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A Comparative Analysis of Adopted Rural Development Measures in Saskatchewan

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Abstract

Most small regions and communities in Saskatchewan, a Canadian Prairie Province, have been facing a decline in their population. Much of this can be attributed to a relatively lower natural rate of population growth, but more importantly to out-migration of young and elderly to larger communities, particularly cities. Little to no immigration into these communities further accentuates this problem. Nonetheless, further economic development remains as one of the major priorities of these local governments. Many of them have employed various types of incentives to attract businesses and residents. Among these the use of tax and non-tax incentives is more common. Most frequently used incentives were property tax incentives -- municipal tax abatement, property tax incentives, and commercial and industrial tax incentives. Question remains whether the use of these incentive programs has been effective in securing competitiveness, and attracting businesses and residents. This study was undertaken to appraise the effectiveness of these measures in the context of rural municipalities in Saskatchewan. This study was based on a case study of five Saskatchewan rural municipalities (RM). Data were collected through a questionnaire filled by the local administrative authority of the RM. Of the RMs, only one experienced an increasing population; the rest have a decreasing trend. In terms of efficacy of these incentives used, only one of the five rural municipality indicated some success. In that RM, two new businesses were opened after these incentives were provided but one of them closed down afterwards. In other words, for all five RMs considered, the success of these incentives was nil to limit. These findings are consistent with those found in the literature. Past studies have suggested that these incentives are not good development policy instruments. Two reasons for this type of conclusion are provided: One, their effect can be offset by other jurisdictions with similar effort; and Two, what businesses seek most is access to resources and skilled workers, in addition to infrastructure and business opportunities. However, these incentives can make a difference in the business location decisions when the choice is narrowed down to two or more sites with a similar economic jurisdiction. Some studies have suggested that these type of incentives can be valuable tools that can influence the decision being made by individuals and businesses, while other studies have indicated that economic growth of rural municipalities is dependent on consistent and effective policies that enhance a high level of attractiveness of the region of interest. It appears that improving the attractiveness of the region might have a better impact on rural economic development.

Keywords: Tax and non-tax incentives, rural municipalities, Saskatchewan, competitiveness, rural economic development

Background to the Study

Over the last century, rural population in Saskatchewan has been declining. This has been a matter of concern not only to the residents therein but also to the provincial and federal policy makers. In 1961 the province had an equal rural-urban share of population. Since then, share of rural population has been declining (Figure 1). Although Saskatchewan as a province has shown some limited growth during the past decade, much of this increase has been through interprovincial migration and to a limited extent, through international migration.

There is also some evidence of significant intra-provincial migration of people. Population of the larger communities has increased over the last decade (Table 1). In a hierarchical order, communities

that are not primary wholesale-retail and secondary wholesale-retail have lost their population as well as their 1961 hierarchal status during 1961-2001 period (Stabler and Olfert, 2002).

In 2016, there were 296 rural municipalities (RMs). Although their total population in 2016, relative to 2011, has increased from 174.6 thousand to 176.54 thousand (an increase of 1.1% as shown in Table 1), not all RMs have experienced this increasing pattern. In fact, it appears that the size of the initial population seems to be related to their change in

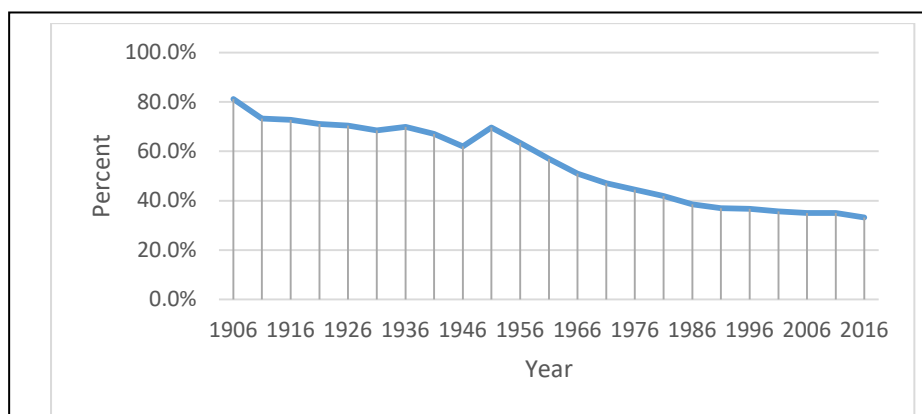


Figure 1. Saskatchewan Rural and Urban Population Growth, 1906-2016

Table 1. Change in the Rural and Urban Community Populations, 2011-2016

Type of Community	Population in 1,000 during			% change in 2016 over 2011
	2011	2016	Change	
Cities	596.12	655.31	59.19	9.9%
Towns	145.78	149.72	3.94	2.7%
Villages	42.92	42.59	-0.33	-0.8%
Resort Villages	4.16	4.72	0.56	13.5%
Rural Municipalities	174.60	176.54	1.94	1.1%
Indian Reserves	56.22	56.05	-0.17	-0.3%
Northern Villages, Hamlets, and Others	13.58	13.42	-0.16	-1.2%
Total	1033.38	1098.35	64.97	6.3%

population. For the smaller RMs (those below 500 people in 2011), chance of a growth is only 38%, as against approximately 77% if the population is 1500 people (Table 2).

Moazzami (2015) attributed the decline of rural Saskatchewan communities to the outmigration of population, particularly members of younger generation, from rural to urban

areas in search of employment, education and other economic opportunities and services provided by urban areas. Although Canada has opened doors for a higher level of international migrants, very few of them make their residency in rural areas of Saskatchewan. One exception to this is that rural communities located near urban areas (a concept called MIZ – Metropolitan Influenced Zone) have gained in population on account of their location. This may support the conclusion by Mahroum et al. (2007) that often economic development policy has focused on cities as the engines for competitiveness and growth, which tended to overlook or even neglect the capacity and capabilities of rural areas.

According to Porter et al. (2016), the economic performance of rural regions in the USA, and across the globe, is stagnant despite efforts and by governments and local leaders to solve the problem. In Saskatchewan, the economy is highly dependent on exports which are heavily based on natural resources, including potash, oil, gas, and uranium. In addition, centralization of private and public sector economic activity has fueled urbanization, which has left many rural communities in Saskatchewan without populations above the threshold level necessary to support many types of economic activity (Hall and Olfert, 2015).

With the declining rural population in Saskatchewan, public agencies (e.g., rural municipalities, and provincial and federal governments) have continuously searched for ways to reverse this declining population trend. Economic and fiscal instruments that are effective in stimulating private investment and job creation to retain residents in their communities have been noted both in the literature as well as in practice. The regions (and communities) face an added pressure to find ways to grow and sustain their local economics, especially in smaller and remote communities, through a range of factors, such as the decline and restructuring of industries, changes in transportation and communication infrastructure, and regionalization of services (Bruce et al., 2005).

Economic development incentives include a wide variety of tools ranging from planning, the permitting process and all the way to direct and indirect funding. Business incentives can vary in form, namely tax or non-tax incentives depending on the desired investment with its associated economic growth and development end goal. For example, at the local level, municipalities can partner with business for the exchange of investment and job creation (LaSalle, 2014). In addition, government can support businesses by offering tax

Table 2. Growth in Rural Municipality Population, by Size, 2011 to 2016

Population of RM in 2011	No. of RMs with Increasing or No Change	No. of RMs with Decreasing	Total RMs	% with Increasing Population
< 500	80	121	201	39.8%
501-1000	23	40	63	36.5%
1001-1500	14	5	19	73.7%
➤ 1501	10	3	13	76.9%
Total RMs	127	169	296	42.9%

credits and abatement rebates, among other incentives, to boost investment while creating a favourable business environment in the municipality (Basile et al., 2011). All these measures lead to a change in the competitive position of a region (community).

In order to develop policies that may foster economic development in rural areas, questions that need to be answered include: Have tax and non-tax incentives been an effective tool for rural economic development in the context of Saskatchewan RMs? Does the use of such incentives make Saskatchewan's rural municipalities more competitive? These issues need answers, not only for the local policy makes, but also those at the provincial government level.

Objectives of the Study

This research project proposes to investigate rural municipal level tax and non-tax incentives that have been adopted by selected Saskatchewan's RMs in order to increase their economic competitiveness, as well as to induce and attract businesses and residents in their local communities. This study was undertaken to meet the following objectives:

- 1) Review tax and non-tax incentives that have been used in similar North American jurisdictions/locations (primarily under prairie setting), and appraise their effectiveness for rural economic development; and,
- 2) Provide recommendations for the use of such incentives at the local level within the broad spectrum of Saskatchewan's rural economic development policy.

The scope of the study is limited to the investigation of Saskatchewan RMs, and even within that on five case studies. Any generalization to other jurisdictions may not be valid and could prove to be somewhat misleading.

Study Methodology

The study was undertaken using two types of research methods: Literature review of concepts related to rural economic development; and a survey of selected rural municipalities in Saskatchewan.

Literature Review: Available literature was reviewed for two topics:

- One, concept(s) related to factors that lead to economic growth in a region competitiveness. One of the rationale for providing such incentives might be to make the region more competitive. Since competitiveness is related to the success of a region to attract new business activity or people, the relevance of factors that affect these processes is needed. One complicating factor is that competitiveness of a smaller region could be affected by that of the larger regions, which needs to be included in this review.
- Two, a second review was done to develop an understanding of the types of tax and non-tax incentives in the context of competitiveness of a rural region

Survey of Saskatchewan’s Rural Municipalities and Rural Regions: Although the conceptual review of the tax and non-tax incentives suggested their ineffectiveness in fostering small area or rural development, more empirical evidence was required. The objective was to identify rural regions in Saskatchewan that had used tax and non-tax incentives for their specific community / region’s development, and to assess their efficacy based on their specific response. To this effect, two types of surveys were undertaken:

Survey One: A formal survey of five rural municipalities in Saskatchewan; and

Survey Two: An informal survey of several rural communities.

In addition to the above two sources, information was gathered from published data collected through previous surveys by SEDA (undated-1). The purpose of this survey was to provide an inventory of “best practices” of concessions currently offered in the province.

Formal Survey of Saskatchewan Rural Municipalities: A sample of six RMs was selected from a short list of all RMs in the province. The selection was not random in procedure. They varied from a

small size region of only 209 residents in 2011, to a large RM containing 8,354 people. Some of these RMs showed a population increase, while others were facing a declining population base.

Table 3. List of Sample Saskatchewan Rural Municipalities

Rural Municipality	RM No	2001 Census Population	2016 Census Population	Change (%)	Potash/ Other Mines	Used Tax /Non-tax Incentives
Moose Jaw	161	1,338	1,163	-13.1	Yes	Yes (Business and Residents)
Prairie Rose	309	345	220	-36.2	Yes	Yes (Business and Residents)
Orkney	244	1728	1875	8.5	No	Yes (Business and Residents)
Mervin	499	1274	1256	--1.4	No	Yes (Business and Residents)
Langenburg	181	647	557	-13.9	Yes	Yes (Personal tax incentives)

Source: Statistics Canada (2016a, 2016b, 2016c, 2016d, 2016e), and Wikipedia (2018).

The selected RMs received a questionnaire asking them information related to economic development activity, use of incentives and concessions, as well as their perception of constraints to local economic development. Two of the originally selected RMs, in spite of several attempts (shown with double asterisks), refused to provide any response to the questionnaire. Their reasons included: very busy time, lack of staff, and not relevant. The survey was closed in March 2018 using only five RMs as the sample (shown in Table 3). The survey results were analyzed mostly as cross-tabulations, frequency distributions and charts.

Informal Survey: In addition to the survey of five RMs, an informal survey of some RMs and rural communities was also undertaken to evaluate their experience in terms of economic development incentives. A total of 30 RMs and 28 smaller communities were contacted for this survey. It should be noted that the selection of these RMs was not based on randomization. Therefore, any generalization for the entire province would be questionable.

SEDA Survey: The SEDA (Saskatchewan Economic Development Authority) undertook a survey of sixteen Enterprise Regions of Saskatchewan. The survey involved contacting various RMs as well as communities (cities, towns, villages, hamlets and First Nations Reserves). This was an attempt to develop an inventory of the types of economic development concessions that were used by various jurisdictions. A list of communities and rural regions that offered some type of incentive programs was developed from this survey.

The study questionnaire included questions related to basic information about the community and its perception of local economic development, followed by questions related to the incentive plan used by the local government for economic development (either attraction of businesses or residents). The evaluation of the effectiveness of these incentive measures were the subject of these questions, followed by a question related to the challenges faced, and the type of help needed to foster local economic development.

Results

Results of this study started with identifying competitiveness of rural regions in Saskatchewan. This was followed by results of the survey-based effectiveness of tax incentives measures used by selected RMs.

Are Saskatchewan Rural Regions Competitive?: Competitiveness, as a concept, goes back to the work of Porter (1990) who explained national competitiveness as a nation's capacity to innovate and sustain an advantageous position over other nations in key industrial sectors. Within regions and localities, competitiveness alludes to the availability of conditions that enable firms to compete in their chosen markets and generate value-added opportunities that can be captured by the regions or localities where the firms locate (Huggins and Clifton, 2011). For a rural region, such as a RM, the competition it faces is a composite result of the competitive position of the larger regions within which it resides. Studies were reviewed on Canada's competitive position in the world markets. The general conclusion was that Canada is comparable to other developed nations with very good institutions and business sophistication. Based on this review Canada was reported to be comparable in attracting industries and residents relative to other developed nations.

Although no formal or rigorous analysis of relative competitiveness of Saskatchewan has been reported, the issue is recognized in policy-making. It has been stated that the competitiveness status of Saskatchewan could be reflected in the cost of doing business in Saskatchewan, which has been reported to be competitive and comparable to other provinces in Canada, with Saskatchewan's export market to the USA (Enterprise Saskatchewan, 2012). The attractiveness of Saskatchewan is credited to low corporate income and property taxation, competitive labour costs, and a variety of economic opportunities. Within Canada, Saskatchewan had the second-lowest taxes, compared to other provinces (except Alberta) with the exception of sales and excise tax, and personal income tax. The personal income tax may affect in-migration of people from other parts of Canada, whereas the higher sales and excise tax may become unattractive to businesses.

According to Enterprise Saskatchewan (2012), to assist rural Saskatchewan to be competitive, the province needs to focus on increasing connectivity between communities and adjacent urban centers to reduce the costs of transportation in rural Saskatchewan. This points out to the need for more man-made capital in these regions.

Use of Economic Incentives: Government entities and institutions are vital in community economic development as their role in local economic development is to encourage investment so that local communities can have an increased capacity to develop their own wealth. In the process of encouraging private sector investment and growth, incentives can be awarded to specific businesses and industries in exchange for certain business conditions (Reid, 2013). The Council for Community and Economic Research (2013) has explained that incentive programs come in two forms: (1) tax program and 2) non-tax programs (Table 4). The tax programs are critical tools or incentives that are administered in the form of tax credit, tax deduction, tax abatements, tax exemptions, tax refund or tax rebate. The non-tax programs are direct or indirect financing programs providing funding to a company with or without third-party involvement, e.g., grants, loans etc. Various RMs in Saskatchewan used two types of incentives for attracting businesses and

residents: (1) Property tax incentive, and (2) Commercial and industrial tax incentives. A typical example of a commercial and residential tax incentives, respectively, is presented in Table 5a and 5b. In most situations, the incentive was for new construction (homes or business) or renovating /refurbishing existing buildings. They were available both for the existing as well as new residents or businesses.

Almost all RM administrators express the opinion that property tax incentives were the most effective type of instruments for their region. Three of the five RM (Langenburg, Orkeny and Prairie Rose) indicated that tax incentives were very effective for businesses. For the residents, although the RM of Langenburg did not provide any financial incentives, providing services and amenities were reported to be more successful in attracting residents to the RM.

Table 5a. Example of a Commercial Tax Incentive

Any existing business will qualify for the following assessment exemptions:

- The assessment exemption will be applied to any increased assessed value, GREATER THAN \$500,000 (improvement), of an existing building due to new construction;
- The assessment exemption will be applied to any increased assessed value GREATER THAN \$500,000 (improvement), of an existing building **due to renovations that require a building permit.**
- The exemption will also be applied to the assessed value GREATER THAN \$500,000 of any expansion or new construction on bare land.

** The exemption does not apply to the assessment of the land.*

The exemption will be applied as follows:

- ☐ 100% Construction Year or portion thereof exempt in year one
- ☐ 80% exempt in year two
- ☐ 60% exempt in year three
- ☐ 40% exempt in year four
- ☐ 20% exempt in year five
- ☐ Full taxation in year six

The exemptions are applied once the expansion (additions/improvements) or new construction is assessable.

** Council reserves the right to approve each incentive package individually and to customize incentives to any specific project.*

Each of the five study RMs were asked to provide an evaluation of the incentives used for attracting businesses by noting the degree of success in economic development of the region. Four of the five RMs indicated that their tax incentive program was successful in attracting businesses to the RM, while the RM of Prairie Rose suggested the opposite (Table 6). This RM was very small in size of population base faced some competition from neighboring RMs. The RM of Langenburg indicated three businesses moved to the RM, but one of them has since closed. Food services-related businesses were among those attracted to the RM, and would likely be attracted in the future. Thus in spite of the enthusiasm shown at the RM administration level, the success of these incentives can be

Table 5b. Example of a Typical Residential Tax Incentive

Residential construction concessions may be granted for new residential construction by way of property tax abatements as follows: (*upon approval of council*)

Year of construction 100% abatement of municipal and school taxes
 Year 1 100% abatement
 Year 2 50% abatement

Table 6. Success of Tax and Non-tax Incentives offered by Study Rural Municipalities, 2017-18

Langenburg	Mervin	Moose Jaw	Orkney	Prairie Rose
Has any business moved into the community over the last five years?				
Yes (3 new businesses); One of them closed down since then.	Yes (Mineral service development; Tourism related)	Yes	Yes	No
What were the contributing factors?				
Needs of community (Lack of food industry options)	Mineral resource development; Improved outlook in agriculture; Tourism related.	Customer service; Business friendly policy; Transportation accessibility.	Location; Taxes; Trading area of people	Too small a community
Do you expect any new businesses in the next five years?				
Food service related businesses	Yes	Yes	Yes	No
What would be the contributing factors?				
Consumer preference	Resulting from Mineral resources spin-offs; Businesses meeting local demand for goods and services	Resulting from support for the City RM industrial park initiative	Resulting from taxes, infrastructure – no main highways, trading area	Community too small and too remote

questioned.

All five RMs reported facing some constraints in fostering their respective economic development. Quality of transportation and cyber technology were cited as the most common

factors (Table 7). The RM of Langenburg indicated that due to being located on a major highway, it makes its own economic development somewhat difficult, as people bypass the community to shop in the larger communities located nearby. High prices for homes and limited options for internet technology were also noted as other barriers to a community's economic development.

In the RM of Mervin, the high cost of road maintenance and infrastructure caused by rail line abandonment is a major barrier to development. Other challenges faced by the RM include high competitiveness from other regions. The RM of Moose Jaw is also facing a lack of transportation upgrades as a barrier, along with a lack of water resources and space for housing. The latter is perhaps a sign of rapid development in the RM. For the RM of Orkney, infrastructure and lack of funds for its improvement were reported to be the major barrier to local development. The RM of Prairie Rose did not report on this question, partly because

Table 7. Barriers/Challenges to Economic Development Faced by Communities, 2017-18

Langenburg	Mervin	Moose Jaw	Orkney	Prairie Rose
What factors serve as a barrier to community economic development?				
<ul style="list-style-type: none"> • Too close to drive to larger city centers • Limited options for internet communication technology • Poor quality internet technology • High housing prices 	<ul style="list-style-type: none"> • High cost of maintenance of road infrastructure created by loss of rail line increased transportation costs; • Inability of the town to develop new lots for housing; 	<ul style="list-style-type: none"> • Lack of transportation upgrades • Lack of water resources • Lack of space for housing 	Infrastructure	N.R.
Main challenges faced				
Too close to the city – bypassing the community	Competitiveness in business	Serviced land	Funding for infrastructure development	N.R.

development is limited due to its location and current size.

Related to the barriers for economic development, the RMs also suggested some of their preferred solutions. Generally speaking, funding of some activities in the RM by higher level of the governments was noted by four of the five RMs (Langenburg, Mervin, Moose Jaw and Orkney). Assistance to keep taxes (at the RM level) lower, and more consultation with the RM for location of the industry, was noted by the RM of Orkney.

Let us divert our attention to the ad hoc survey. Of the total 30 RMs in this ad hoc survey, 18 (60%) had implemented some type of tax-non-tax incentives (Table 8). Tax rebate and abatement for new construction was the most commonly-used measure. Business incentive policy, as well as residential incentive policy, were also noted as being used, but no details on the nature of this policy were available. No information was available on the effectiveness of these measures.

In addition to the five study RMs, 28 rural (non-urban)

communities were included in the ad hoc survey. Half of these communities had implemented some type of incentive program. Only five of the 14 communities that had implemented the incentives had some success in attracting businesses or residents, including existing business restoration. This proportion (18%) is much lower than that reported by the five study RMs.

A review of available studies related to efficacy of incentive measures also support a smaller role for tax incentives. When businesses choose between two or more sites/communities, they weigh several factors on the business climate that is important to their industry. Incentives are often part of this equation, but rarely play a decisive role until the last few sites are being compared. Competing communities may choose to bargain with the business and even to out-bid one another (International Economic Development Council, undated). This practice may be viewed as unfavorable, as it may create a negative environment between competing municipalities. Rainey and McNamara (2002) indicate that although taxes can have an impact on the location of industrial activity, it is only one of several factors that firms examine when making their location choices. Recent research shows that much of the growth in rural areas is occurring in areas that are adjacent to urban areas. For these communities, tax policy can be a determinant in whether a potential firm chooses a community on one side of the metropolitan area as opposed to a community on the other side. However, tax policy alone may not be a good incentive for a business to move in that region; emphasis of the community / rural municipality should be to enhance availability of those factors that are crucial for attracting a new business.

Table 8. Types of Measures for Economic Development by Saskatchewan RMs (Based on an Ad Hoc Survey)

Type of Measure	No. of Rural Municipalities	Percent of Total Responses
Property Tax Incentive	9	45
Business Incentive Policy	3	15
Multi-Unit Residential Policy Residential Incentive Policy	3	15
Capacity Building of Businesses	1	5
Tax Abatement for Major Developers	1	5
Business Loans Program (Including Collateral)	1	5
Tax Concession Policy	2	10
Total Responses	20*	100

* Number of responses exceeds the number of RMs due to multiple responses by some RMs.

Summary and Conclusions

This study was undertaken to review tax and non-tax incentives that have been used in rural jurisdictions/locations in Saskatchewan. It was based on a case study of five rural municipalities (RM): Langenburg (No. 181); Mervin (No. 499); Moose Jaw (No. 161); Orkney (No. 244) and Prairie Rose (No. 309). These RMs varied from small (with a population of 220 people in 2016 for the RM of Prairie Rose) to large RM (with a population of 1256 people in 2016 for the RM of Mervin). The survey was undertaken using a questionnaire sent electronically to the RM Administrators. The sample RMs provided their experience in this respect.

Of these, four RMs had suggested that the incentive programs were successful, although the nature of this success was only noted by the RM of Langenburg. The success of these incentives, as reported by the RM, did not reflect their population growth. A positive growth in population was noted only for the RM of Orkney, while in the other three RMs (Langenburg, Mervin, and Moose Jaw) either the population stabilized or did not decrease. The experience of the RM of Prairie Rose matches with its experience of lack of success in such a program. When compared with the results from an ad hoc survey of rural municipalities and non-urban communities, these study RM results are even more perplexing. The ad hoc survey indicated an even smaller portion of the RMs, and non-urban communities that had successful economic development after implementing an incentive program.

In addition to the survey of the five RMs, a comprehensive literature review was completed on the concept and issues related to competitiveness, and incentive programs used and their effectiveness. These observations were used for arriving at some conclusions for the study and for making recommendations for the future.

The following are listed as the major findings:

- On the definition of competitiveness, the study found that there is no formal definition of competitiveness. In fact, it is based solely on the results of economic development. In other words, a region / community is considered to be competitive if it can attract new businesses or residents.
- Competitiveness is a prerequisite for further economic development of the region. However, the interconnectedness of the two needs to be clarified – it may not be easy to decipher which one happens first.
- Measuring competitiveness is complex as can involve measuring several sets / types of indicators (called pillars). They may include institutions, infrastructure, education and training, and efficiency in labour market and in goods market, among others.
- Competitiveness of a smaller region is affected by that of a larger region. For this reason, this issue was examined for both Canada and Saskatchewan. Although in both cases, there was available evidence to suggest that both larger regions are competitive, no study was found that had actually addressed this issue.

On the use of incentive measures for fostering economic development, this study found the following:

- ❖ Various types of tax and non-tax programs have been used by rural regions. Tax incentive programs include, among others, tax credit, tax deduction, tax abatement, and tax refunds. Non-tax measures include grants, loans, loan guarantees, preferential interest rates, and equity in investment, among others.
- ❖ In all other RMs, the responsibility of economic development planning falls on the municipal council or the chief executive office. All RMs (except the RM of Prairie Rose) has no defined / allocated budget for economic development activities.
- ❖ The effectiveness of these policies was reported to be somewhat mixed – two of the five RMs (Mervin and Moose Jaw) indicated success, while the other three RMs did not respond to this question, although these three RMs (Langenburg, Orkney and Prairie Rose) reported tax incentives to be a successful strategy for businesses. For residents, the local condition and amenities were the reasons for attracting new residents to the RM. However, an ad hoc survey of Saskatchewan RMs and rural communities reported much lower effectiveness of these measures. Challenges faced by the study RMs included poor internet technology, high cost of road maintenance of infrastructure, lack of water resources, and lack of space for housing.
- ❖ There is mixed evidence in the literature on the role played by tax and non-tax incentives for rural economic development. Some studies have suggested that they can be valuable tools that can influence the decision being made by individuals and businesses. Other studies suggest that economic growth of rural municipalities is dependent on consistent and effective policies that enhance a high level of competitiveness.

On the issue of policy development, the study concluded:

- ❖ On the effectiveness of tax and non-tax incentive programs, literature suggests that these incentives are not good development policy instruments. Two reasons for this type of conclusion are: (1) that their effect can be offset by other jurisdictions with similar effort; and (2) what businesses seek most is access to resources and skilled workers, in addition to infrastructure and business opportunities. However, these incentives can make a difference in the business location decisions when the choice is narrowed down to two or more sites with a similar economic jurisdiction.
- ❖ The solutions provided by the RMs for fostering their economic development, funding opportunities was the most common suggestion. Development of institutions, such as an Area Development Council, transfer of funds from higher level governments to keep the local taxes low, and more consultation with the RMs for industry location were also noted.
- ❖ Assessment of competitiveness of a community / rural municipality cannot be done singly on tax – non-tax incentive programs. It requires a more comprehensive assessment of factors that attract a business or people to the community / rural municipality. Deller et al. (2001) found that amenities, quality of life, and local economies performance have predictable relationships. Local and provincial governments, therefore, may put more emphasis on development of such rural amenities for attracting residents and businesses.

- ❖ Provincial level government could help a community / rural region by developing community asset mapping or environmental scan, as well as community needs study in order to develop strategies and action plans to support sustainable communities.
- ❖ Asset mapping is another tool that has been used in North Carolina (Li et al. undated). It suggests inventory of seven types of community assets: Human (population growth, workforce skills, tourist presence); Social (community groups, religious organizations, social clubs); Physical (housing, internet access, community college system); Financial (community development lender, access to federal grants); Environmental (fertile soils, wetlands, public park access); Political (county economic initiatives, zoning ordinances); and Cultural (watermain heritage, agricultural values, community festivals).
- ❖ Financial assistance from senior levels of government has been pointed out to be required by all five RMs. This is needed since their sources of revenue have decreased. However, ensuring accountability in public spending is equally important. Savoie (2000) suggests providing financial assistance through agreements within a designated period on a sliding scale.

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A starting point for reporting sustainable business values -Sustainable Enterprise Theory, SET

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Abstract

This paper develops and discuss a theory of sustainable enterprises, sustainable enterprise theory (SET), which can only be a valid theory if knowledge about life and nature is complete. However, knowledge limitations should not stop enterprises from doing business with a goal of better long-term life on earth. Life demands stewardship of the resources used during one's lifetime. This paper develops a model influenced by enterprise theory and resource theory that includes more than money in the business activities of an enterprise. Values created by a sustainable business entity is a key issue for owners and stakeholders. This paper demonstrate such business values and discuss the implications for accounting information for the enterprise.

Key words: Sustainable business, sustainability reporting, sustainable values, theory of the firm

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A starting point for reporting sustainable business values - Sustainable Enterprise Theory, SET

So far, discussions of sustainable business have been largely *ad hoc*. The next step is to develop and analyse a comprehensive theory of sustainable enterprises that is the first objective of this paper. Following the lead of Suojanen (1954) and his enterprise theory of accounting, this paper presents sustainable enterprise theory (SET) from which implications for business values and accounting is developed. This paper is organised in sections that describe business activities and resource uses, the SET model, value creation and stakeholders, and finally some accounting implications of the values created by an enterprise and the SET model.

Business activities and resources used

Suojanen (1954) developed and discussed enterprise theory (ET) that defined a company as an enterprise or a social unit used by stakeholders. He argued:

If the enterprise is considered an institution, its operations should be assessed in terms of its contribution to the flow of output of the community. If the income generated in the enterprise is to be analysed based on social considerations, then the traditional type of income statement is insufficient. (p.395).

When considering social considerations from a sustainability perspective, it is important first to consider resource use from a sustainable entity perspective. Enterprises need resources to produce goods and services. The one major resource is human and social, another is ecological (environmental). Without these, sustainable life, good environments, and social sustainability, enterprises are in danger. Two other resources, technology and financial, are also needed. Technology and financial resources are tools to develop human, social and ecological sustainability. These four basic resources in SET are further developed and discussed in light of the Sustainable Accounting Standards Boards (SASB) draft conceptual framework (SASB, 2016).

Human and social resources (HSR)

Human beings are social and generally prefer sustainable lives for themselves and for following generations, especially their offspring. In the recent past, resources for enjoyable satisfying lives were plentiful; primary concerns in most 'industrialised' and emerging countries were over financial resources. Now with evolutions in many aspects of life, the scarcity of resources and additional perspectives on how one lives a satisfying life are evolving. These evolutions raise a need for sustainable enterprises. In a broader context, individuals, being social creatures, are part of social networks to achieve sustainable satisfying lives for themselves and for generations to come. One essential element of such a network is a sustainable enterprise. The UN actively promotes companies to 1) operate responsibly in alignment with universal principles, 2) take strategic actions that support the society around them. Then, to push sustainability deep into the corporate identity, companies must 3) commit at the highest level, 4) report annually on their efforts, and 5) engage locally where they have a presence (UN 2016).

The proposed framework of the Sustainability Accounting Standards Board (SASB) recognizes the importance of the human social dimension as a key item to deliver long-term value. This dimension relates to the perceived role of business in society in delivering benefits to society in return for a “license” to operate (SASB 2 and 3).

Management of an enterprise is a human activity and thus falls under human resources in SET. SASB No. 5 describes leadership and governance, which involve management of issues inherent in business models or common practices in the industry that are in potential conflict with interests of such broader stakeholder groups as government, community, customers, and employees. Such stakeholder conflicts create a potential liability, or worse, a limitation or removal of a license to operate, including regulatory compliance, lobbying, and political contributions. They also include risk management, safety management, supply-chain and resource management, conflicts of interest, anticompetitive behaviour, and corruption, and bribery, as well as complicity in human rights violations.

Ecological (environmental) resources (ER)

Ongoing international activity on different levels works to protect ecological resources. The UN plays an active part. In an annual report, it addresses threats and possibilities for environmental resources (United Nations Global Compact, 2016). Ecological resources are not endless and there is a need for action on all levels in the world society. Businesses are an active partner in green development, not only by restricting use of environmental resources, but also by implementing business models and approaches with stakeholders. A recent example from the media is:

When Walmart sets a goal, companies usually find ways to meet it. In its bid to promote sustainability, for example, Walmart wanted General Mills, a big food company, to fit its Hamburger Helper noodles into a smaller box. General Mills replaced curved noodles with straight ones, which lie flatter. The switch took 500 Lorries off the road each year and freed shelf space for other goods. Walmart worked with makers of detergent to develop concentrated versions, in smaller bottles. Over three years the switch saved more than 57,000 tonnes of cardboard, 43,000 tonnes of plastic resin and 400m gallons of water. (*The Economist*, June 4, 2016)

In this situation, Walmart, a large global retailer, worked with a supplier, a large multinational food processing enterprise, to produce a product that enhances ecological sustainability as well as provides business advantages.

In the proposed SASB framework No. 1 (SASB 2016), environmental impact is described as the use of non-renewable natural resources as input to the factors of production and environmental externalities or other harmful releases in the environment, such as air and water pollution, waste disposal, and greenhouse gas (GHG) emissions. Enterprises generate environmental capital, either positive for a sustainably operated business, or negative for businesses that do not operate sustainably.

Technological resources (TR)

Technological resources (TR) represent a human tool kit used to create goods and services. TR used are from raw material extraction, to production and use, and later disposal of products. Human, social and ecological resources are used in the process. Some technological use damages human and ecological resources. As in the Walmart example, the use of resources depends on business models and innovations. A ‘smart’ choice is one businesses

use to be both sustainable and at the same time generate positive technological capital. In the Walmart example, the choice also enhanced profit potential by reducing costs for General Mills, possibly reducing amounts Walmart paid to General Mills, freeing shelf space for other products, etc.

Business model and innovation are included as technical resources in SASB 4, which addresses the impact of sustainability on innovation and business models including integration of environmental, human and social issues in the value chain, as in the Walmart-General Mills example, as well as product innovation, and impacts on financial assets (SASB 2016).

Some values leave the enterprise when products are sold, but an important part of value creation is not limited to values reflected by actual sales. Some value creation stays inside the enterprise or is shared with stakeholders. These intrinsic assets are difficult to quantify, but in a good enterprise, values like human capital, social capital, ecological capital, technological capital and financial capital are present. This internal value creation has a long-term impact on the value of the enterprise and its products.

The Sustainable Enterprise Theory (SET) Model

The SET model is presented below. A business enterprise uses resources in the production of goods and services. Output is delivered to a market in which customers buy it. The customers give of monetary resources back to the enterprise. Some of the value created stays within the company as intrinsic assets: human, social, ecological, and different types of technological capital are some examples. There is a need for a model that is broader than traditional financial and managerial accounting to include sustainable indicator accounting both for internal and external information purposes... Suojanen argued: *“If the income generated in the enterprise is to be analysed on the basis of social considerations, then the traditional type of income statement is insufficient”*. (1954, p.395). As a supplement to the income statement, enterprises can also present a value-added statement. That shows how values generated during a period are distributed for different purposes, such as purchase from suppliers, employee remunerations, dividends and net interest paid, tax payments, cost and investments for environment, costs for research and development and retained in the company.

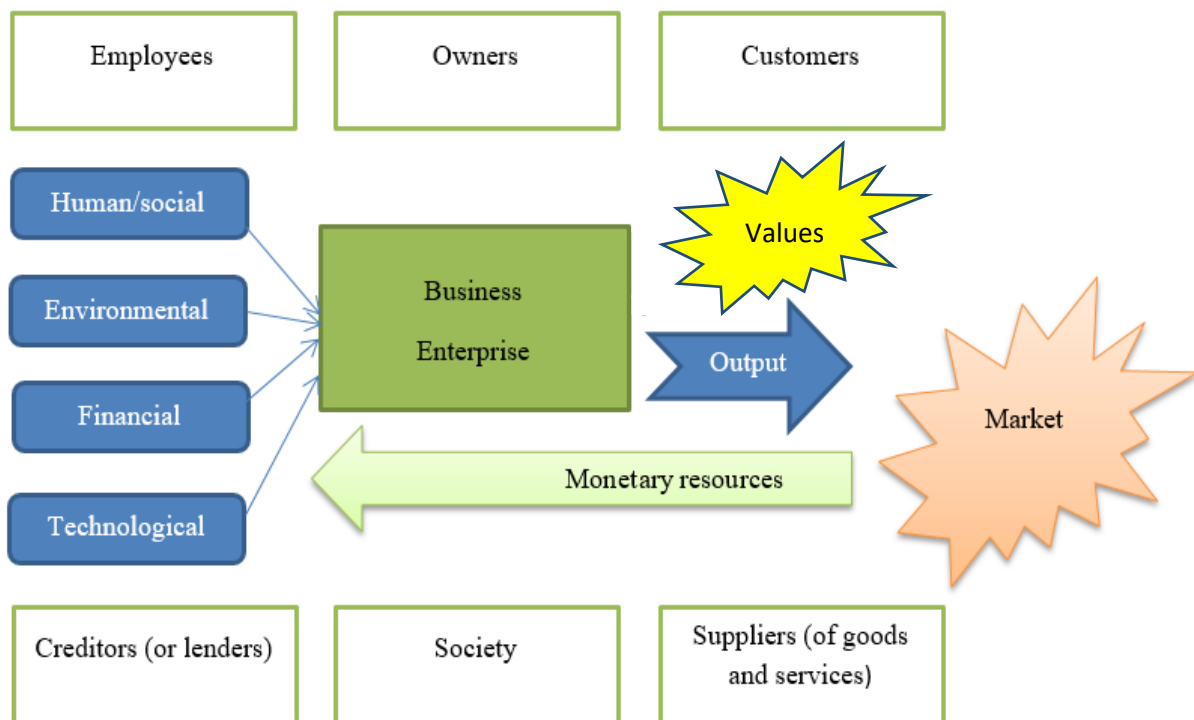


Figure 1. The sustainable enterprise theory (SET)

During the production process, values are created, some leave the company in terms of sold goods and services; other values stay in the company as intrinsic values of various types. Revenue generated provides enterprises monetary resources. Stakeholders have their shares of the values the enterprise generated. The value the enterprise generated is in short-term monetary resources and in different kinds of intrinsic capital or values. In a longer term, these intrinsic values have an impact on monetary flows for enterprises and their stakeholders. A final point in the SET model is that sustainability is inbuilt, in not only enterprises' own operations, but also demand enterprises to take responsibility for sustainability over the full life cycle of its products that includes both threats and opportunities.

The SET model has implications for both management of businesses and accountability to all stakeholders. Financial reporting of business activities are based on assumptions (postulates) about the way enterprises' activities that are measured in accounting systems. SET changes these assumptions and introduces accounting and management systems for 'green' enterprises (Fagerström *et al.* 2017).

Value creation and stakeholders

An important element of SET considering the inherent social implications is the perception of value or utility, "utility" as used by economists. Values or utility are personal beliefs; they can be expressed on various scales in addition to money.

An example of a value is value inbuilt in something, intrinsic value. A piece of land could have a production value for a farmer, but from another perspective, land could have other values. It might be situated in a very beautiful place and have a value from an aesthetical

point of view. These intrinsic values also exist in business. A difficult issue of these inbuilt values is how to measure them before assets (like the land) are sold. A significant part of sales prices on companies' shares is based on the idea of goodwill and other intrinsic values. Rogers (2016, p.1) notes:

In 1975, tangible assets made up more than 80 percent of Standard & Poor's 500 market value, and intangible assets made up less than 20 percent. By 2015, those numbers had reversed a trend that is unlikely to change direction. As the industries shaping our economy, such as the internet, media and services, and biotech, increasingly rely on human capital, technology, and innovation, intangible assets will play a growing role in their success.

Sustainability is another example of an intrinsic value. As discussed above, value is determined by individual persons. A group of persons, however, might have the same value preferences. Stakeholder theory gives directions for which groups surround an enterprise. Donaldson and Preston (1995 p.87) argued that stakeholder theory is managerial and recommends the attitudes, structures, and practices that, taken together, constitute a stakeholder management philosophy. The theory goes beyond the purely descriptive observation that organizations have stakeholders. In stakeholder theory, there is a difference among various groups of stakeholders. One group, a narrow group, has direct transactions with an enterprise, is, in that way, important both short, and long term.

Another group, a broader group of stakeholders, does not have an impact from transactions with an enterprise, but often interact on a long-term basis. This social contract between enterprise management and stakeholders needs to be adjusted over time. Contextual changes in society have an impact on social contracts. It is more difficult to make a new social contract, compared to maintaining ongoing social contracts (Suchman 1995; O'Donovan 2002).

An enterprise must act in an acceptable way in the view of stakeholders in order to gain legitimacy (Gray *et al.* 1996). This notion is discussed in legitimacy theory in which some light is cast over the issue "why enterprises voluntarily publish environmental reports". Enterprise managements do not like to have a legitimacy gap between the business and enterprises' stakeholders (Ljungdahl 1999; O'Donovan 2002; Campbell, Craven and Shrives 2003, Hinson *et al.* 2010).

In SET, value creation and stakeholders are linked. Suojanen (1954) who argues supports this notion:

Recent years have witnessed a considerable discussion by corporate management of the social responsibilities of the institutionalised corporation. A study of the published annual reports of large corporations indicates that there is a definite trend towards a social concept of the firm. (p.391)

Suojanen was early in his development of enterprise theory and the notion of an enterprise as a social activity concept. Examples of value from enterprises from perspectives of various stakeholder perspectives are presented in Table 1:

Stakeholder group	Group	Good value from the enterprise
Shareholders	Narrow	Stable secure return of investment (dividends and value growth), but also a guarantee of sustainable operations ('green' investments)
Employees	Narrow	Good working conditions (sustainable) security and good salary – pension etc., and a guarantee of sustainable operations

Creditors	Narrow	Stable secure payments of interest and amortization of loans, but also a guarantee of sustainable operations ('green' investments)
Costumers	Narrow	Good quality products for a good price, but also values like guarantees of sustainable production and products
Suppliers	Narrow	Good quality products for a good price, but also values like guarantees of sustainable production and products, payments on time
Society	Narrow	Good tax payers and high social responsibility, but also sustainable business enterprises
Environmental organisations	Broader	Demands for responsible sustainable business enterprises

Table 1. Value expectations from different stakeholders

As presented in the table, value has different focuses in different stakeholder groups; it is not limited to production and sales. Sustainability responsibility covers the enterprise, but also the sustainable area of the enterprise operations including suppliers, customers, and disposal contractors. From a sustainable enterprise perspective, product value is measured in terms of resources sacrificed that represent product cost compared to market price. Revenues less expenses result in profit. Revenue (prices) for products is based on customer's preferences. Factors other than product quality are included in customers' preferences. A sustainable product might have a higher selling price if sustainability is important for the customer.

Implications of SET model

The proposed SET extends Suojanen's (1954) enterprise theory of the firm. His theory used stakeholders as an essential part of value creation and was not limited to human capital. The sustainability demand on business gives the SET an even broader base than views on ownership, i.e. shareholders', vs. stakeholders' influence. It includes responsibility and benefits from activity areas inside and outside an enterprise. An enterprise that applies SET theory finds solutions too many areas of concern. Some examples are:

- Make good contracts with all major stakeholders and agree to include a new dimension, sustainability.
- Make agreements with suppliers to work in a sustainable way and to share information about sustainability as in the case of Walmart and General Mills.
- Build a sustainability information system based on accounting concepts including sustainability information after the sale of a product or service during the full product use including recycling and disposal.
- Focus both on short-term value generation and on long-term value generation of intrinsic capital in the enterprise.

To make contracts with stakeholders on sustainability is not an easy task. To change a political tradition of debate among various stakeholders about their share of the value generation in enterprises takes some effort. It is outside the scope of this paper to go further on this issue.

When data provided by periodic reports are broadened to include amounts in addition to financial results and financial positions, the value concept must be included. Traditionally, value has been discussed from a shareholder perspective, but from a sustainability enterprise perspective, value includes values for a broader group of stakeholders. Based on resource theory, resources linked to capital sources illustrate different values, see table below

Resources 1 - 4	Value indicators accounted as:	Values (capitals) (1 – 4)	
1. Human and Social	Expenditures / remuneration cost for labour	1a. Human capital	Sustainability values
	Social expense for labour. Payed taxes.	1b. Social capital	
2. Ecological	Expenditures / costs for the environment are seldom specified in the accounts.	2. Ecologic (environmental) capital	
3. Technological	Expense / cost for Research and Development. Production costs of various types.	3. Brands, patent and rights	
4. Economic	Cost, expenditures, revenues, assets, liabilities and equity	4. Result and equity capital (net assets)	Stock market value
		Values above 1- 4 plus various macro factors and psychology give value	

Table 2. Traditional financial accounting and reporting indicators of value

In table 2, ecological (environmental) resources are seldom systematically specified in traditional financial accounting reports. Other resources are reported in terms of expenditures or expenses, income, assets and liabilities to create the bases for values in table 2. One way to measure, the relevance of traditional balance sheets is to divide the market value of equity, i.e. market capitalization, by the book value of equity. This ratio is often called market to book or M/B. Normally, the M/B-ratio is less than one because market values include other values than those traditionally reported in the balance sheet.

It should be noted that traditional accounting is based on the assumption that values are created as a function of expenditure, an input value. Independent valuations give other perceptions of values such as exit values. Independent valuation is based on other value indicators than those traditionally found in traditional financial reports. As a result, traditional reports need to be expanded with additional value indicators, sustainability indicators and sustainability accounting (Fagerström et al 2017). The market capitalization of a company may, at a given time, be considered to reflect different shareholders' aggregate valuations of the company. The market value is an objective measure that reflects shareholders' perceptions of a company's value. When equity investors estimate the market value of equity, they assess the company's sustainability, i.e. values 1 – 3 in table 2.

Sujanen (1954) notes that the most important report for an enterprise is a value added statement shows the distribution among stakeholders. A value added report has been further developed in order to, except for distribution to capital and labour,- include a distribution to the environment, society and technology (see for example Haller and van Staden 2014; Fagerström and Hartwig 2016). A company's sustainability or going concern can be analyzed by studying the distribution of the value added to the following four sustainability dimensions: 1) financial sustainability, 2) social sustainability, 3) environmental sustainability and 4) technological sustainability (Fagerström and Hartwig 2016):

Sustainability can be both internal and external. As noted by Hartwig and Homayoun (2017 p.164) Internal sustainability focuses on how companies stay in business, their ability to continue as a 'going concern. Internal sustainability approaches issues from the inside.

External sustainability considers impacts companies have on society. The VA model generates information that is used as indicators of both internal *and* external sustainability.

Internal sustainability

An important indicator of internal sustainability is the amount spent on any of the four sustainability dimensions divided by value added, VA. For example, the amount spent on social sustainability divided by VA. Companies' long-term survival, or going concern, is at stake if there is an imbalance among the proportions of value added distributed to the four dimensions of sustainability, financial, social, environmental and technological. It is vital for companies' survival in the long term that company employees receive a reasonable share of company VA so that informal social contracts between the company and the employees are not broken. Hartwig and Fagerström (2016, p.40) explain in more detail: 'the suggested indicators may give a green light, sustainability is satisfactory in the current situation; amber light, sustainability in the current situation is somewhere between satisfactory and unsatisfactory; or red light, sustainability is not satisfactory in the current situation. When environmental sustainability indicators show one percent, about one percent of value added would go to environmental costs therefore giving a strong argument for that particular indicator to glow red. Limits within which indicators should be green, amber, or red are empirical questions that are linked to actual probabilities that a company will not survive.'

External sustainability

For focuses on a company' external impacts on society, the same indicators can be used such as the amount spent on any of the four sustainability dimensions divided by VA. Instead of focusing on company survival, the focus is on the survival or well-being of society. From a society sustainability perspective, it is crucial that companies spend a reasonable share of their VA amounts on salaries; taxes and those they make social, environmental and technological investments.

Accounting implications of SET and value creation.

Traditional accounting aim to give information to investors and owners. There is a need of an expansion of the accounting model in order to give information for a larger group of stakeholders. Needs of an expanded accounting model are also driven by new more sustainable business models. Several new business models are influenced of circular economy and sustainability inventions. Accounting and bookkeeping need to incorporate sustainability reporting's indicators of sustainable business, see Hartwig and Homayoun 2017.

This paper suggest that a new framework for sustainability accounting should be developed. We take a further step from sustainability reporting and argue that all reporting should be based on an accounting system that includes accounts for sustainability indicators from GRI or SASB. The area of accounting for sustainable business demonstrated in the table below:

Level I Traditional accounting

Minor changes in order to include a stakeholder concept and value added statement

Level II Sustainability accounting

Include sustainability indicators in the reporting and bookkeeping of the enterprise. Also including audit report of sustainability of the enterprise.

Level III special reporting for sustainable business

New business models create needs for new reports for example; circular business, sustainable supply chain, product lifetime impact etc.

Level I Traditional accounting
Level II Sustainability accounting
Level III special reporting for sustainable business

Table 3. Levels of accounting frameworks

Accounting need regulation in order to establish accountability. Only limited standards exist in sustainability reporting and there is no demands for bookkeeping as a base for the sustainability reporting.

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Bioflocculant Water Treatment Tank for Surface Water Treatment System

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Abstract

The water treatment tank treating untreated surface water by using a biofloculant that can be deployed and assembled easily at problematic area where the community facing polluted untreated raw water without need to build a fixed structure, both the tank and the biofloculant works and functions together. The water treatment tank structure is made of fiber reinforced plastic (FRP) with build inside of reinforced steel separated by 2 resin coated comprising of a mechanical stirrer (flash mixer), 3 section inside tank (pre-filter section, treatment section, and final filter section), 3 centrifugal pumps for raw water intake and outlet for treated water and sludge waste outlet. The whole size and dimension of the tank as follow; 5000 X 2000 X 1745 mm with degrees of slope 2.807 at the bottom based of the tank. Due to the slope, the 1745 mm is the physical tank heights for the tank, but the actual height or depth of each section is 1500 mm. The water treatment tank using *Moringa oleifera* as a flocculant which is prepared via supercritical fluid extraction, its function for reducing water turbidity and other parameter of raw open water such as river and lake. The tank has the maximum water storage capacity of 6750 L and the removal of the water turbidity and other suspended solids from the treated water in which the byproduct (sludge) settles and is collected from the bottom of the separate stages and a clarified water is produced and channelled back to the surface water. Therefore, from the result, it is showed that the disclosed system able to reduce the turbidity and chlorophyll-a, which was ranged from 70% to 90 %. The disclosed system also capable to change the water quality from Class II to Class I and from Eutrophic state to Mesotrophic state of open surface water.

Keywords: *Moringa oleifera*, bio-flocculant, water treatment, water treatment tank.

Introduction

Availability of clean water is one of problems faced by developing countries such as Malaysia where increasing population and economic activities lead to an increase in requirement of clean water. Water as a renewable yet finite plus vulnerable resource is vital for a sustainable future but this problem of contaminated water is exacerbated by climate change and local water demand conflicts. River water provides 97% of main water source for domestic, industrial and agricultural demand in Malaysia. Department of Environment (DOE) stated in the Malaysia Environmental Quality Report (EQR, 2014) that out of the 473 rivers monitored, 52% of it were found to be clean, 39% semi contaminated and the rest (9%) were contaminated or polluted. The causes of contamination were identified mainly due to flood, construction activities, earth works, and land clearing which contribute to high turbidity caused by silt, clay and other impurities (Linsley *et al.*, 1992). Others such as leachate, surface runoff, commercial waste, factory effluent and agricultural activities also contribute to contaminated river water. The problem of turbidity was often faced with the urban community because the appearance of coloured turbid water was non-appealing and rejected by the general public. The turbidity issue was supported by the Malaysian Water Association (1994) finding that Malaysian river waters are highly turbid due to content of silt and 47% of them shows value of more than 50 mg/L suspended solids. Access to safe drinking water and adequate sanitation services is vital to human health, but also has other important benefits ranging from the easily identifiable and quantifiable (costs avoided, time saved) to the more intangible (convenience, well-being, dignity, privacy and safety) quoted from WHO/UNICEF (2010). The water treatment technology is generally divided into three parts such as using physical actions with filtration and sedimentation, chemical actions such as coagulation and disinfection, and also biological action, such as sludge degradation, and now the latest are membrane aerated biofilm reactor (Kunetz *et al.*, 2016). Coagulation or flocculation is tasked of qualitatively removing turbidity and quantitatively reducing suspended solids. Flocculation is the mechanism of attaching between fine particulates in water column and clumping them together into flocs, forming large agglomerates. Flocculation happens when segments of the polymer chain adsorb on different particles and help particles to aggregate. In the first scenario, pollutant particles that are suspended in water are called colloids and have a negative charge, which causes them to repel each other. This allows the particles to maintain their weight light, making it hard for it to sediment to the bottom of the water column. With time the particles attached to each other and become heavier and thus are forced down due to an increase in their mass. The dosage of flocculants is important in order to avoid problems in settling in the clarification step where it is crucial to have flocs that are either floating or are settled to the bottom which can be easily filtered out from the treatment plant (Davis & Cornwell, 1998). Many flocculants are multivalent cations such as aluminium, iron, calcium or magnesium. These are the main chemicals used by a majority of water treatment operators for water treatment plant daily operation. Of which, aluminium sulfate or alum was the popular choice used in WTP due to its availability and affordability. Alum is derived from natural bauxite which is abundant and dissolved with sulfuric acid. During water treatment process, alum's action of forming Al^{3+} ions will bind with negatively charged impurities creating a body of flocs. Currently in Malaysia, the flocculation step is carried out by alum's variants such as Poly-aluminium chloride (PAC) or Poly-aluminium silico sulfate (PASS) (Bratby, 1980; Jolicoeur & Haase, 1989). However, studies have shown that there are negative implications of using alum such as Alzheimer disease (Suarez-Fernandez *et al.*, 1999) and also due to the limited availability and relative expense of these chemicals for the developing world, there is an demanding need to find alternative water purification solutions (Pritchard *et al.*, 2010). Residual aluminium in drinking water enters the human body and is classified as highly reactive and is more dissolved in the stomach where the pH is very low and the alum's toxicity may be a risk via adsorption (Sieliechi *et al.*, 2010). In Malaysia alone, as much as 22,000 MT of alum's waste are disposed from WTP annually and sent to sanitary landfill as scheduled waste (EQR, 2015). There is ongoing research worldwide to find an alternative

coagulant to alum. For example, a drinking water producer in Saskatoon, Canada has changed from alum to ferric sulfate to offer a higher degree of satisfaction to the consumer despite its higher operating cost (Eaglebrook, 2002). Ideally, the alternative should be cost effective, socially acceptable and environmentally friendly (Niquette *et al.*, 2004). In this context, natural coagulants present a viable alternative (Kawamura, 1991). Other alternative such as inorganic coagulants such as Lanthanide salts which has been considered as a replacement to Alum, and also polymers such as chitosan and *M. oleifera* which have been suggested as the major organic coagulants (Niquette *et al.*, 2004). Organic coagulants or bioflocculant are basically a bio-based organic particle apart from bacteria or algae that promotes clumping action of suspended pollutant waste. Polymers are first used as flocculation agents with its' ionic charge and are derived from plants seeds, leaves and roots (Kawamura, 1991). However polymers mainly served as coagulation aids. Tannin biopolymers were first used and are less harmful than synthetic polymers (Özacar & Sengil, 2003). However since synthetic polymers is cheaper and can be used at below 1 mgL^{-1} in order to follow WHO worldwide regulations, the idea of using biopolymers died down. Later, chitosan was also considered as one of the more promising material (Bratby, 2007). However its availability and uncertain costing, health impacts and other modification problems eventually double the production of cost of drinking water (Najm & Trussell, 1999). The source of the bioflocculant in this study was *Moringa oleifera* (*M. oleifera*) which belongs to *Moringaceae* family which is a kind of shrub tree originating from sub-Himalayan continent of India, and found to flourish on Malaysian soil. Brought by Indian merchants to be cultivated as a food source, it has been found to possess water treatment capabilities. The active component derived from both crushed (powdered) and defatted (oil extracted) seeds of *M. oleifera* is a soluble protein (Flo polypeptide) which contains a natural cationic polyelectrolyte that causes coagulation or flocculation (Barth *et al.*, 1982). Its hydrophobic structure of proline which is a type of amino acids buried inside the *M. oleifera* protein core has the ability to form hydrogen bonds providing the sternness to the protein structure. During water treatment, the polypeptides will attach itself to the impurities causing electrostatic flocculation which is accelerated by stirring. It also contains antimicrobial peptides (AMP) which have bactericidal, fungicidal and tumoricidal properties (Suarez *et al.*, 2005). NAHRIM's Bioflocculant Water Treatment Tank (NBWTT) using *M. oleifera* prepared via SFE is the brand name suggested. The bioflocculant and water treatment tank works and functions together. Generally the main function of water treatment tank is settling by gravity and it is the most common and extensively applied treatment process for the removal of suspended solids from water and wastewater (Goula *et al.*, 2008). The ability of sedimentation tanks to clarify water by letting suspended solids settle down as flocculated particles depends on two aspect; the water flow pattern through the tank, which in turn is determined by the configuration of the tank and by operational parameters (solids concentration, water flow rate and temperature) and the settling characteristics of the particles as determined by their shape, size and interaction with the water through drag and buoyancy forces.

Methods

The conventional method to prepare bioflocculant from *M. oleifera* seeds involves solvent extraction (SE) using n-hexane in order to remove oil (Ali *et al.*, 2010). Solvent extraction (SE) involves Soxhlet extractor setup which includes a percolator or a heater element for reflux process where the liquid solvent is evaporated to facilitate the circulation inside the apparatus, and a thimble to retain the solids or this case the *M. oleifera* seed. Finally the siphon mechanism systematically transfers the solvent's vapour inside and out from the thimble and subsequently removes the oil out from the seed. There are many types of solvents that is used, ranging from ethanol to hexane or other petroleum base solvents. However Ruttarattanamongkol *et al.* (2014) recently proposed using supercritical fluid extraction (SFE) to extract oil from *M. oleifera*. However the potential use of *M. oleifera* as coagulant (bioflocculant) after utilising SFE has not been assessed. SFE is basically a

process of separating extract in liquid state from its original matrix material which is in solid state using a more stable and non-toxic higher pressure CO₂ as solvent. The solvent can push through the matrix diffusing the extracts or in this study the oils. Extraction using SFE leaves no solvent residue in the extracts which unlike SE has a major setback of solvent residue in the extracts. Moreover the extract via SFE is more stable. SFE has been utilised to extract a wide range of organic compound from natural materials. In this study, we harness the ability of SFE to extract and discard as much oil as possible from the crushed seeds and we assessed the potential the pure oil less powder of *M. oleifera* as a coagulant in water treatment after SFE. *M. oleifera* was obtained from state of Sabah in Malaysia. Only good quality seeds from dry pods were used. The seeds were removed from its shells and the kernels were blended into medium fine powder using a domestic blender, and the powder was then oven dried at 50°C overnight (Memmert, Germany) to decrease its moisture content (Fig. 1). Oil inside the *M. oleifera* powder was extracted via the SFE method (Uribe et al., 2011) using the TST Oven Extraction system (OV-SCF-1000, Taiwan). Briefly, the extraction was carried out at 250 Bar and 50–60°C with 10 min of static extraction and 30 min of dynamic extraction with an industrial grade CO₂ flow rate of 0.66 g min⁻¹. The final product was sieved through a 250 µm mesh to remove any remaining husk. The efficiency of all bioflocculant which were prepared as described herein above in the removal of turbidity of raw water were determined via coagulation/flocculation activity or Jar Test. Generally, the coagulation/flocculation activity of bioflocculant were evaluated and verified by jar test wherein the process was conducted using the jar test equipment having a base floc illuminator. In this experiment, the samples of turbid raw water were prepared with varies turbidity (200 – 400 NTU) by using bentonite clay must be free from any contaminants or any coagulant or flocculant agent (Eman, 2012). All parameters that were used in this test were varied in order to determine the optimum condition. The mixing speed were varied from 100, 125 and 150 to 200 rpm; the flocculation time were ranged from 5, 10, 20, 25, 30, 45 and 60 minutes); and the bioflocculant dosage were varied from 0.01 to 1 g/L or 0.5 to 15 mL/L). The water treatment tank structure (Picture 1) is made of fiber reinforced plastic (FRP) with build inside of reinforced steel separated by 2 resin coated comprising of a mechanical stirrer (flash mixer), 3 section inside tank (pre-filter section or S1, treatment section or S2, and final filter section or S3), 3 centrifugal pumps for raw water intake and outlet for treated water and sludge waste outlet. The whole size and dimension of the tank (Figure 1) as follow; 5000 X 2000 X 1745 mm with degrees of slope 2.807 at the bottom based of the tank. Due to the slope, the 1745 mm is the physical tank heights for the NAHRIM'S Bioflocculant Water Treatment Tank (NBWTT), but the actual height or depth of each section is 1500 mm. The 3 sections has the maximum water storage capacity of 2250 L for S1 and S3, for S2 has the maximum water storage capacity of 6750 L. The process of the NBWTT (Figure 2) as follow; raw water i.e. lake, river, pond, etc. will enter the tank (inlet) by using the force of electrical powered mechanical pump. The maximum force of the pump as follow: 2.2kW (3HP) with 50 Hz frequency, there are 1 pump for pumping in (inlet) raw water into S1 and 1 pump for pumped out treated water from S3 to the water body i.e. lake and 1 more pump for drained and pumped out the sludge from the 3 section (S1, S2 and S3). The total pumps use are 3 units with maximum Head of 10 to 20 meter. For this tank the frequency of flow rate was controlled at 20 to 25 Hz (1500 rpm) that will ensure sufficient of 10m³ per hour of water flow (flow rate) by the inverter control system (for changing electric current form DC to AC) at control panel. Total of 4 inverter control system were used for this tank, as mentioned before, 3 for the pumps and 1 inverter for the flash mixer motor. Water inlet was placed at position of negative suction head, whereas for outlet was placed at position of positive suction head. Negative suction head meaning the water level is below pump level, whereas positive suction head meaning the water level is above pump level. To prevent airlock, all PVC piping connected to the pumps must filled up with water prior pumping, and to prevent form losing the water inside the pipes, one way valves were fixed along the pipes. Type of valve for water intake (inlet) are lift check valve where the water were suck in by moving up into the tank. The length of the pipes connecting to the pumps as

follow, for inlet pipe the length was 17.4 m (diameter 100 mm), for outlet was 20 m long (diameter 100 mm) and for sludge pipe was around 4 m (diameter 150 mm). The flash mixer (quantity of 1) was used for the treatment section (section 2 or S2), it's function to mix the raw untreated water with NAHRIM'S *M. oleifera* a biofloculant by motor power of 0.75 (1HP) using 3 phase induction motor at 415 volt. The maximum speed of 2 blade flash mixer rotation was at 1420 rpm (50 Hz) connected at the end of stainless steel shaft to the housing above fixed across the S2 in the middle. For S1 and S3, the space inside on both section were filled with water tank foam/sponge/mesh of 40 ppi (pores per inch) or 1.5 pores per mm of porosity for filtering the water.



Picture 1: Outside view of water treatment tank at pre-installation phase

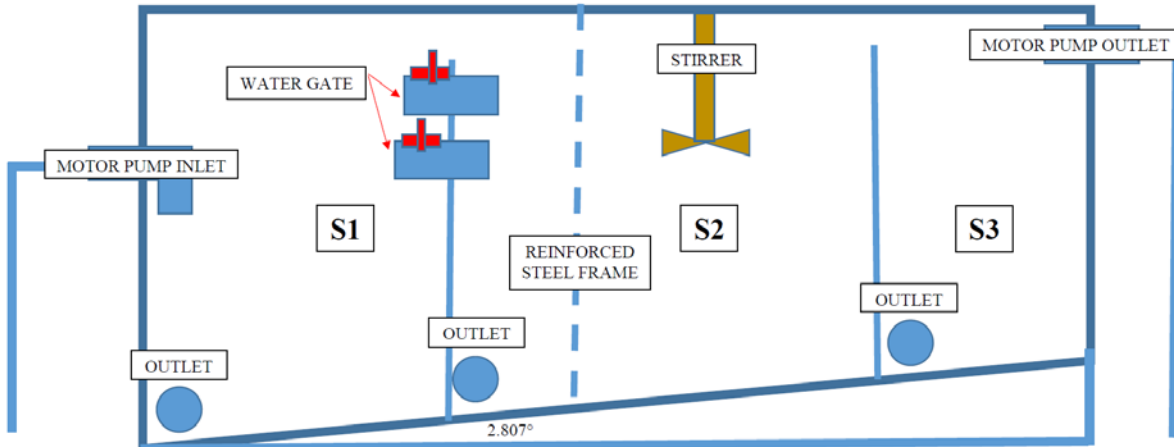


Figure 1: Sketch and outline of water treatment tank (side view) at research site

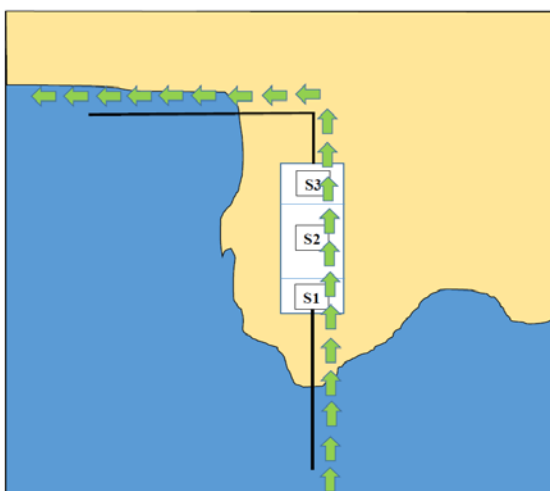


Figure 2: Flow diagram water treatment process at research site

Result & Discussion

The observation result for trial-run and field testing of the system for treating raw surface water using biofloculant treatment tank is as follow; Surface water i.e. lake, river, pond, etc. will enter into the first chamber unit by using the force of electrical-powered mechanical pump. The maximum force of the pump is as follow: 2.2kW (3HP) with 50 Hz frequency, there are one pump (the first pump unit) for pumping in the untreated surface water into the first chamber unit and one pump (third pump unit) for pumped out treated surface water from the third chamber unit into the surface water body i.e. lake and one more pump (the second pump unit) for drained and pumped out the sludge from the first chamber unit; second chamber unit; and a third chamber unit. The total pumps used are 3 units with maximum Head of 10 to 20 meter. For this system, the frequency of flow rate was controlled at 20 to 25 Hz (1500 rpm) that will ensure sufficient of 10 m³ per hour of water flow (flow rate) by the inverter control system (for changing electric current form DC to AC) at control panel. Table 1 below show the pump flow rate (m³/hr), speed (rpm) and frequency (Hz) of the system for treating untreated surface water using biofloculant treatment tank.

Frequency (Hz)	Speed (rpm)	Capacity (m ³ /hr)
50	3000	20.0
48	2880	19.2
46	2760	18.4
44	2640	17.6
42	2520	16.8
40	2400	16.0
39	2340	15.6
38	2280	15.2
37	2220	14.8
36	2160	14.4
35	2100	14.0
34	2040	13.6
33	1980	13.2
32	1920	12.8
31	1860	12.4
30	1800	12.0
29	1740	11.6
28	1680	11.2
27	1620	10.8
26	1560	10.4
25	1500	10.0
24	1440	9.6
23	1380	9.2
22	1320	8.8
21	1260	8.4
20	1200	8.0

Table 1: The pump flow rate (m³/hr), speed (rpm) and frequency (Hz) of the system for treating untreated surface water using biofloculant treatment tank.

Total of 4 inverter control system were used in this system, as mentioned before, 3 for the pumps and 1 inverter for the flash mixer motor. Water inlet was placed at position of negative suction head, whereas for outlet was placed at position of positive suction head. Negative suction head meaning the water level is below pump level, whereas positive suction head meaning the water level is above pump level. To prevent airlock, all pipelines that connected to the pumps must filled up with water prior pumping, and to prevent from losing the water inside the pipelines, one-way

gate valves were fixed along the pipelines. Type of the first gate valve unit for the untreated surface water source inlet pipeline unit are lift check valve where the untreated surface water was suck in by moving up into the treatment tank. A test on turbidity and chlorophyll- α removal on raw lake water test were conducted for investigating the efficiency of the disclosed system. Herein, the system and process were executed as described herein above. Doses of the *M. oleifera* seed powder biofloculant used were 300 g, 600 g and 900 g for each test. The result of analysis was listed in the following Table 2 and were illustrated in the Figure 3 and 4. Figure 3 showed the graph of the turbidity reduction on the raw lake water using the *M. oleifera* seed powder biofloculant which executed by the disclosed system. Figure 4 showed a graph of chlorophyll- α removal on the raw lake water using the *M. oleifera* seed powder biofloculant which executed by the disclosed system.

Treatment	Time (hour)	Temp	spCond	pH	Chlorophyll	Salinity	DO Conc.	DO%	Turbidity+
		°C	mS/cm		µg/L	ppt	mg/L	%	NTU
300 g Moringa seed powder biofloculant	1	29.33	0.30	7.39	46.00	0.13	0.65	8.60	60.50
	2	29.33	0.29	7.36	43.00	0.13	0.63	8.30	58.90
	3	29.33	0.29	7.31	17.50	0.13	0.58	7.50	13.90
	4	29.34	0.29	7.36	15.30	0.13	0.65	8.50	10.70
	5	29.34	0.29	7.25	12.80	0.13	0.62	8.10	9.50
	24	28.87	0.31	6.94	6.70	0.15	0.67	8.70	5.40
600 g Moringa seed powder biofloculant	1	29.15	0.44	10.28	44.50	0.21	0.72	9.40	69.00
	2	29.13	0.41	10.24	27.20	0.19	0.71	9.30	38.60
	3	29.13	0.40	10.22	14.70	0.19	0.68	8.90	17.40
	4	29.12	0.40	10.11	8.70	0.19	0.54	7.10	11.60
	5	29.12	0.40	10.20	9.90	0.19	0.73	9.50	11.40
	24	27.97	0.38	10.12	5.70	0.18	0.72	9.10	6.70
900 g Moringa seed powder biofloculant	1	29.22	0.28	7.62	53.10	0.13	0.99	13.00	58.10
	2	29.04	0.33	9.35	25.00	0.15	0.71	9.30	33.70
	3	28.99	0.33	9.28	6.80	0.15	0.74	9.70	4.60
	4	28.99	0.33	9.22	5.50	0.15	0.82	10.70	3.50
	5	28.99	0.33	9.15	5.40	0.15	0.75	9.80	4.20
	24	28.12	0.34	8.78	3.40	0.16	0.54	6.90	3.70

Table 2: Result analysis of turbidity and chlorophyll- α removal on the raw lake water

The initial treatment was started at 1 hour until 5 hour, and has been further proceeded until the 24th hour in order to confirm the reduction activity which happened before. In this treatment, the main pollution indicator were the turbidity and chlorophyll- α . As illustrated in the Figure 3, after 1 hour treatment, the three doses showed a sharp drop of reduction of turbidity (NTU). On the fifth hours, all three doses of treatment showed the slowing and almost horizontal pattern of turbidity reduction which meaning that it has reached the optimum treatment. At this point, the dose of 300 g showed a reduction of 84%; the dose of 600 g showed a percentage rate reduction of 83%; and the dose of 900 g showed a reduction 93%. Thus, the 900 g dose was seen to be the best choice for the water treatment at that time with high percentage of turbidity reduction and manage to change the initial water quality of Class II to cleaner Class I. For the chlorophyll- α removal, the reduction in chlorophyll- α material in water is an indicator for eutrophication of water body. The less chlorophyll- α content in the water body, the cleaner and less greenish the colour of the water. Through this investigation, it was showed that, the disclosed system was not only can increase the water quality of the treated water, but it also can trap any floating material that pollutes the water body aesthetically where the green algae (contain chlorophyll- α) contributes the green colour scenery of water body (lake and river) by the action of the filter foam, filter sponge or filter mesh which located at the first chamber unit and the third chamber unit of the treatment system. As shown on the Figure 4, for the three doses used (300 g, 600 g, and 900 g), 300 g dose showed 72% reduction; 600 g showed 77% reduction; and 900 g showed 89% reduction. All the three doses were used to reduce the chlorophyll- α content from initial range of 44 to 53 µg/L chlorophyll- α which categorized as polluted less aesthetic Eutrophic state (green color water body) to pleasant view aesthetic mesotrophic condition range of 5 to 12 µg/L after 5 hours of treatment. Therefore, from

the result, it showed that the disclosed system able to reduce the turbidity and chlorophyll- α , which was ranged from 70% to 90 %. The disclosed system also capable to change the water quality from Class II to Class I and from Eutrophic state to Mesotrophic state.

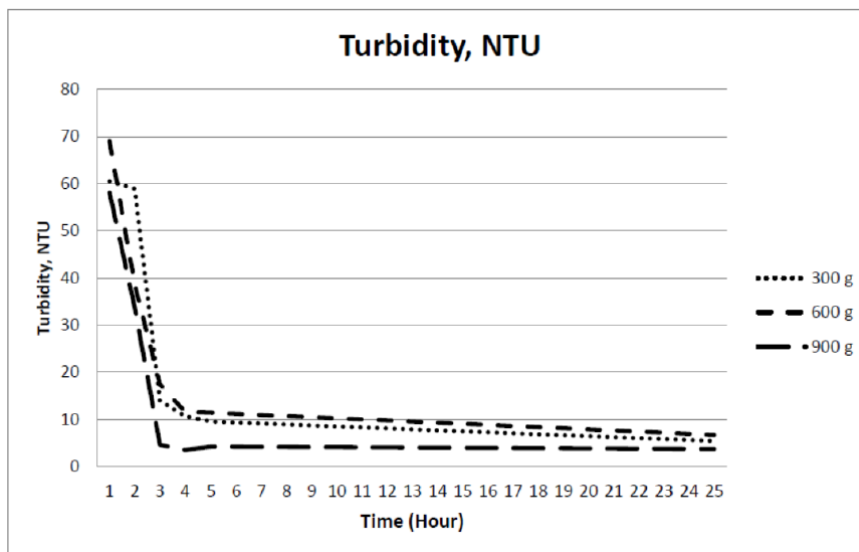


Figure 3: Turbidity reduction on the raw lake water using the *M. oleifera* seed powder bioflocculant which executed by the disclosed system.

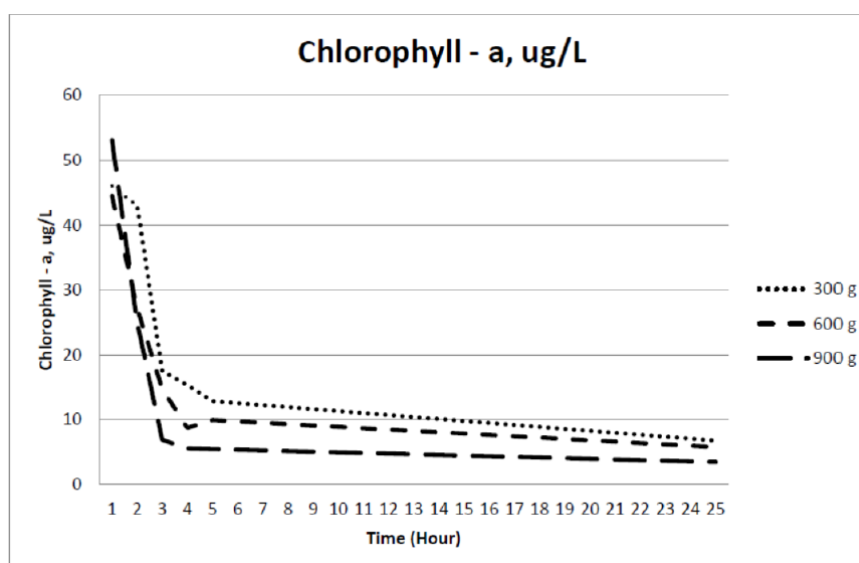


Figure 4: Chlorophyll- α removal on the raw lake water using the *M. oleifera* seed powder bioflocculant which executed by the disclosed system.

This invention using mobile water treatment facility can be deployed and assembled easily at problematic area where the community facing polluted untreated raw water meant to be used for domestic activity, without have to build a fixed structure. Water treatment usually using chemical coagulation agent such Alum and PAM was established for treating raw water by removing the turbid and suspended material. This invention using NAHRIM'S *M. oleifera* bioflocculant as an organic coagulation/flocculation agent which has been opted to replace the chemical agent with the purpose to be environmental friendly. Currently, if there is an area where the water body i.e. river or lake are polluted and cannot be used by the community for their domestic activity. Alternative treated water has to be channeled to the community which will incurred big cost if to compare using mobile water treatment facility that can be deployed there and solved the polluted water issue

directly. For utilizing the sludge produced from the current water treatment facility which contained Aluminum deposits. The sludge are to be made into building brick. But in order to make the brick stronger as normal clay brick they have to incorporate with rice husk and firing in higher temperatures compared with making of clay brick. So the preparation of sludge brick does incur more cost. Our bioflocculant has the advantages not only it is environmentally friendly due to its organic content, the sludge produced also can be used and sold as fertilizer if compared to present conventional coagulant of Alum.

Conclusions

NBWTT was built as a mobile Plug-and-Play water treatment facility using organic NAHRIM's *M. oleifera* bioflocculant powder. It has the potential of replacing Alum as the coagulant and the sludge is environmental safe and can be use a fertilizer. It can be target to commercial, industrial and agricultural sectors and players in setting up water treatment facility. The mobile water treatment facilities have been promoted to the market especially for industrial group which been using it for treating their industrial effluent. This invention targeted community who are facing treated water problem. The water body previously been used by the community for domestic activity cannot be used due to the degrading of water quality. Other research group promoting the bioflocculant but never suggesting the infra or structure that support or handling the treatment process. This application and invention we are using *M. oleifera* as bioflocculant (coagulant) for our own NAHRIM's designed bioflocculation water treatment tank.

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Bioremediation of distillery spent wash and biomass production using Microbial Fuel Cell

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Abstract:

Distillery spent wash (DSW) has become a major source of environmental pollution due to the presence of organic, inorganic pollutants and heavy colour load in it. DSW is a good source of high organic matter and nutrients for microorganism growth. In the present study, bio-electrochemical treatment approach was made to treat DSW using microbial fuel cell (MFC) system. In anaerobic environment DSW was used as substrate in anodic compartment and cathodic compartment was filled with BBM media and *Scenedesmus abundans*. CO₂ generated during breakdown of organic substrates by anaerobes present in DSW was utilized by microalga *Scenedesmus abundans* for photosynthesis. DSW was treated for 21 days using a mixture of two anaerobic bacteria. Significant reduction in COD (10% to 70%), total dissolved solid (30%) and suspended solid (69%) has been achieved. A power density of 180 mW/m² and open circuit voltage (OCV) of 351 mV were obtained along with biomass concentration of 516 mg/L.

Keywords: Microbial Fuel Cell, Distillery spent wash, Bioelectricity, Microalgae

1. Introduction:

The extensive use of fossil fuels, especially oil and gas, in recent years has triggered a global energy crisis which causes depletion of fossil fuels, environmental pollution and efficient development of renewable energy sources. Renewable bio energy is viewed as one of the ways to improve the current global warming crisis [1].

Microbial fuel cell (MFC) is an emerging technology which uses microbial interaction to convert chemical energy to electrical energy and value added products through the metabolic activity of microorganisms [2, 1, and 3]. A general design of a two chambered MFC consists of both anodic and cathodic compartments, microorganisms (Fig. 1). The electrons produced in anodic chamber pass through external circuit with protons passing through a proton exchange membrane (PEM) react with an oxidizing agent, such as oxygen, at the cathode surface which leads to close the circuit.

During the process of ethanol production in alcohol distillery industries, a large volume of liquid waste effluent rejects come out of the distillery industry as spent wash. This high strength toxic liquid waste is a discharge from the fermentative production of ethanol [4]. Brewery wastewater containing COD of 2000 mg/l was treated in dual chambered (rectangular) MFC (0.2 L anode volume), to obtain power density of 305 mW/m² at 30 ± 2 °C with 80% removal of COD [5].

2. Materials and Methods:

2.1 Bacterial Culture and *Scenedesmus* sp. Cultivation

Scenedesmus abundans was procured from NCCS Pune and stored at 4°C. Before inoculation in standardized BBM (Bolds Basal medium), the media was sterilized for 30 mins at 120°C and 150 lb [6]. *Pseudomonas aeruginosa* and *Bacillus subtilis* was obtained from NCL, Pune. Both the bacteria were cultured in agar media at 25 °C. The effluent was collected from malt based distillation plant and was preserved in 4°C prior using. Pre-treatment of distillery effluent by sterilization was done before experiment.

2.2 Experimental Setup

The experimental setup of MFC was designed and fabricated using Plexiglas. The constructed MFC contains two cylindrical chambers with working volume of 900ml each separated by proton exchange membrane, Nafion, from DuPont international. Both the electrodes were made of graphite. The two chambers were connected with a glass pipe to pass gasses produced from anode chamber during anaerobic respiration. The whole set up was operated in batch mode.

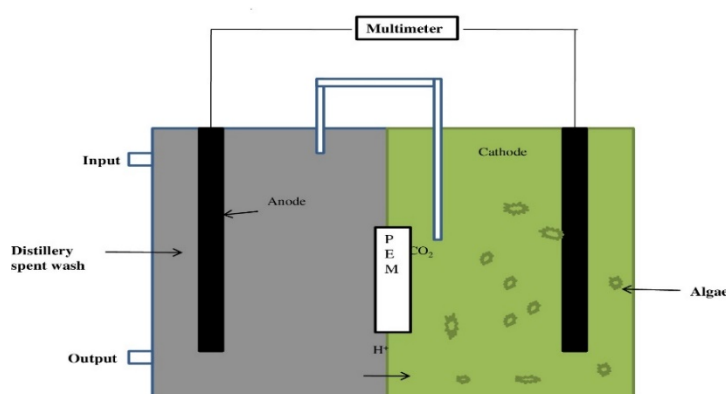


Fig 1. Experimental set used in this study

2.3 Electro chemical Analysis and Calculation

Power was calculated by using Ohm's formula; $P=V^2/R$ where V and R is the Voltage and Resistance, respectively. The power was normalized to the anode surface in order to calculate power density (mW/m^2). Power density was calculated according to the electrode surface area; $PD = P/A$ where A is the total surface area of electrode in m^2 . The COD removal efficiency (% age) was calculated using Eq. (1).

$$\text{COD Removal (\% age)} = \frac{C_i - C_f}{C_i} \times 100 \quad (1)$$

Several parameters including COD, TDS, TSS, TS were measured on each day as per the standard methods (APHA, 1998).

Table 4. Physiochemical parameters of distillery spent wash

Parameter	Color	Odor	pH	COD	TDS	TSS	TS	Total Alkalinity	Chloride	Calcium	Magnesium	Total Phosphorous	Total Potassium
Distillery spent wash (DSW)	Dark brown	Unpleasant	4.5±1.5	65000 - 75000	37500	6500	44000	2160	4900	1850	1100	14680	1000

2.4 Algal growth

The algal biomass was collected on every day basis and concentration was measured by UV spectrophotometer at 680 nm and converted into biomass curve using standard. The sample was collected and centrifuged at 6200 rpm for 5 min and vacuum dried overnight at 104 °C. Dry biomass was estimated by gravimetric process.

3. Results and Discussion

3.1 Electricity generation

The MFC was operated in a proper anaerobic condition in anodic chamber with precautions for 21 days. The output data of voltage for 100 Ω resistance was monitored with multimeter and illustrated in fig.3. Stable voltage growth was observed after 12-14 days which indicates the highest degradation of organic substances after this period. The output of 100% DSW also showed higher power density from the other studies. The peak power density and COD removal efficiency were observed as 180 mW/m^2 and 70%, respectively (Fig.2). The distillery

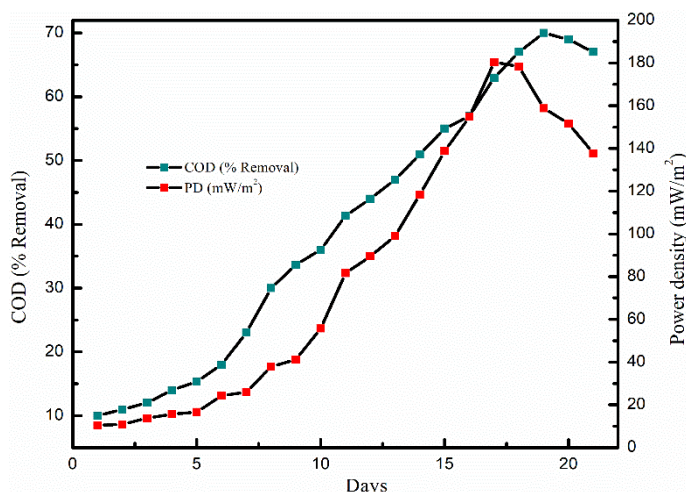


Fig 2. Effect of COD (% Removal) with PD (power density)

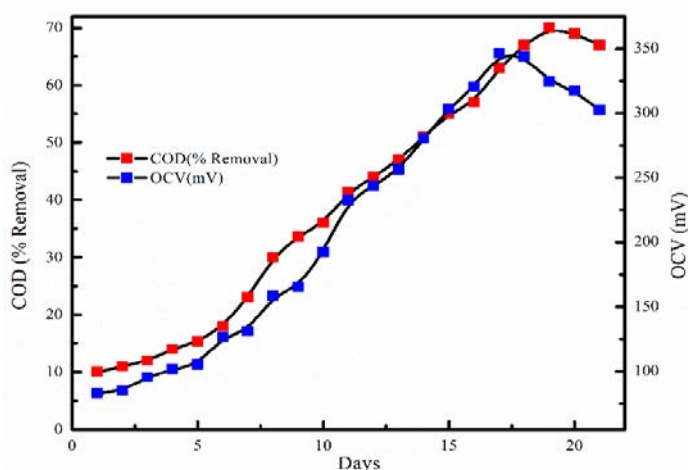


Fig 3. Relation between COD (% removal) and OCV (mV)

effluent was utilized as an organic substrate for bacterial biocatalyst when electrons (e^-) and protons (H^+) produced through redox reaction which facilitated power generation [7]. After 10 days, the MFC yielded a relatively stable operating potential of 193.33 mV in 100% distillery effluent. The generation of maximum voltage and power density of 346.2 mV and 180.42 mW/m², respectively (Fig. 3) were noticed on 17th day and the output was quite high than previous studies.

3.2 Substrate degradation analysis

The correlation between voltage outputs and COD concentration over the incubation period of the distillery spent wash was monitored (Fig. 4). The steady incline in COD reduction percentage with an increase in cell voltage over time, indicates the capability of the inoculated consortia culture to remove COD of the distillery spent wash and generate electricity. After successful run, effective wastewater treatment was noticed along with power generation. COD removal (70%) along with TDS, TSS (30% and 69%) and other components reduction were observed (Fig. 5). The value of voltage was decreased after a steady removal efficiency of COD due to unavailability of organic nutrients. Distillery effluent showed lowest removal efficiency of 65% due to presence of high organic load. It was difficult to sustain microbes in high COD. Time taken by microbes in lag phase was around 5th-8th days. After acclimatization of bacteria in sample, the removal of COD was increased between 16th-19th days.

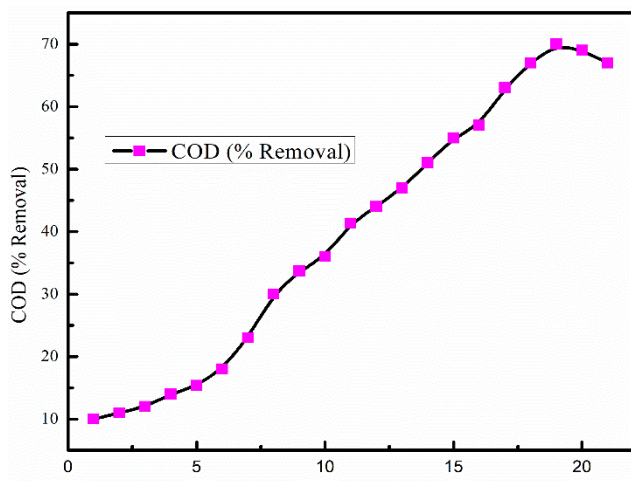


Fig 4. COD (% removal) in the incubation period

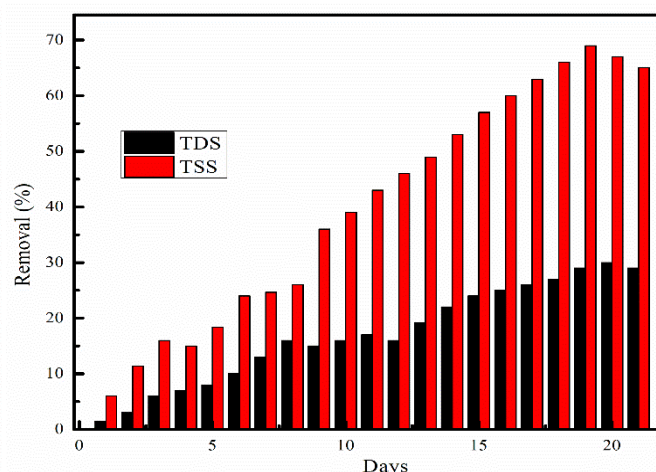


Fig 5. TDS and TSS removal (%) during 21 days of the incubation

3.3 Biomass production

In this study, the culture conditions are same but CO_2 for algae growth was supplied from the anode chamber to the cathode chamber in which algae was cultured and the growth of microalgae was observed. *Scenedesmus abundans* showed the maximum biomass productivity of 0.516 g/L-d on 21st day of cultivation period as shown in fig 6, which indicates the maximum anaerobic digestion in anodic chamber. *Scenedesmus abundans* has a lag phase of 5 days before going to the exponential phase. It attained the stationary phase at 21th day of cultivation period.

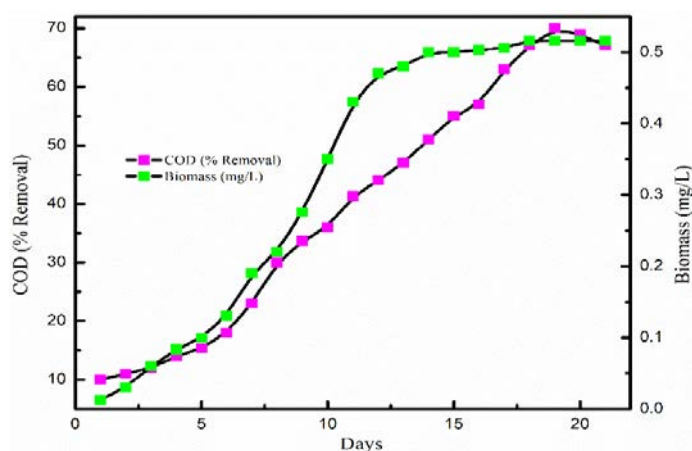


Fig 6. Relation between COD (% removal) and Biomass production (g/L)

4. Conclusion

In this study, the efficiency of H-type two chamber MFC using distillery wastewater as a substrate was observed. The feasibility of power generation using microalgae was demonstrated. The maximum power density (180 mW/m^2) and maximum OCV (351 mV) in this study were found relatively higher as compared to other reports. The production of CO_2 by the degradation of organic and inorganic compounds could be used by microalgae to promote their growth as well as oxygen generation at cathode. The maximum growth of biomass (516 mg/L) was noticed on 21st day. This study suggests that distillery wastewater and optimized conditions for microalgae growth can be a promising way for high power generation in MFC operation.

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Cr-free Fe-Al-Cu catalyst for hydrogen production from waste-derived synthesis gas via the high temperature water gas shift reaction

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Abstract

We have prepared a series of Cr-free Fe-Al-Cu catalysts by the homogeneous one-step co-precipitation method and examined their ability to promote the water gas shift (WGS) reaction and thus facilitate the production of hydrogen from waste-derived synthesis gas. Catalysts prepared using various precursor concentrations have been synthesized on the laboratory scale in a 0.5 L reactor. For laboratory-scale synthesis, the concentration of precursor solutions in a fixed volume of distilled water was systematically varied (Fe: 0.042–0.42 M, Al: 0.005–0.05 M, Cu: 0.005–0.05 M). Large-scale synthesis has been performed in a 20 L reactor (laboratory scale \times 40) and precursor concentrations have been chosen in such a way as to minimize the extent of performance degradation and simultaneously maximize the amount of the produced catalyst. The prepared catalysts effectively promote the WGS reaction without facilitating undesirable side reactions, achieving efficient hydrogen production and high CO conversion. Both commercial Fe-Cr and large-scale Fe-Al-Cu catalysts achieve close-to-equilibrium CO conversions at a gas hourly space velocity (GHSV) of $3,000 \text{ mL} \cdot \text{g}^{-1} \cdot \text{h}^{-1}$, but the latter showed a higher conversion than the former at a GHSV of $40,057 \text{ mL} \cdot \text{g}^{-1} \cdot \text{h}^{-1}$ owing to the promotional effect of Cu on the easier reducibility of Fe species and the formation of additional Cu active sites.

Keywords: Cr-free, Water gas shift, Hydrogen production, Waste-derived synthesis gas, Scale-up

Exploration for defining the role of Corporate Social Responsibility in achieving Sustainable Development Goals in India

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Abstract:

Rapid degradation of environment and climate change is not only concern of each and every country but an unanimous global concern. Realising this many countries have become a part of this common goal of achieving a balance between human and its liveable environment. Therefore, about 191 countries had gathered at United Nations headquarters in 2000 where the historic Millennium Declaration was signed. The declaration was that all countries achieve eight measurable goals by 2015. These goals were called Millennium Development Goals (MDGs). The 8 MDGs were; *eradicate extreme poverty and hunger, achieve universal primary education, promote gender equality and empower woman, reduce child mortality, improve maternal health, combating HIV/AIDS, malaria and other diseases, ensure environmental sustainability and develop a global partnership for development*. These goals included common concerns of many countries and thereby all the countries could easily relate to them for their achievement. The primary concern here was to halve the extreme poverty rate by 2015. The achievements were varied and not attained to the level of satisfaction until they expired in 2015. This was realised prior and therefore in 2012 in the United Nations Conference also called as the Rio+20, it was arrived to develop Sustainable Development Goals (SDGs) to carry the pace that was set by MDGs. The SDGs are supposedly, people-centric developmental agendas and strengthening the environmental goals. There are 17 goals, 169 targets and 229 indicators set for effective implementation and monitoring of SDGs. The 17 goals of SDGs are; *No Poverty, Zero Hunger, Good Health and Well Being, Quality Education, Gender Equality, Clean Water and Sanitation, Affordable and clean energy, Decent work and economic growth, Industry innovation and infrastructure, Reduced Inequalities, Sustainable cities and communities, Responsible Consumption, Climate Action, Life below water, Life on Land, Peace Justice and strong institutions and Partnerships for the goals*. These goals are targeted to be achieved by 2030.

Meanwhile in India, the Corporate Social Responsibility act came into existence in 2013 as a part of the Companies Act 1956 and made CSR mandatory. Notifications came up as schedule VII subsequently, defining the conditions under which the companies are liable to participate.

It is observed that the agendas of SDGs 2015 with CSR schedule of activities of 2013, have a huge interconnecting synergies. Many of the aspects of the far reaching goals of SDGs till 2030 seem to be achieved effectively if the CSR is implemented appropriately. The paper endeavours mapping of the goals of SDGs with schedule VII of CSR to check the effective implementable process and how both ends meet with satisfactory results. The paper includes study and analysis of the Global concerns of SDGs with the National theoretical framework of mandatory CSR, strategies adopted by the government for implementation of SDGs with the present status, role and status of the corporate and suggestions for future strategies to dovetail both SDG and CSR for better on ground results.

Keywords: *Corporate Social Responsibility, Sustainable Development Goals, Millennium Development Goals, schedule VII of CSR, Government policies.*

1.0 Introduction

Degradation of environment and climate change are not only National but global concerns. This has been realised by many countries and hence leaders of 191 countries gathered at United Nations headquarters in 2000 and signed the historic Millennium Declaration. The declaration was that all countries to achieve goals with concerns of human development. Eight measurable goals with 18 targets were established to be achieved by 2015 to find solutions for the global concerns. These goals were called Millennium Development Goals (MDGs). The 8 MDGs were; *eradicate extreme poverty and hunger, achieve universal primary education, promote gender equality and empower woman, reduce child mortality, improve maternal health, combating HIV/AIDS, malaria and other diseases, ensure environmental sustainability and develop a global partnership for development*. These goals included common concerns like poverty and hunger of many developed and developing countries and thereby all the countries could relate to achieve them collectively. The primary concern of the MDG was to halve the extreme poverty rate in the world. The achievements were varied and were not attained to the level of satisfaction until they expired in 2015.

In 2012, the United Nations Conference on Sustainable Development, also called as in the Rio+20, it was arrived to develop Sustainable Development Goals (SDGs). These goals were identified to carry the pace that was set by MDGs. The SDGs are designed to be with people-centric developmental agendas and strengthening the environmental goals. There are 17 goals, 169 targets and 229 indicators set for effective implementation and monitoring of SDGs. The 17 goals of SDGs are; *No Poverty, Zero Hunger, Good Health and Well Being, Quality Education, Gender Equality, Clean Water and Sanitation, Affordable and clean energy, Decent work and economic growth, Industry innovation and infrastructure, Reduced Inequalities, Sustainable cities and communities, Responsible Consumption, Climate Action, Life below water, Life on Land, Peace Justice and strong institutions and Partnerships for the goals*. These goals are targeted to be achieved by 2030. Implementation of SDGs in respective countries is the responsibility of the National Government of each country. The UN is responsible to offer suggestions and recommendations on the steps taken by the countries. All the countries are required to meet at the UN in the high level political forum every four years to present what have they achieved for 2030 agenda.

Meanwhile almost at the same time, in India the CSR act came into existence in 2013 as a part of the Companies Act 1956 making it compulsory for Government and private companies to get involved in CSR depending on the prescribed fiscal conditions. Notification for the same came up in February 2014 under section 135 making it mandatory for the government or private companies as obligatory if they fall under the following fiscal conditions; (i) *Net Worth of the company is Rs 500 Crores or more*, (ii) *Annual Turnover of the company Rs1000 Crore or more* and (iii) *Annual profits of the company atleast Rs 5 Crores or more in any financial year*. Such a company to spend *at-least 2% of the average net profit of preceding three years in CSR*. Further, the areas in which CSR should be conducted

by the companies is elaborated in schedule VII of activities. The schedule earlier included the following; (i) *eradicating extreme hunger and poverty*, (ii) *promotion of education*, (iii) *promoting gender equality and empowering women*, (iv) *reducing child mortality and improving maternal health* (v) *combating human immunodeficiency virus, acquired immune deficiency syndrome, malaria and other diseases*, (vi) *ensuring environmental sustainability*, (vii) *employment enhancing vocational skills* (viii) *social business projects* and (ix) *contribution to the Prime Minister's National Relief Fund or any other fund set up by the Central Government or the State Governments for socio-economic development and relief and funds for the welfare of the Scheduled Castes, the Scheduled Tribes, other backward classes, minorities and women*.

Soon the schedule got revised and reframed the existing areas and added the following in the list; (i) *protection of national heritage, art and culture including restoration of buildings and sites of historical importance and works of art; setting up public libraries; promotion and development of traditional and handicrafts*, (ii) *measures for the benefit of armed forces veterans, war widows and their dependents*; (iii) *training to promote rural sports, nationally recognised sports, paralympic sports and Olympic sports*, (iv) *contributions or funds provided to technology incubators located within academic institutions which are approved by the Central Government* and (v) *rural development projects*.

If the companies meet any of the above mentioned fiscal conditions, then the company should constitute a CSR committee and composition of such a committee should be disclosed to public. The Committee is responsible to recommend the policies to the Board as per the list of activities in schedule VII. It will require to guide and suggest the amount that the company should spend and monitor the status and progress of the company. The Board of the company will be required to approve the policy suggested by the committee, disclose the contents to public after the approval by putting the information of public portal and ensure that the company follows the policy adopted. The Board shall ensure that the company spends *at-least 2% of the average net profit of preceding three years*. In selection of projects, the preference be given to local area of operation of the company so that easy and effective implementation of the policy takes place. In case the company is not able to perform or spend as per the policy, reasons for the same need to be stated explaining the reasons of failure.

India is the first country to have legislation for implementation of CSR followed by the United Kingdom. If we look at the historical perspective of CSR in India, whether or not CSR act, practised the idea of charity and philanthropy since many years. Before 19C it was more of charity perspective which further got practiced like philanthropy for many years. Before independence, the Gandhian thought of trusteeship was practiced in India predominantly. Trusteeship was a socio-economic theory wherein the wealthy are the trustees to take care of the welfare of others. It was in early 20C, the Indian business started contributing for Independence of the country and thus the private companies started to participate in the people's welfare. During the mid of 20C, India was witnessing golden years

of capitalism until 1960s but during then, there came economic and political struggle and the businesses started to suffer. In 1970s corporate interest were getting renewed and until 1990s, when the globalisation occurred and the businesses in India got a boom, and involvement of private sector for the well being of communities, people, employees and other stakeholders increased manifold.

The Indian CSR policy can be observed to have a triple bottom approach for environmental care, social equity and economic prosperity. It means that the corporate need to work in a manner that along with economic gains, it has to take into account the ecological and social performances. It also means that the responsibility is not only on the shareholders of the company but lies with stakeholders too. It clearly states that the CSR is supposedly to be practiced in a sustainable manner so that it is viable, bearable and equitable. It should be undertaken in a manner that it adheres to the concerns of People giving Profitable outputs and in a manner that saves the Planet in the long run.

2.0 Study & Analysis

Now if we closely look at the agendas of SDGs 2015 with CSR 2013 schedule VII of activities, many of the aspects of the far reaching goals of SDG to be achieved in 2030 seem to have an overlap. Mapping of these goals and schedule gives a clear picture that both have interconnected synergies.

(i) Study of the agendas and schedule of CSR activities show that the visions of both farsighted visions meet at various points. Following table shows the agendas of SDG covered under respective CSR activities:

S.No	SDG	Brief description of SDGs	CSR Act 2013 India- Revised Schedule VII
1	No Poverty	<i>End poverty in all its forms everywhere</i>	i. eradicating hunger, poverty and malnutrition, promoting preventive health care and sanitation and making available safe drinking water
2	Zero Hunger	<i>End hunger, achieve food security, improve nutrition and promote sustainable agriculture</i>	
3	Good Health and Well Being	<i>Ensure healthy lives and promote well-being for all at all ages</i>	
4	Clean Water and Sanitation	<i>Ensure availability and sustainable management of water and sanitation for all</i>	
5	Quality Education	<i>Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all</i>	ii. promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly, and the differently abled and livelihood enhancement projects

6	Gender Equality	<i>Achieve gender equality and empower all women and girls</i>	iii. promoting gender equality, empowering women, setting up homes and hostels for women and orphans; setting up old age
7	Reduced Inequalities	<i>Reduce inequality within and among countries</i>	homes, day care centres and such other facilities for senior citizens and measures for reducing inequalities faced by socially and economically backward groups
8	Affordable and clean energy	<i>Ensure access to affordable, reliable, sustainable and modern energy for all</i>	iv. ensuring environmental sustainability, ecological balance, protection of flora and fauna, animal welfare, agroforestry, conservation of natural resources and maintaining quality of soil, air and water
9	Decent work and economic growth	<i>Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all</i>	
10	Responsible Consumption	<i>Ensure sustainable consumption and production patterns</i>	
11	Climate Action	<i>Take urgent action to combat climate change and its impacts</i>	
12	Life below water	<i>Conserve and sustainably use the oceans, seas and marine resources for sustainable development</i>	
13	Life on Land	<i>Protect, restore and promote sustainable use of terrestrial ecosystems, etc.</i>	ix. contributions or funds provided to technology incubators located within academic institutions which are approved by the Central Government
14	Industry innovation and infrastructure	<i>Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation</i>	
15	Sustainable cities and communities	<i>Make cities and human settlements inclusive, safe, resilient and sustainable</i>	v. protection of national heritage, art and culture including restoration of buildings and sites of historical importance and works of art; setting up public libraries; promotion and development of traditional arts and handicrafts
16	Peace Justice and strong institutions	<i>Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels</i>	Not covered in CSR

17	Partnerships for the goals (<i>global partnerships</i>)	<i>Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development</i>	Not covered in CSR
18	Not covered in SDG		viii. contribution to the Prime Minister's National Relief Fund or any other fund set up by the Central Government for socio-economic development and relief and welfare of the Scheduled Castes, the Scheduled Tribes, other backward classes, minorities and women
19	Not covered in SDG		vii. training to promote rural sports, nationally recognised sports, paralympic sports and Olympic sports;
20	Not covered in SDG		vi. measures for the benefit of armed forces veterans, war widows and their dependents
21	Covers 1,2,3,4,5,6,8,10		x. rural development projects

(ii) In the analysis of the above study, it is clear that agendas of SDG and CSR prescribed schedule VII activities have common interests and missions. Agendas like No Poverty, No Poverty, Good Health and Well Being and Clean Water and Sanitation in schedule (i) of CSR; agenda of Quality Education in schedule (ii); agenda Gender Equality in schedule (iii); agenda Affordable and clean energy, Decent work and economic growth, Responsible Consumption, Climate Action, Life below water, Life on Land in schedule (iv); agenda Industry innovation and infrastructure in schedule (ix); agenda Reduced Inequalities in schedule (iii); agenda Sustainable cities and communities in schedule (v) and agenda of Peace Justice and strong institutions and Partnerships for the goals (*global partnerships*) are not covered under CSR as they are more pertinent for global concerns. Vice-a-versa a few activities of CSR are completely Nation centric and hence can not be compared with the SDGs. Also there is an overarching schedule X, rural development projects which, directly covers most immediate pertinent agendas, and indirectly connects to allied agendas. As per the census 2011, out of 121 crore of Indian, 83.3 crore live in rural areas. Therefore, no poverty, zero hunger, good health and wellbeing, quality education, gender equality, clean water and sanitation, decent work and economic growth and reduced inequalities cater to the rural development and thus to the overall development of the country. These are not only directly related to rural parts of India but are also impacting the urban India. Thus it makes CSR and SDG both very crucial for effective implementation for overall development of the Country. .

3. Present Status in India

In India, it is the responsibility of implementation of the SDGs is National Institution for Transforming India (NITI Aayog), a primary policy planning institute and a premier policy think tank of the Central Government. It is chaired by the Prime Minister of India himself so that the agendas are taken up expeditiously. Further, the State governments are directed to draw their plans so that the road map of SDGs is chalked out with practical approaches and no loop holes are left. Moreover, the clarion of Prime Minister, *Sabka Saath, Sabka Vikas*, embodies the five Ps of the global SDG movement – people, planet, prosperity, partnership and peace. As per NITI Aayog Baseline report 2018, there are 13 out of 17 SDGs pertaining and considered immediate for implementation in the Indian context. SDGs 12, 13 & 14 have been left out since they are immeasurable by the States or Urban territories of India. SDG 17 is considered out of focus, since it depends on International partnerships. NITI Aayog has developed the SDG India Index, in collaboration with the Ministry of Statistics & Programme Implementation to assess the present status of different States and UTs of India. As per the index, 5 States/ UTs are categorised to be front runners, 28 to be performers, 3 to be aspirants while none are the achievers so far.

So far as per the government initiatives it can be seen that the goal numbers 1,2,5,9,14 and 17 have been already initiated its implementation. There are several Centrally sponsored schemes floated by the NITI Aayog making the concerned Ministries and their departments responsible for the effective implementation addressing each of the SDG. It can be observed that the schemes launched by the government encompass several goals together. For example, the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), Deen Dayal Antyodaya Yojana (DAY) -National Rural Livelihood Mission (NRLM) and Pradhan Mantri Awaas Yojana - Gramin (PMAY) addresses the SDGs 2,3,4,5,6,7,8, 10,11 and 13. Schemes like Pradhan Mantri Jan Dhan Yojana largest financial inclusion program, Bima Yojana, Pension Yojana etc are some of the finance schemes that are crucial for upliftment of the poor. National Health Mission, Food subsidy, National AYUSH mission etc are the schemes which directly take care of the agenda 2 and consequently also 1,3,4,5,6,8 and 12. Schemes like Sarwa Shiksha Abhiyan, missions for protecting the girl child, empowerment of women, Swacha Bharat Mission, National Rural drinking water program, AMRUT, SMART city mission, strengthening of power systems, LPG subsidy, Start-up India, make in India programs, Conservation of National resources, National mission for green India and many such, are the overarching schemes that are rigorously been implemented to achieve the target by 2030.

Coming to the scenario of CSR by the Corporate Sector of India, involvement for achieving SDGs can be witnessed through the companies like Tata Consultancy Services, Mahindra, Infosys, ITC, HDFC Bank, IOC ONGC, RIL, NTPC, Tata Steel and WIPRO which have performed and expressed rigour in including the society and stakeholders, following ethical business in the financial year 2018. The CSR expenditure has increased by

11% to Rs 10,030 Cr as per the analysis of 1080 companies of 1795 companies listed by National Stock Exchange by PRIME Database Group. In the year 2017-18, 931 companies and in the year 2018-19, 1016 companies are spending on CSR. The top 10 companies namely, Reliance Industries, ONGC, TATA consultancy services, HDFC Bank, Indian oil Corporation, Infosys, ITC, NTPA, Tata Steel and Wipro have accounted for 36% spending of CSR alone. The highest contribution was found to be in the Swachh Bharat scheme though it is declined as per the previous years contribution. Spending of CSR is directed to agendas like reducing inequalities, protection of national heritage, armed forces, sports and Prime Ministers Relief fund, which has the highest attraction with biggest rise of 139%.

4. Conclusion

SDGs and CSR activities, both are the innovative measures that need to be adopted in a synchronic manner to achieve better results for human development. Along with Government initiatives, it is also the role of corporate which may drive the SDGs effectively if the activities are dovetailed with the CSR. It is evident that the corporates world wide can not flourish if the World is in poverty or people are in deplorable conditions. Only about 12 years are left for achieving SDGs and making the world a better place to live. Therefore new paradigm of partnerships between the Government and the corporate world need to be explored. Interlinking of SDG and CSR can therefore demonstrate strategic channelisation of resources. The corporates may be guided to adopt them both in their business management policies and include them as top priority in their business plans. Companies may select SDG as per the area of their concern, in the surrounding areas where they function. For example if there is some cement manufacturing company, it may chose suitable SDGs such as 6, 11 and 12 clean water and sanitation, sustainable cities and communities, responsible consumption and production. Or an IT company may take up agendas like providing quality education to children starting from the stakeholders like all the employees. Thus the companies will automatically integrate CSR schedule (iii) and (iv) in its activities and thus can intervene positively with the social, economic and environmental concerns of both. Additionally they get benefits like branding, tax exemptions, awards for motivation and continued support from government for their endeavours. Since the companies can not benefit and flourish without sharing the benefits with the stakeholders, both CSR and SDG leads a path for the company to share their benefits with stakeholders. In this manner the companies interests may be retained on one hand and a sustainable society is produced in the other hand. Thus the far reaching goals of having all the social, economical and environmental well-being will be addressed if the SDG and CSR are treated symbiotically.

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Impact of Difference Dimensions of Corporate Social Responsibility on Financial Performance of Firms listed in the Stock Exchange of Thailand

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Abstract

The objective of this study was to disaggregate CSR into three dimensions for environment, employment and community base on corporate voluntary disclosure of firms listed in the stock exchange of Thailand (SET) and examine how each dimension would affect financial performance. A sample size of 61 listed companies on the Stock Exchange of Thailand was randomly selected due to their consistency in performance. CSR score for each dimension was obtained using content analysis and firm financial performance were calculated from the annual reports during the period of year 2014 through 2016. A multiple regression model was established to determine the relationship. Control variables of return on equity, leverage ratio and firm size were also introduced in the regression model. The results indicated that CSR community activity and leverage ratio have negative and significant relationship but firm size has positive relationship with return on asset. In addition, the results of the study also showed that only return on equity factor has statistically significant impact on company stock price with positively relationship.

Keywords: Corporate Social Responsibility, Corporate Financial Performance, Stock Exchange of Thailand

1. Introduction

The field of Corporate Social Responsibility (CSR) has been a topic of debate from the last few decades. The companies pay more attention to define and integrate corporate social responsibility in all aspects of their business. CSR has been defined in various ways. Majority of these definitions integrate the three dimensions: economic, environmental and social aspects into the definition, what is usually called the triple bottom line which are People, Planet and Profit [14]. The triple bottom line is considering that companies do not only have one objective, profitability, but that they also have objectives of adding environmental and social value to society [7]. It proposes that a private firm has responsibilities to society that extend beyond making a profit. It is the obligation of the firm's decision makers to make decisions and act in ways that recognize the relationship between the business and society. Therefore it is an important for a business to continue in its commitment to behave ethically and contribute to economic development while improving the quality of life of the work force and the surrounding community at large [8].

The increasing attention to CSR is firstly based on its capability to influence firms' performance [6]. A wide variety of definitions of firm performance have also been proposed in the literature. Both accounting and market definitions have been used to study the relationship between corporate social responsibility and firm performance [10]. Many empirical studies have been conducted in order to know the impact of corporate social responsibility on the Corporate Financial Performance (CFP). Different researchers used different techniques for knowing their relationship and found variations in results. In general, when the empirical literature assesses the link between social responsibility and financial performance the conclusion is that the evidence is mixed [11].

As mentioned above, CSR activities are becoming more widespread among businesses. Corporations are developing awareness that CSR activities affect the image of the company and may therefore affect their performance as well [16]. The trend in developed markets such as North America and Europe show there have been widespread empirical tests of the relationship between CSR and CFP [12]. It is important for Thai businesses to understand what social responsibility is and to adopt it as part of their operations. In Thailand, CSR activities are on the rise in many businesses. The SET has developed the corporate sustainable practices of listed companies that are key players of the capital market's sustainable development [13]. The aim is to boost consistent economic growth, while promoting social responsibility and environmental stewardship with corporate governance. The SET has been helping Thai listed companies to have good governance adopted by the recognized international standard. The starting point was in 1995 before the financial crisis, when it studied roles of audit committee for listed companies. After that, in early 1998 it issued a listing requirement indicating that effective from 1999 onwards, all listed companies have an audit committee. The firms listed at the SET are classified into different sectors based on the nature of their activities and operations which had 567 companies with 8 categories as at 31 December 2016 that including agricultural, commercial and services, banking, insurance,

investment and the manufacturing, construction and allied sector among others. However, little research have been conducted to measure the statistical association between CSR and CFP. The aim of this study was, therefore, to examine how different CSR dimensions including employment, environment and community would affect CFP among firms listed in the SET. The result of this study will be beneficially to the managers with clear insight into which CSR activities areas would improve their companies' financial performance.

2. Objective of the Study

To examine the impact of different dimensions of CSR on corporate financial performance of firms listed in the stock exchange of Thailand.

3. Research Methodology

3.1 Population and Sample

In this study the population of 576 was made up of all listed public companies classified under 8 categories by the SET. Each company in the population must have finished its obligation in delivering annual report of the year ended from 2014 through 2016. A sample of 61 firms out of the population of 57 were randomly selected due to their consistency in performance which fulfils the sampling criteria.

3.2 Data Collection

According to several previous research [1] [4] [5] [6] [9] [15], three dimensions of CSR were considered in this study as employment dimension, environment dimension, and community dimension. The employment dimension consist of 5 indicators as health and safety system, training and development system, equality of opportunity policy, employee relationship system, and system for job creation and job security. The environment dimension consist of 3 indicators as quality of policy, management systems, and reporting. The community dimension consist of 1 indicator as the community. In this study the multiple regression analysis was used to examine the impact of difference dimensions of CSR on corporate financial performance of firms which data must be the quantitative data. Therefore content analysis was used in order to obtain the CSR scores for each dimension from the annual reports during the period of year 2014 through year 2016. For each company's annual report, the weight of CSR scores have the following steps.

- (1) Considering of the sentences that have stated the concerned text with all indicators of three dimensions of CSR and weighted those sentences into the scores as follow:
 - For indicators in employment dimension and community dimension will be scored from 0

to 3 (0 = not stated, 1 = few stated, 2 = slightly stated, 3 = completely stated) [13].

- For indicators in environment dimension will be scored from 0 to 4 (0 = not stated, 1 = few stated, 2 = slightly stated, 3 = completely stated, 4 = very completed) [1].

(2) Sum of the total scores and compute the mean values for each dimension of CSR that were considered from the annual reports during the period of year 2014 through year 2016. These mean values were applied into the multiple regression analysis.

After the weight of CSR scores, the nine independent variables of three dimensions of CSR from the sample of 61 companies are translated into the scaling scores for the three previous years.

For the financial performance, the data of ROA, SP, ROE, SIZE and LEV are calculated and/or gathered based on the financial statements and management reports of the 61 selected firms from the stock exchange of Thailand website.

3.3. Data Analysis Techniques

Regression analysis was then used to test the relationship between three dimensions CSR practice and CFP. Three dimensions CSR were the independent variables including employment (EMP), environment (ENV) and community (COM). CFP, which is represented by return on asset (ROA) and stock price (SP) were as the dependent variable. Other independent variables considered in the model include firm's size (SIZE) and financial leverage ratio (LEV) which were used as control variables. SIZE is defined as the total annual sale, and LEV is defined as the ratio total debt to total asset. The data of ROA, SP, ROE, SIZE and LEV are calculated and/or gathered based on the financial statements and management reports of the 61 selected firms from the stock exchange of Thailand website.

3.4 Regression Model

The relationship was explained by the following regression model:

$$F_{ROA} = a_0 + a_1EMP + a_2ENV + a_3COM + a_4LEV + a_5SIZE$$

$$F_{SP} = b_0 + b_1EMP + b_2ENV + b_3COM + b_4LEV + b_5SIZE$$

Where:

a_0, b_0 = Intercept coefficient

a_i, b_i = coefficient for each of the independent variables

F_{ROA} = financial performance as measured by return on asset

F_{SP} = financial performance as measured by stock price (baht)

EMP = CSR scores of employment dimension

ENV = CSR scores of environment dimension

COM = CSR scores of community dimension

$SIZE$ = firm size (measured as total asset in million baht)

LEV = financial leverage ratio (computed by total debt to total asset)

The Statistical Package for Social Sciences (SPSS) was used to analyze the data collected [3].

4. Results

4.1 CSR Activities Undertaken by the Firms and their Financial Performance

Table 1 shown the summary of descriptive statistics of all variables used in this study. It found that all variables had variations in terms of their deviations around their averages.

Table 1 Descriptive Statistics

Variable	n	Mean	Standard Deviation	Maximum	Minimum
EMP (15) ¹	61	7.90	1.96	10.8	4.61
ENV(12) ¹	61	4.90	1.15	6.50	2.61
COM (3) ¹	61	2.60	0.29	3.00	2.04
LEV	61	0.47	0.15	0.61	0.32
SIZE(million baht)	61	19,339	23,666	57,698	781
ROE (%)	61	10.15	5.52	15.49	-0.72
ROA (%)	61	7.83	2.43	10.32	2.60
SP (baht/stock)	61	39.39	44.01	141.10	7.39

¹ Total score for each dimension of CSR

4.2 Regression model result with ROA as dependent variable

Table 2 presented summary of regression model result with ROA as dependent variable. The value of *R* and *R*² were 0.657 and 0.431 respectively. The *R* value of 0.657 represented the correlation between ROA and the CSR activities and the independent variables. The *R*² which indicated the explanatory power of the independent variables is 0.431. This meant that 43.10% of the variation in ROA was explained by the independent variables. The remaining balance could be explained by other variables, which were not examined in this study. The standard error of the estimate was 5.062, which explained how representative the sample was likely to be of the population.

Table 2 Model Summary^b Result

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.657 ^a	0.431	0.379	5.062

a. Predictors: (Constant), EMP, ENV, COM, LEV, lnSIZE

b. Dependent Variable: ROA

According to the fitness of the model, explained by F-ratio (F) in Table 3, the F-ratio in the model was 8.339 which was significant at the 0.01 level of significance. This meant that there was a significant evidence to conclude that at least one of the explanatory variables was linearly related to ROA.

Table 3 Summary of ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	1068.514	5	213.703	8.339	0.000 ^a
Residual	1409.458	55	25.627		
Total	2477.971	60			

Table 4 shown the results of the coefficients of regression model with ROA as dependent variable. The t-values for COM, LEV and lnSIZE were -1.796, -20.898 and 1.983 respectively. These values were also significant at the p-value which is less than the 0.10 and 0.05 level of significance. Since the value of value inflation factor (“VIF”) were less than 10, it is safe to conclude that there was no multicollinearity in the data set [15]. This ensured independency among independent variables. So it could concluded that CSR community, leverage and firm’s size had significant effect toward ROA.

Table 4 Summary of Coefficient Regression Model

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (Constant)	5.881	4.103		1.433	0.157		
EMP	-0.008	0.211	-0.005	-0.038	0.970	0.649	1.540
ENV	-0.247	0.240	-0.130	-1.032	0.306	0.652	1.534
COM	-1.796	1.046	-0.213	-1.717	0.092	0.675	1.482
LEV	-20.898	3.370	-0.713	-6.201	0.000	0.781	1.280
lnSIZE	1.983	0.557	0.454	3.563	0.001	0.638	1.568

4.3 Regression model result with SP as dependent variable

Table 5 presented summary of regression model result with SP as dependent variable. The value of R and R² were 0.550 and 0.303 respectively. The R² value as revealed by the result was quite low which meant that about 69.7% of the variation in the dependent variable was unexplained by the model.

Table 5. Model Summary^b Result

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.550 ^a	0.303	0.226	1.245

a. Predictors: (Constant), EMP, ENV, COM, LEV, lnSIZE

b. Dependent Variable: lnSP

The fitness of the model could also be explained by F-ratio (F) in Table 6 “A good model should have a large F-ratio (greater than one at least)” [2]. The F-ratio in the model was 3.921, which was significant at the 0.01 level of significance. This meant that all variables used in this study had some degrees of influence toward stock price, simultaneously.

Table 6 Summary of ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	36.439	6	6.073	3.912	0.003 ^a
Residual	83.822	54	1.552		
Total	120.261	60			

Table 7 shown the results of the coefficients of regression model with lnSP as dependent variable. All independent variables but ROE did not display significant effects on stock price. The ROE had only influential factor to lnSP with the t-value is 2.647. This values was also significant at the 0.05 level of significance.

Table 7 Summary of Coefficient Regression Model

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (Constant)	0.575	1.018		0.565	0.574		
EMP	-0.022	0.052	-0.060	-0.421	0.676	0.636	1.573
ENV	0.001	0.059	0.002	0.017	0.987	0.651	1.535
COM	0.330	0.259	0.177	1.271	0.209	0.666	1.502
ROE	0.028	0.010	0.357	2.647	0.011	0.710	1.408
LEV	-1.434	0.960	-0.222	-1.494	0.141	0.583	1.715
lnSIZE	0.195	0.151	0.203	1.287	0.203	0.521	1.918

5. Conclusions

The findings indicated that there was a significant negative relationship between the community dimension of CSR and ROA. Other variables that have significant influences toward

ROA are size and leverage. Furthermore, all CSR dimensions do not display significant effects on stock price (SP). Results of this study corresponded with the study by Afiff, S. and Anantadjaya, S.PD. [1]. They prescribed that CSR's activities of the firm require sufficient funds for both internal and external operations. But as those funds are expensed-out, this may appear reduce the level of firms' profit. It means that firm should also manage their financial performance carefully. From the investor's perspective, it is also apparent that the timeline orientations between CSR results and investor's expectations may not be closely matched. Investors have relatively short-sighted orientations while CSR's impacts are mostly medium to longer terms. Moreover, we agree with Mwangi, C.I. and Jerotich, O.J. [9] who concluded that although CSR practice does not have a significant relationship with firm performance, firms should not incur high costs on CSR with the hope of improving financial performance but rather for some other sustainability reasons and the CSR activities that are targeted at the community welfare are more popular and firms should engage in these activities if they are to be in line with what their competitors are doing.

6. Limitations and Future Study

The results of the research must be interpreted carefully and thoroughly. This was related to a number of limitations which could be used as a basis for making recommendations. The main limitations of the analysis were : (1) relatively limited number of samples, namely 61 companies listed in the SET (2) the quality of disclosure for CSR was not easily measurable; there was a lack of general accepted principles and most firms use CSR disclosure as an additional instrument of advertising, avoiding to give relevant information. For future research, it was recommended that a similar study may be undertaken using a bigger sample and should use data with a longer period to obtain a more valid measurement results. The study will however need to identify the relevant variables influencing firm financial performance in order to implement the regression model.

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Material system analysis of the Czech Republic: Presentation of a running project

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ABSTRACT

The overall environmental pressure and impact caused by human societies is to a large extent induced by the consumption of energy and resources [1]. In order to measure resource and energy flows and to mitigate the related problems, material flow analysis has been developed. The economy-wide material flow analysis and indicators (EW-MFA) treats the economy as a black-box monitoring overall input and output flows only [2]. In order to increase an analytical potential of EW-MFA, it can be extended by material system analysis (MSA). MSA is based on material specific flow accounts, focuses on selected raw materials, semi-finished or finished goods at various levels of detail (e.g. cement, paper, iron and steel, copper, plastics, timber, water) and considers life-cycle-wide inputs and outputs. It applies to materials that raise particular concerns as to the sustainability of their use, the security of their supply, and/or the environmental consequences of their production and consumption [3].

A three year project focusing on MSA of the Czech Republic has started this year with the aim to cover all materials directly entering the Czech economy and captured in EW-MFA for 2017. It will include extraction of raw materials from domestic environment and imports of raw materials and products from abroad. The flows of these materials through the economy will be mapped in detail taking into account the life cycle perspective. The content of the MSA will be specified by a list of MSA indicators, MSA database and flow charts, and a reference unit.

The MSA indicators will describe physical flows and stocks along the life cycle of the materials including exploration, extraction, manufacturing of end products, use, collection and recycling. The resulting indicators will be organized in a database at high level of disaggregation (particular raw materials, groups of end products, waste flows, etc.) which allows for various aggregations such as by four major material categories (biomass, fossil fuels, metal ores and non-metallic minerals). The indicators will be further presented with the use of Sankey Diagrams. Regarding the reference unit, the indicators will be measured in metric tonnes.

The poster will present an overall concept of MSA and its benefits for sustainable resource management, the definition of the studied system, its boundaries, major types of material flows and preliminary list of MSA indicators. It will also discuss further steps and outline possible questions to answer by analysing MSA results.

KEYWORDS: Economy-wide material flow analysis and indicators (EW-MFA), material system analysis (MSA), extraction of raw materials, imports, Sankey Diagrams, Czech Republic

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OCCURRENCE, DETERMINATION AND TREATMENT FOR BISPHENOL A IN LANGAT RIVER, MALAYSIA

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Abstract: Rivers as surface water in Malaysia are recipients of effluents and wastewater and yet it is important water source for daily uses of some villagers living along the river. Endocrine disruptor chemical such as Bisphenol A (BPA) can be found in river due to continuous discharge into it. The objectives of this research is to find out the occurrence and concentration of BPA in Langat River and also the performance of removal Bisphenol A using magnetic titania. 12 stations in total including upstream to downstream of Langat River and also tributary of Langat River. The water quality parameters is also calculated using water quality index from National Water Quality Standard of Malaysia. The instrument used to find out concentration of BPA is Triple Quadrupole LC/MS. The source of BPA are mainly industrial effluents and also direct domestic discharges.

Key words: Surface water, Endocrine disruptor chemical, Bisphenol A, water quality index, magnetic titania

INTRODUCTION

Bisphenol A, a common plasticizer, is massively consumed in the formulation of polycarbonate and epoxy resins which are produced over 680,000 t/annum by the European Union itself (Voutsas et al., 2006). Polycarbonate is used in reusable plastics, food packages, cans (baby bottles, drinking water bottles, etc.), electrical insulations, dental sealants, thermal papers, etc. Epoxy resins are often coated in food contact surfactants, electrical coils, cans and in PVC pipes (Voutsas et al., 2006). From various investigations, BPA has been reported to cause biological effects on fish, rats and human cell lines (USEPA, 2010).

In spite of the wide use and ubiquity of Endocrine disruptor Chemicals (EDCs) in the environment, low- and middle-income countries often still lack the awareness on environmental monitoring (Duong et al., 2010). In Malaysia, rivers are intensively used for irrigation and drinking water such as Langat River. Langat River is the prime source of drinking water in the basin and the pollution of the river is one of the major threats to the local population (Alsalahi et al., 2014; Juahir et al., 2011). The water of this river is used for drinking, domestic and agricultural activities (Santhi and Mustafa, 2013), as well as for the industrial activities. Chemicals from the agricultural activities urbanization highly contributed to the Bisphenol A (Santhi et al., 2012) and asbestos pollution respectively in the Langat River (Safitri et al., 2013). It is odd that even now pollution controlling authorities in low- and middle-income countries do not have environmental guidelines on emerging chemicals such as plasticizers, phthalates, pharmaceutical and personal care products (PPCPs), etc. This publication will discuss the occurrence, determination and potential treatment of BPA in Langat River, Malaysia.

The recent advancement in nanoparticles and nanotechnologies have shown promising potential in water purification for different contaminant removal. Such applications can be referred to many review papers (Mahmoudi et al., 2011; Teja & Koh, 2009; Savage & Diallo, 2005; Tratnyek & Johnson, 2006; Theron et al., 2008; Li et al., 2006). Nanoparticles possess high reactive capacity due to their large surface area. They can be functionalized with various chemical groups to increase their affinity/selectivity towards a given compound. However, the separation difficulty of these particles always exists in practice due to their ultrafine size (Poursaberi et al., 2012). Magnetic nanoparticles (MNPs), which possess both the properties of nanoparticles and magnetic behaviours, make the nanoparticle recovery and recycle easier via magnetic separation, and thus find their wide applications in very different areas including water

purification (Pope et al., 1994; Pieters et al., 1992; Raj et al., 1995; Lesile-Pelecky & Rieke, 1996; Berkovsky & Bashtovoy, 1996; Abo et al., 2001). The most widely used MNPs are iron oxide MNPs (mainly Fe₃O₄) or γ -Fe₂O₃). In recent years, a lot of work has been reported on the iron oxide based nanomaterials as purification media in water/wastewater treatment. This publication will discuss the occurrence and determination of BPA in Langat River, Malaysia. and its potential treatment using magnetic titania.

EXPERIMENT

Water Sampling

The Langat River Basin occupies three distinct areas of the Putrajaya Federal Territory, the southern part of Selangor State and the northern part of Negeri Sembilan State. The basin catchment area is approximately 1815 square kilometres (km²) and lies between latitudes 2°40'152"N–3°16'15"N and longitudes 101°19'10"E–102°1'10"E. The basin contains three topographical types: a lowland area, a hilly area and a mountainous area ([13],[14]). Swamps also exist along the river. In general, the topography of the basin is flat in the west, and from hilly to mountainous in the east and the north. More than half of the catchment is categorised as 'steep land'. The basin has three major tributaries: the Sungai Langat, the Semenyih River and the Labu River. The main river in the basin, the Sungai Langat, is 141 kilometres (km) long. It flows from the high hills in the north towards the flat west, turns westward towards the coast in the state of Selangor and ends in two estuaries: the Melacca Strait and Lumut Strait. The Melacca Strait is situated to the north of the Lumut Strait. The Langat River Basin acts as a catchment area supporting approximately 1.2 million people. There are two major impoundments (the Langat Dam and Semenyih Dam) and eight water treatment plants that supply water to the entire basin.

The surface water samples from 12 locations were collected using 250 mL amber glass bottles and avoiding the immediate vicinity of wastewater (industrial/domestic) discharge point. Then they were immediately transported in cold condition to the laboratory and stored at 4°C until chemical extraction. Water quality index parameter were also measured for all 12.

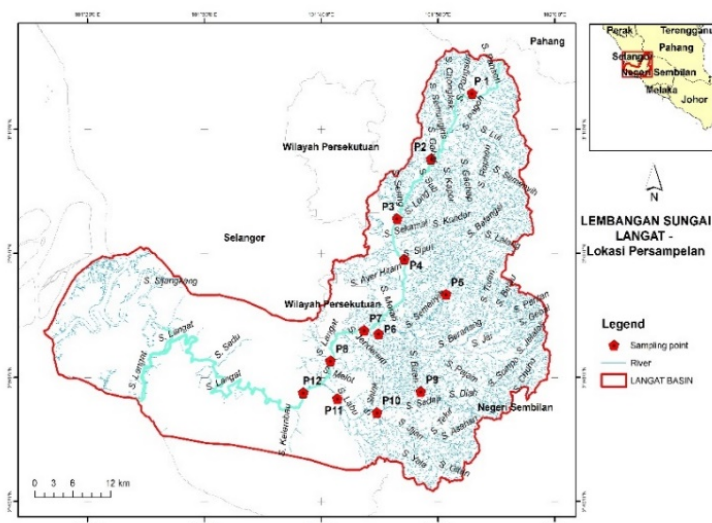


Figure 1: Map of sampling in the Langat River basin

Reagents and Solutions

BPA standard 4,4'-Isopropylidenediphenol 97% was purchased from Acros Organics. Meanwhile HPLC grade ammonium acetate, methanol, acetonitrile were purchased from Fisher Scientific. Ultra pure water (UPW) used must be 18.2 MΩ resistivity.

Standard Preparation

The stock solutions of BPA were prepared by dissolving 10 mg of each chemical in 10 mL methanol. Working solutions for calibration and recovery check were prepared by diluting the stock solutions at required concentrations in methanol and water. All the standards were stored at -20°C.

Sample Extraction

All surface water were centrifuged and filter. Sample were mix with methanol in 1ml vial before inject to the LC MS/MS.

Instrument

Identification of peak concentrations was made by means of a chromatogram of a standard solution of each compound. BPA was identified by respective retention time and peak area. Optimum condition to indentified and quantified Bisphenol A are as per Table 1.

Table 1: Chromatographic conditions for Bisphenol A

Instrument High-Performance Agilent 6470A Triple Quadrupole LC/MS	
Analytical Column	:Zorbax Eclipse Plus C18 2.1x50mm,1.8um
Guard Column	:Infinity In-line filter with 0.3um SS frit
Injection volume	:10 uL
Mobile phase	:A= UPW +5mM ammonium acetate; B=(90% ACN + 10% UPW)+ 5mM ammonium acetate
Run time	: 6.4 min + 1.5 min post time
Flow rate	: 0.4 ml/min

Water Quality Analysis

12 locations were measured for water quality analysis such as pH, Total Suspended Solids (TSS), Ammoniacal Nitrogen (AN), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO).

All sampling bottles were washed with distilled water prior analysis to ensure no impurities found in the bottle that can affect the water samples. Six parameters were included to determine the quality of Langat River; pH, Total Suspended Solids (TSS), Ammoniacal Nitrogen (NH₃-N), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Dissolved Oxygen (DO). In-situ measurement of dissolved oxygen (DO) and pH were obtained using YSI Model 556 Multi probe system (MPS). This instrument was calibrated and cleaned before being used for the sampling. Concentration of BOD, COD, TSS, and Ammoniacal Nitrogen were determined in the laboratory. The water samples were stored in temporary ice box container before being transported to the laboratory for analysis.

Water samples for the BOD test were taken using dark glass bottles to prevent the sample from sunlight exposure. The bottles were capped while they were still submerged in the water to prevent oxygen in the atmosphere to dissolve in the samples. Water samples collected were stored in ice boxes with the temperature of 4°C to be preserved before laboratory analysis were done. APHA 5210 B method was used to measure the BOD₅ days. Reactor digestion method was used to measure COD. COD reactor is heated up to 150°C and the vial cap containing reagents digestion COD was opened. 2 ml of the sample was piped into a vial and sealed. The outer surface of COD vial was rinsed with water and dried. Vials were rotated several times slowly and placed in the COD reactor and heated for 2 hours. The reactor was shut down after 2 hours and left for 20 minutes. Again, each vial was rotated several times while they were still hot and placed in the test tube racks. When the vials have cooled to room temperature, the analysis was done via HACH DR 2500 spectrophotometer. The Nessler method was used to measure the concentration of NH₃-N. A total of 25 ml of water and 25 ml of de-ionized water sampling inserted into different cylinders. Three drops of mineral stabilizer were added into the cylinders and shaken to mix [7]. Then, 3 drops of poliovinil alcohol dispersing agent were added to the cylinders and shaken thoroughly to mix well [7].Then 1 ml of Nessler reagent is added into the cylinders and shut immediately. The contents were left to stand for 1 minute. The mixture was then inserted into the sample cell and analyzed by

HACH DR 2500 spectrophotometer. Total suspended solids were measured using the gravimetric method. The GF / F type Whatman cellulose-nitrate filter paper with 0.45 µm thickness and diameter size of 47 mm was dried at 103°C in an oven for 2 days. It was then weighed using an electronic weighing scale after it was cooled in a drying jar to determine the dry weight of the filter paper. A total of 200 ml water samples filtered using filter paper and dried in a petri dish at a temperature of 103°C in an oven for 2 days. Then the filter paper was weighed again to obtain the total weight of suspended solids (TSS).

Water Quality Index

In Malaysia, the existing methodology for river water quality classification and monitoring is quite extensive. There are two primary methods employed to classify the river water quality monitored; the Water Quality Index (WQI), which in turn is rooted on the Interim National Water Quality Standards (INWQS), a set of standards derived based on beneficial uses of water. In an attempt to simplify the extensive amount of data collected coherent to the parameters listed in the INWQS, an indexing system was introduced. A Water Quality Index (WQI) ascribes quality value to an aggregate set of measured parameters. It usually consists of sub-index values assigned to each pre-identified parameter by comparing its measurement with a parameter-specific rating curve, optionally weighted, and combined into the final index. The purpose of a WQI is to summarize large amounts of water quality data for a specific river into simple terms (i.e. one number and a statement such as “good”). This makes it easily understandable for communities in the river basin and for river basin management (Saffran et al., 2001). The WQI primarily used in Malaysia (also referred to as the DOE-WQI) is an opinion-poll formula where a panel of experts is consulted on the choice of parameters and on the weight age to each parameter [2]. Six parameters were chosen for the WQI; Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD₅), Chemical Oxygen Demand (COD), Suspended Solids (SS), Ammoniacal Nitrogen (AN) and pH. Calculations are performed not on the parameters themselves but on their sub-indices. The sub-indices are named SIDO, SIBOD, SICOD, SIAN, SISS and SIPH. The Best Fit Equations used for the estimation of the six sub-index values are shown below:-

Table 2: Excerpt of the INWQS

Parameters	unit	classes					
		i	iiA	iiB	iii	iv	v
Ammoniacal Nitrogen	mg/l	0.1	0.3	0.3	0.9	2.7	> 2.7
BOD ₅	mg/l	1	3	3	6	12	> 12
COD	mg/l	10	25	25	50	100	> 100
DO	mg/l	7	5 - 7	5 - 7	3 - 5	< 3	< 1
pH		6.5 - 8.5	6.5 - 9.0	6.5 - 9.0	5 - 9	5 - 9	-
Total Suspended Solids	mg/l	25	50	50	150	300	300

Table 3: WQI calculation formula

Subindex for DO (in % saturation): SIDO SIDO = 0 for x ≤ 8 % = 100 for x ≥ 92 % = $-0.395 + 0.030x^2 - 0.00020x^3$ for 8 % < x < 92 %	Subindex for BOD : SIBOD SIBOD = $100.4 - 4.23x$ for x ≤ 5 = $108e^{-0.055x} - 0.1$ for x > 5	Subindex for COD : SICOD SICOD = $-1.33x + 99.1$ for x ≤ 20 = $103e^{-0.0157x} - 0.04x$ for x > 20
Subindex for AN : SIAN SIAN = $100.5 - 105x$ for x ≤ 0.3 = $94e^{0.573x} - 5x - 2$ for 0.3 < x < 4	Subindex for SS : SISS SISS = $97.5e^{-0.00676x} = 0.05x$ for x ≤ 100 = $71e^{-0.0016x} - 0.015x$ for 100 < x < 1000 = 0 for x ≥ 1000	Subindex for pH : SIPH SIPH = $17.2 - 17.2x + 5.02x^2$ for x < 5.5 = $-242 + 95.5x - 6.67x^2$ for 5.5 ≤ x < 7 = $-181 + 82.4x - 6.05x^2$ for 7 ≤ x < 8.75 = $536 - 77.0x + 2.76x^2$ for x ≥ 8.75
Note : x = concentration in mg/l for all parameters except pH		
WQI = 0.22*SIDO + 0.19* SIBOD + 0.16 * SICOD + 0.15 * SIAN + 0.16 * SISS + 0.12 * SIPH		

Table 4: DOE Water Quality Index

Parameters	unit	classes				
		i	ii	iii	iv	v
Ammoniacal Nitrogen	mg/l	<0.1	0.1 – 0.3	0.3 – 0.9	0.9 – 2.7	> 2.7
Biochemical Oxygen Demand (BOD ₅)	mg/l	< 1	1 – 3	3 – 6	6 – 12	> 12
Chemical Oxygen Demand (COD)	mg/l	< 10	10 – 25	25 – 50	50 – 100	> 100
Dissolved Oxygen	mg/l	> 7	5 – 7	3 – 5	1 – 3	< 1
pH	mg/l	> 7	6 – 7	5 – 6	< 5	> 5
Total Suspended Solids (TSS)	mg/l	< 25	25 – 50	50 – 150	150 – 300	> 300
Water Quality Index (WQI)	mg/l	> 92.7	76.5 – 92.7	51.9 – 76.5	31.0 – 51.9	< 31.0

RESULT AND DISCUSSION

Water Quality Results

The levels of BPA in the Sungai Langat were in the range of 3.82 ppb to 20.7 ppb respectively. BPA was detectable at all locations (Table 4 and Figure 1). The BPA distribution in Sungai Langat showed at all location. The highest concentration of 20.7 ppb was detected at residential area, crops and waste dumping area (P4). Among the phenolic compounds, BPA is the most documented chemical reported in surface waters around the world. It was reported at higher levels in the European rivers, i.e. up to 2970ng/L in Spain, 776 ng/L in Germany and up to 683 ng/L in Portugal, and also in China (up to 1040 ng/L), than observed in Langat River in the present investigation (Alessand et al. 2015; Cousins et al. 2002; Farhana et al. 2005; Huang et al. 2011)

Table 4: BPA mean concentration according to station

Station	Site description	Mean concentration of BPA (ppb)
P1	Recreational area, receive water flow from Langat Dam	7.46
P2	Recreational area and waste dumping area	6.12
P3	Residential area, crops and waste dumping area	6.59
P4	Residential area, crops and waste dumping area	20.7
P5	Illegal waste dumping area, receives input from cattle farm and crops plantation	5.09
P6	Construction site, metal industries, illegal waste dumping area	4.60
P7	Residential area and waste dumping area. Receive input from sand mining, oil palm plantation and construction site	5.84
P8	Residential area, waste dumping area, and crops plantation	3.88
P9	Residential area, construction site, waste dumping area	5.82
P10	Residential area, poultry farm	3.82
P11	Plantation area, receive plantation discharge and domestic waste	3.91
P12	Residential area and waste dumping area	3.88

The Water Quality Index for Langat River as shows in Table 5. Based on the findings, Langat was classified in class III based on the WQI classification averagely. The water quality at Sungai Langat is highly affected by the surrounding human activities such as construction, manufacturing factories, sand mining and from domestic wastes.

Table 5: Water Quality Analysis and Water Quality Index for 12 sampling point

Station	DO%	BOD (ppm)	COD (ppm)	TSS (ppm)	pH	AN(ppm)	WQI INDEX	CLASS
P1	100.8	5.8	4.88	10	6.24	0.514	87	II
P2	100.7	3.5	5.33	26	6.25	0.227	89	II
P3	49.4	17	10.31	78	5.87	3.788	53	III
P4	43.5	16.8	87.3	72	6.29	4.585	42	IV
P5	94.1	17.3	33.8	13	6.33	3.733	65	III
P6	84.7	11.3	8.03	22	5.14	1.355	72	III
P7	55.1	16.8	35.44	23	5.4	5.05	52	IV
P8	100.3	16.9	29.38	26	5.61	5.145	63	III
P9	111	17	67	34	6.34	9.665	59	III
P10	114.3	17	18.55	22	6.36	4.082	67	III
P11	101.9	13.2	34.79	33	5.65	7.805	64	III
P12	93.9	16.8	22.97	36	5.27	4.24	62	III

As per the WQI index calculated, upstream area of Langat River (P1 & P2) shows clean water index. Both station is recreational area. Meanwhile in the middle stream toward down stream of Langat River shows slightly polluted and polluted water index. The respective class designation for the WQI scores in turn are tabulated in Table 6.

Table 6: DOE Water Quality Classification Based on Water Quality Index

Parameters	index Range		
	clean	Slightly Polluted	Polluted
SIBOD	91 – 100	80 – 90	0 – 79
SIAN	92 – 100	71 – 91	0 – 70
SISS	76 – 100	70 – 75	0 – 69
WQI	81 – 100	60 – 80	0 – 59

Removal of BPA compound

Magnetic Titania was successfully design which can remove BPA in aqueous solution. It was prepared via sol-gel method using *tetraethyl orthotitanate (TEOT)* as precursor gives high adsorption capability. It has extended surface area at the value $754 \text{ m}^2 \text{ g}^{-1}$ and high surface absorption area with the value $730 \text{ m}^2 \text{ g}^{-1}$ proven by Brunauer–Emmett–Teller (BET) analysis as per Table 7. From morphology analysis using scanning electron microscopy(SEM) and transmission electron microscopy(TEM), it shows that element titanium and iron are in the sample with the particle size of 85 nm as shows in Figure 2. BPA concentration decrease after introducing the magnetic titania in the solution as shows in Figure 3. The magnetic titania able to remove BPA up to 97 % within 5 minutes. The sample after treatment as shows in Figure 4.

Table 7: BET results

BET analysis	Value
$S_{\text{BET}} (\text{m}^2 \text{ g}^{-1})$	730.1752
$S_{\text{ext}} (\text{m}^2 \text{ g}^{-1})$	754.5954
$V_{\text{pore}} (\text{cm}^3 \text{ g}^{-1})$	0.471401
$D_{\text{pore}} (\text{nm})$	2.58240

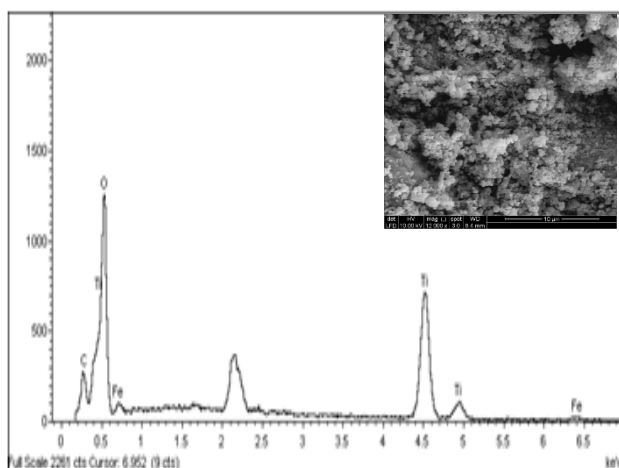


Figure 2 : TEM & SEM-EDX micrograph of magnetic titania

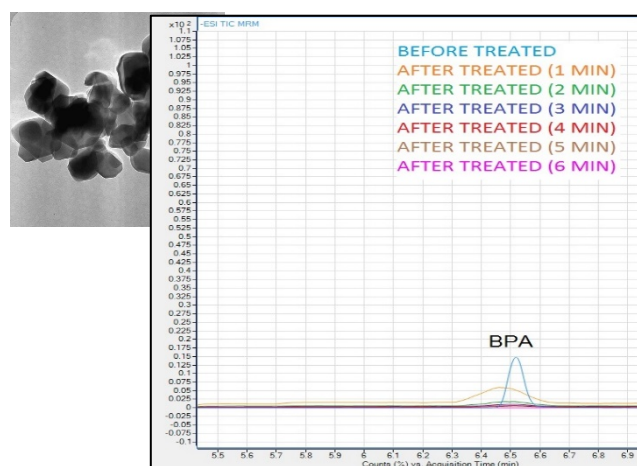


Figure 3: BPA Chromatogram treated with titania

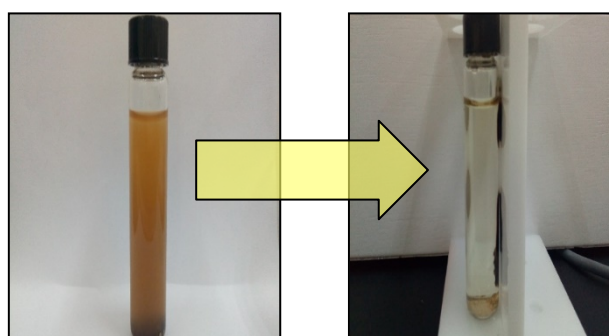


Figure 4: Langkat river sample treated with magnetic titania.

CONCLUSION

The results show that the changes in water quality of Langkat River can be explained by the landuse characteristics of the river basin. Similar trends with respect to distance were obtained for the various water quality parameters. The water quality at the upper catchment is very clean makes the water a good source of potable water. Unfortunately the uptake for potable water supply is further downstream and the most polluted section of the river is at P4 and P7. The organic loading to the river is mainly from non point sources rather than specific large industries. However, the concentration of BPA is not dependable to the water quality index. Currently, there is no guideline value for BPA for raw water abstracted for potable use. This studies will serve as abaseline data for future environmental monitoring, fate and toxicity research initiatives to support and upgrade the National Water Quality Standard of Malaysia. Besides monitoring, initiative step on the treatment using magnetic titania is one of the alternative product that can be used for BPA removal.

ACKNOWLEDGMENTS

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Open spaces in the neighborhood and its effect on the activities of the users

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Abstract

The modern city of Pune has many distinct neighbourhoods. The peths or neighbourhoods form the core of Pune city, and is referred to as the old city. The constant development in these areas is leading to increase in the number of buildings thus reducing the open areas and affecting the resident's activities. Maintaining the fabric of the city for environmental and cultural reasons is important. The open spaces in the neighbourhood play an important role in terms of activities of the residents; it also creates a balance between the built and unbuilt areas.

The relationship between the open spaces and resident's activities are studied in this research. The study also includes the effect of open spaces on resident's satisfaction as well their attachment with the neighbourhood. The selected area for the study is Rasta Peth; planned in grid iron pattern in the early 17th century. The purpose was also to study overall the connectivity of the open spaces in a residential neighbourhood.

The aim was to study the existing open spaces in the neighbourhood and the type of activities residents carry out in those areas. Random household samples were selected for the survey. Findings demonstrated the important role of open spaces in the attachment with neighbourhood. The other two important criteria were resident's everyday activities in the open space and social gathering space. From findings, it can be concluded that the open spaces play an important role in the neighbourhood; they provide space for social activities. The results show that the type of space does affect the activity of the residents; also the quality, accessibility and security are the other factors which affect the activities in the open spaces.

Key words: *Open spaces, residential neighbourhood, users, activities, attachment.*

1. Introduction

Open spaces are one of the land uses that are provided for in the planning of urban centres. All over, open spaces play a major role in the life, form and experience of towns and cities. The need for urban open spaces present social benefits, opportunities for health benefits, opportunities for environmental benefits as well as opportunities for economic benefits. Nearness of open space, such as parks, gardens and other green open spaces has considerable benefits on the health of people, and it has been shown to be more likely to use such space for physical activity if it is of high quality. (Beheshti, 2010)

A residential neighbourhood built form only cannot support the liveability of its residents. Hence it is necessary to provide open spaces in the neighbourhood for the residents. The open spaces not only provide social value but also environmental and health benefits to the residents of the neighbourhood. The open spaces gives a particular identity and character to the neighbourhood and sense of belonging as well.

Access to public transport, areas for interactions with neighbours, community gathering, walkways, cycling track is affected by the way a neighbourhood is designed. It is important to provide better access to open spaces as it increases the level of physical activity of the users it also develops the mental health of the residents. Various areas such as gardens parks, empty green land , riverside corridors , areas with natural vegetation , public , private , protected unprotected all such types spaces fall under open spaces. It includes house gardens, community gardens etc. (Dennis Wakaba 2016)

The neighbourhood open spaces include all those areas which provide small gathering space to users a place of interaction. These areas include the porches, front yards, backyards, benches along the streets, seating areas in between the lanes, sit outs provided around a tree, seating provided around small temples, benches provided below the building. Such open spaces not only give a sense of belonging to the residents but also various everyday activities are included around these spaces in the neighbourhood. These areas are used by different age groups at different time of the day. It is important to maintain such existing open spaces and consider such areas while redevelopment. These spaces become the cultural and community identity of the neighbourhood

Aim

The purpose of the study is to collect empirical evidence on the quality of open space in Pune (city core area) neighborhoods and the relationship between the activities and the lifestyle of the users - all age groups.

Objective:

The study will be carried considering following objectives:

1. To study the lifestyle of the people in the selected neighborhood.
2. To study the impact of open spaces on the user activities.
3. Study the interrelationship between the open spaces and user activities.
4. To study the quality of the open spaces

Scope and Limitation

Scope

The study will focus on the structural and social aspects of the open spaces in the neighborhood. Impact of open areas specifically on the everyday activities of the users. The area selected for the research will be limited to Pune city or similar type of settlements. The neighborhood selected is the Rasta Peth area. Factors considered – social behavior, user activities, existing open spaces, physical activities.

Limitations

The research will be conducted in a limited time frame therefore only one neighborhood from Pune will be selected to conduct the research.

2. Literature Review

The focus areas in the literature review were types of open spaces, importance of the open spaces, and quality of open spaces, social value and accessibility to the open spaces. These areas were considered for study and case study was further done considering these points in the previous research.

2.1 Types of open spaces

The neighbourhood open space are streets, walkways, medians and sometimes front yards. The spaces in between the building share a similarity with the urban parks or garden. They are open to anyone and everyone, the trees around in the parks get in shade and comfort and makes the environment greener, facilities like sit outs and benches and other facilities get people together to gather and interact. However places like urban parks are just public areas, whereas the neighbourhood open spaces are both public and private because of the activities that occur in these areas are both public and private for e.g. children playing on the streets and front yards. (Romain Cheynet 2013)

Open spaces also include the river sides, parks, streams and any other natural area within the urban and the suburban areas of the city. Spaces such as areas within the housing area, gardens, parks. The neighbourhood opens spaces include; parks, gardens, playgrounds, sports grounds, school play areas, streets, roads, naturally green areas in the neighbourhood. (Dennis Wakaba 2016)

Markets areas, historical markets areas also are open spaces in the neighbourhood enhance the quality of local environment, they also increase the value of the community, and safety and security are the main goals. To promote the heritage of the city , to provide easy access to the social gathering spaces, reduce the vehicular movement in the neighbourhood, to form attractive public spaces , improve the security conditions of the space, and develop a healthy life style like walking , cycling are the main sustainability goals. (Khalid S. Al-Halga July 2008)

2.2 Importance of open spaces

Urban open spaces are irreplaceable in maintaining the environmental health in a densely developed urban fabric. The constant urbanization challenges the ecological value and neighbourhood values. Urban open spaces are an integral part urban ecological system with its certain set of function. Open spaces add better quality to human life in many different ways the open spaces can be natural or man made (Burke, 1999). There are certain environmental benefits of these open spaces (Chiesura, 2004)

2.3 Quality of open space

One of the most important factor providing the satisfaction of residents is the quality of space, in the redevelopment areas as well as the areas in which new developments. The quality of the open spaces affects the social and physical parameters in the neighbourhood. (Katarina Ana Lestan) The open space is determined how lively, interactive and social life is generated to the residents this defines the quality of the space. The quality of open spaces is defined by the ease of access, use, supply, the need of the residents, and demand of open spaces. The planning and designing, maintenance of open spaces , use of the open spaces will define the quality of the open space(Dennis Wakaba 2016) The residents are affected more by the social environment rather than built environment , he built environment defines the activities performed by the users. The state of side walk and street surface will create an impact on the user. If the sidewalk and street surfaces are uneven and unmaintained it will create a negative impact on the users. (Romain Cheynet 2013)

2.4 Social Value

The residential neighbourhood cannot be developed by the built form alone nor will it support the liveability of the residents alone. Therefore, it is important to provide open spaces in the neighbourhood for the use and various activities of the residents. The important benefit of the open spaces is it provides social benefit, better health and environmental and economic benefits to the residents in the neighbourhood. These open spaces actual shape the cultural identity of any neighbourhood, it develops a unique character in the neighbourhood and a sense of belonging and community to the residents. The residents of the neighbourhood develop their identity with the character of the neighbourhood they stay in. Open space add social value to the neighbourhood it enhances and develops the social life of the residents. It is very difficult to develop such kind of spaces and create it as an identity of the neighbourhood, but once such kind of space is developed its becomes the identity of the neighbourhood. Creating attractive open spaces where people can gather is the key. (Dennis Wakaba 2016)

Built environment least affects the activities of the residents in the open space of a neighbourhood. The social and environmental factors are to major factors which affect the activities of the residential neighbourhood open space. (Romain Cheynet 2013)

There is a relationship between the open space and the everyday activities of the users in relation to the certain pattern in which the space functions and is been used, generation of user interactive spaces, is the base on which it is recognized whether the new changes in the open place are developed, the movement patterns of the residents, and the intensity in the use of space.(Miroslava Vujadinovic 2016)

Factors like: sense of belonging, attachment to the community, participation of the users, sense of security, community gathering spaces and housing areas developed around open spaces are the social and physical factors which give maximum residential satisfaction, sense of place , sense of belonging. (Kylie M. Smith)

2.5 Accessibility

Connections to the surroundings, physical and visual connections are the factors on which the accessibility of the place is judged. Visual and physical accessibility are the two factors on which the accessibility to the open space is measured. The connectivity to the open spaces by means of cycling, safe pedestrian walk, easy access by means of public transport connectivity. (Dennis Wakaba 2016)

Accessibility to open spaces have major impact on the satisfaction level of residents in the neighbourhood, the access to the open space affects the community attachment. The ease of the accessibility to the urban open space, the lesser time cost the residents requires, the more often the use and higher the satisfactions with the neighbourhood open spaces it increases the attachment of community.(Yuemei Zhu, Junxiang Ding, Qing Zhu April 2017)

3. Methodology

The research was conducted with three methodological phases which consist of mapping out existing open spaces, activity observation of the users and the use of open spaces and the resident opinion survey which helped in assessing the use of the open space in the study area.

3.1 Sampling

Target Population- A set of persons or objects that possesses at least one common characteristic (Smith, 2015). The population targeted will be the residents of Rasta peth, who are the users of the open the spaces in the neighbourhood. The researcher will be able to find exactly what happens in the open space and the use of the open spaces from the users view.

Sample Size- a small part of the population selected for observation or analysis. By observing the characteristics of a carefully selected representative sample, one can make certain inferences about the characteristics of a population from which it is drawn (Atkinson & Flint, 2001)

3.2 Data collection

The data was collected from primary and secondary data sources. The primary data was collected by interviews, questionnaires, activity mapping and observation. Secondary data was collected from journals, articles and internet. The data collection focuses on the types of open spaces and uses of the open spaces in Rasta Peth Neighbourhood.

a) Primary Data

3.3 Questionnaires

According to (Mugenda & Mugenda, 1999) questionnaires give detailed answer to complex problems. Questionnaire is a popular method to collect data because it gives relatively objective data and hence its very effective. The research used the questionnaires which were administered to target residents of the Rasta Peth the activities happening in the open spaces and the current state of the open spaces in the Neighbourhood. The information given by the residents will be used to understand the importance of the open space and the benefits of the open spaces.

3.4 Interview

An interview schedule is a set of questions that the interviewer asks when interviewing the respondent (Mugenda & Mugenda, 1999). An interview is a flexible and adaptable way of finding things out. Interviews generally yield highest cooperation and lowest refusal rates, offers high response quality and it is multi-method data collection that is it combines

questioning, cross examination and probing techniques (Owens, et al., 2002). The interviews will be conducted with the target residents of the neighbourhood. To understand from their perspective the use of open spaces, use and misuse of the open spaces , facilities provided in the open spaces , maintenance of those open spaces. This data helped to understand the exiting condition of the open spaces as well what the residents expect them to be like. The resident opinion survey involved survey of residents in selected residential area. The survey was conducted within three weeks' time at the end of January and beginning of February 2019. The questionnaire was prepared in order to understand from resident's perspective their idea of open spaces their experience in the neighbourhood.

3.5 Mapping the area

The mapping of the focus area was the first step in the analysis. The first one shows existing open spaces inside the selected area. The second map shows the density of the selected neighbourhood and the connectivity in the neighbourhood. It helped to identify the different types of open spaces and the areas which lack open spaces and access to them. The third map shows the activities mapping of the selected area which helps to identify the various types of activities happening within the neighbourhood and in the open areas of the neighbourhood. It also identifies the current use of existing open spaces. The maps were generated using ArcGIS software.

3.6 Observation

“Participant observation is a method in which a researcher takes part in the daily activities, rituals, interactions, and events of a group of people as one of the means of learning the explicit and tacit aspects of their life routines and their culture” (DeWalt & DeWalt, 2011).The observation matrix helped to understand the neighbourhood from a user point of view. The observation schedule is observations made at a particular place and time in the neighbourhood to describe the use of open space, the daily activities of the neighbourhood. The observations were made at specific points and focus areas to document the use and issues related to open spaces and access to them. The onsite study was helpful to understand the behaviours of the residents. The each focused point was observed at four different times of the day Morning, Afternoon, Evening and Night.

b) Secondary data

The data obtained from journals, articles, literature, newspaper which helped to add more information to the study. The information obtained focused on the different types of open spaces and importance of open spaces in a city, in a local context and in a neighbourhood.

3.6 Data Analysis



3.7 Observation

The observation method is used to analyse the various activities happening in the neighbourhood. The intersection with temples and sit outs around the trees and in between the buildings was selected as focus points for observation. The Lakerya Maruti temple intersection was selected because it's a connecting point to the complete neighbourhood. It was observed maximum people gathering at the temple early morning 7.30 am to 9.00am and then evening people gathered around the sit outs provided by 5.30 pm – 6.45 pm.

The Maruti Road has many small temples on the main road with benches provided by government older residents in the neighbourhood prefer sitting on them in the morning before 10.00 am as it is cooler in the morning than later time of the day. At night same places is used by college going students as a gathering area. The kids play on the main road at night on weekends 10.00 pm onwards.

Shiral Seth chowk intersection has all the food shops and stalls in the lane early morning and evenings it is crowded. The trees provide shade throughout the day, users prefer sitting under them for eating, chatting, gathering. On the weekends the weekly vegetable market for the neighbourhood gathers there, multiple activities happen here during the weekdays as well as during the weekend.

The neighbourhood is planned in grid iron pattern so all the lanes are interconnected. The backyards of residences are connected throughout creating open spaces with tree plantations which keeps the area cool and shaded throughout the day. The front yards of the houses are various types which have small sit outs which act as gathering in the evenings and used for small kids to play.

The neighbourhood roads are well maintained and shaded so kids of the neighbourhood prefer playing games on streets on the weekends or in the afternoon 2.30 pm to 4.30 pm, during the weekdays as it is calm and cool. Chowks or Junctions were crucial meeting places for community discussion and participation.

The lanes in between the buildings if maintained properly can provide gathering space for the residents. The existing lanes are clean and maintained, facilities should be provided so it can be used for better purpose. The neighbourhood has service lanes which are also backyards of houses currently used as dump yards if used properly can be used as connecting lanes to the main roads. The service lane maintenance is very poor, which makes them inaccessible to the residents.

The porches and front yards of the old residential units are used by children for playing, in the morning it is used as common study place, the women of the house gather in the afternoons for various activities, and at night same place is used for gathering and chatting. These characteristics are the identity of the neighbourhood.

The temples in the neighbourhood are the cultural identity. The residences are developed around these temples. They not only act as a gathering place but also provide a common platform for celebrations during festivals and develop a sense of belonging in the neighbourhood.

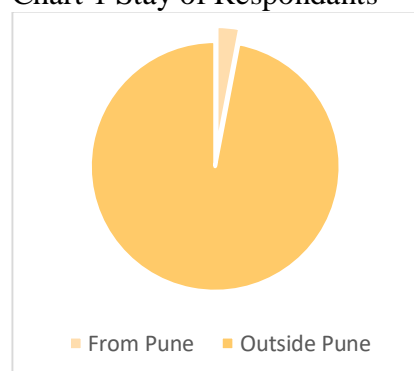
4. Findings

Interviews

The interviews were conducted with school children, college going students, the working residents, business owners. These interviews got inputs from people have different experiences about the neighbourhood as the users. The overall study shows that the neighbourhood has population of mixed families with households, households with children, working class families. The interviews helped to understand the use of open spaces their need of open spaces. The interviews gave result that the residents enjoy existing small open spaces within the neighbourhood and they want these spaces to be well maintained.

Location

Chart 1 Stay of Respondants

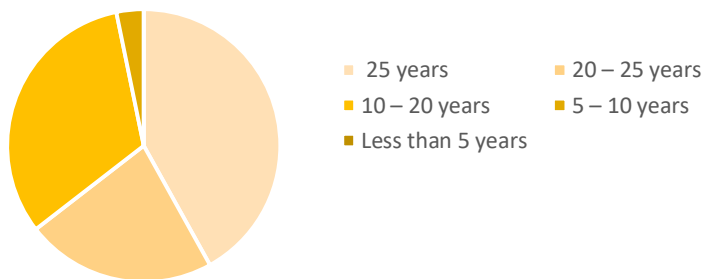


(Source: Author, 2019)

The study was conducted to understand if the people are staying in the neighbourhood are from Pune or have migrated. Out of the total number of respondents it was found that only 3% of the people have migrated from other place to Pune, 97% of the respondents are from Pune. So most of the people staying in the neighbourhood are from Pune.

Time lived in Neighbourhood

Chart 2 Years of stay

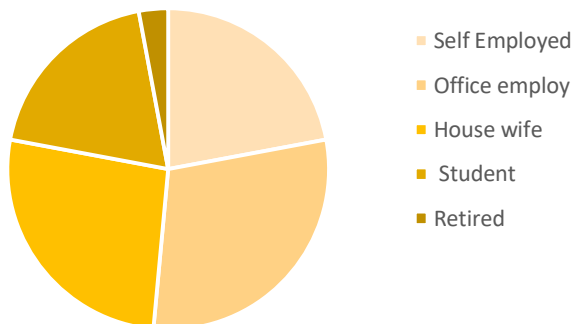


(Source: Author, 2019)

The chart 2 shows that majority of the people 42% have stayed in the neighbourhood for more than 25 years. 23 % of the residents are staying from 20 – 25 years while 32% people have stayed from 10 – 20 years. Maximum number of people have been staying here in the neighbourhood from more than 25 years so they are aware about the open spaces in the neighbourhood.

Occupation

Chart 3 Occupation

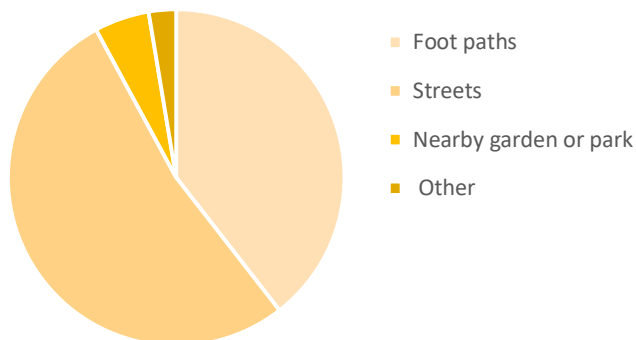


(Source: Author, 2019)

Chart 3 shows 29% of the respondents are office employees, 26% are housewives, 22% are self-employed, 19% are the students , 3% are of the respondents are retired. The majority of people 51% of the respondents are non-working, while 49% of the open spaces are used by working class of people. So the maximum open space is used by the non-workers in the neighbourhood.

Preference for walking

Chart 4 Walking

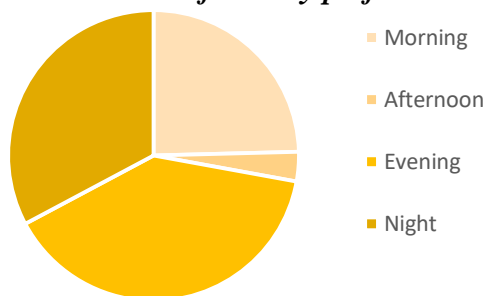


(Source: Author, 2019)

The chart 4 presents the preference given by the respondents for walking maximum respondents 49% prefer walking on streets, 36% respondents prefer walking on streets while only 5% respondents prefer going to the nearby parks and gardens. The maximum respondents prefer walking on streets and footpath because it is well maintained and shaded throughout the day.

Time of the day

Chart 5 Time of the day preferred

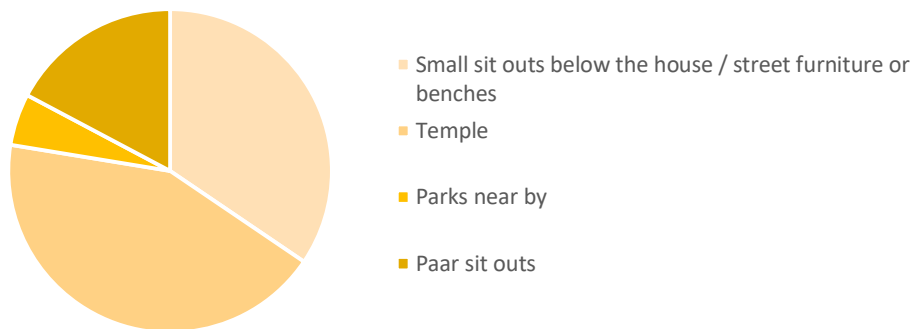


(Source: Author, 2019)

The chart 5 shows the time of the day preferred by the respondents to use the open spaces 39% of the total respondents prefer using the open space in the evening, 33% of the respondents prefer night time to use the open space, and 25% respondents use it in the morning while only 3% use it in the afternoon. Majority of the people use the open space in the evening and at night.

Types of spaces

Chart 6 Types of the spaces used

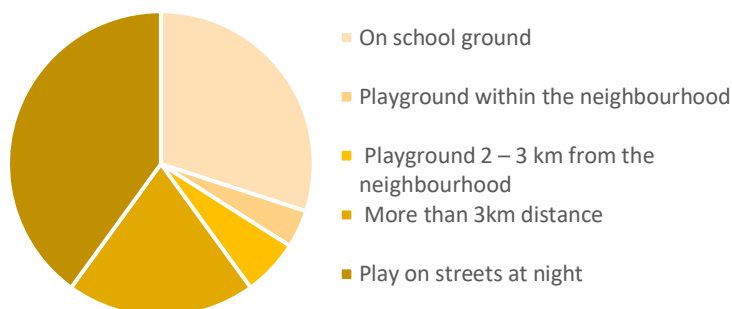


(Source: Author, 2019)

The chart above presents the types of open spaces used in the neighbourhood most of the respondents 43% go to the temples present in the neighbourhood, 34% of the respondents prefer sitting on the sit outs and street furniture, minimum prefer going to parks as they not easily accessible, while remaining prefer sitting under the Paar sit outs in the neighbourhood.

Play grounds

Chart 7 Playgrounds for children in the neighbourhood.

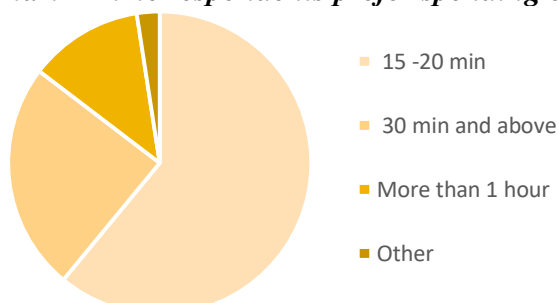


(Source: Author, 2019)

The chart above presents that maximum number of children in the neighbourhood play on the streets at night 40%, 30% of them play on school ground on the weekdays and weekends, 4% of the of the children go on the playground to play the neighbourhood has one playground. Remaining of them 6% of the total respondents go the playgrounds which are 2-3km away from the neighbourhood, maximum children play on the streets as its safe and near the house.

Time spent Outdoors

Chart 7 Time respondents prefer spending outdoors

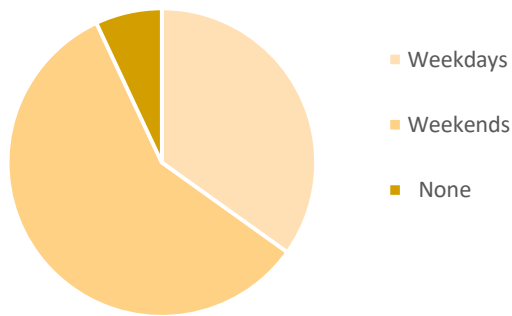


(Source: Author, 2019)

The chart shows 61% maximum number of time spent outdoors in open space is 15-20 mins respondents like spending time outdoors, only 12% of the people like spending time more than an hour outside.

Days Spent days Outdoors

Chart 8 Day of the week respondents like spending outside

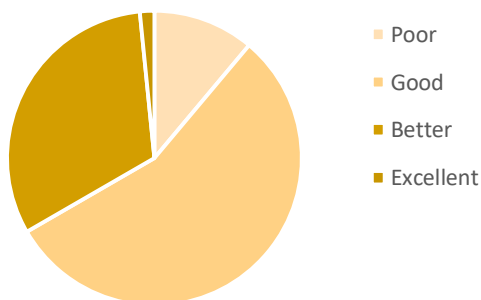


(Source: Author, 2019)

The charts shows the residents spend time outdoors mostly on weekends 58% of the total respondents. 49 % are working respondents so they prefer to spend time on weekends than weekdays. 35% of the them spend during the weekdays that is majorly the non-working respondents.

Condition of the Street furniture

Chart 9 Street furniture existing condition



(Source: Author, 2019)

The chart above shows the current state of the benches and street furniture provided in the neighbourhood. 56 % of the respondents say that it is in a good state and comfortable for them to use, 36% respondents say that the furniture is in a better state but the respondents say that it could get better if maintained, 11% say that the condition of the benches is very poor in few areas of the neighbourhood and need improvement in the condition of the benches and also the number of benches provided are not enough for the respondents to use. Only 2% of the total respondents say that the street furniture and sit outs are in excellent state. Most the residents say that they want better facilities and they want those facilities to be maintained.

5. Conclusion

The research conducted concludes that there are a number of factors which affect the use of open space directly or indirectly. The condition of the open spaces, the facilities provided, the surrounding areas, accessibility affect the use of the space as well as the satisfaction of the residents. If the open spaces are well maintained and are designed correctly it attracts more people than that open space. A place that gathers more residents develops a sense of belonging and attachment. The open spaces in residential neighbourhood should be developed and well maintained in the redeveloped areas as well as in the new upcoming developments. The open spaces develop the character and the identity of the neighbourhood and it is important to maintain them. The activities of the users are related to the location of the open spaces. Everyday activities of people are affected by the location, quality of the open space.

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PERCEIVED TOURISM IMPACTS OF TOURISTS ON THE ENVIRONMENT OF THE PHILIPPINE MILITARY ACADEMY

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ABSTRACT

At present, there is an incredible increase in tourism activities in the Summer Capital of the Philippines, Baguio City, specifically at the Philippine Military Academy (PMA). Unfortunately, these tourism activities consequently led to the growth of environmental pressures. An environment-friendly or a sustainable form of tourism is seen as a solution to this growing problem. A perception analysis of tourists on the impacts of tourism will provide information about the existence and extent of the environmental effects as well as the areas for improvement in the environment initiatives of PMA. Hence, this study is conducted to analyze the perception of tourists on the impacts of tourism on the environment of PMA. This study used a quantitative research method in the form of a survey. A total of 109 respondents were interviewed through an internet-based questionnaire. The result of this study revealed that tourists perceived tourism as having a moderate impact on the environment of PMA. It also showed that respondents were aware of and concerned about the effects of tourism in the environment of PMA. Hence, this study suggests that bigger efforts should be carried out to make tourism in PMA, specifically the identified aspects, more environment-friendly or sustainable. A follow-up study is also recommended to assess the perception of the community, such as the students or personnel, on the impacts of tourism to the environment of PMA. These perceptions will then be compared to and evaluated base on the result of this study.

Keywords: perception, tourism impacts, tourists, Philippine Military Academy

INTRODUCTION

The Philippines has many natural and human-made attractions that make tourism as one of its primary sources of income (Manuela and de Vera, 2015; Manalo, 2017; Aquino et al., 2018). Ashley et al. (2007) noted that industry leaders and development experts observed that there had been apparent growth in tourism contribution in most countries. This observation is also true in the case of Baguio City. As the summer capital of the Philippines, Baguio City, has long been a place that pulls-in large numbers of tourists (Morley, 2018). It is a popular northern Philippines destination that is frequently visited by many local visitors and annual tourists on weekends, and holidays, most especially during the Lenten period and the *Panagbenga* festival (Hagad and Cayetano, 2018). Aside from natural attractions, Baguio city is also famous for several historic landmarks and institutions such as the Philippines' premier military school, the Philippine Military Academy (PMA). This military institution boasts a long and illustrious history of preparing the best military officers of the country (Nerona et al., 2018). It is located at a verdurous pine forest in Fort General Gregorio del Pilar in Loakan road with manicured grounds composed of installed vintage tanks, other historical military weapons (Stach et al., 2014), and a museum. All these as well as activities like cadets marching off and performing drills entice tourists to visit. However, as tourism peaks, the PMA ground is often congested with people and consequently, environmental issues such as garbage problem arises.

A study by Cassidy et al. (2007) shows that tourists often increase Baguio city's population during the peak of tourist influx. This results to the congestion and pollution. According to the Philippine Statistics Authority (2015), Baguio City has a 345,366 population with a growth rate of 1.54 percent. This rapid population growth, as well as the rampant urbanization, has impacted the city's environment. A study by Jackson (2007) shows the rising indications that the increase of tourism in a natural area is accompanied by a significant increase in environmental effects. Although tourism can be a vital tool for economic development, it can have destructive impacts on biodiversity and pristine environments if not adequately planned (Kavallinis and Pizam, 1994; Ghulam Rabbany et al., 2013; Garcia et al., 2015; Selamat et al., 2016). It can also result to the misuse of natural resources such as freshwater, forests and marine life if improperly managed (Kavallinis and Pizam, 1994; Ghulam Rabbany et al., 2013; Garcia et al., 2015; Selamat et al., 2016). To avoid these negative consequences, tourism should be managed and planned in a way that it must not compromise the environment and the socio-economic viability (Manalo, 2017). Identifying the perceptions of visitors regarding the environmental impacts of tourism can provide information about the existence and extent of its effects on the environment (Aspe et al., 2017). Also, such knowledge will lead to a more sustainable management of the tourism site (du Plessis, 2010; Snyman, 2011). Hence, this study is necessary as it aims to determine the perceptions of visitors regarding the impacts of tourism in the environment of PMA. Ultimately, the goal is for PMA to design and apply appropriate management measures for the protection and sustainability of its environment. However, at present, no related studies are conducted focusing on PMA grounds or other military installations (Weaver, 2011). This fact makes this study valuable and timely.

METHODOLOGY

The primary research method used in this study is quantitative design in the form of a survey. The nature of the survey questions is descriptive. The purpose of this study is to look at the perception of visitors on the impacts of tourism to the environment of PMA. The instrument used to collect data is a survey using an internet-based questionnaire. The questionnaire consists of questions that are adopted from the study of du Plessis (2010) on general management, commercial area, tourist routes, and tourist facilities. A four (4) point Likert scale was developed to investigate the perception of respondents, and the mean was used to analyze and interpret the data using the table below (Table 1). The study site is the Philippine Military Academy in Fort General Gregorio del Pilar, Baguio City.

The data collection was carried out on the first until the second quarter of 2019. The researchers distributed the questionnaire link through email and social media and gave some time for the respondents to fill in their answers and to avoid incomplete entries. The questionnaire was pre-tested on ten (10) respondents for clarity and reliability of the questions. The population of tourists in PMA per month is roughly around 5,000. The computed sample size for the said population with $\pm 10\%$ margin of error and a 95% confidence level is 95. The questionnaires were randomly sent to 110 respondents that are at least a graduate of secondary school and able to visit PMA. 109 respondents were able to accomplish the questionnaire.

Table 1. Likert scale for the perceived tourism impacts of tourists on the environment of PMA.

Scale	Scale Limits	Level	Interpretation
4	3.25-4.00	Major	This tourism aspect has a major impact on the environment of PMA
3	2.41-3.24	Moderate	This tourism aspect has a moderate impact on the environment of PMA
2	1.75-2.40	Minor	This tourism aspect has a minor impact on the environment of PMA
1	1.00-1.74	Negligible	This tourism aspect has a negligible impact on the environment of PMA

RESULTS AND DISCUSSIONS

The reliability of each item in the survey questionnaire was measured using the Cronbach's Alpha Coefficient. Table 2 shows the result of the reliability test for the four variables. It is recommended that Chronbach's alpha values above 0.7 as a sufficient measure of reliability or internal consistency of an instrument (Taber, 2018). The table below shows that the variables addressed in the questionnaire achieved a reliability of 0.8 and above, reflecting the items in the questionnaire reliable and deletion is not required.

Table 2. Reliability coefficients for the variables.

Variable	No. of item	Cronbach's Alpha
General management tourism aspect	10	0.917
Commercial area tourism aspect	5	0.851
Tourism Routes tourism aspect	12	0.962
Tourist facilities tourism aspect	9	0.948

The study set out to investigate the perceived impact of tourism by the tourists on the environment of PMA. The respondents of this study were predominantly females (63.3%).

Most of the respondents were between 18 to 27 years old. 86.2% are single, and 13.8% are married. Most respondents are well educated since 33.9% of them were college graduate, of which 56% were at the tertiary level, and the rest were in the secondary level.

The respondents believed that the general management of PMA has a moderate impact on its environment (Table 3). This shows that aspects such as pollutions (solid wastes, noise and aesthetics), lack of energy and water saving measures, inappropriate solid waste management and sewage discharge, excessive tourists in the area, absence of environment-friendly products, and lack of Information Education Campaign (IEC) materials are all present in PMA. It gives the impression that these aspects genuinely contribute to the negative consequence of the place. Inappropriate water pollution discharge, for instance, can carry potential diseases which can be spread out by vermin such as flies, mouse, and cockroach affecting human health. Noise pollution, such as those coming from the vehicles, causes annoyance and distress not only to humans but to wildlife as well. Improper disposal of solid wastes adds on the poor aesthetic condition of the area, and it also attracts unwanted pests. The presence of too many visitors also entails problems on the environment. Tourist activities can alter the integrity of cultural resources. This damage includes vandalism and looting of sites of cultural significance (Ghulam Rabbany et al., 2013). Likewise, the vehicles of the tourists that pile up in one parking area congest that zone and emit a large amount of carbon dioxide. Also, the absence of environment-friendly products such as paper bags adds on the long-time garbage problem. Finally, people are not really aware of the possible impacts they might bring in the environment of PMA due to lack of information and education campaign. IEC materials such as brochures and information booklets provide information on the potential harm a human can do whenever they come closer to nature and the environment. It also includes information about how people can mitigate their impacts on nature.

Table 3. Perception of tourists on the impacts of the general management tourism aspects on the environment of PMA.

General Management Tourism Aspect	Mean	Level
1. Solid waste/Litter/Garbage	3.11	Moderate
2. Lack of energy saving measures (for ex. Energy saving lights, solar panels, etc.)	2.83	Moderate
3. Inadequate water saving measures	2.98	Moderate
4. Visual Pollution (For ex: signs/advertising, building structures)	2.94	Moderate
5. Noise Pollution (For ex: Music/people)	2.75	Moderate
6. Sewerage Systems (Inappropriate discharge)	2.99	Moderate
7. Inappropriate waste management – the absence of recycling waste bins	3.01	Moderate
8. Too many tourists in the park at a given time	3.02	Moderate
9. Lack in the use of environmentally friendly products (For ex: Paper bags)	2.66	Moderate
10. Lack of brochures and information booklets about the tourism site.	2.78	Moderate
Mean	2.90	Moderate

Table 4 shows that respondents perceived the tourism aspect of commercial area as having a moderate impact on the environment of PMA. The respondents see that inappropriate waste disposal, and non-usage of locally produced products in restaurants exist in PMA. There is also utilization of single-use plastics, visible pollution at restaurants and

non-organic food products. All these observations have negative impacts to the environment of PMA. The plastic bags, for instance, have been seen to create environmental challenges because of its physical and chemical composition (Chen, 2008; Clapp and Swanston, 2009; Nielsen et al., 2019.). Plastics are made of fossil fuels that are infamous for its contribution to the worsening effects of global climate change.

Table 4. Perception of tourists on the impacts of commercial area tourism aspects on the environment of PMA.

Commercial Areas Tourism Aspect	Mean	Level
1. Inappropriate waste disposal at restaurants (For ex: not using organic gardens)	2.96	Moderate
2. Restaurants not making use of locally produced products	2.63	Moderate
3. Impacts of using non-renewable resources (For ex: plastics)	3.09	Moderate
4. Pollution at restaurants	2.91	Moderate
5. Use of food products that aren't organic	2.58	Moderate
Mean	2.89	Moderate

The tourism aspect of tourist routes has a moderate impact on the environment of PMA according to the respondents (Table 5). Attributes under this aspect include the physical damage on the natural vegetation and soil, effects on wildlife and plants, and speeding vehicles that may kill animals. Any previous activity disturbs wildlife in many ways. Many species will perceive the consequents disturbance in various ways and for different reasons. Some will be affected in terms of their breeding season, feeding patterns, behaviors, and many more (Ghulam Rabbany et al., 2013). Visitors may damage the ecosystem due to their activities such as walking along restricted areas or places where trails are not apparent resulting to trampled vegetation. One or two tourists may not cause visible harm, but hundreds over time can do substantial damage (Ghulam Rabbany et al., 2013). A critical attribute under this aspect is the possible introduction of alien species. Many visitors do not know the effects of introducing alien/exotic species in an environment. These alien species threaten the local environment and interfere with the essential species balance, and they generally destabilize the ecosystem.

The respondents perceived that tourist facilities have a moderate impact on the environment of PMA (Table 6). Under these are waste spillage in the garbage bins, interference of animals, attraction of wildlife to the rubbish bins, lack of energy saving measures, lack of waste management and use of non-renewable resources by the tourist. Each of these aspects has detrimental effects on the environment. Solid waste management has been a long-time problem throughout the Philippines. Despite the passing of the RA9003 or the Ecological Solid Waste Management Act of 2001, many organizations and institutions fail to comply appropriately on the provisions of the said law.

Table 5. Perception of tourists on the impacts of tourist routes tourism aspects on the environment of PMA.

Tourist Routes Tourism Aspect	Mean	Level
1. Damage to natural vegetation due to uncontrolled tourist behavior	3.15	Moderate
2. Erosion in the roadway due to tourists	2.96	Moderate
3. Overcrowding of tourist at wildlife sightings	2.91	Moderate
4. Impacts of wildlife attracted to rubbish bins along tourist routes	2.87	Moderate
5. Impacts of plant collecting along tourist routes	2.84	Moderate
6. Introduction of alien plants and species due to tourism	2.63	Moderate
7. Interference of breeding of wildlife due to tourism	2.70	Moderate
8. Specimen collection (for ex: butterflies) by tourists	2.75	Moderate
9. The killing of animals for comfort and safety (for ex: spiders, snakes, mosquitos)	2.78	Moderate
10. Road killings as a result of reckless tourist driving and speeding in the tourism site.	2.91	Moderate
11. Speeding of staff and delivery vehicles in the site	2.81	Moderate
12. Lack of environmental-friendly support	2.88	Moderate
Mean	2.84	Moderate

Table 6. Perception of tourists on the impacts of tourist facilities tourism aspects on the environment of PMA.

Tourist Facilities Tourism Aspect	Mean	Level
1. Waste spillage around waste bins by tourists	3.09	Moderate
2. Interference of wildlife due to noise, cars, and people	2.93	Moderate
3. Overcrowding of people	3.17	Moderate
4. Visual pollution (e.g. signs and direction)	2.99	Moderate
5. Wildlife attracted to rubbish bins	2.91	Moderate
6. Supplementary feeding of wildlife by tourists	2.72	Moderate
7. Lack of energy-saving measures (e.g. solar panels)	2.72	Moderate
8. Insufficient management of waste (e.g. lack of recycling measures)	3.08	Moderate
9. Use of non-renewable resources (e.g. plastic) by tourist	3.09	Moderate
Mean	2.96	Moderate

The respondents believed that the impact of tourism aspects in the environment of PMA was all moderate. It means that the management of the PMA has still a lot to improve in order to lower the tourists' perceived tourism impacts in the environment of the academy. More so, each aspect presented above can be used as indicator on which areas to improve. Study shows that the PMA can improve further on the aspects of general management, commercial areas, tourist routes and tourist facilities. Sustainable management or making it a more environment-friendly can be carried out as improvement. Moreover, an independent t-test was performed to determine the significant difference of perception between female and male respondents (Table 7). The analysis revealed that there is no significant difference in the perception of female and male respondents ($t_{stat}=5.49 > t_{Critical\ two-tail}$; and $P\ value = 5.84 \times 10^{-7} < \alpha=0.05$).

Table 7. Independent t-Test sample for female and male respondents mean responses.

Variable	Mean	StDev	t stat	T Critical two-tail	P value
Female	2.97	0.03	5.49	1.99	5.84x10 ⁻⁰⁷
Male	2.76	0.03			

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to determine the perceptions of tourists regarding the impacts of tourism in the environment of the PMA. It was found that the tourists believe that general management, commercial areas, tourist routes, and tourist facilities of PMA have a moderate impact on its the environment. It also showed that respondents are aware and concerned about the effects of tourism to the environment of PMA. Furthermore, findings from this study suggest that more efforts should be carried to make tourism, specifically the identified aspects, environment-friendly or sustainable. A follow-up study is also recommended to assess the perception of the community, such as the students or personnel, on the impacts of tourism to the environment of PMA. These perceptions will then be compared to and evaluated base on the result of this study.

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Study of ‘Light’ in vernacular temples of Pune

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Light is an integral and a very important aspect of Hindu temple design. Light is not only used for its functional quality of facilitating visibility, but rather has more metaphysical associations connected to it. Historic classical temples are conceived to modulate light not only internally, but externally as well. Hindu myth and philosophy also makes rich allusions to light.

Numerous temples were built in the city of Pune in the seventeenth to nineteenth centuries. These are not of the classical typology and quality, but are rather stylised vernacular adaptations of classical temples. It would be interesting therefore to study how the element of light finds expression in these temples. Is the understanding of light, its quality and its modulation technique the same as the classical temples or has it undergone changes? The current paper enquires into this question with a two-fold methodology. Firstly, it analyses the light in these temples qualitatively, interpreting it for the culture of the times these temples were built in. Secondly, it measures the quantity of light in the various parts of these temples and tries to find a correlation between these values and the experience and associations of the space with respect to this light. The research thus tries to build a correlation between the light values and its experience in the context of vernacular temples of Pune.

Key Words: light quality, Light quantity, experience, vernacular temple architecture

Introduction:

The following paper discusses the phenomenon of natural light that becomes the holy light in temple / religious spaces. In view, this paper addresses two major objectives. First, is to understand the significance of light in the domain of temple Architecture. Secondly, is to understand the methods used to achieve the desired light quality in the typical vernacular temples of Pune.

The focus of study remains to the existing body of knowledge in the field of study of the temples built in the 17th to 19th Century. Based on the following two hypotheses a careful analysis of the design of the temples, analysis of the materials used, the physical light readings were carried out.

The first hypothesis says that the quality of light in these temples is governed by the design of the temple, design that is culturally governed (era specific). The second hypothesis suggests that the light design technology is a function of time as expressed through building technology and building size. To test these hypotheses, 05 temples from the city of Pune were studied for their natural light systems, the intensities of light in various parts of the temples and the impact of light on human psychology and perceptions.

The study focused on using multi-method analyses that included a qualitative analysis using accepted lighting design guidelines, and a quantitative analysis using Lux Meters (Light measuring instruments). After studying the five temples, their locations, their contexts it was observed that though there are differences in the building materials, sizes, planning techniques in each of the five temples, on the whole the quality of light inside the temples did not undergo much change. Also though there has been a substantial change in the type of construction techniques, material usage and planning methods, there hasn't been a direct impact on the use and quality of light inside these structures. The paper concludes that the results support the two hypotheses and follow similar principles of lighting design.

For centuries now, light has had more of a symbolic role directly related to the sacred, religious and cosmologic beliefs of people. In turn, this role is evidently noticed in the religious buildings taking a leading part in the creation of worshipping and aesthetic forms of any particular religion. Be it a mosque, a church or a temple, the design is sub-consciously dictated by the way in which light is handled in these structures. Thus light is an influential factor not only in the spiritual relation between the devotees and the religion but also in the spatial relation between the believers and the building (place of worship). Spatial structures construct the religious environment while light re-constructs the religious experience. (Theodora Antonakaki, 2007)

Furthermore various form of sacred monuments have provided spaces that would facilitate a dialogue between man and God, make the former feel more closer and connected. The simplicity and the functional character of these temples as well as the deliberate arrangement of various spaces in conjunction with each other helped to create a holy atmosphere through some simple yet deliberate manipulation of light. Techniques such as clear storey, multiple reflections, jali walls, light reflecting from the walls creating mysterious shadows, subdued light filtering through the different openings, light being used as a focal point, were some of the ways in which the natural light was used to represent itself as a fundamental connection to God. Thus, natural light was used as an important part of religious symbolism in temples not just in Pune but across the country. (Anuradha Mukherji, 2001)

Sun, Light, Design:

In spite of the importance given to sun, wind, light in the Hindu scriptures, the natural light has been very sparsely used in the Hindu temples, though there are a few contemporary exceptions. According to the Hindu faith, when a worshipper is in the presence of the divine, there should be nothing in between to distract his / her senses, including vision and God shall reveal himself to his devotee gradually (Deva 1995). Therefore, the innermost sanctum of the temple is shrouded in total darkness and the progression into the temple is a ritual movement where the devotee goes through the dynamic experience of the darkening spaces before reaching the darkest sacred chamber (Michell 1987). This treatment of light ensures that by the time the devotee, visitor reaches the dark sanctum (Garbha griha) his eyes slowly become accustomed to the darkness and the transition which is cutting him off from the outer world starts making his mind more focused and it no longer is plagued by worldly thoughts. During this switch, the devotee transverses through many doorways, colonnaded halls (Mandapa's) and corridors (Antarala) which are decorated with sacred carvings and motifs. These sacred symbols have a profound impact on the mind of the devotee; they simulate the mystery that envelops the universe and the divine spirit that illumines the universe.

The paper examines the two hypotheses with simple tools to understand the qualitative and quantitative aspects of light in the five Vernacular temples of Pune Viz. The Ram Temple at Tulsi Baug, the Parvati Temple, the Omkareshwar Temple, Someshwar Temple and Narsimha Temple.

The Someshwar Temple:

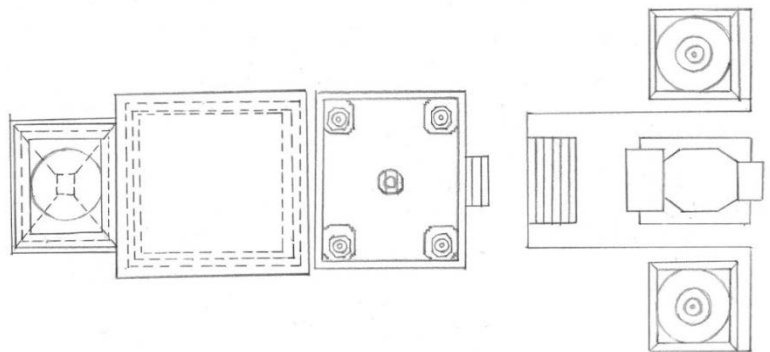
Location: is located on the bank of river Ramnadi.

History: Someshwar temple was built in the year 1640 by Jijabai, mother of Great Shivaji. The history dates back over 700 years ago when a cow used to sprinkle milk over a snake hole (varul) which was seen by a cowherd, after this incident Lord Shankar came in his dream. Directing him to dig up the snake hole where he found the Shivalinga. One can see this Swaysmbhu (self-originated) Shivalinga in the inner sanctum of this magnificent temple. Presently, the Shivalinga is covered with a golden mask of Lord Shiva. The Samadhis of Hanumante, one of the asthapradhans (a council of eight ministers) of Shivaji's court and Chitrav Swami, who contributed gold coins to Peshwas for the renovation of the temple, are located at the north of the temple. During the rule of Mughals, a divine intervention stopped the destruction of this splendid piece of architecture. So as repentance Shahiste khan a prominent Mughal general built the sabha mandap, ceilings of the mandapa are crafted with wonderful carvings.

Architecture: The temple is built in Hemadpanti Sculpture in black stone and has approx. 40 feet tall Deep mala, which is surrounded by Ganesh, Hanuman and Bhairavnath temple. To the south of the temple near the bank of the river there is a temple of Padmavati, the goddess of fulfillment.

The temple also has a homkund for havans and pujas and a *naubat khana*

(an urdu word which means drum room) for music. This temple houses a beautiful Palkhi which has brilliant wood work on it. Inside the Palkhi there is an ancient murti (idol) of Lord Shiva made up of *panch dhatu* (five metals). There is a garden next to the temple.



Tulshibaug RamMandir

Location: is located in the heart of the city, the most important landmark in Budhwar peth.

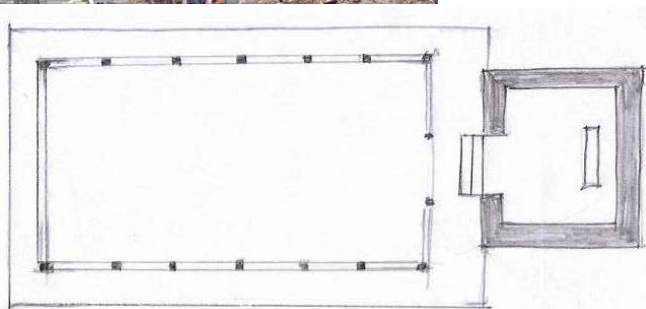
History: As its name implies, the site was once time a garden of tulsi plants. Balaji BajiRao, the third peshwa was responsible for ordering that the temple be built. Naro Appaji was charged with the construction and management of the temple. According to the historians, the temple was finished in 1761.

Architecture: The main one in the middle is temple of Lord Rama. This is a vaulted stone shrine with a shikara and a hall, with a marble floor. Two smaller stone temples of Ganpati and Mahadev are on either side of it. The temple wall has murals depicting the exploits of Lord Rama painted on it. The interiors of the main hall are similar to the old wadas found in old Pune. The surrounding yard was at one laid out as a garden with flowerbeds, today it is completely paved with stone.

Entry is through two rather inconspicuous gateways in the north and south with nagarkhanas for musicians above them. These came alive to the sound of drumbeats on special festive days. Over the years this temple complex has grown through additions and alterations. The blackish tinge on the brick structure of the spire gives it – the temple is aged. Shrines, halls, restrooms and shops were gradually added to the complex as it grew in importance as both a religious as well as a social space for puneites. Today the courtyard within has grown into a traditional and popular shopping enter selling all manner of brass and copper utensils. In fact the whole precinct wears a festive look with the loud sounds and smells of an old fashioned bazaar.



Sanctum: The sanctum has beautiful wooden art work. The idols of Ram, Laxman and Sita are made of marble which is indeed a mesmerizing work. On both the sides of the idols you see the idols of Lord Vishnu and Garuda in the niches. Lord Hanuman sits exactly opposite them, not in the sanctum but in the sabhamandap with folded hands and a gaze constantly fixed at His Shree Ram. The dome in the sanctum has beautiful design of lotus. There is ample space of circumambulation provided around the mandap area where one gets a glimpse of other smaller temples dedicated to Lord Shiva, Lord Vithal-GodessRakhumai, Lord Ganesha, Godess Parvati, Lord Dattareya . When you see the ventilation and light arrangements in the temple you get the idea of the architectural perfection of the construction.



Porch: The porch which is called the sabhamandap has a wooden roof with beautiful art work. The temple has a wooden sabhamandap (congregation hall), essentially an open space supported by withered columns and carved arches with an attractive teak ceiling decorated in ornate designs and patterns. The sabhamandap evokes sense of peace.

Omkareshwar Temple



Location:Omkareshwar is one of the many names of the Hindu Lord Shiva.Omkareshwar Temple is situated on the banks of Muthariver.It's located in Shaniwar Peth.This is one of the oldest Shiva temples of Pune.

History:KrishnajiPantaCitrava built this temple in 17th century, during the times of SadashivraoBhau. This is one of the oldest and biggest temples of Lord Shiva in Pune.The temple is also famous as a symbol of survival as it had

successfully survived the huge havoc that was created in 1962 due to the Panshet floods. Since then, the temple has become well known for its extravagant style of construction and huge domes and has become one of the main attractions.

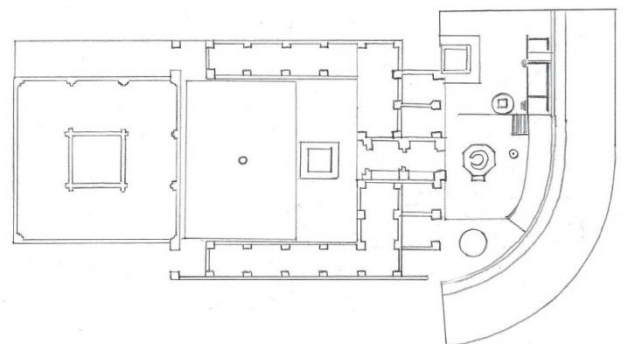
Architecture:The temple provides a nice showcase of the creativity and charm of the architectural workings of the ancient India. The temple is 250 years old and still provides the alien view of the architectural designs. The shrine is surrounded by verandas with columns.



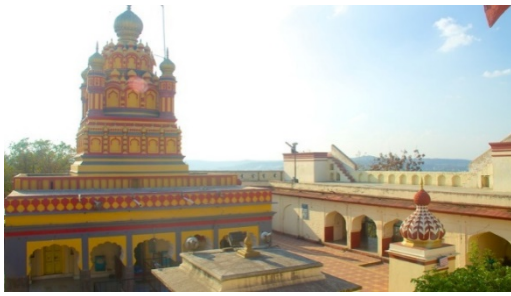
These columns are carved in circles, polygons and squares. The temple faces east and has an impressive gateway.The temple is unique as far as the plan and elevations are concerned. The ceiling of the temple is divided into nine domes constructed with bricks. The sanctum houses a huge Shivalinga.

Courtyard :The Nandi mandap is constructed (reconstructed in 1993) in an large and open courtyard. The courtyard itself is surrounded by a structure that includes the 'garbhagriha' (sanctum sanctorum) which is further adjoined to various rooms, which seem to be inhabited by the temple authorities.Between the main Garbhagriha and the Nandi temple is aAgnikunda or the place for the ceremonial fire.

The outer walls of the temple are made from black stone. The structure of the temple takes us back to the Peshwa regime as it was constructed during the reign of SadashivBhau, the Peshwa. A 250 year old construction on the banks of the river Mutha still proclaims the glory of the fallen Peshwa Empire. It can be seen as a perfect piece of art and architecture prevailing in the 17th century.



Parvati Hill Temple

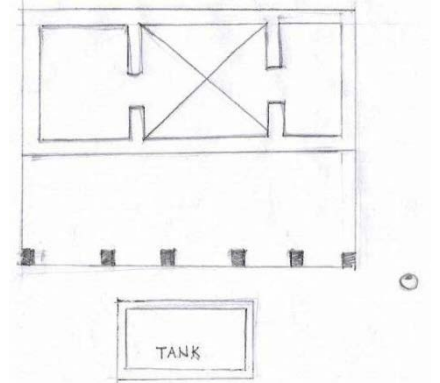


Location: Parvati hill temple is one of the Pune's prime historical attractions. Situated near the center of the city and near to the Swargate bus station, the Parvati mandir is situated on a small hillock which rises around 2100 feet above the sea level.

History: The existence of this temple can be found even during the reign of the great Maratha Ruler

Chattrapati Shivaji Maharaj. However, this temple actually flourished during the Peshwa rule in Pune. According to several written documents found, the temple was built by the third Peshwa, Shrimant Nana Saheb to fulfill the vow taken by his mother Kashibai.

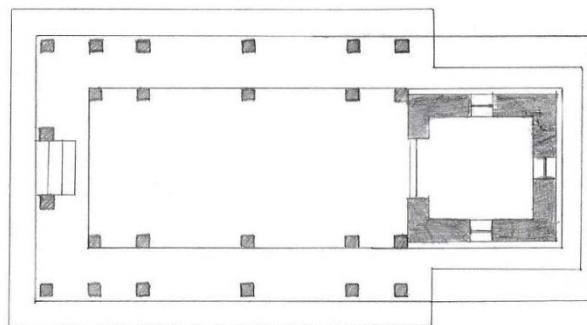
Architecture: This magnificent Pune temple was built under the reign of the Peshwa Dynasty which dates back to around 17th Century. This temple has five large shrines inside. Typical peshwa architecture of late 17th and early century architecture is seen in this campus.



Narsimha Temple:

Location: it is located in the city core area behind the famous Kasba temple.

History and Architecture: A 19th Century temple made entirely wood, the temple was built by Mr. Shirole inside the courtyard of their ancestral house. The temple currently is inside a housing complex. It's the only Narsimha temple in the city and is frequented by visitors every morning and evening. The residents of the society use the mandapa for evening leisure activities.



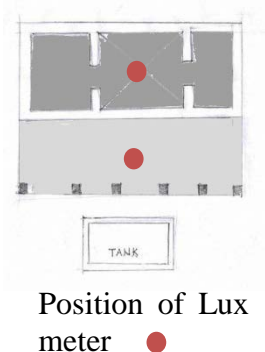
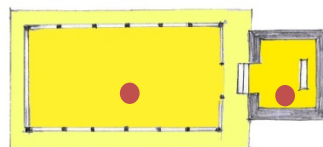
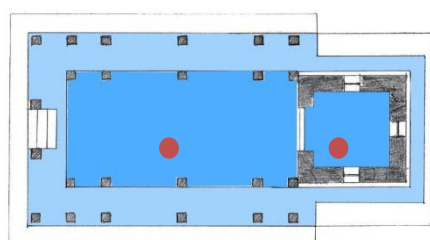
Methodology and observations:

To examine the two hypotheses considered in this paper, several visits were made to the five temples at specific time intervals on each day. To understand the effect of light, its play, three specific timings were decided, viz. 10am, 2pm and 5pm. A set of readings were recorded at these three timings. The temple precinct, the mandapa and the garbhagriha were the three locations where these readings were recorded.

A total 490 readings over 12 days under different sky cover conditions with varying light luminance were recorded with the help of 'Lux Meters'.

The following diagrams, graphically documents the change in the light intensities quantitatively at various times of the day in three of these five temples. Similar drawings were made to document the readings of the average lux readings for all five temples at the decided times of the day.

Figures 1, 2, 3: Show the graphical representation of lux readings and their intensities at various times of the day – 10am at Narsimha Temple, 2pm at Tulsi Baug Temple and 5pm at Parvati Temple



All readings were taken at the centre of the Mandapa, on the floor and the readings for the garbhagriha were also taken recorded at the floor level at the centre of it. Care was taken that no artificial light sources were switched on and no other light or shadow sources were directly affecting the readings.

The second hypothesis was based on quantitative readings that are these various set of readings, which were taken outside the temple, inside the Mandapa and then the garbhagriha. The following table of reading summarises all the readings of one of the five temples where it is clearly observed that there is a consistent drop in the light intensity from outside the temple to the mandapa and into the sanctum area. Such a constant variance is clearly observed in all the five temples under consideration.

Table 01: Readings of the Omkareshwar Temple

	OUTSIDE THE TEMPLE			Mandapa			GarbhaGriha		
Date	TIME 10:00 AM	TIME 02:00 PM	TIME 05:00 PM	TIME 10:00 AM	TIME 02:00 PM	TIME 05:00 PM	TIME 10:00 AM	TIME 02:00 PM	TIME 05:00 PM
20.08.2016	427	498	400	227	303	199	47	52	42
21.08.2016	435	508	409	238	312	208	54	52	48
22.08.2016	438	511	502	241	315	211	56	57	50
24.08.2016	408	481	472	211	285	181	50	59	45
25.08.2016	418	491	482	222	295	190	53	54	50
26.08.2016	449	520	512	253	324	220	56	50	54
28.08.2016	459	530	522	262	335	230	61	54	59
31.08.2016	450	521	513	253	326	221	56	59	54
04.09.2016	460	531	523	264	336	231	56	54	59
05.09.2016	470	541	533	274	346	241	61	59	64

016									
06.09.2016	482	553	545	286	358	253	66	64	69
08.09.2016	472	543	535	276	348	243	60	69	65
11.09.2016	452	523	515	256	328	223	50	64	55
AVERAGE	447.6 92307 7	519.30 76923	497.15 38462	251	323. 9230 769	219.3 0769	55.846 15385	57.461 53846	54.923 07692
	448	520	497	251	324	219	56	57	55

Moreover, the hypothesis also meant to analyse that across the 17th to 19th century owing to the cultural and governance change and the several changes on the material use, design and orientation of the temple, if there is any effect on the light conditions inside the temples. The following table sums up the total average lux readings differences across the five temples and their three areas at three times of the day. Hence as per the second hypothesis, it is observed that even though building construction, materials, and sizes of the temples changed over a period of time, the use of light, its intensities still follow similar principles of design and in the process govern the effect light has on the visitors.

Table 02: Summary of all the average readings

SUMMARY 01	OUTSIDE THE TEMPLE			Mandapa			GarbhaGriha		
	Avg 10 AM	Avg 2 PM	Avg 5 PM	Avg 10 AM	Avg 2 PM	Avg 5 PM	Avg 10 AM	Avg 2 PM	Avg 5 PM
Omakreshwar	448	520	497	251	324	219	56	55	57
Ram Temple, Tulshi Baug	404	445	375	223	276	197	62	74	57
Parvati Temple	421	517	404	204	299	206	53	62	47
Someshwar Temple	417	436	397	198	238	172	53	60	43
Narshimha Temple	320	362	296	110	144	92	48	55	38

Table 03: Summary of differences of lux readings

SUMMARY 02	(R1)	(R2)	(R1 - R2)	(R3)	(R1 - R3)	(R2 - R3)
	Avg. Outside	Avg. Mandapa		Avg. GarbhaGriha		
Omakreshwar	488	265	223	56	432	209
Ram Temple, Tulshi Baug	408	232	176	64	344	168
Parvati Temple	447	236	211	54	393	182
Someshwar Temple	417	203	214	52	365	151
Narshimha Temple	326	116	210	47	279	69

The tables also clearly shows that even though these temples are culturally built in different eras, they all observe the same principles of quality of light, its use in connecting the devotees more profoundly to their inner self towards their journey in to the garbhagriha. Thus the first hypothesis seems valid as well were as a visitor, the effect of light in all these five temples, the transition, the diminishing light intensities are all qualitatively same. Table 03 also allows us to know that because the Narshimha Temple is inside a housing society, the difference in readings increase towards the evening meanwhile in the Ram Temple, due to the bazaar around the temple and owing to the design of the temple, there is a larger difference in lux readings in the morning.

Conclusions:

Light, as an element plays an important role in creating effects that influence the perception about the space of the visitor. For centuries, light has been a catalyst in design of religious spaces, for example the direct use in the Egyptian temples, the use of skylight in Pantheon or the interesting use of clear storey lights in the south Indian temples. The above study conducted in the vernacular temples of Pune allows us to conclude the following: the light in these temples qualitatively remains more or less the same, even though the culture of the times these temples were built in is different for each one of them. Secondly, on measuring the quantity of light in the various parts of these temples it is found that there is a direct correlation between these measured values and the experience people have in these temple spaces and each of these spaces have a direct connection to light and its intensities. Considering this as a base a further study could be conducted taking this research forward where the effect of design and light on human comfort could also be analysed.

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- All readings taken by the author on site (20th August to 11th September 2016)
- All sketches are done on site for understanding of proportions, location of mandapa and understanding co-relation of spaces.

Sustainable Development Goals (SDGs): Implementation status in Bangladesh

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ABSTRACT

Bangladesh together with other world leaders adopted the 2030 Agenda for Sustainable Development at the United Nations General Assembly in New York on 25 September 2015. This is a global commitment towards a more sustainable, resilient and inclusive development, with 17 Sustainable Development Goals (SDGs) and 169 targets. The 2030 Agenda has been shaped by relevant United Nations (UN) agreements and conventions as well as the experiences and achievements gained through the Millennium Development Goals (MDGs): the global development agenda spanning the period 2000–2015.

The 2030 Agenda was the result of two years of intensive public consultation and engagement with civil society and other stakeholders around the world. SDGs transcends the MDGs to include wider economic, social and environmental objectives, and with a greater focus on peace, participation and inclusiveness.

SDGs can be met only through high standards of governance at all levels. In this respect, Bangladesh is especially fortunate to have highly committed governments at the centre. Bangladesh has played an important role in shaping the SDGs. This has meant that the country's national development goals are mirrored in the SDGs. As such, Bangladesh has been effectively committed to achieving the SDGs even before they were fully crystallized.

Keywords: Sustainable Development Goals (SDGs), Millennium Development Goals (MDGs), Bangladesh Bureau of Statistics (BBS), GoB (Government of Bangladesh), Bangladesh Bank (BB).

1 INTRODUCTION

As the fastest growing major economy of the world, today, Bangladesh is uniquely placed to deliver on its commitments to inclusive and sustainable development. Externally the country has played a key role in shaping the SDGs and ensuring the balance among its three pillars - economic, social and environmental. Internally, it has launched many programs to make progress towards achieving these goals. Notwithstanding its scarce financial resources due to relatively low per-capita income and large population, Bangladesh is committed to achieving within a short period such ambitious goals as universal rural electrification, road and digital connectivity for all, massive expansions of clean and renewable energy, sanitation and housing for all and universal elementary school education.

2 OBJECTIVES

The Government of Bangladesh (GoB) has established an inter-ministerial committee on SDGs implementation and review demonstrating her commitment recognizing the challenge of coordination of various ministries and agencies responsible for implementing projects/programmes contributing toward attainment of SDGs and providing data and information for monitoring and evaluation of progress at the national level. The Committee comprising secretaries from 20 ministries/divisions coordinates SDGs monitoring and implementation. The principal coordinator (SDGs Affairs), a newly created high-level position in the Prime Minister's office, heads the Committee.

The Government has been following “whole of society” approach in carrying out the task of SDGs implementation by involving various stakeholders. Several important documents, quick in succession, have been prepared to identify the ministries and agencies responsible for SDGs implementation and guide them in their actions. These include mapping of ministries by targets in the implementation of SDGs aligning with 7th Five Year Plan (2016-2020), preparation of ministry/division action plan to achieve SDGs, National Action Plan of ministries/divisions by targets for the implementation of SDGs, data gap analysis for SDGs, monitoring and evaluation framework of SDGs, SDGs financing strategy and education sector strategy.

Thus, the initial intellectual work for assignment of responsibilities across ministries and their agencies and related tasks for implementation have been largely done, it was imperative to see the progress during the first two years of implementation of SDGs (2016-2017). This paper will emphasize several things. First, given the availability of data, it will shed light on where we are on track and where we are lagging behind to achieve the targets. Secondly, it will reveal the data gap which must be filled. Otherwise, our success cannot be numerically measured and demonstrated. Thirdly, it will prompt us to rethink our policies and strategies and actions to help achieve the targets.

3 IMPLEMENTATION STATUS OF SDGs: BANGLADESH'S PERSPECTIVE

3.1 Sustainable Development Goals (SDGs): Bangladesh Progress Report

Bangladesh Planning Commission, Ministry of Planning, Government of the People's Republic of Bangladesh has published the progress report on implementation status on SDGs in the country titled 'Sustainable Development Goals (SDGs): Bangladesh Progress Report 2018'. This is the first formal report on implementation progress of SDGs in the country published in December 2018 by GoB. This report is prepared with the inputs received from different ministries/divisions/agencies implementing various programmes/projects relating to SDGs following the result framework developed for monitoring progress of SDGs. The SDGs progress report-2018 is a guiding document that sheds light on the progress as well as on the challenges behind achieving the 17 global goals and the 169 targets for Bangladesh. Besides, the said progress report is a new impetus for reinforcing revision of existing policies for taking more holistic approach towards implementation of the SDGs by 2030.

3.2 The SDG Tracker: Online Monitoring System

The GoB has also taken a plan to monitor the impact of its policies, which must be able to benchmark data and see year on year progress of implementation status of SDGs. An effective, widely used, comprehensive SDG monitoring framework provide essential support in order to achieve the SDGs. As such, creation of monitoring mechanism is important for reliable assessment of progress towards SDGs. Considering this, the GoB has prepared a software namely "The SDG Tracker" is intended to create an online data repository for accurately monitoring implementation of various initiatives in line with the SDGs leading to efficient resource allocation and effective policy making for inclusive and sustainable development and to strengthen timely data and improving situation analysis and performance monitoring of achieving the SDGs.

4 SDGs: GOALWISE PROGRESS IN BANGLADESH

4.1 Goal 1: End Poverty in All its Forms Everywhere

The progress on reducing extreme poverty measured by \$1.90 a day or by national poverty line is on track. Similarly, progress on expanding coverage of social protection and proportion of government expenditure on services (health, education and social protection) as share of total government expenditure are also on track.

With higher expected economic growth in the economy (based on most recent developments) it is possible to achieve the 2030 milestone for poverty if the increase in income inequality does not offset the impact of higher growth on poverty reduction. The incidence of headcount poverty was 24.3 per cent in 2016 and estimated poverty level stood at 23.1 per cent and 21.8 per cent in 2017 and 2018 respectively. The government has adopted policies and programmes to address multidimensional nature of poverty in the country.

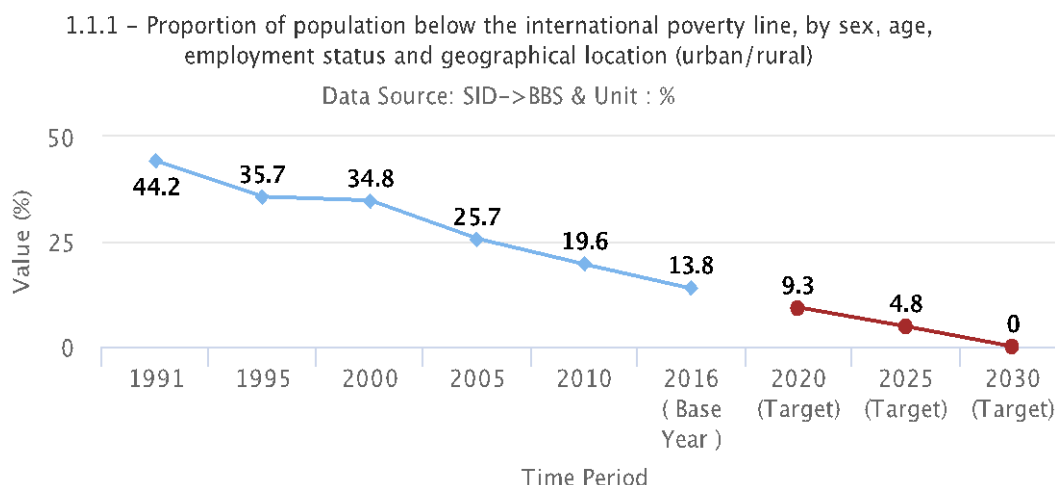


Figure-1.1: Proportion of population below the international poverty line [Source: Bangladesh Bureau of Statistics (BBS)]

These include fostering accelerated, inclusive and resilient growth, increasing coverage and effectiveness of social protection, achieving gender parity, increasing the size, reach, and diversity microcredit programmes, promoting financial inclusion, and providing stable macroeconomic environment. Bangladesh will continue to strive to achieve SDG1 emphasizing job creation, social protection, human capital development, improving private investment climate and mitigating the impact of various shocks.

4.2 Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Progress on reducing stunting which stood at 36.1 per cent in 2014 is virtually on track at the current rate of reduction. Similarly, progress on reducing wasting which stood at 14.3 per cent is also on track. Agriculture Orientation Index (AOI) with a value exceeding 0.5 compares favourably with those of India (0.4), Sri Lanka (0.4) and Nepal (0.2). Total official flows to agriculture sector is low mainly because of changing development partners' preferences in aid allocation over time. It will require alignment of aid policy in view of SDGs emphasis on international support to agricultural transformation.

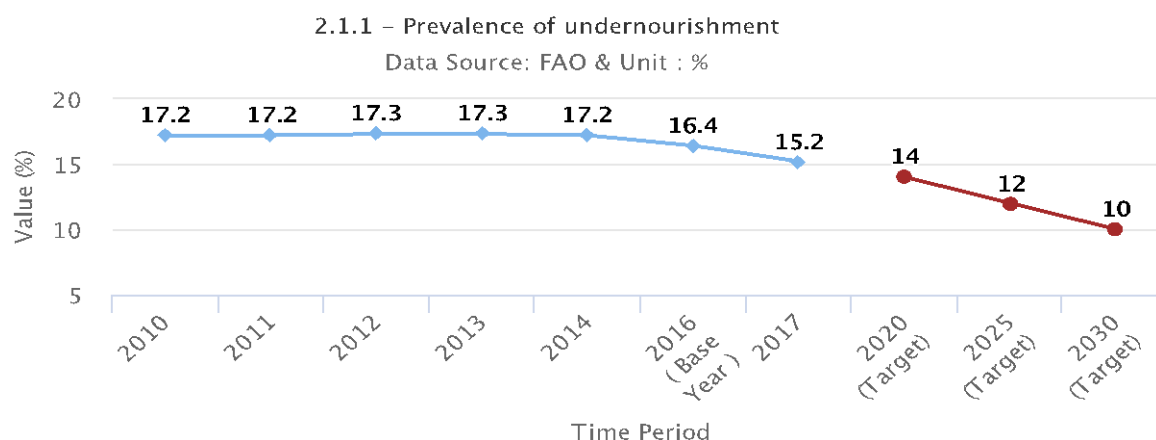


Figure-1.2: Prevalence of undernourishment [Source: Food and Agriculture Organization]

Besides, government policies and programmes to ensure food security to people some specific programs have been adopted to address specific hunger and nutrition issues. These include introduction of nutrition fortified rice, distribution of iron-folic supplementation among pregnant, lactating women and adolescent girls, vitamin-A distribution for children, deworming, salt iodization, maternity leave for mothers to assist breast-feeding, and implementation of 'WASH' programme emphasizing quality water, sanitation and hygiene. Challenges to 'Zero Hunger' will be related to implementation of the Delta Plan 2100 which takes account of future uncertainties in climate change, socio-economic development, population growth and regional cooperation, addressing hunger in lagging regions and of disadvantaged groups, building resilience of poor people and problems emerging from urbanization. The Government has articulated that these challenges and policies will be in place to address those.

4.3 Goal 3: Ensure healthy lives and promote wellbeing for all at all ages

Bangladesh has remained a low HIV/AIDS prevalence and incidence country. But it is one of the 30 high TB (Tuberculosis) burden countries in the world, one of the major malaria endemic countries in South East Asia, and one of the top 10 countries in the world with high prevalence of current tobacco use.

The GoB has been following segment-wise approach in the health sector of the country from 1998 and presently the 4th program – Health, Population and Nutrition Sector Program (HPNSP) (2017-22) is being implemented. The program is comprised of three components, namely: governance and stewardship of the sector, strong health systems, and quality health services to achieve health, population and nutrition sector targets and the health-related SDGs.

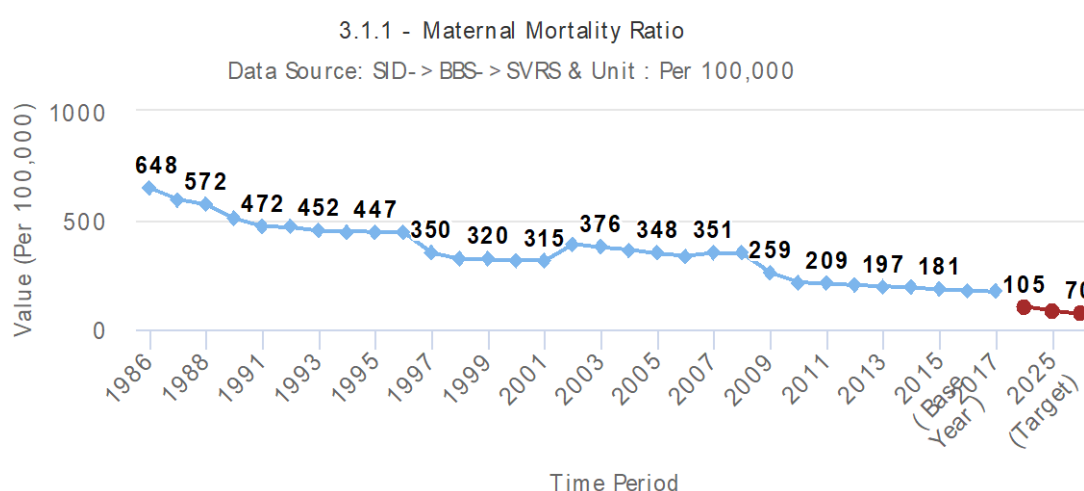


Figure-1.3: Maternal Mortality Ratio [Source: Bureau of Bangladesh Statistics (BBS)]

Health sector faces considerable challenges concerning increasing access to, improving quality of and achieving equity in health care services for all. There is also increasing burden of Non-communicable Diseases (NCDs), increasing incidence of various injuries, drowning, ageing and geriatric diseases, spread of infectious diseases, health effects of geo-climatic disasters and arsenics and re-emergence of traditional diseases such as malaria and TB as mentioned before.

4.4 Goal 4: Inclusive and Equitable Quality Education

Gender Parity Index (GPI) exceeded 1 at primary and secondary levels of education and has remained above 1 for more than a decade. GPI at tertiary education reached its peak at 0.737 in 2014 and then declined to 0.701 in 2016 and 0.71 in 2017 respectively. Concerted efforts are needed to reverse the direction of change in tertiary GPI. The proportion of primary school teachers with required qualifications has been rising reaching more than 80 per cent of total teachers in 2015. The gross enrolment ratio in pre-primary education has been increasing at 1.45 percentage points per annum since 2013.

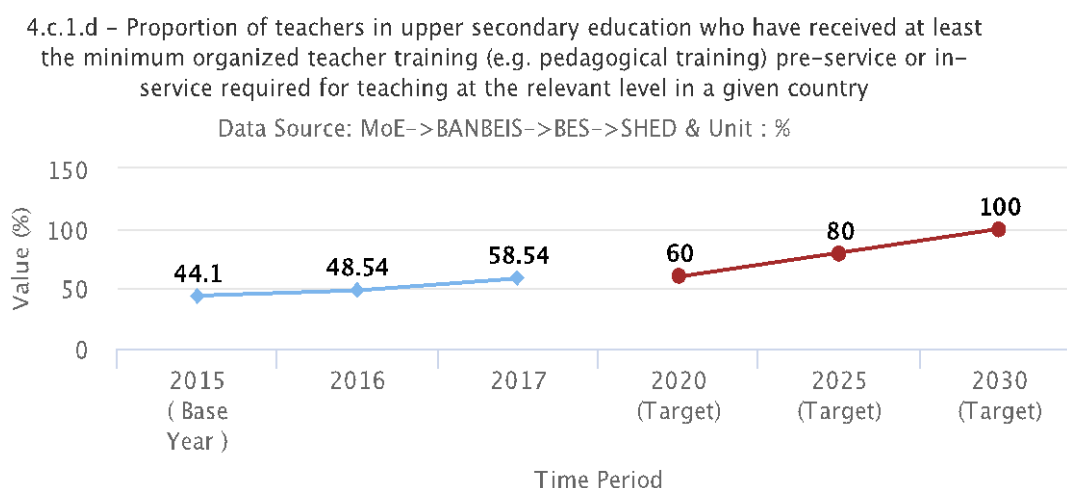


Figure-1.4: Proportion of teachers in upper secondary education [Ministry of Education]

The Government has continued to implement policies and programmes to increase access to education and training, improve quality and relevance of education, reduce inequality in education and leverage on knowledge and skills in science, technology and innovation. Despite various government efforts and progress achieved in the education sector in different dimensions significant challenges remain. The government is concerned for inclusive and equitable education, quality of education at all levels, quality of teaching, adult literacy and lifelong learning as the goal 4 cannot be achieved without increase in supply of quality teachers including through international cooperation for teacher training and increase in the number of scholarships available to developing countries for higher education in developed countries.

4.5 Goal 5: Achieve gender equality and empower all women and girls

Bangladesh ranks 48 in global ranking of countries with a score of 0.721 indicating significantly better performance in promoting women empowerment compared to South Asian neighbours. Women and girls aged 15 years and over are subjected to different types of violence by their current or former intimate partner as well as by persons who are not intimate partners, and they are significantly more vulnerable to violence by their intimate partners. In 2017, the proportion of women aged 20-24 years who were married or in a union before age 15 years stood at 10.70 per cent and before age 18 years 47 per cent which registered some decline over time. Women bear significantly greater burden of unpaid domestic and care work in the family than men. About a quarter of women's daily time is spent on such work. The proportion of female members in the parliament has been increasing over time reaching 20.57 per cent in 2017.

5.2.1 – Proportion of ever – partnered women and girls aged 15 years and older subjected to physical, sexual or psychological violence by a current or former intimate partner, in the last 12 months, by form of violence and by age group

Data Source: SID→BBS→VAW Survey & Unit : %

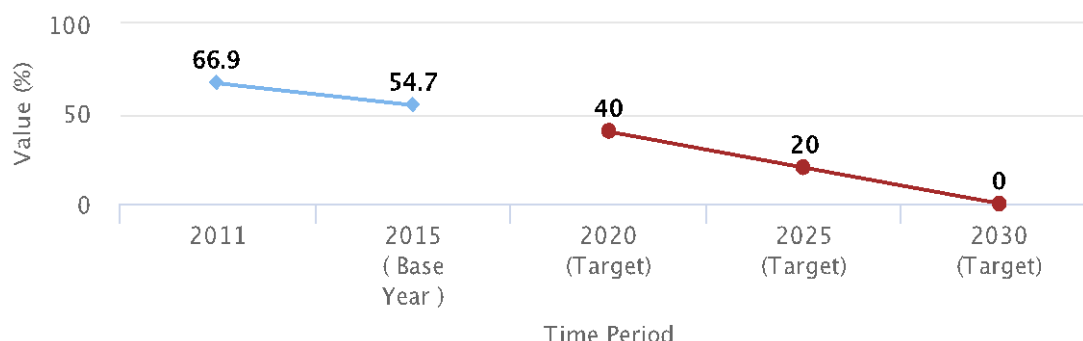


Fig: 1.5: Violence against women (VAW) [Source: BBS]

4.6 Goal 6: Clean Water and Sanitation

The success of Bangladesh in achieving MDG targets is well recognized. As part of this recognition, the prime minister of Bangladesh has been made a member of High-Level Panel on Water (HLPW) for SDG 6. This membership has induced lots of activities in SDG 6 and an action plan has been formulated by ministry of water resources (MoWR). Currently 87% of population has access to safe water sources (Target 6.1) and 61% population has access to safe sanitation (Target 6.2). For sustainable management of water resources, two key initiatives can be observed related to Target 6.3 (improvement of water quality) and Target 6.6 (protection of water ecosystem).

6.1.1 - Proportion of population using safely managed drinking water services

Data Source: UNJMP & Unit : %

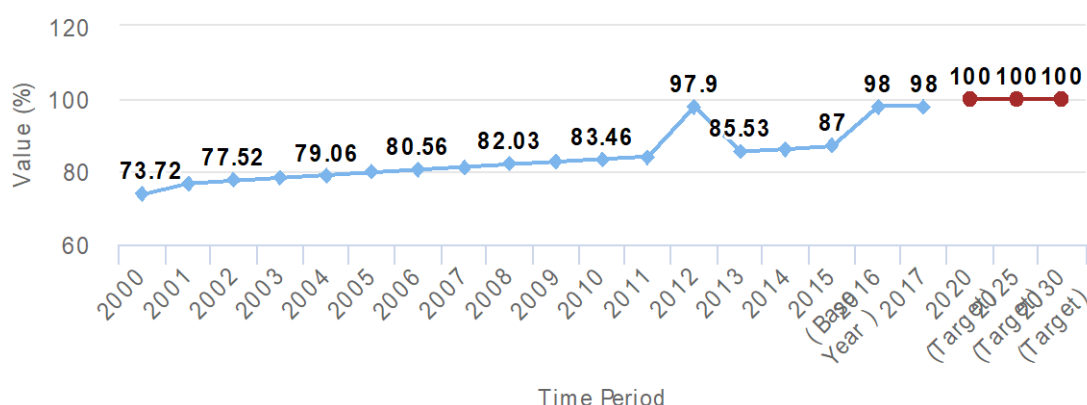


Figure:1.6: Proportionate of population using safely managed drinking water services [Source: UNICEF]

4.7 Goal 7: Affordable, Reliable, Sustainable and Modern Energy

It is encouraging to note that Bangladesh is moving steadfastly towards ensuring access of 100 per cent households to electricity well ahead of the target time in 2025; it reached 85.3 per cent in 2017 (91% in 2018 December). The country lags behind in other energy indicators. The combined effect of slow increase in renewable energy and fast increase in non-renewable energy is very slow rise in the share of renewable energy in the total final energy consumption. Energy efficiency in the country appears to have been improving.

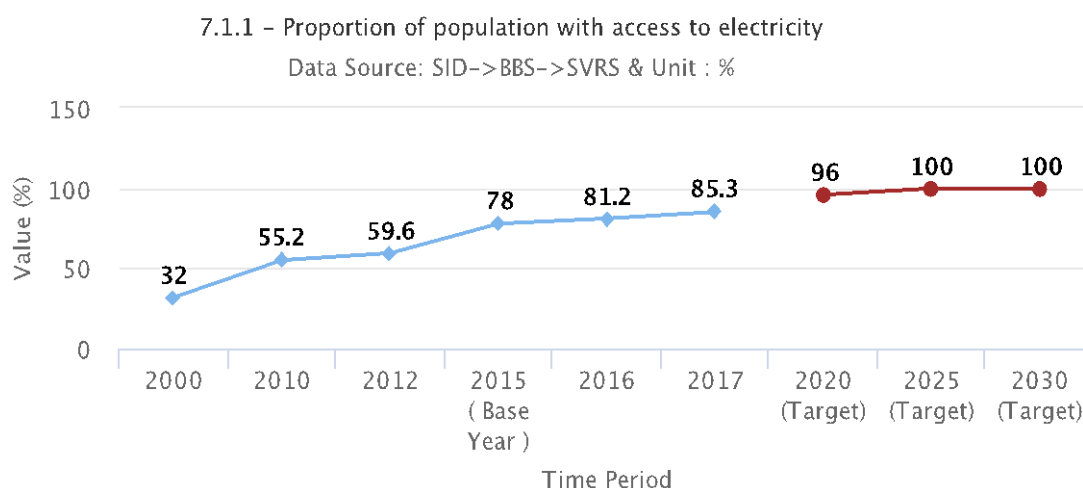


Figure-1.7: Proportion of population with access to electricity [Source: BBS]

The Government's ongoing efforts to ensure reliable energy supply to all households has been complemented by yet another effort to achieve SDG 7. The ministry has prepared SDG action plan up to 2030 to achieve the targets of SDG 7 embracing universal access to affordable, reliable and modern energy services, increase in the share of renewable energy in total energy, and improving energy efficiency in the country.

4.8 Goal 8: Sustained, Inclusive and Sustainable Economic Growth and Decent Work

Bangladesh has made an upward shift in the average annual growth rate to more than 7 per cent in the recent years (FY2015-FY2018) from the above 6 per cent rate over the last decade. This coupled with slower population growth led to increasing per person gross development product (GDP) growth and the country is nearly on track to achieve the 2020 target.

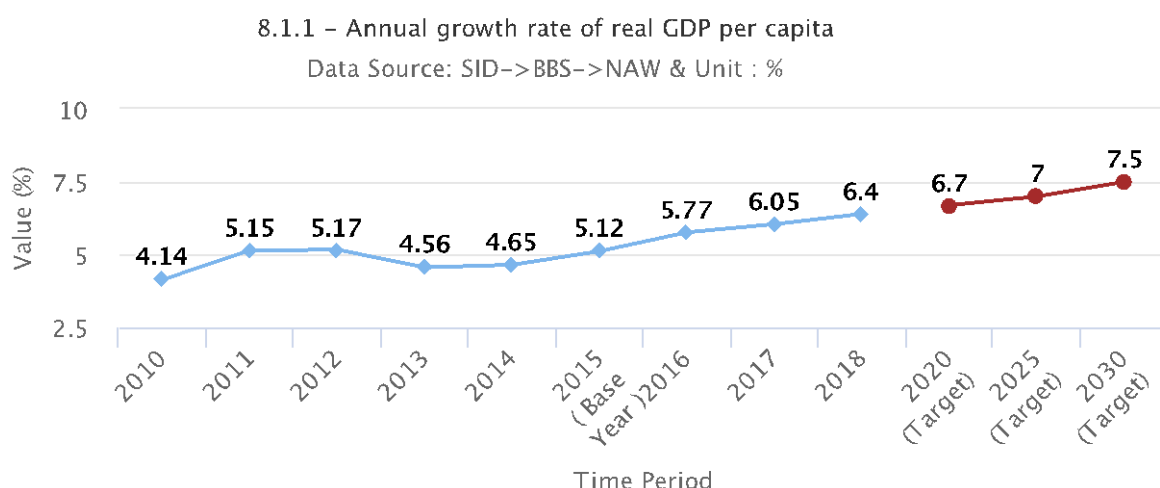


Figure-1.8: Annual Growth Rate of real GDP Per Capita [Source: BBS]

It is also inspiring to note that the average annual growth rate of GDP per employed person has already reached the 2020 target in FY2017. The estimated unemployment rate in Bangladesh has been closer to 4 per cent for a long time and it can be reasonably expected to remain closer to this long run level in the near future.

4.9 Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

The road density per 100 square kilo-meter increased to 14.61 kilo meters in 2017 from 14.41 kilo meters in 2010. Upgrade of existing roads by constructing additional lanes has been an important aspect of road infrastructure development in recent years. The share of manufacturing value added in GDP has increased significantly already exceeding the 2020 milestone in FY2017. Similarly, manufacturing value added per worker has been increasing. The share of manufacturing employment in total employment increased up to 2013 and then levelled off in the last two years. Total international support to infrastructure has been increasing with some annual fluctuation. The proportion of population covered by mobile network has reached close to 100 per cent in case of 2G technology. In case of 3G technology the 2020 milestone has already been achieved in 2017.

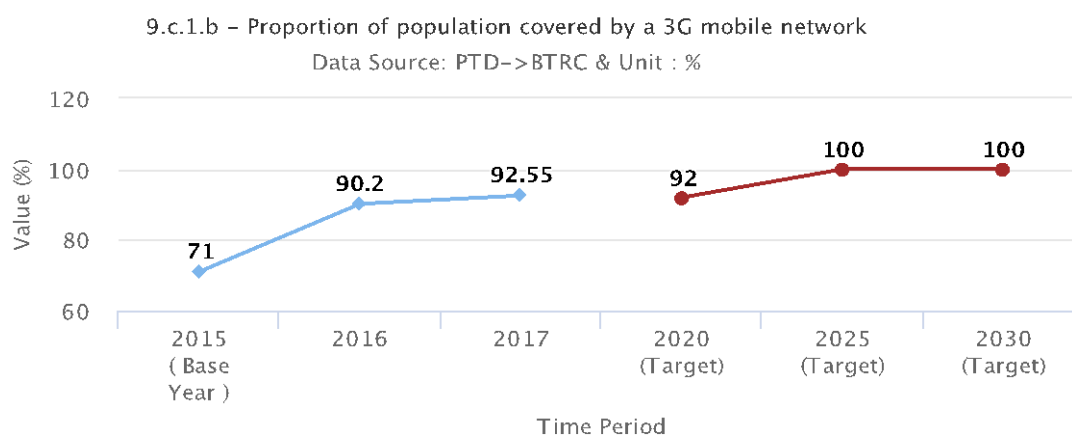


Figure-1.9: Proportion of population covered by 3G mobile network [Source: BTRC]

Government's efforts to achieve SDG 9 rest, on the one hand, on providing infrastructure comprising all modes of transport and ICT infrastructure and, on the other hand, on providing policy support to private sector investment as well as foster public-private partnership.

4.10 Goal 10: Reduced Inequalities

The increasing inequality which has implications for poverty reduction and relative deprivation poses a challenge confronting Bangladesh. Partly it is a problem of the inability to bring all types of income under progressive taxation and partly a problem of not being able to appreciably increase the share of government expenditure on education, health, rural development, and social protection in total government expenditure.

More focused policies and programmes which have larger impact on reducing inequality have been identified. These include better governance and institutions to combat transfer of income and wealth through rent seeking behaviour, corruption in public procurement and spending, illegal land grabbing, and delivery of public services.

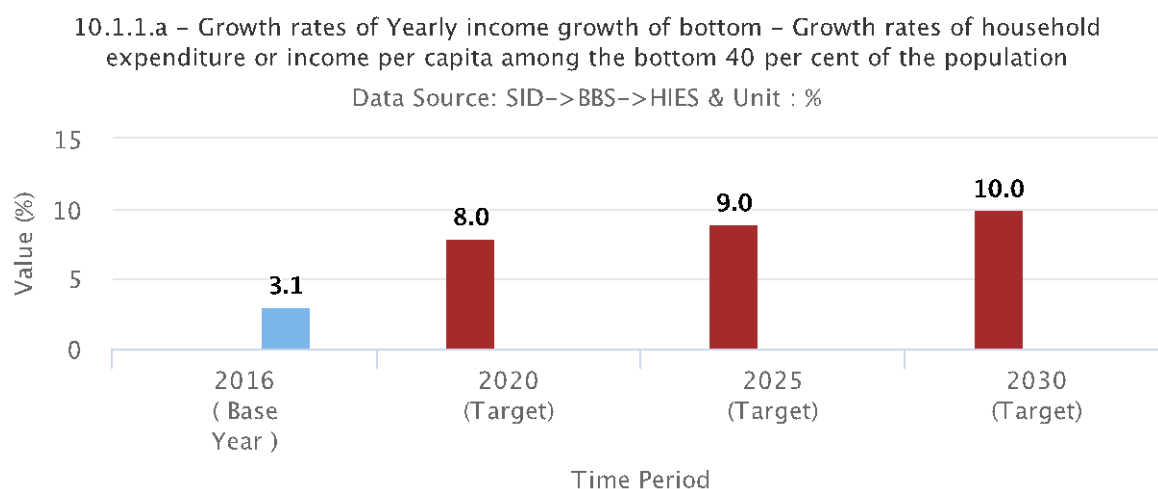


Figure: 1.10: Growth rates of household expenditure or income per capita [Source: BBS]

The Government has been following a pro-poor development strategy which combines promotion of economic growth and reduction of poverty and inequality. According to recent available data income inequality has increased while consumption inequality has remained relatively stable.

There have been some developments with regard to reducing inter-country income inequality. Bangladesh has approved Expatriates' Welfare and Overseas Employment Policy 2016 in January, 2016 with a view to ensuring and encouraging safe migration and protection of migrants and their families. The proportion of tariff lines applied to imports from least developed countries with zero tariffs remains the same as the Doha Round of WTO negotiations—formally, the Doha Development Agenda launched in 2001. Official development assistance has an increasing trend which has continued in the SDGs period as 2030 agenda.

4.11 Goal 11: Sustainable Cities and Communities

Bangladesh has yet a low level of urbanization with an estimated 35 per cent of the population living in urban areas in 2016. In terms of absolute urban population of 56.28 million, it is quite large. Lack of adequate housing is a key problem in all of the cities and secondary towns in Bangladesh which is manifested in housing deficit of 4.6 million units in 2010. Nearly 44 per cent of the urban population lived in purely temporary structures and 29 per cent lived in semi-permanent structures. Thus, an overwhelming proportion of urban households' lived-in poor-quality houses. There has been significant improvement in the quality of housing in recent years as evident from Household Income and Expenditure (HIES) 2016. Close to 96 per cent of slum households live in poor quality (not pucca) houses.

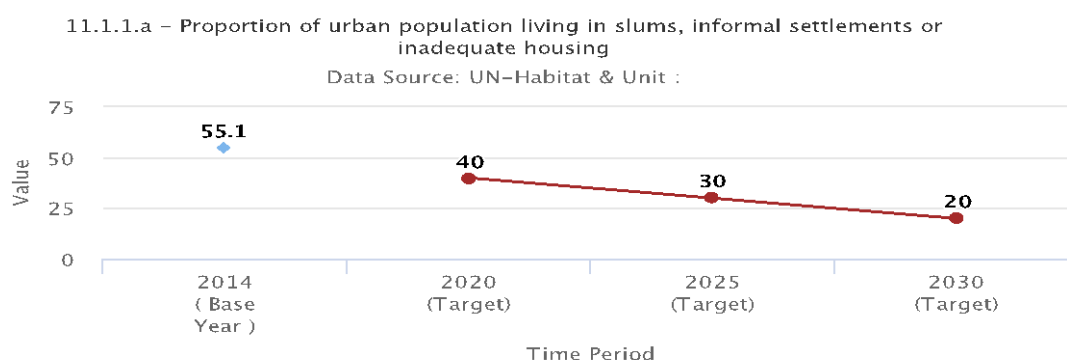


Figure-1.11: Proportion of urban population living in slums, informal settlements or inadequate housing

Many of the cities in Bangladesh are vulnerable to various natural disasters such as river erosion, cyclones, droughts, tornadoes, cold waves, floods, flash floods and earthquakes as well as human induced disasters such as fire and building collapse. Bangladesh has made significant efforts to reduce its disaster vulnerability and is considered today a global leader in coastal resilience due to its significant long-term investments in protecting lives.

To achieve this goal, all stakeholders are working towards sustainable cities and contributing to provision of various urban services: urban housing, slum housing, urban transportation, water supply and sanitation, solid waste management, urban disaster risk reduction, air pollution and urban safety and security

4.12 Goal 12: Sustainable consumption and production patterns

The global population is estimated to reach 9.6 billion by 2050 which could require the equivalent of almost three planets to provide the natural resources needed to sustain current lifestyles. Each year, an estimated one third of all food produced – equivalent to 1.3 billion tonnes worth close to USD 1 trillion – ends up in the bins of consumers and retailers, or spoiling due to poor transportation and harvesting practices. Humanity urgently needs to change the current pattern of consumption and production of goods and resources to reduce the ecological adverse footprint. SDG 12 aims at 'doing more and better with less', increasing net welfare gains from economic activities by reducing resource use, degradation and pollution, while increasing the quality of life.

SDG 12 calls for action to achieve the agenda 2030, the GoB has taken the initiatives for adoption of sustainable management and efficient use of natural resources, environmentally sound management of chemicals and all wastes and sustainability reporting by businesses; promotion of sustainable procurement practices and rationalisation of inefficient fossil-fuel subsidies by policy-makers that encourage wasteful consumption; environmentally-aware lifestyles of consumers; development of new technologies and production and consumption methods by researchers and scientists and others.

SDG 12 envisages sustainable consumption and production, which uses resources efficiently, reduces global food and other waste, and disposes safely toxic waste and pollutants. It also highlights the importance of strengthening scientific and technological capacity in developing countries to move to sustainable patterns of consumption and production and developing tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products. This will evolve a new global partnership between business, consumers, policy makers, researchers, scientists, retailers, the media and development cooperation agencies.

By this time, Bangladesh graduated to lower middle-income country according to the World Bank definition in 2015 and met the criteria for graduation from the LDCs to developing economy group during the Committee for Development Policy (CDP) triennial review of the LDCs in March 2018 as per UN criteria. Bangladesh has been able to reduce poverty by an average 1.8 percentage points during 2000-05 period, by 1.7 percentage points during 2005-10 period and by 1.2 percentage points during 2010- 16 period. The declining rate of poverty reduction observed in the 3 consecutive HIES highlights the challenge of poverty reduction in the future towards achieve the target of SDGs.

4.13 Goal 13: Climate Action

Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population (Indicator 13.1.1) have fallen over the years. Now it stands at 12,881 with a target of 6500 by 2020 and 1500 by 2030. Given the track record of Bangladesh in disaster management, this target will not be difficult to achieve. Ministry of Disaster Management and Relief Ministry (MoDMR) has prepared Disaster Risk Reduction Strategies of Bangladesh (2016-2020) in line with the Sendai Framework which will be helpful in this regard. In facing the climate change scenarios, Bangladesh is well prepared with a number of climate change related strategies, plans and actions. Bangladesh Delta Plan 2100 has been formulated primarily to address climate change adverse impacts and ensuring availability of water for safe multi-uses.

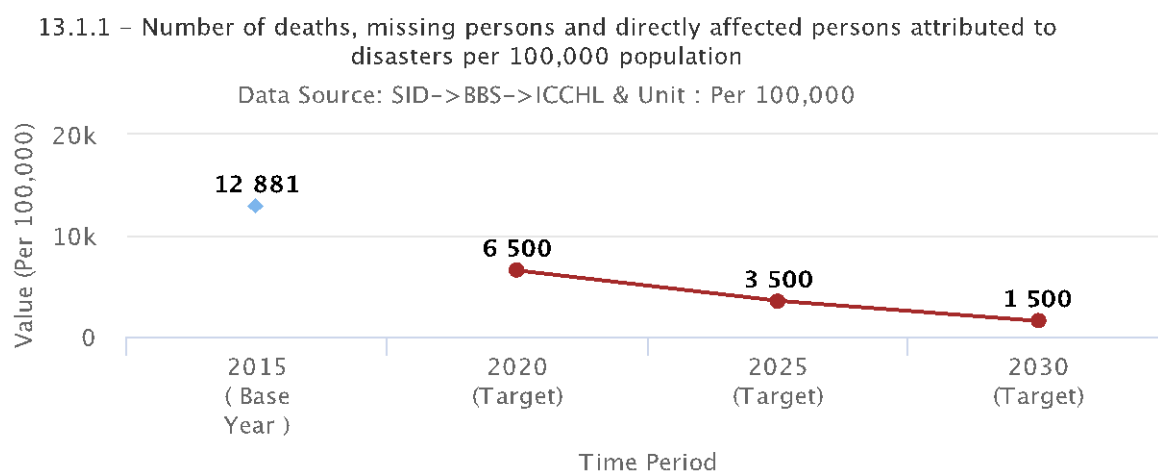


Figure-1.12: Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population [Source: BBS]

4.14 Goal 14: Conserve and sustainably use the oceans, seas and marine resources

Bangladesh has recently gained a vast swath of marine territory. This marine area is rich in natural gas resources and biodiversity. Exploitation of gas resources may pose grave danger to the biological resources. Sustainable management of these resources is now a big challenge for the country. In recent times, it has declared two marine protected areas, one targeting Hilsa breeding ground and another targeting Cetaceans. Total protected area now stands at 2.05% of the marine area (Target 14.5). Major success has been achieved in Hilsa protection with production almost doubling in last 15 years.

A balance needs to be maintained between protection of marine biodiversity and industrial activities in and around the coast. Sustainable management of fisheries requires keeping the fish catch within sustainable yield. The government has already imposed a 2 months fishing ban in the Bay of Bengal during fish breeding season in order to conserve fish resources. In order to assess the fish stock of the Bay, a fish stock assessment has started this year after nearly three decades. The assessment is expected to be complete by 2019. At the same time, a management or strategic plan on how to manage the marine stock for sustainable use will also be prepared towards achieving the goal.

4.15 Goal 15: Life on Land

The forest coverage of the country now stands at 17.5% which is targeted to increase to 20% by 2020. The quality of the forest in terms of canopy coverage is becoming a major concern. Increasing tree density is therefore a major target under 7th FYP. In order to protect its very rich bio-diversity, the country has taken many steps which include continuing moratorium on tree felling, declaring Ecologically Critical Areas (ECAs), creating special bio-diversity zones and creating two vulture safe zones.

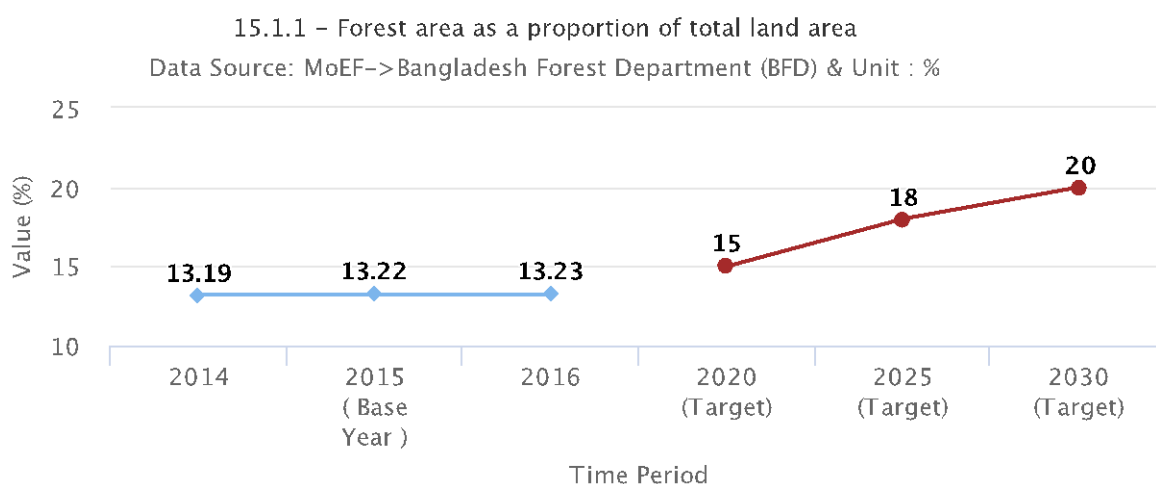


Figure-1.13: Forest area as proportion of total area [Source: Ministry of environment and Forests (MoEF)]

4.16 Goal 16: Peace, Justice and Strong Institutions

The number of victims of intentional homicide reduced significantly from baseline values. Appropriate measures undertaken by the government of Bangladesh contributed significantly to improving human trafficking and youth mental and physical abuse. Improvement has also taken place in other vital sectors. Number of victims of human trafficking declined more than the required rate in the past couple of years. If the current average performance continues, majority of the SDG targets of Goal 16 will be achieved ahead of the estimated time frame.

16.1.1 - Number of victims of intentional homicide per 100,000 population, by age group and sex

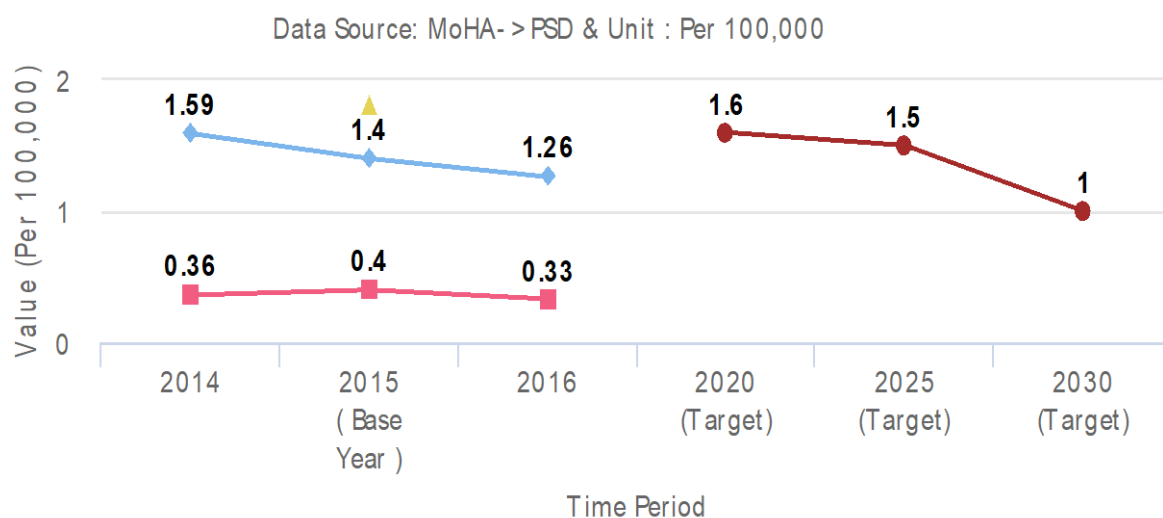


Figure1.14: Number of victims of intentional homicide per 1000,000 population, by age group and sex Source: Ministry of Home Affairs

4.17 Goal 17: Revitalize the global partnership for sustainable development

While working towards revitalizing the global partnership for the achievement of the SDGs, Bangladesh reaffirms the principle of common but differentiated responsibilities. Despite significant efforts for domestic resource mobilization, Bangladesh is unlikely to gather sufficient revenues for achieving the SDGs. Therefore, Bangladesh reiterates that the developed countries have an essential obligation to provide financial assistance to the developing countries, especially for global public goods such as climate change mitigation and control of pandemics, so that they can fully achieve the SDGs. Bangladesh also highlights the need for international cooperation for curbing illicit financial flows, defining aid unambiguously and establishing robust systems for monitoring commitments made by donor countries.

5 IMPLEMENTATIONS OF SDGs: ROLE OF CENTRAL BANK

Bangladesh Bank as central bank is playing a vital role to design policy guidelines and programs for stakeholders of financial sector of Bangladesh towards implementing the above sustainable development goals. Bangladesh Bank acts as bridge monitoring communication and coordination among concerned government agencies to implement the terminology and financing approaches of sustainable development. Five out of seventeen goals of SDGs are directly and more intensively while some other goals are indirectly/loosely related with the activities of the banking sector of Bangladesh. As a regulatory authority, Bangladesh Bank (BB), the country's central bank, is actively working on the achievement of its related goals through inclusive and sustainable strategy; and other policy measures. A mapping has been done by the Government of the People's Republic of Bangladesh including different ministries/divisions by SDGs' goals and targets. In mapping the roles of BB as the central bank of the country are also identified. In line with that the central bank of Bangladesh has also identified the relevant departments and specified the department-wise targets as a part of our monitoring and evaluation to facilitate the achievement of SDGs in time.

BB has been pursuing its monetary and credit policy with a view to facilitating and strengthening economic growth, strategically focusing on inclusive financing through small and medium-sized enterprise (SME) financing, micro finance, agriculture financing, special financing for vulnerable groups including youth and women, green financing.

One of the core functions of the central bank of Bangladesh is to formulate and implement monetary policy, broadly fixing some monetary and credit targets aligned with SDGs and their targets. Sustainable Finance Department (SFD) has been primarily working as coordinator and focal department of SDGs coordination committee in the BB where it will provide all types of knowledge and coordination support in monitoring & evaluation and capacity building functions. Corporate Social Responsibility (CSR) activities and green banking are also very importantly linked with the SDGs.

Bangladesh Bank has been pursuing policies supporting to bring unbanked section of the people and sectors of the economy under the umbrella of banking sector through various initiatives like opening no-frill account for farmers, refinancing for 10-taka account holders, school banking account and introducing agent banking system etc. As more and more sectors and segment of population will be coming under the purview of the banking sector, the economy will be broad-based; growth will be sustainable as well. By 2030, SDG agenda seeks to ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technologies and financial services including microfinance.

Digital financial services are very helpful in achieving financial inclusion. The policy initiatives of the central bank also include the issue of providing such services. Various important goals of the SDGs are linked with financial inclusion. Different categories of banks in Bangladesh are also trying to play their role in achieving the targets of financial inclusion with the guidance and supervision of the central bank. Achieving SDGs is of course a difficult and challenging task. It is not possible for any particular institution or stakeholder to achieve these very comprehensive goals. Appropriate policy initiatives, well-functioning institutions with proper motivation, continuous collective efforts and coordination among different stakeholders may ensure the success in this way of development.

6 MAPPING THE SDGs: BANGLADESH'S CONTEXT

Bangladesh has played an important role in determining for timely implementation of the SDGs. Unsurprisingly, therefore, the country's national development goals are mirrored in the SDGs. As such, Bangladesh has been effectively committed to achieving the SDGs mapping with the goals through following major initiatives :

- i. **Enhance inclusiveness towards an equitable society** to ensure all Bangladeshi benefit from economic growth-regardless of gender, ethnicity, socio economic status, or geographic location.
- ii. **Improve the well-being for all** to promote a socially advanced Bangladesh with healthy individuals and happy households, living in cohesive and united communities.
- iii. **Accelerate human capital development for an advanced nation** to improve labor productivity, deliver a higher-skilled workforce, and create a virtuous cycle of job creation, growth and social development.
- iv. **Pursue green growth for sustainability and resilience** to ensure “green growth” will be a way of life and lead to strengthened food, water, and energy security; lower environmental risks; and ultimately, better well-being and quality of life.
- v. **Strengthen infrastructure to support economic expansion** to ensure all Bangladeshis will have access to basic amenities and be connected through integrated transport and high-speed Internet.

- vi. **Re-engineer growth for greater prosperity** to ensure quality growth and international competitiveness. All economic sectors will migrate towards more knowledge-intensive and high value-added activities with greater productivity.
- vii. **Unlocking the potential of productivity** to ensure that multi-factor productivity becomes a major source of growth apart from capital and labor to ensure a sustainable and inclusive growth. Specific initiatives will be targeted at all levels - the government, industry and enterprise.
- viii. **Embarking on green growth** to ensure a balance between the nation's development needs and the need to protect its environment;
- ix. **Investing in villages** as nodes for strong economic agglomeration to attract investment and talent and drive innovation while ensuring inclusivity.

7 CONCLUSION

The Government of Bangladesh (GoB) has been standing in good stead for its outstanding progress in the areas of poverty alleviation, ensuring food security, primary school enrolment, gender parity in primary and secondary level education, lowering infant and under-five mortality rate and maternal mortality ratio, improving immunization coverage, and reducing the incidence of communicable diseases under the Millennium Development Goals (MDGs). Buoyed by the successes of the MDGs, Bangladesh became one of the forerunners in embracing the SDGs –known as the 2030 Global Development Agenda – to end poverty by increasing national income through redistributive justice, fight inequality and tackle adverse impacts of climate change.

Bangladesh takes pride as one of the early starters by completing all groundworks for implementing the SDGs as well as embedding the Global Development Agenda into the 7th Five Year Plan, mapping of ministries by goals and targets, data gap analysis, SDG monitoring and evaluation framework, SDGs financing strategy, preparation of ministry/division action plan, preparation of sector strategy action plan. It has also submitted Bangladesh Voluntary National Review 2017 in HLPF in July 2017.

The GoB has adopted an inclusive approach to development so that the poorest and the most vulnerable section of the country can be integrated into its national development efforts and Bangladesh has already been on track towards achievement of SDGs. Like many other Asian countries, Bangladesh has demonstrated a good initiation and through the concerted and collective efforts along with commitments.

8 RECOMMENDATION

The GoB has to take some priority action agendas for implementing SDGs in Bangladesh. Operationalise National Food Policy Plan of Action (2008-2015) through better integrating, and if needed, revising it, in accordance with the hunger and food security-related targets of the SDGs. To be enacted National Pension Scheme to ensure the right of the elderly to social security and necessary steps to be taken for increasing the doctor-patient ratio, particularly in the rural and hard-to-reach areas.

The GoB has to take efforts to finalise the Education Act by keeping in the purview the broad objectives of establishing an equity-based and quality-assuring education system. It is needed to accelerate the enforcement of National Tourism Policy 2010 and to be improved land management system to promote industrialisation through digitisation of land-related acts/rules and regulations. The government has to be formulated and implemented the policy for the protection, support and resettlement of the displaced, marginalised and ethnic groups.

To be created public awareness on environmental issues through advocacy and campaign activities and steps to be taken to enact policy/act for water protection and for ensuring sustainable use of oceanic, coastal, terrestrial and inland fresh water ecosystems.

To be promoted 'non-discrimination' at every level as per the Constitution of Bangladesh and to make a uniform Family Law to increase the participation of women in family decision-making, exercise their right to property and reduce gender-based violence. It has to be strengthened capacity of national statistics organisations (NSOs) through allocating adequate resources and to be increased skilled manpower to generate the data needed for monitoring the SDGs.

The efforts to be taken to introduce Office of the Ombudsman to enhance the role of the parliamentarians as the overseeing body and to ensure effective implementation of the existing laws and policies towards ensuring social justice by allocating required budgetary resources.

Finally, localization of SDGs and private sector engagement can play a vital role to achieve the SDGs in Bangladesh. Localising the SDGs means more than just 'naming and messaging' internationally-agreed goals at the local level. It is all about making the aspirations of the SDGs become real to communities, households and individuals, particularly to those who are at risk of falling behind. For this reason, first of all, awareness needs to be created at all levels in turning 2030 Agenda from a global vision into a local reality. And local communities and stakeholders, who must know individual and collective needs and capacities best, are critical partners in implementing and realising the goals. Targets and indicators of SDGs for contextualising the 2030 Agenda need to be appropriately synchronised with local development plans and strategies with utmost importance.

Bangladesh will achieve the goals and the government is confident to set the example of a leading SDGs achiever throughout the world. Like the achievement of MDGs, to uphold the image of Bangladesh, the people of the country need to work together in this regard. Moreover, achieving the SDGs requires the partnership of governments, private sector, civil society and citizens alike to make sure we leave a better planet for future generations.

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Sustainable Impact of Organic Farming: A Social Constructivist Perspective

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Abstract

The bottom-line for businesses is to earn profit or maximize the wealth of its shareholders. It is a matter of great debate, who comes across that slogan. Sampran Riverside, however, has been a successful business model for Thailand, which has been known as the maximizer of its customers' wealth as well as health, by an extensive production of organic products through organic farming and food, subsequently spreading it through cultural and tourism activities. Present study is a qualitative case study that describes how the Sampran riverside grew into an environment- friendly model from a conventional business entity. The study revealed how the business transformed and reached success through the constructive learning process. A detailed study showed that organic farming helps society to grow healthy and also creates economic opportunities for the people. Site visits of the business and organic fields, as well visit of organic markets and interviews with the farmers, customers and the CEO of the Sampran Riverside, concluded that organic farming serves the society in a holistic way by providing social, environmental, economic and health benefits at one platform, eventually, contributing in community and societal development. The study also concluded that through this development, the Riverside contributes in meeting some of the Sustainable Development Goals (SDGs). Adopting this model may pave the way for sustainable development in the society which will help country in long run.

Key Words: Community development, constructive learning, organic farming, SDGs, societal benefits.

SUSTAINABLE MINED LAND RECLAMATION: THE PUJADA NICKEL CASE STUDY

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ABSTRACT

Designing a sustainable mined land reclamation is severely challenging. It is influenced by various stakeholders grounded with varying magnitude and directions of interests. Using a qualitative research design and employing the use of Multi-Criteria Decision Analysis extracted from the lenses of indigenous peoples, mining host communities, non-government organization, church, mining company, Mines Bureau, National Commission on Indigenous Peoples and the local government units, a sustainable mined land reclamation with encompassing characteristics that is environmentally sound, technically feasible, economically viable, socially acceptable, culturally sensitive and spiritually rooted are fully explored and considered. It reflects a complementary options of Forestry Reclamation Approach, Sloping Agro-forest Land Technology and Botanical Park Development.

KEYWORDS: Multi Criteria Decision Analysis, Pujada Nickel Project, Sustainable Mined Land Reclamation

1. Background of the Study

Globally, mining and sustainability have been a major subject of discourse among interest groups eyeing towards mining closure. At any given time, all mining firms will be challenged in its operation and possibly be closed due to mineral exhaustion or even due to regulatory, environmental, technical, social or economic influences making it as a toughest challenge. Legacy issues surrounding many closed mines have been haunting the industry up to the present. The country is not spared by this global threat. The same agony has been suffered by the country's mining firms both in its exploration and operation stages affecting mining-dependent workforce and their families as they will lose their source of livelihood. This incident has become traumatic and devastating in the local communities where mining is considered as their prime economic driver.

However, closure has evolved from mere technical solution. There is a wider demand to integrate diverse interests in the formulation of rehabilitation criteria and closure plan. The industry and the mining regulatory institutions together with mining community stakeholders must collaborate to collectively explore alternatives for a transformative and sustainable mined land reclamation. It is emphasized that closure and its reclamation plans must be feasible and is site-specific, meaning generic and "off-the-shelf" plans must be readily rejected (Sellers, R., & Vogel, P., 2015). Closure efforts should give emphasis on sustainable development with the intention of creating the "Second Economy" that enable people to help themselves in consonance with biodiversity, land stewardship and sustainable development (Prinsloo, HB & Pieterse F, 2015).

Highlighted in the policy framework adopted by the Inter-Governmental Forum (IGF) on Mining and Sustainable Development of the United Nation, it reaffirms that mining is considered consistent to sustainable development when planning for closure is present during the entire operation of the mine. Therefore, it requires that stakeholders be consulted in the development of closure plans and objectives. Further it also encourages progressive rehabilitation as soon as the disturbed area is no longer needed for mining to reduce future closure liabilities and reverse the adverse environmental, social and economic impacts (IGF, 2013).

Locally, the Pujada Nickel Project is among the contentious mining projects in the country. It is located in Mati, Davao Oriental, near the two protected areas; the Hamiguitan Protected Area inscribed as World Heritage site by the UNESCO and also near the declared Pujada Protected Seascape. Moreover, it is also within the ancestral lands of the Mandaya indigenous people who gave the company its Free and Prior Informed Consent. Multiple stakeholders have expressed their interests on the sustainable use of the area and the transformation of the mine disturbed lands into sustainable land uses. Thus, the study is conducted to determine the best reclamation option of the Pujada Nickel mined land.

1.1 Statement of the Problem

The study is conducted to determine the mine closure options of Pujada Nickel Project. Specifically, it answered the following question;

1. What are the interests of stakeholders over the mined land?
2. What are the options of reclaiming the mined land?
3. What is the decision on how the mined land be reclaimed?

1.2 Objectives of the Study

The study primarily aimed determine a sustainable reclamation option of the Pujada Nickel mined land.

1.3 Significance of the Study

The study can serve as a concrete basis for mining companies and environment department in the reconfiguration of their mine land reclamation design making it more community responsive, sensitive and adaptive. Further result of the study will also serve as a tangible and reliable source for designing a policy relative to sustainable mining.

1.4 Scope and Limitation

The study focused only in Pujada Nickel Project in Mati City where other mining areas have different set-ups and experiences. Moreover, it only utilizes qualitative research design employing Multi-Criteria Decision Analysis which may be challenged by its generalizability. This study was also conducted from December 12, 2017 to April 24, 2018. Experiences, desires and situations outside the months covered may be different.

1.5 Definition of Terms

Mining refers to the process of mineral exploration, development, extraction, utilization and decommissioning of mining areas.

Mine Closure refers to the period when mine operation ceases due to reasons such as legal, political, social, technical, environmental and economic and resource exhaustion. It is either temporary or permanent in nature depending on the reason of stoppage.

Mined land or Mine-Out Area refers to the site where ore extraction is completed due to mineral exhaustion. This is an area where reclamation shall be undertaken to transform the site into other land uses.

Mine Reclamation refers to the process of transforming the mined land into other land uses such as; park, agriculture, forest, biodiversity and others.

Mining Stakeholders refer to the individuals and group of people with interests and influence over the mining area. They are those people who are affected or shall be affected by the mining projects either positively or negatively.

Multi-Criteria Decision Analysis refers to the branch of Operations Research that integrates multi-interests and multi-perspectives of various stakeholders in the decision making using coherent steps in determining best alternatives in addressing a particular problem, in this case, mine closure and reclamation.

1.6 Theory Base

The study is anchored in the theory of Five Capital Development Model as developed by the “Forum for the Future” where authors recommended that businesses and organizations should take into account full accountability in enhancing the natural Capital: land, air, water, fisheries, forest, and others including genetic resources; Human Capital: the skills, knowledge, health and well-being that enables people to function and live effectively; Social Capital: network and relationships of trust and reciprocity that enable people to live in harmony with each other and cooperate; Economic Capital: income and financial resources and, access and sharing of these resources; Built Capital: infrastructures and facilities including buildings, telecommunication and transportation that enhances mobility and exchange in driving their operations and projects efficiently (Brereton & Pattenden, 2007).

Further decision theory also supports the study. It assumes that people make decision or make a choice between and among options on the basis of some standards or criteria where values are subject to moral philosophy. The theory postulated that problem solving consist of five consecutive stages; first, the felt of difficulty, second, the definition of the character of that difficulty, third, suggestion of possible solutions, fourth, evaluation of the suggestions

and lastly, further observation and experiment leading to the acceptance or rejection of the suggestion (Hansson, 2005).

1.7 Conceptual Framework

The conceptual framework follows three stages. Stage 1: is the determination of the stakeholders' interest over the mined land and the recognition of instruments covering the Pujada Nickel. Stage 2: is the identification of reclamation options. Local and internal best practices in mine reclamations, landscape architectures and mandatory requirements form part of the basis of options proposed. Stage 3: is the decision phase. All proposed options is assessed in conjunction with the multiple-interests identified in the stage 1. The decision is validated using Pairwise Comparison Technique thereby validating the result of the MCDA Performance Scoring to increase confidence in the decision arrived.

2. Method Used

2.1 The study employs a qualitative research design in understanding the deeper meanings of the reclamation project to the view-point of mining stakeholders who have influenced and or to be impacted by the reclamation project. These meanings are generated thru in-depth interviews, focus group discussions and brainstorming involving the research participants who manifested their interests and proposed options in reclaiming the mined land. These interests and options are analyzed using the Multi-Criteria Decision Analysis. Findings of reclamation researches, best practices and, guidelines in mine reclamation around the globe and within the country also form part of the document review to enrich the study.

This method of analysis has five components; 1. Goal, 2. Decision Maker (stakeholders), 3. Decision Alternatives (Options), 4. Evaluation Criteria (Interests) and, 5. Decision Outcome associated with alternatives and interests combination (Natural Resource Leadership Institute, 2011).

2.2 Sources of Data

The data are generated from primary and secondary sources. Primary information is collected from stakeholders such as: the leaders of indigenous cultural communities, the mining-host community leaders, the officers of non-government organizations, leaders of the church, the technical experts and persons in authority. Secondary data include reports and documents in the repository of the Mines and Geosciences Bureau, the Environmental Management Bureau, the Department of Environment and Natural Resources (DENR), the National Commission on Indigenous People, minutes of the meetings of the Mine Rehabilitation Fund Committee (MRFC), local government units and, the non-government organizations.

2.3 Data Gathering Instrument

The data gathering instrument consist of open-ended interview guide being used during the field interview, brainstorming (Focus Group Discussion), workshops and roundtable discussions. The data gathering is done in series with interview and brainstorming guides are as follows: The guide is divided into three phases. First is the description of Mine Reclamation Area (Decision Context); What is the size, terrain, soil characteristic of the mine-out area (physical attributes)? What are the ownership, access and uses of the area (social, economic and environmental attributes)? Who are those with interests and influence over the area (Stakeholders analysis)? Phase II: Identifying Options, Criteria and Objectives; What are the interests of stakeholders in the reclamation? What are alternatives (options) to develop the mined land? What are the attributes of each of these alternatives? Phase III: Scoring and Weighting; What are the environmental significance of each of the alternatives?

What are the social significance of each of the alternatives? What are the cultural significance of each of the alternatives? What are the economic significance of each of the alternatives? What are the most preferred alternatives (ranking and prioritization)? Why are these alternatives being preferred (sensitivity analysis)? Moreover, for greater appreciation to decision makers, the use of imagery collected from drone photos is sought to ascertain location and spatial attributes of the mine reclamation areas to the surrounding ecosystem and communities.

2.4 Research Participants

The study purposively engaged multiple stakeholders as primary sources of data. The inclusion criteria is based on the following: those who owns the land and resources, who currently use the area, who plans to develop the area, who uses the area legally or illegally for access, extractive and productive purposes, who uses the land and resources at different period of the day or year (Beukering, P.V., Brander, L., Tompkins, E., McKenzie, E., 2007).

Further they are classified as to basis of their interests and their use of the land and resource such as: being an on-site users, off-site users, stakeholders from the province, region, and country with interests over the area and are further into those who will be affected positively or negatively by the decision and those who have the power and those who have no power to influence the decision. This include the, tribal council of Macambol and Cabuaya, Mati City Davao Oriental, the Elderly of Brgy Macambol, the Local Government Unit of Mati City, Provincial Planning and Development Office, Mines and Geosciences Bureau, technical Personnel of MGB, Non-Government Organization, Philippine Catholic Church, the Parish Priest, the National Commission on Indigenous Peoples and the Mining Company.

2.5 Procedure of the Study

The procedure of the study include: defining the problem, generating alternatives and establishing criteria, assigning weights to the criteria, construction of evaluation matrix, selecting evaluation methods and, ranking the alternatives. All the steps should involve key stakeholders such as technical experts in their fields, people who shall be directly or indirectly affected by the reclamation project and also decision makers (J.R. San Cristobal Mateo, 2012).

The procedure adheres to the prescribed steps in the Multi-Criteria Analysis as enumerated : Establish the decision context. What are the aims of the MCA, and who are the decision makers and other key players? Identify the options. Identify the objectives and criteria that reflect the value associated with the consequences of each option. Describe the expected performance of each option against the criteria. Assign weights for each of the criteria to reflect their relative importance to the decision. Combine the weights and scores for each of the options to derive and overall value. Examine the results. Conduct a sensitivity analysis of the results to changes in scores or weights (Beukering, P.V., Brander, L., Tompkins, E., McKenzie, E., 2007). Based on the foregoing steps, the study shall commence with defining the mining areas for closure that needs to be rehabilitated; its size, location, terrain, soil features, flora and fauna of the area, land tenure, access and contribution to the surrounding communities. Then come-up with the best reclamation alternatives after a thorough analysis and weighing of the criteria being considered.

2.6 Mathematical Treatment

The nature of the study requires that it presents a decision matrix as output in the evaluation and treatment of alternatives or options being identified and considered. The matrix is shown below in table 1, where *Criteria i j* is the evaluation given to options *ith* with

respect to criterion j th, w_j is the weight of criteria j , n is the number of criteria and m is the number of options (Opricovic S, Tzeng GH 2004).

Table 1.

Criteria	Criteria 1: Economic Viability	Criteria 2: Social Acceptability	...	Criteria n:
Weights	Assigned Weight on Economic	Assigned Weight on Social	...	Total Weight (100)
Options				
Option 1: Forestry	Score on Criteria 1	Score on Criteria 2	...	Total Score of Forestry
Option 2: Agriculture	Score on Criteria 1	Score on Criteria 2	...	Total Score of Agriculture
Option 3: Botanical Park	Score on Criteria 1	Score on Criteria 2	.	Total Score of Park
Option 4: Tourism	Score on Criteria 1	Score on Criteria 2	.	Total Score of Tourism
...
Total Options	Total Sub-weight	Total Sub-weight	...	Total Scores

3. Results and Discussion

3.1 Interests of Stakeholders

The kind of reclamation options must satisfy and address the interests and criteria raised by the stakeholders with influence and interest over the mine disturbed areas. The criteria identified during the data gathering are the following:

Economic Viability. Economic viability simply means that the revenue of the project is greater than or equal to the present and future expenditures. The reclamation option should be able to financially sustain itself even if mining support ceases. The succeeding custodians of the reclaimed area should be able to maintain the project from the revenue that it generates. The cost of reclamation must also be aligned with the approved allocation indicated in the Final Mine Rehabilitation and Decommissioning Program otherwise the project shall be budget-deficit where funds need to be sourced outside the budgeted activities required in the mining regulations. Participant “G” pointed out that: *“In choosing reclamation options one should take into consideration the budget as well as the plan indicated in the Final Mine Rehabilitation and Decommissioning Program. This will ensure that the rehabilitation plan is more realistic hence it has budget.”*

Economic viability also means job generation for the stranded communities after the life of mine. It must be one of the sources of livelihood for the people of the host communities should jobs from mining is eventually over. It should respond to the immediate and long term economic needs of the communities. The option should incorporate production of economically beneficial goods and services such as marketable crops. Participant “L” suggested that *“Main considerations in choosing the best options should include; economics – such as its potential to create jobs and sustainable livelihood for people of the community to continuously earn a living even after mining. Hence good reclamation shall entail significant cost it is also wise to consider possible return of investment for the company to pursue the best reclamation options. Ways of managing the reclamation should also be considered in choosing the options. It is recommended that a corporation shall be created to manage the reclamation project to ensure its viability.”*

Participant “K” emphasized that: *“He envisions the kind of mine rehabilitation that would ensure a source of economic livelihood for the indigenous peoples. He pointed out that 60% of the lands in the Region are owned by the indigenous peoples yet they remain poor. This way the indigenous peoples have the means to sustain themselves while waiting for the long term plan. He also emphasized that the indigenous peoples in the area should be actively part of the creating the plan.”*

Technical Feasibility. Reclamation of nickel laterite mined-land is a tough challenge. The characteristic of the soil and rocks of these iron rich lands in addition to the sloping landscape footprint of nickel mine-out areas pose limitations of stability and also of plant growth. These limitations have been noted by mine environmentalists, mining engineers and geologists working in the nickel mining projects. Engineering and vegetative measures for slope stability and the introduction of soil amelioration technologies to promote plant growth have been employed by the proponents of nickel mines. Participant “L” emphasized that: *“Another criteria to consider in selecting the best option is the technical feasibility – technology in changing the soil characteristics to make it suitable to the growing of crops should be assessed and the cost it entails to employ the technology. “It is imperative that technology in reclaiming the nickel mined land should be available, scientifically tested and are appropriate to the local conditions”*

Participants “A” stated that: *“We are familiar with the place, given the mineralized soil, plants could hardly thrive and be productive. Ways of making the soil productive must be studied and employed”*

Andrew M. Robertson in his presentation to the 6th International Conference on Mine Closure, September 18-21, 2011, in Alberta, Canada, cited: *“That there are 10 Things that Go Wrong with Plans for Mine Closure, one of it is planning based on flawed science which causes reclamation failure. The natural systems of geological, seismic, climatic and other natural variables have to be fully investigated, tested, monitored and, considered in the design of closure plans. Flood flows, strength of the surface layers, geochemical behavior, seepage and other variables have to be precisely considered in the design.”*

Participants “F” added that: *“That the reclamation plan must be site specific, mineral commodity specific and mining method specific. It is recommended that the reclamation plan should integrate a design and visual not purely narratives for greater appreciation.”*

Social Acceptability. Means the stakeholders’ assent, agreement or at least tolerance to the reclamation project. This means that the options is welcomed by the stakeholders who shall be directly or indirectly impacted by the reclamation. It implies that in one way or the other, the rehabilitation should satisfy the interests and the desired conditions envisioned by the organizations and agencies with influence over the area. This means it is aligned to the land-uses assigned by the local governments with jurisdiction over the area.

Participant “D” emphasized that: *“The City has formulated its City Land Use Plan (CLUP) and that industries’ actions including that of mining reclamation should be aligned to the City’s zoning and land use plan.”*

Participant “E” stated that: *“Any development in the Province should be in line with the five development agenda: defeat poverty, safeguard environment, expand access to basic utilities and facilities, effective and efficient governance and, peace and public order. The Province has adopted agro-industrialization and eco-tourism strategy.”*

Participant “L” suggested that: *“Finding the interests of the community on the kind of reclamation and assessing if it is doable given the land and soil characteristics of the mine disturbed areas should also be determined.”*

Social acceptability of reclamation means responding to the social needs of the stakeholders. It should help promote the smooth interaction and network of people thereby enhancing the human and social capital of the communities. The design and its management

must be responsive to the interaction and movement of the custodian and visitors. In one way or the other, the project must enhance the health, wellness and education of stakeholders.

Participant “J” shared that: *“Any form of development plan can be made. What he considers more crucial is the issue of management, who will manage the development program in the mine-out area. He strongly suggested that the management should be through shared responsibility or through a cooperative. This is the way for the community to really own the program.”*

Culturally Sensitive. Cultural sensitivity of the reclamation project means that it is acceptable to the indigenous peoples. It should afford due respect and promote the culture of the indigenous cultural communities and their practices. The reclamation should be sensitive not to disintegrate the uniqueness of the Mandaya Culture rather should promote it. Research participants have recognized culture as one of the interests in determining possible options of reclamation.

Participant “I” emphasized that: *“The Church is interested in restoration work, and mine reclamation or rehabilitation is putting back order in nature. Reclamation options that are acceptable to the indigenous people and, restoring the forest could be one of them. Culture is an expression of faith and the project should help preserve and nurture the culture.”*

Participant “L” shared that: *“Culture promotion should also be a paramount criteria in planning for options hence the area is within the Mandaya ancestral land.”*

Participant “F” added that: *“The reclamation plan must be synchronized with the tribal community and local government units’ development plans.”*

Spiritually Connected. Spirituality is commonly defined as the one that gives meaning and purpose. The reclamation should be strongly aligned with the clear vision and is inspired by the sense of meaning and purpose. It should satisfy the hierarchy of needs including self-actualization (Neal, J and Harpham, A, 2012).

Participant “I” shared that: *“Spirituality manifest the inner realities and uncover the invisible mystery of the person...”. “Spiritually connected reclamation means that the project brings order in the individual, community and nature. It puts order and restores connectedness and wholeness of creation. It restores the forest that gives food and livelihood to the communities that depend on it”...”. “Restoration and protection of the environment that is disturbed by mining is morally acceptable because it puts back order in nature and its interconnectedness. Any projects including reclamation should bring us to our core and give us the sense of purpose. It should bring order in the individual, communities and nature. Should there be ‘order’ then there is peace, as there could be no peace when there is no order in the individual person, communities and nature. It should be order and peace, not the other way, which is peace and order.”*

Environmentally Sound. Environmentally sound reclamation means aligning the project to the global call on sustainable development goals, among others, Goal 15: Sustainably manage forest, combat desertification, halt and reverse land degradation, half biodiversity lose. Among other immediate targets by 2020 under goal 15, is to ensure the restoration and sustainable use of forest and mountain ecosystems and restore degraded forests and sustainably increase afforestation and reforestation. Urgent action is also rallied to protect and prevent the extinction of threatened species (UN SDG, Goal 15).

The expressed interests of stakeholders of the Pujada Nickel Mines suggest that the reclamation project should address the following needs and interests under each corresponding criteria indicated in Figure 1;

Interests of Stakeholders in the Reclamation Project

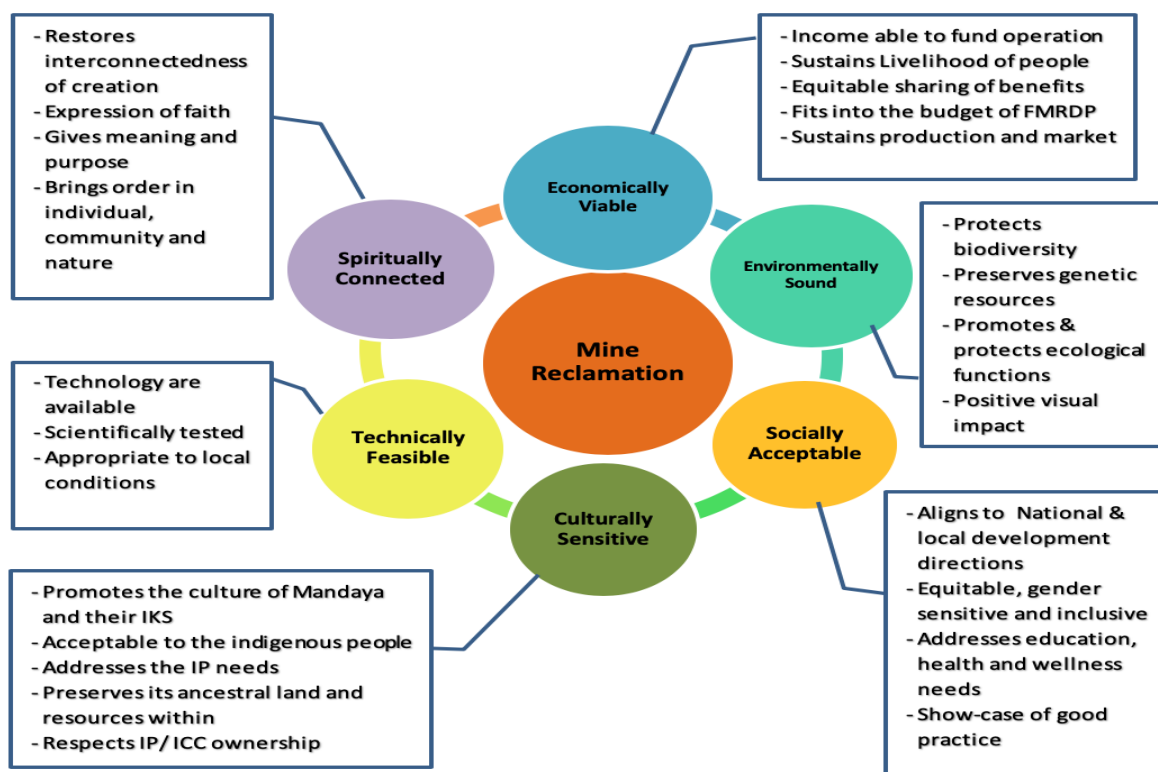


Figure 1. Interests and Needs

Options of Reclamation Identified

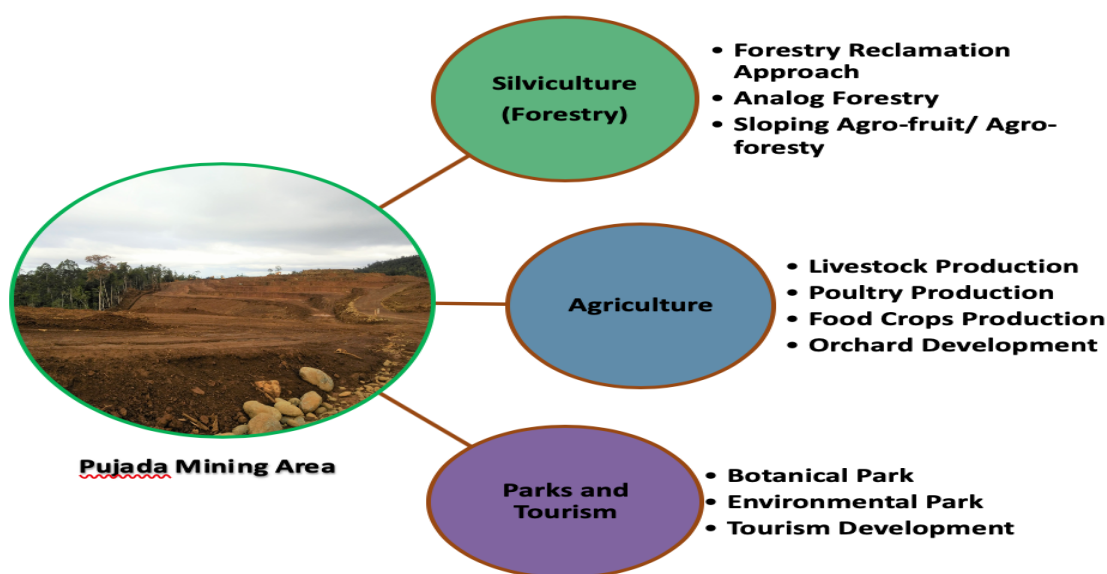


Figure 2. Mined Land Reclamation Options

The mined land of the Pujada Nickel Project should be reclaimed in three major identified categories of options indicated in Figure 2: Silviculture (Forestry), Agriculture and, Parks and Tourism Development.

Reclamation thru Silviculture. The Society of Irish Foresters defined Silviculture as “the art and science of controlling the establishment, growth, composition and quality of

vegetation for the full range of forest resource objectives”. In mining reclamation, silviculture plays the major process of re-vegetation of mined lands. However, careful scrutiny should be placed in understanding the right approach hence among the top ten causes of reclamation-failure is reclamation based on flawed science (Robertson, A, 2011).

The Pujada Nickel Mine Reclamation is facing complex and multiple challenges such as: highly mineralized land that limits plant growth, its closer proximity to protected areas and biodiversity concerns, responding to the needs of forest-dependent stakeholders, land custody after mining, alignment to development directions of the national and local governments and many others.

Best industry practices and stakeholders information sharing reveal three major silviculture-based reclamation approach worth considering in the decision making process such as: Analog Forestry (Sri Lanka), Sloping Agroforestry Land Technology (MBRLC of the Philippines) and Forestry Reclamation Approach (Office of Surface Mining Reclamation and Enforcement, USA). Figure 2. Represents the major branches of forestry approaches to reclaim the mine-out areas of Pujada Nickel Project:

Participant “K” suggested that: *“Whether the rehabilitation program be geared toward agriculture, tourism or forestry, the design should be such that it would have a short, medium and long term plan.”*

Participant “L” proposed that: *“Reclamation could mean transforming the mine disturbed areas closest to the original land form (forest) or better than the original. These could be tourism development and, agriculture – related development like finding suitable crops to be planted in the area or having poultry, cattle, swine production and others so that when mining ceases the community could still thrive. Having more options or combination of options is practical so that whenever the first options will not work still there could be other alternatives to choose from. Visual presentation of end-of-mine land use should be done (not purely narrative) for better appreciation of the option”*

The Forestry Reclamation Approach

The Forestry Reclamation Approach has been advocated by the US Department of Interior – Office of the Surface Mining Reclamation and Enforcement. The Approach is a product of more than 2 decades of research conducted by several leading universities which yielded significant results in transforming mined lands into commercially productive forest.

The FRA consists of five steps: 1. Creating favorable rooting medium of four feet deep comprising of topsoil and weathered available materials, 2. Loosely grade the topsoil or topsoil substitutes to establish non-compacted growth medium, 3. Grow ground cover that are compatible with growing trees, 4. Plant two types of trees: early succession species for wildlife and soil stability and commercially viable crop trees, and 5. Observe proper planting techniques (*source: Appalachian Regional Reforestation Initiative*).

Analog Forestry: Analog Forestry is an ecological restoration approach that mimic the natural forest succession process as guide to establish ecologically stable and socio-economically productive landscape. It seeks to establish a sustainable ecological system with useful economic yield and significant utility to human. It takes into consideration both the biomass and biodiversity. This could mean that some species with viable economic yield are propagated. Analog forest creates habitat, provides economic impetus and combat climate challenges (Senanayake, 2016). During Permaculture, a system of agriculture and social design is established that directly simulate and utilizes the features and pattern in natural ecosystems (Holmgren and Mollison, 1978). As succession is levelled-up to Analog forest, the conditions that enhance productivity among others, healthy and fertile soil are sustained and ecological functions are enhanced further.

Participant “H” presented that: *“There could be range of options; the mine-disturbed areas can be developed back to the original state or closer to the original state. Analog Forest is another option where the approach will mimic the natural forest succession dynamics from denuded lands to the climax vegetation of the area but can be designed to provide economic, social and environmental benefits.”*

Sloping Agro-forestry Land Technology (SALT). SALT is a package technology of food production and soil conservation. It integrates various measures of soil conservation by planting double hedgerows of nitrogen fixing plants along contours of the 3-5 meters farm plots. It is a form of integrated farming and agroforestry system originally developed by the Mindanao Baptist Rural Life Center in Bansalan, Davao del Sur, Philippines.

This contour farming technique has 9 steps to follow which helps revert the depletion of soil nutrient and loss of top soil in sloping areas by way of: establishing double-rows hedge of thickly planted nitrogen fixing plants along the systematically located contour lines, employing terraces farming and planting of alternate crops along strips of 3-5 meters width, establishing diversified farm thru planting permanent shrubs like coffee, cacao, citrus, fruit trees and crops it alternately plants cereals, legumes, cover crops in strips not planted with permanent crops. It has four variations: SALT 1-4 including agro-livestock, agro-forest, agro-fruits. (Asian Rural Life Development Foundation, 1997).

Participant “H” proposed that: *“Agro-Forestry development is also an option that can balance conservation and livelihood where crops such as coffee and cacao and other shade tolerant crops are introduce as the area becomes more forested.”*

Reclamation thru Agriculture. The sloping terrain of the mine-out areas in addition to the characteristics associated with lateritic soil and ultramafic rocks of the Pujada Nickel Project poses a greater challenge to develop the areas for agricultural production purposes. However, given the right technology, producing crops, livestock and poultry would still be possible. The key is determining the appropriate crops, technology and farming system to make it work and economically viable. Some of the agriculture-based possibilities raised during the research process are the following:

Livestock production using cut and carry system: dairy milk production, goat production and cattle production are potential ventures by planting forage along strips and contour hedgerows to feed the animals. The system allows to raise animals ten times more than the pasturing system of livestock production. A stocking ratio of 6 heads of goats per hectare of grazing land could be multiplied by four times (24 heads) using the cut and carry feeding system (Palmer, J., 1998).

Poultry: Production of poultry including native chicken is another agri-ventures with market potential. Hence the area is within significant distance from the nearest settlement, poultry production could be suitable including free-range chicken which recently command higher price.

Food Production: Production of cereals, vegetable, pineapple and other food crops: appropriate technology could unfold the potential of cereal, vegetable, pineapple and root crop production within the contour strips. Cereals and vegetables such as corn, upland rice, ginger, turmeric, cassava, sweet potato, cabbage and many others could be planted. Using locally available organic materials, amelioration of the soil could boost and sustain production of these crops in sloping terrain. The key is finding the right mix of farming system, technology and the variety of marketable crops to be introduced.

Orchard Development refers to the international planting and maintenance of trees and shrubs for food production. It involves the planting of fruits or nut-bearing trees for commercial production (Encyclopedia Britannica, 11th ed). The tribal council and the elderly of Macambol proposed to examine the possibilities of planting fruit trees like Rambutan, Lanzones and Durian that thrive in the forest and could be economically viable and suitable

to the area. Mati City is known of its Menzi Pomelo. While Cashew nuts is also known to thrive in some lateritic soil like the Hinatuan of Surigao, Philippines.

Reclamation thru Park and Tourism Development. Best practices in mine reclamation suggests the development of environmental, botanical and recreational parks. Several former mines throughout the world have been transformed into top tourism destinations as they become show-cases and venues of education, recreation and researches.

Botanical Park. The park shall serve as Ex-Situ conservation of genetic resources found within and nearby the mine sites and within the ancestral domain of the Mandaya indigenous people. The plants of immediate interest being identified by the academe and also by the local communities can be collected and propagated within the reclamation area for conservation, research and education of these genetic resources. The botanical park could be gene-bank or repository of vegetative materials.

The presence of plant species with medicinal value within the mine areas and the adjacent sites prompted the some stakeholders to propose that the area be transformed into Botanical Park. Some herbalists and elders practicing herbalism identified and named trees and plant species that can be located within and near the mine areas which they and their ancestors used to treat various illnesses. The park when developed could be a source of readily accessible medicinal plants to remedy diseases and illnesses. This could also serve as venue for further research and scientific studies to add more value to the use of these plants.

Participant “C” proposed: *“Examine the possibility of planting forest-loving fruit trees in mined land should characteristics of the soils warrant its productive growth. Transforming the place into a botanical and medicinal park and eco-tourism area could also be great options.”*

Participant “D” recognized that: *“There are presence of medicinal trees in the area locally named: Lapnisan (agar wood), Pili, Kaningag, Bangkal, Duguan and Madbad. The project should incorporate the production and planting of endemic plant species that promote and restore health and wellness. Therefore they proposed for botanical park development. Possibility of orchard development is also proposed. Community’s livelihood are main interests of reclamation.”*

Following the narratives of local herbalists and indigenous people, some endemic plants with medicinal value are locally named and identified as part of their indigenous knowledge of restoring wellness and health such as Lapnisan, Pili, Kaningag, Bangkal, Duguan and Madbad. The researcher sent a team to document and take photos of these plants to verify their existence in the wild within the indigenous peoples’ ancestral land.

Reclamation thru Environmental Park Development

Environmental Park is an area protected or developed primarily for ecological purpose to protect of the area with significant ecological value. These types of parks protect and enhances biodiversity being habitat for flora and fauna and their movement corridors. These parks are planned and managed to sustain environmental values while recreational use could also be incorporated like the pathway, cycle lane for forest bathing (Environmental Park, lgam.wikidot.com). Since the mine disturbed land is within the multiple use zone of the expanded Mt Hamiguitan Range, the area could serve as buffer and movement corridors of flora and fauna inhabiting within and adjacent to Hamiguitan protected area.

Tourism Development: The province of Davao Oriental adopts Ecotourism as one of its development directions. The International Union for the Conservation of Nature (IUCN) describes Ecotourism as the environmentally responsible travel to natural areas in order to appreciate nature and culture. It promotes low-impact visitor behavior, conservation efforts, sustainable benefits to local communities, education and more (*Nature Conservancy, Ecotourism of nature*).

Mine tourism is another show-cases of best mine reclamation practice where areas are transformed into eco-tourism land-uses after the life of mine. The mine-out areas can be transformed into an eco-village, eco-farm and mining-tourism that could accommodate travelers who yearn to experience the best mining practices as well as experience the culture of Mandaya and their indigenous knowledge system.

Participant “K” proposed that: *“He envisions the development of a tourism in the mined out areas. He pointed out that reclamation should be a link to the Hamiguitan World Heritage Site. Perhaps after the tourists have seen the Hamiguitan then they would stay at a resort in Macambol where they can enjoy the beaches. Another option is to develop the area into a settlement or village for the IP communities.”*

Table 2. Reclamation Options Performance Scoring

RECLAMATION OPTIONS PERFORMANCE SCORING (Scores generated from the Mean Scores of the 16 members of MRFC and MMT in April 24, 2018 decision-workshop)																								
Interests and Sub-Interests	Rank	Group Weight	Sub-Interest Weight	Rating										Score										
				FRA	ANALOG	SALT	Live stock	Poultry	Food Crop	Orchard	Botanical	Envl Park	Tourism	FRA	ANALOG	SALT	Live stock	Poultry	Food Crop	Orchard	Botanical	Envl Park	Tourism	
ENVIRONMENTALLY SOUND	1	20													232	232	232	147	147	174	174	232	232	220
Protect biodiversity			16	4	4	4	3	3	3	3	4	4	4	64	64	64	48	48	48	48	64	64	64	
Preserve genetic resources			15	4	4	4	2	2	3	3	4	4	4	60	60	60	30	30	45	45	60	60	60	
Promote ecological functions			15	4	4	4	3	3	3	3	4	4	4	60	60	60	45	45	45	45	60	60	60	
-Conserve soil and water																								
Positive visual impact			12	4	4	4	2	2	3	3	4	4	3	48	48	48	24	24	36	36	48	48	36	
TECHNICALLY FEASIBLE	2	20												200	184	184	138	138	138	138	170	170	154	
Technology are available			16	4	4	4	3	3	3	3	4	4	3	64	64	64	48	48	48	48	64	64	48	
Scientifically tested			16	5	4	4	3	3	3	3	4	4	4	80	64	64	48	48	48	48	64	64	64	
Appropriate to local conditions			14	4	4	4	3	3	3	3	3	3	3	56	56	56	42	42	42	42	42	42	42	
ECONOMICALLY VIABLE	3	16												208	208	208	156	156	156	156	188	188	178	
Income can fund operation			11	4	4	4	3	3	3	3	4	4	4	44	44	44	33	33	33	33	44	44	44	
Sustain livelihood of people			11	4	4	4	3	3	3	3	4	4	4	44	44	44	33	33	33	33	44	44	44	
Equitable sharing of benefits			10	4	4	4	3	3	3	3	4	4	3	40	40	40	30	30	30	30	40	40	30	
Fits with the FMRDP budget			9	4	4	4	3	3	3	3	3	3	3	36	36	36	27	27	27	27	27	27	27	
Sustain production and market			11	4	4	4	3	3	3	3	3	3	3	44	44	44	33	33	33	33	33	33	33	
SOCIALLY ACCEPTABLE	5	15												160	160	160	120	109	130	120	160	141	130	
Align to gov't development directions			10	4	4	4	3	3	4	3	4	4	4	40	40	40	30	30	40	30	40	40	40	
Equitable, gender sensitive & inclusive			11	4	4	4	3	2	3	3	4	4	3	44	44	44	33	22	33	33	44	44	33	
Address education, health & wellness			10	4	4	4	3	3	3	3	4	3	3	40	40	40	30	30	30	30	40	30	30	
Show-case of good practice			9	4	4	4	3	3	3	3	4	3	3	36	36	36	27	27	27	27	36	27	27	
CULTURALLY SENSITIVE	4	16												244	244	244	183	183	183	208	232	232	208	
Promote culture & IKS of Mandaya			12	4	4	4	3	3	3	4	4	4	4	48	48	48	36	36	36	48	48	48	48	
Acceptable to the indigenous people			13	4	4	4	3	3	3	4	4	4	4	52	52	52	39	39	39	52	52	52	52	
Address needs of the IPI/CC			12	4	4	4	3	3	3	3	4	3	3	48	48	48	36	36	36	36	48	36	36	
Preserve ancestral lands & resources			12	4	4	4	3	3	3	3	4	3	3	48	48	48	36	36	36	36	36	48	36	
Respects IP ownership			12	4	4	4	3	3	3	3	4	4	3	48	48	48	36	36	36	36	48	48	36	
SPIRITUALLY CONNECTED	6	13												136	136	136	102	102	102	102	128	111	102	
Restore interconnectedness of creation			9	4	4	4	3	3	3	3	4	4	3	36	36	36	27	27	27	27	36	36	27	
Expression of faith			8	4	4	4	3	3	3	3	4	3	3	32	32	32	24	24	24	24	32	24	24	
Gives meaning and purpose			9	4	4	4	3	3	3	3	4	3	3	36	36	36	27	27	27	27	36	27	27	
Brings order in individual, community and creation			8	4	4	4	3	3	3	3	3	3	3	32	32	32	24	24	24	24	24	24	24	
		100																						
Note: FRA - Forest Reclamation Approach AL - Analog Forest SALT - Sloping Agro Land Technology														FRA	ANALOG	SALT	Live stock	Poultry	Food Crop	Orchard	Botanical	Envl Park	Tourism	
Computation framework is sourced from Natural Resource Leadership Institute of NC, USA														TOTAL SCORE	1180	1164	1164	846	835	883	898	1110	1074	992

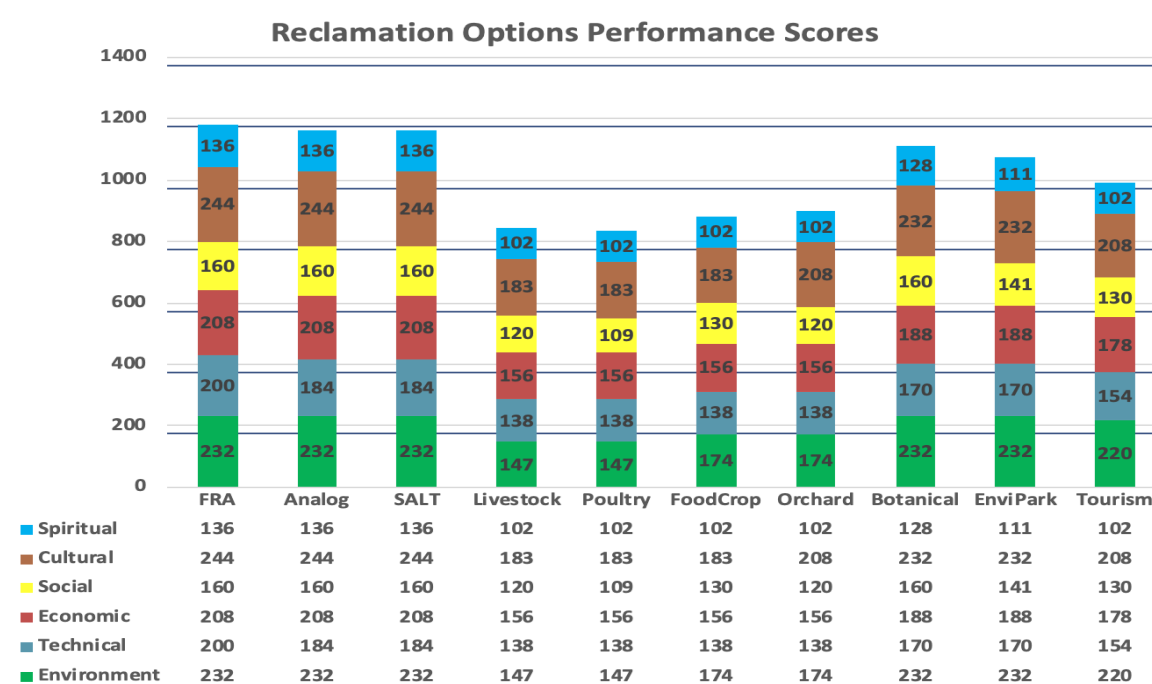


Figure 3. Options' Performance Scores

Decision on Reclamation Option. The Natural Resource Leadership Institute of NC, USA provides a step-by-step process of computing the scores of all options presented given the criteria identified by the concerned stakeholder (*Natural Resource Leadership Institute, 2011*).

The researcher facilitated a workshop involving the Mine Rehabilitation Fund Committee (MRFC) and the Multi-partite Monitoring Team (MMT) following the MCDA scoring process to decide on the best reclamation options to be adopted for the Pujada Nickel Project. The scoring shown in table 2 reveals that the Reclamation Options with highest scores are Forestry options and, Parks and Tourism Options. These are the most preferred under the environmental, technical and other criteria.

The graphical presentation of overall scores in Figure 3 shows that forestry options ranked high. The Forest Reclamation Approach (FRA) is the most preferred followed by Analog Forestry and Sloping Agro-forestry Technology (SALT) having the same scores and Botanical Park Development at fourth rank. The least preferred are the conversion of mined land into livestock and poultry farm which ranked 9th and 10th respectively.

Decision of the Mine Rehabilitation Fund Committee Resolution. The Mining Regulation mandates the creation of the Mine Rehabilitation Fund Committee (MRFC) which shall perform among others; discuss the adequacy of control and rehabilitation measures; resolve issues involving rehabilitation programs and; hire experts to do independent studies and researches on the environment, engineering and socio-cultural to assist them in making judicious decisions and help ensure that the mine disturbed areas is transformed into beneficial land uses (Section 182, paragraph a, c and, d of DAO 2010-21).

The establishment of a functional and post-disturbance land use capability that is proximate to the land prior to disturbance or other more beneficial land uses as agreed in partnership with local communities and LGUs is mandated in the regulation (Section 167, paragraph b., DENR Administrative Order 2010-21, the Revised Implementing Rules and Regulations of the Philippine Mining Act of 1995).

The Multi Criteria Decision Analysis Framework (Natural Resource Leadership Institute), is one of the decision-making tools that helped the Mine Rehabilitation Fund

Committee to fully satisfy the mandates of establishing a functional and post-disturbance land use capability that respond to the multi-interests of various reclamation stakeholders. Thus, Mine Rehabilitation Fund Committee (MRFC) and Multi-Partite Monitoring Team (MMT) during their meeting last April 24, 2018, at Seda Hotel in Davao City, Philippines rated the options based on the agreed main criteria and sub-criteria as generated by the researcher during the interview, Focus Group Discussions and also based on best practices literatures.

The Pairwise Ranking Method. To increase confidence on the decision arrived, the use of pairwise ranking method is introduced to validate the options being evaluated. During the pairwise comparison, every option is compared against all other options taking the criteria as basis of comparison. The options that valued more against its paired option scored ONE (1) or ZERO (0) if it is valued less. In summary, options that scores the same shall be re-examined until consensus is arrived on which option should be ranked higher.

Table 3 below is the pairwise ranking output of the MRFC and MMT showing scores of the reclamation-options. Thru consensus, the members of the Mine Rehabilitation Fund Committee (MRFC) and The Multi-Partite Monitoring Team (MMT) have paired each options against all other options considering the expressed interests by the various stakeholders during the data gathering phase. The result of pairwise revealed that both the MMT and the MRFC preferred to develop the mined land using Forestry using Forest Reclamation Approach (FRA) and Sloping Agro-forest/fruit Technology (SALT) and, into Botanical Park. The three options got the same highest scores dominating the rest of the other seven alternatives.

Table 3. Pairwise Ranking of Reclamation Options

Reclamation Options	(1) FRA	(2) AF	(3) SALT	(4) LPD	(5) PP	(6) CFCP	(7) OD	(8) BP	(9) EP	(10) ETD	Total
(10) Forest Reclamation Approach (FRA)	0	1	0	1	1	1	1	1	1	1	8
(2) Analog Forestry (AF)	0	0	0	1	1	1	1	0	0	1	5
(3) Sloping Agro-forest/forestry (SALT)	1	1	0	1	1	1	1	0	1	1	8
(4) Livestock & Dairy Production (LDP)	0	0	0	0	1	1	0	0	0	0	2
(5) Poultry Production (PP)	0	0	0	0	0	0	0	0	0	0	0
(6) Cereal/ Food Crop Production (CFCP)	0	0	0	0	1	0	0	0	0	0	1
(7) Orchard Development (OD)	0	0	0	1	1	1	0	0	0	0	3
(8) Botanical Park (BP)	0	1	1	1	1	1	1	0	1	1	8
(9) Environmental Park (EP)	0	1	0	1	1	1	1	0	0	1	6
(10) Eco-Tourism Development (ETP)	0	0	0	1	1	1	1	0	0	0	4

While it is suggested to re-evaluate the top three options to determine the most preferred, the MMT and MRFC resolved to blend the three options in the preparation of the landscape design. The members of the team and committee believed that a Reclamation Design with influenced of the three options shall perform better. Having agreed on the option-mix, the two bodies passed a resolution adopting a Mined Land Reclamation Project that embraces the principles, criteria and approaches promoted by the Sloping Agro-forest Land Technology, Botanical Park Development and Forest Reclamation Approach. It is resolved further that the kinds of plants and vegetation which suits to the local conditions and

the soils including those identified by herbalists and the tribal elders be studied further to enhance the success of the reclamation.

Comparing the output of pairwise ranking and the option performance scores, still the Forest Reclamation Approach, Sloping Agro-forest Land Technology and Botanical Park Development outperformed the rest of the options except the Analog Forestry which ranked high in performance scoring. While Analog Forestry ranked the same with SALT in MCDA Performance Score, it lagged behind ranking 5th in the pairwise. The urgency of the transforming the land into functional and more beneficial post-mine land use somehow limits the attractiveness of the Analog Forestry establishment. Understandably, mimicking the natural ecological succession as one of the salient features of Analog Forestry may take some time of which the mining industry does have much leeway. The circumstances and the mandates are pressing hard to the industry for immediate restoration and reclamation of mined land.

The decision is consistent to the Mining Policy Framework (MPF) of the Inter-Governmental Forum (IGF) on Mining, Metals, Minerals and Sustainable Development of the United Nations as a global policy guidance and assessment tool. The MPF promotes that stakeholders participation in the decision making on post-mine-transition should be sought. It also encourages that mine disturbed areas should be progressively rehabilitated when no longer needed by mining to reduce future liabilities and to reverse environmental, social and economic impacts (IGF, 2017).

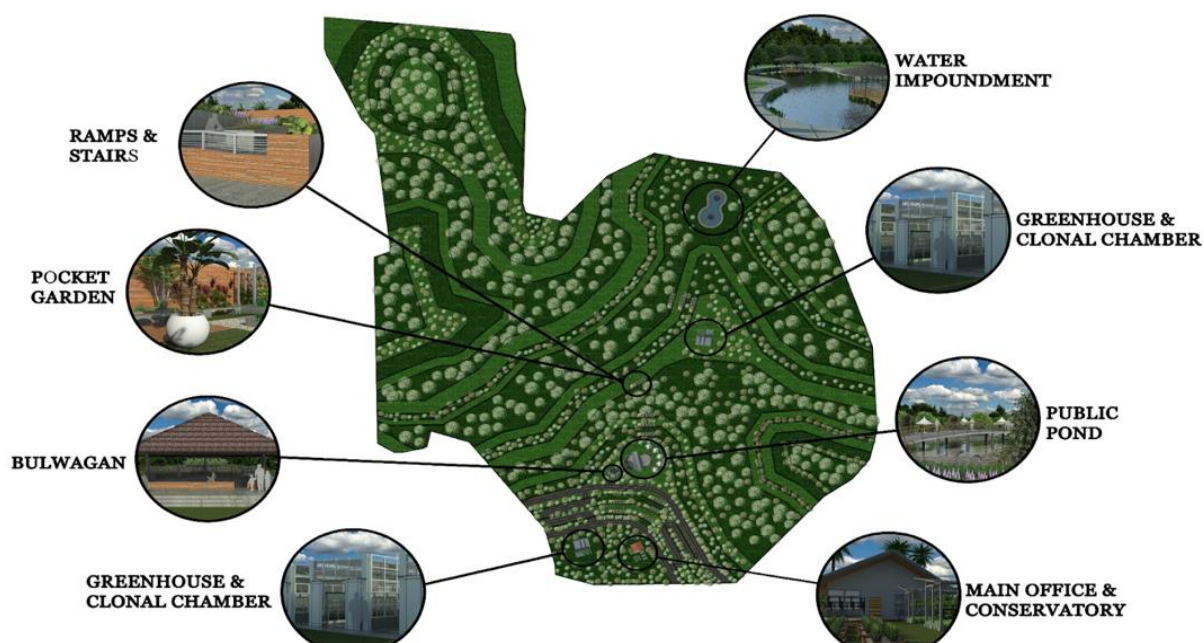
Salient Features of the Adopted Options-Mix. The options-blend could enhance the effectiveness of reclamation project based on the complementary features of the three adopted options presented in Table 4. The complimentary natures of the three options enhances the confidence of the Mine Rehabilitation Fund Committee and the Multi-partite Monitoring Team to decide on blending the options as they believed that it enhances the chances of reclamation success.

Table 4. Complimentary Features of Reclamation Options

Options	Objectives	Features	Applicability
Forestry Reclamation Approach (FRA)	Optimize growth of trees in mined land and the establishment of forest for economic and ecological values.	It has defined steps and techniques that are scientifically proven to significantly enhance the growth of trees and forest in mined land environment.	It is a reclamation technology that could compliment SALT and enhance botanical park establishment by selecting plants of immediate interests instead of tree crops.
Sloping Agro-forest Land Technology (SALT)	Optimize soil and water conservation and enhancement for production of agriculture and forest products for ecological restoration and economic production.	It has defined steps that significantly stabilizes slopes and enrich soil and nutrients. It limits soil erosion and enhances the conditions of soil for the establishment of vegetation with ecological and economic values.	Nickel mined land possesses challenge conditions where technology like SALT could enhance slope stability and enhance the soil and nutrients to make plant grow faster and desired vegetation thrive.
Botanical Park Development	Conserve the genetic resources of flora within the area for education, health and wellness and, cultural preservation and sustainability	It provides for an environment where plants of immediate interests can be planted, preserve and nurtured. A place where threats to plants vulnerability and extinction is restricted.	Plants of immediate interests with medicinal values are found near the mined land. These are endemic to the area, thus, adoptable to the soil and local conditions.

The Mine Rehabilitation Fund Committee in one of its meetings has approved the reclamation design illustrated in Figure 4 prepared by a landscape architect commissioned to MRFC.

Figure 4. Approved Sustainable Mined Land Reclamation Design:



5. Conclusions

Decision making in mine reclamation is significantly influenced by multiple forces of varying magnitudes and intensities. The use of Multiple Criteria Decision Analysis Options Performance Scoring and the Pairwise Ranking enable the Mine Rehabilitation Fund Committee and the Multi-partite Monitoring Team of the Pujada Nickel Project to consider an environmentally sound, technically feasible, economically viable, socially acceptable, culturally sensitive and spiritually rooted mine reclamation characteristics thru blended options of Forestry Reclamation Approach, Sloping Agro-forest Land Technology and, Botanical Park Development. This study recommends that the same study should be conducted however, to other mining areas of different characteristics (e.g. location, stakeholders involved and size) with an increase number of participants and integrating different methodologies. This will validate the existing mine reclamation characteristics established in the study. Moreover, the developed mine reclamation can be reviewed and be materialized and be further evaluated for its feasibility.

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The Impact of Information & Communication Technologies (ICT) on Sustainable Development Goals (SDGs) Progression in the Era of Digital Economy

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Abstract

In this era of digitalization, digital economy is emerging as one of the key driving forces behind economic development. While the growth of digital economy can extensively benefit global economies, it has raised questions regarding the social and environmental wellbeing driven by automation and disruptive technologies.

Digitalization and sustainability are two of the most powerful influences in today's economic landscape. Each has generated massive amount of research on how it influences different aspects of people lives. However, the impact and intersection between the two remains largely untapped research area.

This paper aims to review the impact of ICT on sustainable development. It highlights how we can harness the power of ICT to achieve each of the seventeen Sustainable Development Goals. In addition, the paper presents the strong correlation between ICT and sustainable development. Furthermore, it discusses the critical pathways for countries to progress towards the achievement of sustainable development. It includes case studies of selected countries highlighting examples of key programs and initiatives.

This paper encourages policy makers to integrate ICT policies addressing social and environmental issues within their national framework and strategies in order to advance towards an inclusive and sustainable digital future.

Key Words: ICT, SDGs, Digital, Suitability, Economic, Social, Environmental

1. Introduction

Digital Economy is referred to as “a global network of economic and social activities enabled by Information and Communication Technology (ICT)” [1]. In 2015, 193 countries around the globe agreed to the United Nations agenda on sustainable development by 2030 in a summit held in New York. In the summit meeting a new framework with 230 indicators and 169 targets [2] was proposed. The 17 sustainable development goals which are shown below in Figure 1 and their associated targets are based on a comprehensive framework to tackle a wide range of environmental, social and economic issues which include climate change, energy, water conservation, poverty, food security, healthcare, education, gender equality and fostering economic growth.



Figure 1. UN 17 Sustainable Development Goals [2]

The Sustainable Development Goals (SDGs) build on the efforts of the well-known Millennium Development Goals (MDGs) adopted in 2000. The new SDG framework benefits extensively from the previous experiences gained and identify gaps and offer improvements. Although none of the 17 sustainable development goal specifically refers to Information and Communication Technology (ICT), it is proven that it can substantially accelerate the development progress of the countries, bridge digital gaps and in the process construct inclusive and knowledge economies. It is due to these reasons that leading ICT companies have suggested that their sector can play a vital role in achieving SDGs. Ericsson president, Hans Vestberg stated that “Information and communication technology offer an incredible platform for achieving SDGs” [3]. Similarly, Accenture strategy emphasized the fact that digital solutions can rapidly transform the world economies and generate positive impact to achieve the SDGs [4].

2. Research Questions and Methodology

The following major research questions were formulated to guide the data collection.

RQ1. Can ICT & The Digital Economy Contribute to the Achievement of the SDGs.

RQ2. Which out of the 17 SDGs are the ones impacted the most by ICT.

RQ3. Which sectors of the Digital Economy has the highest impact on SDGs achievement

Data was collected using the following mixed secondary and primary sources:

- Comprehensive Literature Review
- Ten Qualitative Expert In-depth Interviews
 - 4 ICT Experts
 - 4 Economic Experts
 - 2 Development Experts
- Analysis of International Organizations Data (UN, OECD, ISIC, ITU, etc.)

3. ICT, SDGs and Sustainability

Several pioneering actions have been carried out for the better implementation of SDGs. We have identified several SDG related research activities. Holden et al. [5] proposed SDG model reflecting the satisfaction of human needs, respecting environmental constraints and the enhancement of social equity. There were some key conclusions that were drawn from the model. One of the important implications was that different countries face different policy

priorities hence there is a need for countries to prioritize their needs to facilitate the transition process. Study conducted by Costanza et al. [6] examined different methods to measure the sustainable well-being to stimulate global societal changes and in particular proposed SDGs. The study highlighted the lack of aggregate indicator to measure the progress towards the goal and argued that there is an utmost need of one such indicator to assess the relative contribution of each of the individual goal towards the overall progress.

Dandabathula et al. [7] work presented the result of the survey to identify the state of the ICT enabled e-governance landscape in India. The survey finds that Indian e-governance has proved to be an effective tool to improve public sector efficiency by promoting accountability and transparency through open data. Gouvea et al. [8] hypothesize the link between information and communication technology, human development and environmental sustainability. The study concluded with ICT and human development having significant effects on environmental sustainability. Rappitch [9] analyzed the impact of digitalization and sustainability across different markets (Energy, Food, Health, Housing, Mobility and Finance) and insisted that - if we adopt new technologies in a sustainable and responsible way the positive effects outweighs the negative ones. Similarly, Goswami [10] work outlined the negative and positive impacts of new technologies on environmental, economic and social well-being. He also argued that although ICT sector offers profitable and critical opportunity to create a green economy but the key to achieving this objective lies in the cooperation between government and industry. Jones et al. [11] reviewed the different ways in which ICT industry can contribute towards the achievement of SDGs. The study outlined the ways in which ICT companies can contribute towards sustainable development and also examined the key challenges faced by these companies. Wu & Guo [12] work discussed the role-played by ICT in achieving SDGs and identifies several research gaps from social, economic and environmental perspective of sustainable development.

In summary, Table-1 below summarizes the possible role of ICT in achieving each of the SDGs and the expected impact. It shows that ICT has high impact on at least 7 of the SDGs.

SDG	ICT role in achieving the SDGs	ICT Impact
Goal 1: End poverty	ICT provide opportunities for businesses to become part of formal economy; mobile banking provides easy access to loans and mobile credit services.	High
Goal 2: Zero Hunger	Smart agriculture system allows farmers to monitor the soil and weather conditions hence increasing productivity and reducing the use of water resources. Efficient crop management techniques can retain soil condition and leads to more sustainable agriculture.	High
Goal 3: Good Health and Well-being	The use of IoT applications in the delivery of health care services allow intelligent monitoring and diagnosis of diseases. Further, big data analytics allow timely forecast of diseases.	High
Goal 4: Quality Education	ICT have enabled the access to online educational resources. Big data analytics have assisted educators to identify learning challenges and deliver more personalized and tailored education training.	High
Goal 5: Gender Equality	ICT increases women access to information and services including microfinance and banking services	Low

Table-1 ICT Role in Achieving SDGs

SDG	ICT role in achieving the SDGs	ICT Impact
Goal 6: Clear Water and Sanitation	Smart water management techniques have reduced water wastage and enhance water safety.	Low
Goal 7: Affordable and Clean Energy	Smart metering techniques allow better energy management, smart grids have allowed for sustainable energy supply while reducing the carbon footprint.	Low
Goal 8: Decent Work and Economic Growth	Application of IoT and artificial intelligence possess great amount of potential to improve the production processes and leads to substantial economic growth. These technologies not only reduce the emission of greenhouse gases but also provide new opportunities for the manufacturers.	High
Goal 9: Industry, Innovation and Infrastructure	Integration of ICT, big data, IoT and artificial intelligence into the industrial processes have allowed for better fault tolerance techniques and continuous monitoring of industrial process. This has also contributed towards innovation and smarter infrastructure.	High
Goal 10: Reduced Inequalities	Advance ICT will allow for localized production and will lead to lower income inequalities.	Low
Goal 11: Sustainable Cities and Communities	IoT applications can transform the ideas of smarter and efficient cities into reality. Artificial intelligence and big data analytics can create better transportation systems and will enhance the transparency within the government processes.	High
Goal 12: Responsible Consumption and Production	IoT, big data analytics and artificial intelligence can significantly improve the coordination between producer and consumer, thus increasing efficiency and sustainability.	Low
Goal 13: Climate Action	ICT can help reduce the carbon footprint and greenhouse gas emissions by making the production processes more efficient.	Low
Goal 14: Life Below Water	Use of new sensor and monitoring techniques can track oceanic resources. In addition, it allows for better resource management and early warning systems.	Low
Goal 15: Life on Land	ICT enabled efficient monitoring of land resources, soil conditions and deforestation can help in the preservation of natural resources.	Low
Goal 16: Peace, Justice and Strong Institutions	Use of open data policies can empower citizens; big data can increase the government transparency.	Low
Goal 17: Partnerships for the Goals	ICT will enable in the formation of new communities of engaged citizens; Artificial intelligence will allow advance modelling of development that can be shared widely and rapidly.	Low

Table-1 ICT Role in Achieving SDGs (cont.)

Sustainability is defined on three dimensions; economic, social and environmental. ICT has proven to be an enabler for all of them. The following section will review the impact of ICT on the different dimensions of sustainability.

Economic Sustainability. In 21st century eradication of poverty still remains to be one of the toughest challenges faced by countries. The first step is to determine the poverty appropriately. Previously, it has been determined using traditional methods such as poverty line and income indicators which often lead to unrealistic indicators. Recently, state of the art research has been carried out to reduce poverty through digital technologies. Roubaie et al. [13] examined the significance of establishing ICT infrastructure to alleviate poverty in Muslim countries. His work highlighted that setting up ICT infrastructure will not only empower the nations through the spread of knowledge but will enable holistic human development. Cecchini et al. [14] outlined the practice to overcome poverty through ICT projects by improving the access to healthcare facilities and education institutes in India.

Agriculture is vital for the people living in rural areas. Nowadays, agriculture faces tremendous amount of challenges due to the fast-growing population and the degradation of natural resources such as water shortage, declining soil fertility etc. The use of ICT products and services can greatly increase the farm productivity and enhance efficiency. For instance, the use of wireless sensor network for remote monitoring can effectively improve the production of the farms. Several studies assessing the impact of ICT on agriculture are demonstrated here. Awuor et al [15] highlighted the contribution of ICT in achieving food security and sustainability in developing countries. He presented an e-agriculture framework in order boost productivity and exposing farmers to information related to agriculture.

Recent advancements in mobile technologies have revolutionized the healthcare sector leading to new healthcare models. Solanas et al. [16] introduced the concept of smart health (emerging from the concept of smart cities and mobile health services) and gave an overview of knowledge areas involved in the realization of this concept. Skubic et al. [17] work was based on capturing early health changes through home monitoring system. The embedded sensor network continuously monitors the environment to detect behavior patterns of the target. In addition to this, Loan et al. [18] proposed an IoT architecture that can be used in healthcare to monitor the ECG signal acquired by the patient using mobile tele-cardiograph.

Nowadays, educators can deliver an engaging educational content through media and internet rich web applications as compared to conventional classroom methodology and face to face engagement. These new technologies have enabled the students who couldn't attend the classes to have similar level of opportunities as the rest of the students. Vanja et al. [19] carried out an extensive user requirement study in order to define the functionality scope of m-learning applications to enhance the student performance. A range of potentially helpful m-learning concepts were presented by the students.

Social Sustainability. Another important impact of digitization, yet unexplored enough, is its impact on social welfare. Several studies showed that the increase in the level of digitization boosts societal well-being [20]. One way of achieving societal well-being and improving the quality of people's lives is by making cities smarter through the integration of digital technologies within different sectors. Thus, Vilajosana et al. [21] examined the importance of big data technologies to build smart and sustainable cities. In addition, it was

found that internet adoption, introduction of broadband and using personal computers yielded significant increase in household income.

Digital technologies help in better informing citizens of government's activities and hence open new paths for participatory democracy, as well as improve public sector efficiency. This is usually accompanied with a stronger demand for e-Government services. Finally, digital identification facilitates conquering barriers to participation. Several countries have launched digital identity schemes to streamline government processes. These together with digital systems for elections aim to avoid post conflict transfers. Moreover, mobile phones enable citizens to report instances of violence and voter intimidation, thus improving electoral participation.

Environmental Sustainability. At present drastic effects of climate change can be experienced across the globe. Extreme droughts, rising sea levels, melting of ice-bbergs are all due to the global phenomenon called global warming. Luckily, digital technologies possess tremendous potential to reduce the greenhouse gas emissions, which is considered to be one of the key factors contributing towards global warming. According to Global e-sustainability Initiative (GeSI) digital solutions, smart manufacturing, smart mobility, smart city can cut over 12 gigatons of Carbon dioxide emissions across the global economy by 2030. Several research activities have been carried out to better understand the climate change. For example, Liestol et. al [22] presented the idea of visualizing climate change using augmented reality technologies. The underlying purpose of his work was to effectively convey information about climate change to the public. Recently, Paris agreement [23] which is signed by 195 countries illustrates the determination of the world to mitigate global warming. In addition to climate change digital technologies improve the protection of oceans and water quality. Around 32 per cent of the world coastal areas have already been benefitted by smart conservation solutions. Smart conservation has been made possible through a range of digital solutions including data analytics, real-time satellite imaging, advance mapping and real time weather forecasting.

4. Critical Pathways for Countries to Use ICT as Enabler for Sustainability

Digital technologies can accelerate human progression towards sustainable development by increasing access to information, driving innovation and enabling highly efficient processes. Achieving all three can be quite challenging thereby hindering the progress towards sustainable future. Following are the proposed three critical pathways for countries to fast track their progression towards SDGs achievement.

Increase access to information and services: ICT infrastructure coupled with the availability of devices such as smart phones, computers and tablets have allowed the individuals and organizations to gain access to information and communication services. This has really allowed both the developed and under developed countries to achieve substantial amount of progress on SDGs. Before this unequal access to resources, information, education and services led to disparities among the nations and aggravated the issues of inequality worldwide. Although there are numerous challenges associated with the access to high quality ICT infrastructure but the affordability of devices in recent years is helping least and developing countries to empower society and reduce inequalities.

Increase connectivity between people and organizations: Increased access to information and communication leads to better connectivity and communication between individuals, and

organizations at all levels. This can greatly result in the increase in productivity and innovation in wide range of sectors and provide critical real-time communication which is essential for rapid growth and expansion at all levels. According to the statistics by International Telecommunication Union (ITU), youth is at the forefront of today's digital economy. About 70% of the world youth aged between 19-24 use internet which is significantly high as compared to the total population using the internet (48%).

One of the keys to achieve progress on the SDGs is to bridge the gender divide in connectivity. While the adequate availability of internet and communication services have narrowed the gender gap in internet usage lately, proportion of men using the internet still remains higher as compared to the women. ITU figures estimate that the global internet penetration rate for men was 50.9% compared to 44.9% compared to women in 2017 [24]

Increasing digital skills is another major factor that determines the pace of digital connectivity. It is quite evident that its mainly the least developed economies that suffer the most from lack of advance digital skills, which poses risk to be left behind in the race to digital economy.

Increase productivity and resource efficiency: ICT holds immense potential to raise the productivity level through an increased access to information and communication. Rapid advancements in digital technologies assist us to harness the true potential through efficient ways to collect and analyze large sets of data with the help of big data and analytics.

The private sector will play a key role in these productivity gains, however to achieve a substantial progress on SDGs, these solutions will be spearheaded by public sector. Some estimates suggest that active involvement of public sector would result in substantial cost saving benefits and free up significant resources in key sector: healthcare, education and other major areas of societal well-being.

5. Impact of ICT & Digital Economy

Digitization, including computing, broadband and mobile telephone networks, helps in relaxing scalability constraints, thus allowing traditional sectors of the economy to grow more rapidly. Mature technologies contribute to improving productivity owing to the introduction of more efficient business processes supported by ICTs, marketing excess inventories and supply chain optimization. Moreover, digitization results in extending market coverage leading to revenue growth. It also affects the composition and operation of industrial value chains. In addition, digitization promotes the growth of some industries within the services sector (e.g. business process outsourcing, and software development).

The introduction of new applications and services, including for example internet information searches, distance education, e-commerce and social networks boosts economic growth. These technologies facilitate businesses in lowering costs, and hence increase efficiency and labor productivity in almost all economic sectors. This is due to the fact that increasing access to digital technologies lead to the optimization of inventory and supply chain management, hence allowing the better utilization of resources. Furthermore, the internet contributes to making workers more productive, as it helps in handing off routine and repetitive tasks to technology, and hence workers can focus on activities with higher value. Additionally, the developments in big data analysis, robotics, and machine learning have significant implications for productivity improvements.

Study by Sabbagh et al. [25] shows that an increase of 10 percent in a country's digitization score increases GDP per capita growth by 0.75 percent on average. Moreover, Katz and Callorda [26] reached the result that 1 percent increase in a digital ecosystem development index, which corresponds primarily to the first and second waves of digitization yields 0.13

percent increase in per capita GDP growth. In addition, it is concluded that as the digitization level of a country advances, the higher is its growth:

Digitization had significant impact on employment, since it increases the demand for labor. In addition, it results in job creation due to the construction and deployment of telecommunications networks. Many jobs were created as a result of increased demand for labor in specific jobs linked to the development of digital services or the emergence of collaborative business models. In general, digitization creates new jobs, whereas other jobs turn out to be redundant [27] . It transforms existing jobs, since new skills are required to accomplish new tasks. This implies that the current work force has to be either retrained or replaced by workers who already have these skills. Studies indicate that the fourth industrial revolution will have a huge impact on the labor market. They also argue that this impact will differ by sector and that the rising new jobs will take many forms. Forecasts reveal that digitization could result in creating about 6 million jobs worldwide during the period (2016-2025) in the logistics and electricity industries alone [28].

Governments, mainly those in digitally advanced countries, take advantage of data analytics and digital platforms for faster, integrated, and more informed policy making. The internet further raises government efficiency and productivity through automation and data-driven management. Nearly all countries are trying to incorporate automation within their governmental aspects including tax and customs administration, budget preparation, execution, and accounting. Digital technologies have made it possible to monitor the performance of the workers thereby improving management and institutional reforms within the government. Finally, it is true that digital technologies help overcome information barriers that hinder service delivery.

Comparison between ICT and SDG scores reveal a strong correlation between the two, suggesting that ICT enables the countries to fast-track their progress on the SDGs. Majority of the countries at the top of the benchmark are primarily European countries which is relatively not a surprising, as European countries lead both in the progression in ICT and sustainable development. The benchmark reveals a significant gap to close between the lowest scoring country (Pakistan) and highest scoring country (South Korea). Almost all the leader countries score evenly on six of the SDGs (good health and wellbeing, quality education, gender equality, affordable and clean energy, Industry innovation and infrastructure, Sustainable cities and communities) which can be highly influenced through ICT. Figure 2 below shows the correlation between the ICT and SDG score.

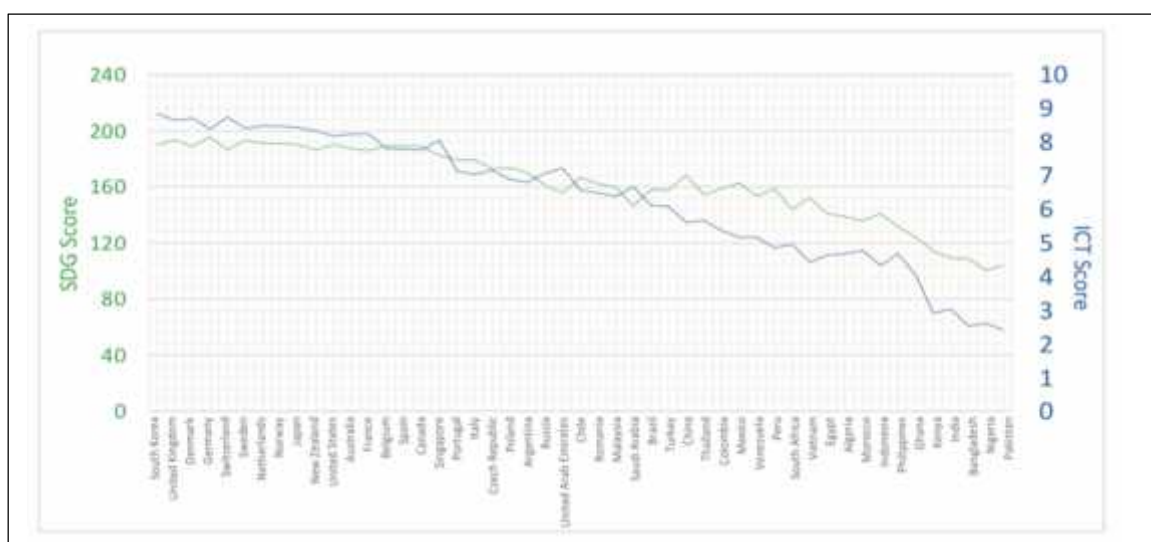


Figure 2. Correlation between SDG and ICT score

In this section we will analyze the progress of ICT and sustainable development in four countries namely Argentina, UAE, South Africa and Philippines, examining the role of key ICT programs and initiatives to achieve sustainable progression.

5.1 Argentina

Hydro-meteorological monitoring system: It's a water and weather monitoring system comprised of inter-connected network of sensors that collect environmental and meteorological data. This data is useful in the prediction of floods hence allowing for emergency planning and protection of water resources. The outcome of this projects supports both the SDG 9 and SDG 11. [29]

City performance tool: City performance tool uses data analytics technique to analyze the impact of different technologies implemented across a wide range of sectors such as energy, transport and infrastructure. The outcome of this project resulted in the outlining of technologies which will result in the achievement of sustainable development goals by 2030. For instance, it gave recommendation regarding the installation of intelligent transport system to control traffic flow thereby reducing the CO₂ emissions. This tool contributes towards the achievement of SDG 7, SDG 9, and SDG 11. [30]

Tech-enabled schools: In rural parts of the country Argentina has set-up a network of tech-based schools. The classroom lectures are live streamed extending the reach to students in remote areas. This program has been successful in connecting students to higher quality educational opportunities and enriching their learning experiences. This program directly contributes towards SDG 4.

5.2 United Arab Emirates

Abu Dhabi Digital Government: Keeping in view of the social and economic objectives of Abu Dhabi Vision 2030, the successful implementation of e-government strategy will be key driver for the realization of these objectives and for the transformation of traditional government services.

Smart Patient portal: This program [31] aims to provide world class health care services through an online portal where patients can easily access their health profiles. Other initiatives include Electronic medical records and National Unified database of Patients which are centered around the e-health strategy. These projects highlight the utmost importance of ICT in making health services easily accessible to the masses thereby supporting SDG 3.

South Africa

Ekurhuleni smart city partnership: Great deal of investment in projects covering broadband connectivity, smart meters and fiber installation had led to efficient monitoring and integration of different services. These technological developments will attract startups and promote entrepreneurship within the country hence leading to job creation and better energy consumption patterns, contributing towards SDG 11, SDG 9 and SDG 7. [32]

C40's modeling tool, 'CURB' [33]: This modelling tool help the city to measure the greenhouse emissions and selects the best actions to reduce the carbon footprint. Overall, it will assist Johannesburg to execute its Climate change strategy, contributing towards SDG 7.

Open Medicine Project South Africa [34]: The project aims to provide healthcare professionals with access to relevant information through mobile technology. Under the project a number of innovative applications have been developed to tackle specific health problems. Ultimately, this project can improve the overall quality of the healthcare delivery services in South Africa, Contributing towards SDG 3.

5.3 Philippines

National Telehealth Center: The program focuses on making healthcare accessible to people living in remote communities. The center offers ICT enabled solutions to overcome the critical issues in the healthcare system. One such example of ICT solution includes electronic medical record for the government based medical facilities. Moreover, center conduct training sessions on eHealth and eMedicine thereby increasing the awareness of ICT solutions among the patients. This contributes directly to SDG 3. [35]

Ayannah: A social enterprise that aims to bring digital financial services to the unbaked workers in rural areas. In order to facilitate the financial inclusion of the middle class the program promotes the access to digital payment services via online and mobile applications. This model supports SDG 9 by providing access to financial services. [36]

7. Conclusion & Recommendations

The achievement of SDGs will prove to be challenging in the long run without the intervention of digital technologies. The 17 SDGs proposed by United Nations offer a pathway towards a global and inclusive economy. This paper has highlighted the Impact of ICT in achieving economic, social and environmental sustainability and investigated the correlation between ICT and SDGs. Every goal- from the eradication of poverty to climate change to the creation of global partnerships can be positively impacted by embracing digitization. In fact, ICT can pave a way for the age of sustainable development-transformation of societies where technology is a key enabler for planetary and human well-being.

Finally, based on the reviewed case studies the following recommendations can be proposed for countries to capture the power of ICT to deliver SDGs by 2030. These include:

- Development of physical infrastructure to enable broadband connectivity throughout the country
- Interoperability of e-governance tools and integration of e-payment solutions within businesses.
- Use of ICT to strengthen the monitoring of the SDGs at the national and sub-national level. (SDG dashboards)
- Integration of ICT application into national programs, plans and strategies for SDGs.
- Collaboration among relevant stakeholders across public, private and non-profit sector. Build on existing governance framework and develop strategies to strengthen collaboration among actors

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