aim of an Environmental Impact Assessment is “to give the environment its due place in the decision-making process by clearly evaluating the environmental consequences of a proposed activity before action is taken (Gilpin, 1995). Environmental Assessment may be quite complex, especially if applying to broad policies and large sector programs. (Morris and Therivel, 1995; FAO, 2012).

To make an environmental impact assessment of a given production and consumption system, it is necessary to analyze the relationship between what this system assimilates in terms of environmental resources on one hand (inputs), and on the other hand, what this system release in terms of several emissions (outputs), which can be chemical and / or physical agents, like substances, noise, odours, etc.. Phases**,** possibilities, weak points, tools**,** and assessment through stages include (Michelle, 2001). EIA can be a useful tool in identifying different types of interventions which might be desirable at different levels of the chain. It provides a practical focus for stakeholders to discuss their common or conflicting perspectives and a benchmark framework against which impacts and contextual changes can be identified (Morris and Therivel, 1995; Kaplinsky and Morris, 2000). This is particularly useful since it is typically much easier to prevent problems from occurring in the design of the development than correcting problems after the development is built (Smit and Spalding, 1995; Canter and Kamath, 1995). If the impacts identified can then be classified as sever, moderate, slight, and zero, or a numerical scheme may be used (Henry and Gary, 2009).

Flow diagram overview of environmental value chain

Value chains analysis can be a participatory and empowering process, by using maps and diagrams. In its simplest form bring together with knowledge of different levels of the chain to construct a standard flow mapping. This map identifies the main activities in the chains, their geographical spread, and a rough idea of the relative size and importance of each element, explain how strategies at one level impact on others and existing or potential relationships between enterprises on the same level (Kaplinsky and Morris, 2000).

Flow diagrams are sometimes used to identify action effect impact relationships, and permits the analyst to visualize the connection between action and impact. The method is best suited to single project assessments **(**Shank and Govindarajan, 1993), as summarised in Figures 1.

Input – output analysis has been used around the world at both the national and regional levels, by highly developed and underdeveloped nations. The basis of input – output analysis is the table design which shows how inputs is distributed to be used as outputs (Wu and Coppims, 1981).

Research method and data sources survey

The variety of methods used to assess is very large. The assessor has a number of techniques that he may use for gathering and synthesizing information like: Field surveys, Modeling, Monitoring, Agency guidelines, Literature searches , Workshops, Interviews with specialists, Public opinion polls (Kaplinsky and Morris, 2002; UNEP, 2002).

Questionnaire quantitative data permit a more objective assessment and facilitate an assessment of larger-scale patterns, trends and relationships among different value chain actors, focus on what are doing to check the reliability of data and gave more insight into why actors are doing what they do and how they formulate their decisions on environmental problems (Rebitzer et al. ,2004; Henry and Gary, 2009).

Case study: public water supply in Hilla city

The methodological approach was grounded on actual case study and associated with field work , data collection and segregation. The selection of indicators consists of the description of environmental impacts and benefits relevant to each stage. The water supply chain model analyzed by functions, key, stakeholders, opportunities, constrains, and the value chain development strategy.

Hilla city area is equal to 55 km^2 contains 60 residential areas with population of 258568 capita (Babylon statistics office, 1997), located on both sides of the river (Katib, 1974). The Iraqi environmental legislations protect and enhance the river from pollution, which regarded the main source for water supply (Environmental legislations, 1998). There are three plants in Hilla city for treating raw water: the old (3600 m^3/h) , the new (6000 m^3/h), and al-Teyara (760 m^3/h) projects, connected together with one distribution system. The treatment done by using physical and chemical processes includes screening, coagulation and flocculation mixing, sedimentation, filtration, and disinfection with chlorine, provide 250 L/capita/day for person after cutting losses and other uses (Babylon water office, 2012).

The information was collected over a period of one year of 2012. Comprehensive lists of environmental effects and impact indicators designed to stimulate and think broadly about possible consequences of actions, to detect the full range of important elements and combinations of elements. The task of avoiding double counting of effects and impacts is difficult because of the many interrelationships existing in the environment.

The EIA process begin by gathering information on the environmental problem and analysis stages for each node. During these phases, specific indicators tracking environmental performance was monitored and opportunities for improve was evaluated as shown in Tables 1, 2, and 3, and Figures (2). Interrelationships produced a nonmathematical modeling which show that environmental value chain of water supply of 86 %, with impact 14 % in the macro level survey over a period of one year of 2012, due to:

a. Ability to define delivery complex, and lack of Innovation in water treatment technologies.

b. Inefficient water storage infrastructure is a major concern, which prevents transfer of water for far region locations, which causes high energy demand for water pumping. Solar pump uses in water supply and treatment schemes not addressing by water projects.

c. Impact of local changes to the supply chain and Sustainability of water resources.

d. Absence of loss monitoring and subsequent reduction scheme, and restoration of water bodies.

e. Deterioration of groundwater quality.

f. Absence of sludge treatment and cleaning technologies, and poor maintenance of systems.

i. Large industrial users of water.

g. Old pipes networks in most city.

Conclusions

1. Preliminary assessment for the environmental value chain of the public water supply in Hilla city during 2012, pull out from Questionnaire have no adverse impacts on public health or environment.
2. Interrelationships produced a nonmathematical modeling which show that environmental value chain of water supply of 86 %, with impact 14 % in the macro level survey over a period of one year of 2012.
3. Design questionnaire permit objective assessment of larger scale patterns to any project for formulating decisions on environmental value chain problems. Approach is grounded on case study and associated with field work. Five factors incorporated in optimizing water supply chain operations for less cost and be more effective, representation water supply in Hilla city : Quality (85 %), Accessibility (95 %) , Reliability (Feasibility) (85 %), Flexibility (74 %), Current time and Future (78 %).

4. The functions in water include input supply, abstraction, treatment, storage, distribution, and consumption.
5. Inefficient management structure and old systems which lead to higher level of operating and maintenance costs.
6. Consumers not satisfied with current services and are not willing to pay higher tariffs.
7. Data collection and results outcome pulled out from questionnaire presented that it must develop take on future sustainability practices.
8. Different methodologies and concepts are available to analyze different aspects of value chains. One of them EIA process which is necessary in providing an anticipatory and preventive mechanism for environmental management and protection in any development.

Recommendations

For operation staff of treatment plants and future studies there is necessity to argue:
1.Countries must have environmental laws and multilateral included VCA, EIA and LCA requirements in their project eligibility criteria. Value chains and their changes over time are rarely analyzed. Comparisons of the same value chain in the present compared to the past and its conception of causal relation have not been done.
2. There is uncertainty on how best to do, so economists and ecologists most work together for design and build for long useful service life.
3. All political, technical and social developments can easily be evaluated in the light of chain analysis by arguments of needs and limits. Any development should help fulfill needs and should not increase limitations.
4. Culture should tends to look overall of things, and put the changes in the external environment and internal structure as priority**.**
5. Opportunities for future research may lead to value chain improvements, by the ability to define complex delivery schedules based on a calendar.

References

Anja, C. Fasse, Ulrike Grote, and Etti Winter, 2011 , " Recent developments in applying environmental value chain analysis", Environmental Economics, Germany, 2 (3), 74 – 86

Babylon statistic office, 1997, Central statistic chamber, Babylon, Iraq.

Babylon water administration, 2013, Statistic chamber, Babylon, Iraq.

Bair, J. , 2005, " Global Capitalism and Commodity Chains: Looking Back, Going Forward", Competition &Change, 9 (2) , 153-180.

Canter, L.W. and Kamath, J., 1995, " Questionnaire for cumulative impacts", Environmental Impact Assessment , 15 (4), 311–339.

Department of Environment protection and enhancement, 1998, "Environmental legislations", Ministry of health , Iraq.

Finnveden, G., and A. Moberg , 2005, " Environmental Systems Analysis Tools – An Overview", Journal of Cleaner Production, 13, 1165-1173.

Food and agriculture organization of the united nations (FAO), 2012, " Environmental impact assessment", Guide lines for (FAO) field projects , FAO, Italy.

Ganeshan, R., and Harrison T. P., 2004 , “ An Introduction to Supply Chain Management”, Penn State University, USA.

Gilpin, Alan, 1995, “ Environmental Impact Assessment – Cutting Edge for the Twenty-First Century”, Cambridge University Press, Boston.

Grote, U., Basu, A.K., and N.H. Chau, 2007, “ New Frontiers in Environmental and Social Labeling”, Physica - Verlag, Germany.

Henry, J.Glynn and Gary, W. Heinke, 2009, “Environmental Science and Engineering”, Second Edition, Prentice – Hall of India, New Delhi.

Ishii, K., 2000, “ Course Materials, Design for Manufacturability”, Stanford University, USA.

Ishii, K., C. F. Eubanks, and P. Di Marco , 1994, “ Design for product retirement and material lifecycle”, Journal of Materials & Design, 15(4), 225-233.

Kaplinsky, R. and M. Morris , 2002, “ Handbook for value chain research”, IDRC,UK.

Kaplinsky, R. and Morris, M. , 2000, “ A handbook for value chain research”, IDRC, UK.

Katib, S. M., 1974 , “ The Large Hilla City, Functions and regional relationship”, Menar library , Baghdad.

Masters, Gilbert M., 2005, “Introduction to Environmental Engineering and Science”, Prentice – Hall of India, New Delhi.

Michelle, C., 2001, “ Design for Environment: a Method for formulating product end-of-life strategies ”, Doctorate thesis, Department of Mechanical Engineering , Stanford University.

Morris P, and Therivel R., 1995, “ Methods of environmental impact assessment”, UCL press, London.

Organization for Economic Cooperation and Development (OECD) , 2003, “ Special Session on Material Flow Accounting” , OECD Working Group on Environmental Information and Outlooks (WGEIO), Paris.

OECD, 1996, “ Coherence in Environmental Assessment” , Practical Guidance on Development Cooperation Projects, OECD, Paris.

Pacifica, F., 2007, “ Environmental impact assessment general Procedures”, Geothermal Training Programme , United Nation University.

Rebitzer, G., Ekvall, T., Frischknecht, R., Hunkeler, D., Norris, G., Rydberg, T., Schmidt W.P., Suh, S., Weidema, B.P. and D.W. Pennington , 2004, “ Life cycle assessment, Part 1: Framework, Goal and Scope Definition, Inventory Analysis, and Applications” , Environment International, 30 (5), 701-720.

Shank, John K., and V. Govindarajan, 1993, “ Strategic Cost Management”, Free Press, NewYork, USA.

Sincero, Arcadio P., and Gregoria A. Sincero, 2010, “Environmental Engineering, A design approach”, Prentice – Hall of India, New Delhi.

Smit, B., and H. Spalding, 1995, " Methods for Cumulative Effects Assessment", Environmental Impact Assessment, Elsevier Science Inc., New York, 15, 81–106.

Susman, G.I. ,1983, " Strategies for Social Research" , Sage Publications, London.

United Nations Environmental Protection (UNEP), 2002, " Environmental Impact Assessment ", Training Resource Manual. 2nd Ed., Geneva.

United Nations Industrial Development Organization (UNIDO), 2011, " Industrial Value Chain Diagnostics: An Integrated Tool", UNIDO , Vienna, Austria.

Wu, N., and R. Coppims, 1981, " Linear programming and extensions ", Mc Gram, USA.

Table (1): Actions performance of input – output value chain survey within environmental field of the public water supply in Hilla city; by the researcher.

NO	Items	Rank
1	Sources of operational water supply	x
2	Population benefiting from treatment plant	3
3	Treatment process	3
4	Water quality measurements prior to consumption	x
5	Water supply storage	3
6	drinking water network (distribution network)	2
7	Information , Education and Knowledge	2
8	Overall consumption	3
9	Water consumptions for industrial purpose	3
10	Water consumptions for the purpose of operating water supply network	x
11	Resolve conflict and consensus	3
12	Coordination of field offices	2
13	Local planning visits the field and site	2
14	Inspection procedures	1
15	Money	x
16	Time	2

1 = low, 2 = medium, 3 = high, x = capability, green = gray color.

Table (2): Frequency Percentage of Activities impact within environmental field of the public water supply system in Hilla city; by the researcher according to (Ishii et al. 1994; Masters, 2005; Henry and Gary, 2009)

Impacts*	Months of 2012											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Avoid	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Reduce	8.7	9.0	10	10	10	9.5	9.4	8.7	8.6	8.7	8.7	8.7
Continues	2.7	3.0	2.5	2.3	2.3	2.3	2.4	2.6	2.3	2.3	2.3	2.3

*****Dependent variables used as input ranges are categorical and not continuous.

Table (3): Nonmathematical problem for the input – output modal analysis[*1]; calculating by the researcher according to (Wu and Coppims, 1981; Kaplinsky and Morris, 2000; Henry and Gary, 2009)**.**

	Variables (Activity stages)											
	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_n	

Environmental Function (*f*) (Impact) / Value chain $_n$	Water Source	Population benefit	Treatment process	Water quality	Storage	network	Inspection	Consumption	Money	Time		Sign* Output average
Value chain 1 [*2]	90	95	85	85	87	66	87	90	95	83		**86.3**
Value chain 2	90	95	84	84	87	65	87	89	95	83		**85.9**
Right hand side Indicator												**86**
Impact	**14**											

*1 Represent percentage value return from original measurement numbers (Some of them probability level because lack of measurement process).
*2 For one month cycle process.

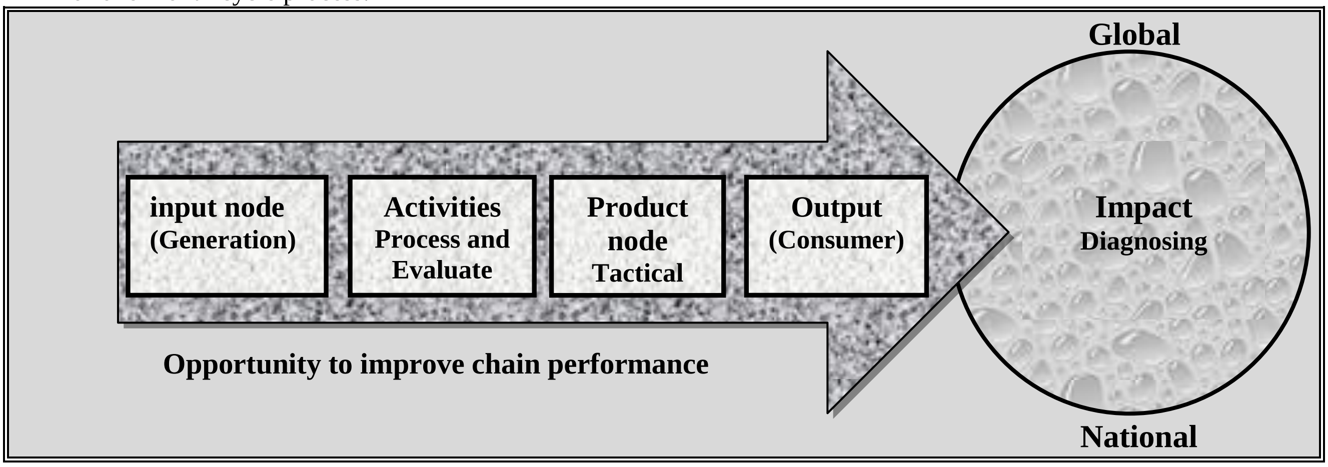

Figure (1): Hierarchy Scheme of Environmental chain action and impact in the Macro level; by the researcher according to (Susman, 1983; OECD , 2003; Rebitzer et al., 2004; Ganeshan and Harrison, 2004; Henry and Gary, 2009; UNIDO, 2011).

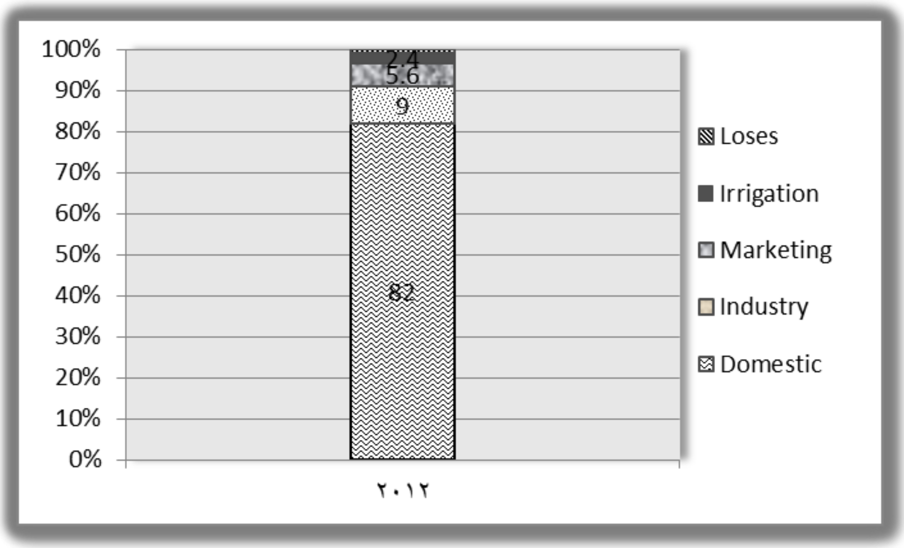

Figure (1): The main water supply consumption across different uses in Hilla city; by the researcher.

Appendix:

Appendix (1): Macro level assessment

Macro-level analyses refer to the national level as a whole, focusing on cycles of activity and used to offer evidence of general trends towards the decoupling (relative or absolute) of economic growth from environmental deterioration and resource depletion. These assessments are most often based on aggregate data from the various sectors (Rebitzer et al., 2004; UNIDO, 2011) .

Appendix (2): Questionnaire for preliminary assessment, by the researcher according to (Susman, 1983; Rebitzer et al. ,2004; Henry and Gary, 2009).

Questionnaire

Babylon University / College of Engineering / Department of Environment

Note 1: This Research for scientific purpose to addressing environmental value chain analysis issues.

No. (   )   **Date**   /   / 20….

Research title: A Conceptual Framework to Analyzing and Optimizing the Environmental Input – Output Value Chain; A Case Study: Public Water Supply System in Hilla City

Researcher name:

First: General Environmental information

A. Project name:…………………………, Project location: ………………………….

B. Field description:…………………………………………………………………….

C. Date of beginning   …………………………

D. Are you a governmental employer or working in private sector? Yes ……. No ……………

Second: Environmental Screening

No.	Would the project	Yes	No	Not sure	Unable to determine
1	have significant adverse impacts on public health or safety.				
2	have significant or controversial environmental effects on biophysical resources such as land, water, soil, biodiversity.				
3	have adverse impacts on unique characteristics, such natural rivers.				
4	have highly uncertain and potentially significant environmental impacts with unique or unknown risks.				
5	precedent for future action or represent a decision in principle about future actions.				
6	accumulate of significant environmental and social impacts				
7	have adverse impacts on important national or international species.				
8	restrict access to sites or adversely affect the physical Integrity.				
9	have adverse impacts on natural resources or properties.				
10	encourage migration or other population shifts.				
11	work in opposition with ongoing socio-economic development goals or efforts.				
12	considered alternatives.				

13	conducting an EIA during the project design phase.				
14	Have life cycle thinking and the value chain.				
15	use laboratory testing and scale models.				
16	operating with high cost.				
17	have safety quality standards & certifications.				
18	have urgent needs of the target sector.				

Third: Environmental impact evaluation process

No.	Framework	Yes	No
19	Level in the value chain is your organization targeting.		
20	Use value chain practices to approach the technologies.		
21	Induce low energy consumption technologies or promote bioenergy sources.		
22	Formulated within the framework of national or local sustainable development plans.		
23	Avoid the release of chemical substances or the introduction of biologically modified organisms.		
24	Decrease reliance on non-renewable sources of energy.		
25	Preserve local environment, in particular, avoid risk of disease transmission.		
26	Avoid greenhouse gas emissions.		
27	Introduce preventive measures that reduce degradation of natural resources, protect natural ecosystems and biodiversity, and reduce human risk.		
28	Increase local and national understanding and knowledge of Value chain processes.		
29	Should the project be cancelled.		

Four : Action plan evaluation

Environmental performance Criteria	Value chain				
	Weaknesses opportunities	Causes for weaknesses	Activities	Time frame	Expected outcome
Quality					
Reliability					
Flexibility					
Feasibility					
Time (Current and Future)					

Ranking of options (1 = very bad, 2 = bad, 3 = medium, 4 = good, 5 = very good).

Five : Any necessary information or details:

In consideration of the above factors, are additional studies or an EIA necessary?
Yes …….., No…….. If Yes, list the additional studies that are needed.