Session of Sustainable Development Goals

Peaceful and Nonviolent Societies as a Sustainable Development Goal 16

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Abstract

In the light of the UN Sustainable Development Goals, there is a growing need for approaches, tools, policies and practical solutions for peaceful, just and strong societies in today's multicultural community. This paper describes a model of a peaceful society within the Närpes community in Finland by employing ethnographic participant observations and semi-structured interviews. In 2016, the ethnographic data were gathered during different occasions via the acquaintance networks and seven interviews were conducted with the experts of the areas of interest for the purpose of this research. The Närpes Model comprehends five elements; (1) the ethnic identities of the Närpes inhabitants, (2) the values of the Närpes society, (3) Närpesians' relation to the foreign cultures, (4) socioeconomic equality and stability, and (5) tight interaction among different sectors and institutions. This holistic Närpes approach reveals that promotion of peace and justice along with apprise of peoples' identities and values, positive interaction among different ethnic groups, and creation of effective and accountable institutions can make the world to be a better place. It is possible to have a peaceful and nonviolent society as in the example of Närpes model. Although Närpes is a small-scale community, the approach to achieve peace, justice and strong institution can be applied to broader societies to fulfill the challenges of extremely multicultural communities. Thus, the SDG 16 is one of the global goals, which is possible to reach worldwide by 2030, if the action is taken now.

Keywords: Peaceful Societies, Nonviolent Societies, Närpes model, The UN Sustainable Development Goals.

1. Introduction

The official end of the Millennium Development Goals in 2015 brings the world to the new era of the Sustainable Development Goals (SDGs) [1]. With the SDGs, the implementation of the goals become universal since the goals focus not only on the developing countries, but also on the developed countries to take action to provide a sustainable planet for the future generations. In order to end poverty, protect the planet, and assure people living in peace and prosperity, these 17 goals are adopted by the countries having priorities on climate change, economic inequality, sustainable consumptions, innovations, and peace and justice [2].

Although all 17 goals have different aims and targets, they are all interconnected. In order to reach the targets set out in the SDGs, the fundamental issue is to work on the goals collectively and interdependently. In this respect, not only governments but also private sectors, civil societies and citizens need to work together in order to achieve the SDGs.

Turning plans into actions and promises into reality as foreseen in the SDGs is not something that impossible to achieve, if all nations work together collaboratively. Authors of this paper focus on the SDG 16, which is promoting peace and justice with building effective and transparent institutions. This aims to create peaceful, nonviolent and sustainable societies. In this regard, the unique case of Närpes, an exceptionally peaceful community on the west coast of Finland, can be seen as an example of how to implement these goals in practice. For that reason, Närpes as a model of peaceful society that is achieving Goal 16 in the SDGs will be discussed in this paper

Närpes is a small Swedish-speaking town in South Ostrobothnia region that became well-known for its peacefulness, multiculturalism, successful integration and cohesion among the inhabitants, and very low levels of violence and crime. In 2016, approximately thirty-five different nationalities (11% of all population), with over fifteen spoken languages, reside within a community of 9387 inhabitants [3]. However, foreign population is not exactly presented in the statistical database. First, only those persons that have an A-status for staying in the country are officially registered. Second, people that acquired Finnish passports are totaled as Finnish nationals [4].

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Table 1: Närpes Population Based on the Language Background

	Total	Finnish speakers	Swedish speakers	Other languages
	9387	**523**	**7 747**	**1 117**
Men	**4 750**	**210**	**3 951**	**589**
Women	**4 637**	**313**	**3 796**	**528**

Beside the metropolitan cities, Närpes was the first community that received refugees in Finland [5]. In 1988, the first Vietnamese came; in 1992, the first Bosnians arrived, in 2004 followed by labor immigration from the other Balkan countries, Eastern Europe, Central America, and in 2014 refugees from Sudan [6]. During the past year, fluctuating number of the asylum seekers and refugees from mainly Middle East reside in Närpes [7],[8].

Based on the collected statistics from the year 2010 to 2013, out of the 304 municipalities, Närpes was ranked the 11th safest place to live in Finland [9]. In 1995, the only case of homicide since 1980 took place. It was an incident caused due to the jealousy and drinking problems when a husband murdered his wife. Between the year 2000 and 2015 July, only 23 aggravated assaults were recorded [10]. Närpesians themselves feel safe in this community and are not afraid to walk in the streets in the dark. Local people say that it is quite and safe in Närpes; “our children can go to and from school unaccompanied and play safely in the parks and close by the forests”. At the moment, Närpes municipality does not have any police station. For couple of years, a police establishment in Närpes was operating twice a week as a service station, which was totally closed in the beginning of 2016 [11],[12]. In addition, recent research that looked at a drug use for the depression, need for child protection, allowances given due to the sickness, and crimes influenced by alcohol or drugs found out that out of 317 municipalities, Närpes is the 5th happiest municipality in Finland [13].

2. Materials and Method

In order to get the insights on the social relations between the locals and immigrants of Närpes as well as to understand the work of institutions, two complementary methodologies were employed: ethnographic participant observations and semi-structured interviews.

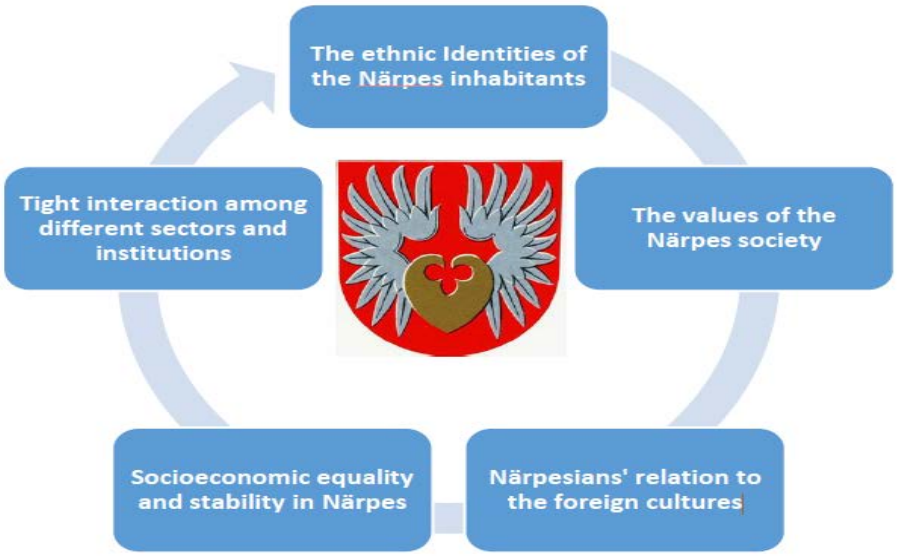
Ethnographic participant observations have been conducted since 2016. The data related to Närpes culture, its peacefulness, and Närpesians’ nonviolent behavior have been gathered andrecorded, by talking with people on daily basis, and by going on the visits and attending social gatherings. Thus, it has been a possibility to conduct ethnographic observations on different occasions via the acquaintance networks. These observations were recorded on a paper in a notebook providing a commentary on the happening, interactions, and behavior of the observed people.

In 2016, semi-structured interviews were carried out with seven participants. These participants were selected via acquaintance networks based on their knowledge and familiarity of interest areas of a researcher; a 56-year-old lady that works as an integration coordinator of a Welcome office, a 74-year-old chairwoman of Närpesnejdens fredsförening [Närpes Peace Civil Society], a 37-year-old chairwoman of Ljusets kvinnor [Women of Light CSO], a 77-year-old man that worked as a primary school teacher with the first Vietnamese and Bosnian refugee kids, a 33-year-old service lady at the local employment office, a 46-year-old language and culture teacher at the local Adult Education Center, and a 27-year-old lady working as a Islam religion teacher at the local high school. Emerging themes for the interviews focused on the social cohesion, daily lives, integration processes within the community, people's behavior, and culture of a Närpes society. Prior to the interview session, interviewees were informed about the topics of the interview, rights of an interviewee, usage of the material, practical issues related to the interview session and so forth. One interview took place at the respondent’s workplace and the remaining five at the respondents’ homes. Interviews were conducted in Swedish and approximately took one hour. The interviews were audio recorded, indexed by general topic, and transcribed into electronic form using a word processor.

3. Results and Discussion

The Närpes model comprehends the five following components: (1) the ethnic identities of the Närpes inhabitants, (2) the values of the Närpes society, (3) Närpesians' relation to the foreign cultures, (4) socioeconomic equality and stability, and (5) tight interaction among different sectors and institutions.

Figure 1: Närpes Model



The ethnic identities of the Närpes inhabitants

In Finland, Swedish community faces culture survival challenges but yet people of Närpes are proud of their strong unique culture deriving from the local traditions and traditions brought up by the immigrants. Närpesians themselves are not true Finns or Swedes and they cannot either be purely classified under the Swedish-speaking Finn culture either due to their strong Swedish dialect or due to a great mix of cultures residing with the community.

Närpesians are a minority within the minority Swedish population among the major Finnish population. They know how it feels to be an ethnic minority within the major culture and so it is relatively easy to sympathise with the town foreigners. Especially, the younger Närpesian generation are more open to the diversity and has more willingness to create cross-cutting ties among the locals and foreigners. They tend to be less religious than their parents, they have received degrees of higher education, they have experienced working or studying abroad, and their background is a rich blend of various cultures. It is a growing phenomenon that while growing up, a child speaks three or four languages as well as encounters traditions and behavior patterns of several ethnic groups. For instance, a mother speaks Swedish to a child, a father speaks Dutch, between each other parents speak English, and a child is attending Finnish speaking school. This creation of multicultural identities have been present in Närpes for several decades, and it is one of the factors contributing to Närpesians' pragmatic openness towards the other ethnic groups.

The values of the Närpes society

The old Närpesian values owe to both, Swedish and Finnish cultures. The main characteristic of the Finns is their sameness; they do not like to stand out from the crowd and they mode of dress is very similar to everyone else's. Finns do not celebrate their achievements since it would be seen as bragging. They are naturally reserved, especially towards the chatty foreigners, and are likely to seem very formal and aloof. Meanwhile Swedes, are open-minded, social, and chatty in contrast to the Finns. Swedes value personal equality, they are liberal even though they are moderate and do live their cultural lives based on traditions, stability, and customs. In both cultures, there is a relative absence of social barriers – no class distinctions in education and everyday social life that minimize the gaps between the racial, social, or class superiority. Little town of Närpes, when compared to Scandinavia, has long and extensive experience of immigration, which brought up an equal society based on diversity. One of the local teachers says that "we all can be equal even though we all cannot be the same". Närpesians value people and the strongest values noticed within their community are honesty, equality, humbleness, modesty, privacy, calmness, directness, and integrity. Also, it is very important to obey the rules,

which is also their moral and ethical code. Immigrants of Närpes see locals as civilized, calm, independent, autonomous, and silent people. But if they overcome embarrassment speaking out loudly in public, then they say what they mean and mean what they say. Immigrant people of the Närpes community often say that Finns can be shy as well as suspicious towards the strangers but they are very honest and loyal once you make friends with them.

Närpesians'relation to the foreign cultures

Närpes people's relation to the foreign culture has much to do with about a century long embedded tradition of emigration and immigration. The first migration wave to the US took place in the beginning of the 20th century and during the 1960s and 1970s people migrated for the employment and education opportunities to Sweden, other Nordic countries, and bilingual towns in Finland. When it comes to immigration to the town of Närpes, it has a 29-year-long tradition of integration. In 1988, Närpes was the first Swedish-speaking municipality in Finland that received quota refugees from Vietnam followed by the Balkan countries. Later on, employment based migration from the Baltic countries, Russia, Ukraine, Belarus, Poland, Ecuador, and the Netherlands, just to name view, took place. Thus, marriage based migration brought to town people with Thai, Moroccan, or Slavic backgrounds. At the moment, Närpes municipality is offering resident places to the current quota refugees and asylum seekers. This exchange of interaction between locals and foreigners keeps on continuing. Today, it is relevantly easy for the immigrants to come to Närpes since they already have family members or friends who explored the town before them; they already know what to expect and thus, a new-comer does not have to feel alone or lonely since there are others who have similar cultural background and reasons for immigrating. Occasionally, locals and foreigners might be xenophobic, however, this does not last long since within the small scale community as Närpes is, people get to know each other fast, they interact daily, and so differences start to be seen as advantages for shaping a multicultural community.

Socioeconomic equality and stability in Närpes

Finns and people from the Ostrobothnia region are known as hardworking and have deep-rooted entrepreneurial skills. This is shown in the high levels of work sufficiency and low levels of unemployment (4% unemployment), lowest in the country (13% in all Finland) [14].

In Närpes, economic situation started to progress during the past decades. During the middle of the twentieth century a large proportion of the working age Närpesians emigrated leading to unbalanced age structure. In the beginning of the twentieth first century, there was a big need for a labor force, therefore, immigration from abroad successfully met labor demands. At the moment, labor immigration is more intense than it has been ten years ago and this balances widespread emigration, especially among the youth, due to which labor needs within the sectors of agriculture, healthcare, and metal industries had emerged. These labor immigrants become employed taxpayers that occupy vacant and create new working places as well as they inspire and develop entrepreneurship. Since labor force has increased, entrepreneurs were also able to expand their businesses. Small family-based firms became well-developed companies.

Education, which is a big part of successful integration planning, also gave opportunity to town foreigners to become well-known entrepreneurs, politicians, restaurant owners, photographers, academics, and respected people not only in Närpes but also elsewhere. Immigrants agree that steady income and education is an important factor for their well-being, life quality as well as it allows them to plan their own economy and the future. This financial security also allows raising children that has opportunities to free education, healthcare, and a future in Närpes. Närpes municipality pays a great attention to education for both, adults and children. Immigrant adults can participate in language and culture courses and for immigrant children there are arranged lecturing in native language that could strengthen multicultural identity and create functional bilingualism. This positive inflow of international migration that balanced age structure allowed Närpes to become a transparent society that has transformed from emigration to immigration rural countryside.

Tight interaction among different sectors and institutions

People from Närpes region are known to be as self-assertive and noblest. Day to day life affairs are handled in a tight, smooth, and client oriented manner through dialogue and communication. Within the small scale community such Närpes, errands are fixed based on a close communication between the community inhabitants, immigrants, companies, authorities, and the third sector. For instance, employers actively facilitate integration, employment office or social care services relatively easily can direct people to acquire suitable housing or schooling. People are usually aware of happenings within the community and they are quick to react to any potential problems, issues, and needs. It is relatively easy to communicate and solve problems in a small town with people you know, and so a positive circle of successful actions that manage diversity are created. A work of a third sector, which is various CSOs, associations, non-profit organizations, and clubs means a lot to Närpes community and their identity. In Närpes, there are 108 registered associations and their networks are

connected to traditions, native regions, cultural manifestations and language, as well as they provide a great number of meeting places, which is especially important to the minority. The life of a third sector also has an immense meaning in creating more coherent and interdependent society; it keeps people of different ages and cultural backgrounds active and interactive and it improves relationships and communication within and among Närpes inhabitants.

4. Conclusion

There are many challenges and threats in achieving the targeted UN Global Goals worldwide. However, in the light of our case study, the Närpes model exhibits possibilities for peaceful, inclusive, and nonviolent societies in today's diverse world. This paper presents a holistic example, Närpes model, which is a successful approach to implement the SDG 16 within the small-scale Swedish community in the Finnish context. In this particular case, there are five components, which complement each other to create peaceful, inclusive, and harmonic environment for Närpes inhabitants. If this model to be applied in Finland or elsewhere in the world, the following should be considered; (1) there should be a support for creation of multicultural identities in order to have a prejudice free generation; (2) the values of Närpes inhabitants are welcoming, and so long there is a mutual respect in the society, there can be a presence of positive circles of interactions; (3) exposure to the foreign cultures through migration in the forms of labor, education, or marriage allow people to relate and understand the conditions of others; (4) providing free education and equal working opportunities for all, allow people feel secure to have a positive future; (5) close communication and cooperation within different sectors and institutions allow constructive dialogue creation among the inhabitants to keep them interdependent and solve their daily concerns peacefully. This Närpes model can be used as an example to form more peaceful, inclusive and violence-free social structures within not only the small-scale communities, but also in broader parts of the world.

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UNESCO Global Geoparks : A New Management Tools for Sustainable Development and Satun Aspiring UNESCO Global Geopark

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Abstract

UNESCO Global Geopark model is a new management tool for communities to manage heritages effectively and sustainably. It is one of the best practices on sustainable development regarding to protect and promote international value on geological sites. It aims to empower local communities to balance and raise awareness on how to use their heritages sustainably for the next generation. It is best management tools for local administrative organization to lead by example and manage the area from the bottom up. Instilling the locals to care and share their heritages through public education. 'Geo' part of Geopark recognized as everything that mother earth and our forefather have given us including geology, biodiversity, history, cultural heritages, intangible assets such as custom, belief, myths, and traditions. Geopark has been recognized by UNESCO since 2015 after 24 years of establishment. It is a part of International Geoscience and Geopark program (IGGP) as a new tools for balancing between the conservation of natural heritage, education, infrastructures and sustainable development of socio-economy. In 2017, there are 127 UNESCO Global Geoparks from 35 countries worldwide. UNESCO Global Geoparks support 8 Sustainable Development Goals of the United Nations 2030 Agenda for Sustainable Development especially for people, and planet. Thailand started the project on geopark since 2013 by learning from the Statutes and Operational Guidelines of the UNESCO Global Geopark and international experts. Satun Geopark is the 1st National Geopark with approved and nominated by Thailand's cabinet to apply for UNESCO Global Geopark through Thai National Commission for UNESCO since 2016. It located in Southern Thailand. It has strongly supported and collaborated by many stakeholders and strategic partners including local and central organizations. After establishing geopark, new concept of tourism – geotourism has created. Communities get new opportunities such as extra income, job creation, infrastructures, new local products which related to geology and natural resources. The Petra Islands National park has new model of mutually beneficial collaboration with local communities. Local schools have materials and program for students' outdoor learning. They can better understand their place and heritages especially fossils and geology. Nowaday, Satun Aspiring UNESCO Global Geopark has been known as Fossil Land. It is 1 of 18 submitted applications by Member States for the nominations of UNESCO Global Geoparks. Application dossier of Satun Aspiring UNESCO Global Geopark already passed the desktop evaluation, field evaluation and recommendations on applications by the UNESCO Global Geoparks Council since September 2017. The final decision by the Executive Board of UNESCO will be decided during its spring session.

Keywords: Geopark, Sustainable Development, UNESCO Global Geoparks, Satun Geopark, Thailand Geopark

1. Introduction

Geopark is one of the best sustainable development tool for protection and promotion of geological heritages internationally by local communities involvement. Geopark concept was introduced through a global network since 1991. It took 24 years until the International Geoscience and Geoparks Programme (IGGP) was approved as a programme of UNESCO on 17 November 2015. This program comprises the International Geoscience Programme (IGCP) and the UNESCO Global Geoparks aims to promote sites of international geological value on the basis of local sustainable development. In 2017, there are 127 UNESCO Global Geoparks in 35 countries, varying in size from 57 to 12,884 km^2. [1] There are 49 UNESCO Global Geoparks from 6 countries in Asia-Pacific Geoapark Network (APGN) including 35 areas in People Republic of China, 8 areas in Japan, 2 areas in Indonesia, 2 areas in Republic of Korea, 1 area in Vietnam and 1 area in Malaysia.[2]

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The United Nations Educational, Scientific and Cultural Organization (UNESCO) defines UNESCO Global Geoparks as "A single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development". [3] Many people confuse about "Geo" which is part of Geopark. It does not mean geology but it came from Greek word. Mc Keever explained that "Geo" refers to 'Gaia'- Earth itself, and everything that Earth has given us and every way it has shaped us including geodiversity, biodiversity, cultural diversity and even the diversity of our intangible heritage are so intimately linked." [4] Komoo and Patzak added some details that "the geopark concept is defined as one of the sustainable development tools that can ensure balance between three main elements, namely : conservation of heritage resources; development of tourism and infrastructure; and enhancement of local participation and socio-economic development".[5]

The Geopark concept was implemented in Thailand by the Department of Mineral Resources since 2014. Satun province accepted geopark as the tool for sustainable development of the area and established the new aspiring geopark, namely Satun Aspiring Geopark. By the strongly supported of many stakeholders and partnerships including ; local communities, travel agencies, restaurants, hotels, local communities enterprises, schools, community college, universities, provincial administrative organization, subdistrict administrative organizations, Satun Office of Natural Resources and Environment, national parks, wildlife sanctuary, Department of Mineral Resources and etc., especially the experts from Global Geoparks Network (GGN), Asia Pacific Geoparks Network (APGN), and European Geoparks Network (EGN). Satun Aspring Geopark was established since 2014 and declared as the 1st Thailand National Geopark. The application dossier for nomination as UNESCO Global Geopark of Satun Aspiring Geopark was approved by Thai cabinet and nominated to Chief of Section, IGGP Secretary of Section on Earth Sciences and Geohazards Risk Reduction via Thai National Commission for UNESCO since 2016. Satun Aspiring UNESCO Global Geopark has international significance on the richest diversity of Paleozoic fossils, international value of the region and well known globally by geologists, paleontologists and researchers. Satun Aspiring UNESCO Global Geopark is one of the best geopark model for Thailand regarding sustainable development with bottom up approach - community based development. which concern the 2030 Agenda for Sustainable Development for all people and sectors based on societal and geographical conditions.

2. Objective

To study the UNESCO Global Geopark concept as the new management tools for sustainable development of Satun Aspiring UNESCO Global Geopark, Thailand.

3. UNESCO Global Geopak

3.1 Geoparks' concept and development

Geopark is the new tool aimed to protect the geological heritages and promote sustainable development. It comes from 2 words, Geo and Park. McKeever explained that "Geo" part of Geopark refers to 'Gaia' – Earth itself, and everything Earth has given us and every way it has shaped us.[1] Many people get confused on geopark. It does not mean the protection and conservation of geological heritages only. It was the concept which concern the protection between socio-economic, cultural development and conservation of the natural environment for the next generation.

John said that "Philosophy behind the Geopark concept was first introduced at the Digne Convention in 1991" , aimed to protect and promote geological heritage and sustainable development through a global network and it was introduced to support national and international endeavours in Earth heritage conservation in 1997.[6,7] After that, the European Geopark Network (EGN) and the Chinese National Geoparks Network (CNGN) were created in 2000 and a year later, in 2001, EGN was placed under the auspices of UNESCO. In 2004, 17 European and 8 Chinese geoparks came together at UNESCO headquarters in Paris to form the Global Geoparks Network (GGN) where geological heritage initiatives contribute to and benefit exchange and cooperation among their membership of a global network.[7] Global Geopark Network members increase year by year until 17 November 2015, the 195 Member States of UNESCO voted to accept the creation of a new label, the new official brand, the International Geoscience and Geoparks Programme (IGGP), during the 38th General Conference in Paris. Geopark is a part of IGGP, which mainly promotes sites of international geological value on the basis of local sustainable development. This expresses governmental recognition of the importance in managing outstanding geological sites and landscapes in a holistic manner.[8]

UNESCO defines UNESCO Global Geoparks as :

> …a single, unified geographical area where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development. A UNESCO Global Geopark uses its geological heritage, in connection with all other aspects of the area's natural and cultural heritage, to enhance awareness and understanding of key issues facing society, such as using our earth's resources sustainably, mitigating the effects of climate change and reducing natural disasters-related risks. By raising awareness of the importance of the area's geological heritage in history and society today, UNESCO Global Geoparks give local people a sense of pride in their region and strengthen their identification with the area. The creation of innovative local enterprises, new jobs and high quality training courses is stimulated as new sources of revenue are generated through geotourism, while the geological resources of the area are protected. [9]

UNESCO Global Geoparks aims to empower local communities and give them the opportunity to develop cohesive partnerships with the common goal of promoting the area's significant geological processes, features, periods of time, historical themes linked to geology, or outstanding geological beauty. UNESCO Global Geoparks are established through a bottom-up process involving all relevant local and regional stakeholders and authorities in the area (e.g. land owners, community groups, tourism providers, indigenous people, and local organizations). This process requires firm commitment by the local communities, a strong local multiple partnership with long-term public and political support, and the development of a comprehensive strategy that will meet all of the communities' goals while showcasing and protecting the area's geological heritage.[3]

3.2 UNESCO Global Geopark and the United Nations Sustainable Development Goals

The United Nations inform us on their formal website that "UN member countries adopted a set of goals to end poverty, protect the planet, and ensure prosperity for all as part of a new sustainable development agenda." [10] UN believes that the specific targets of each goal can be achieved over the next 15 years. A set of goals demonstrate the scale and ambition of this new universal Agenda called the United Nations' 2030 Agenda for Sustainable Development which is a plan of action for people, the planet, prosperity, peace and partnership. [11,12] From the UNESCO websites inform that UNESCO Global Geoparks contributing to 8 Sustainable Development Goals including [9]:

Goal 1 : End poverty in all its forms everywhere (especially target 1.5)

Disaster risk reduction is essential about ending poverty and fostering sustainable about development. The bottom-up approach of the UNESCO Global Geoparks reduces the vulnerability of local communities to extreme events and other shocks and disasters through active risk awareness and resilience training.

Goal 4 : Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all (especially target 4.7)

UNESCO Global Geoparks actively educate their local communities and their visitors of all ages. They are outdoor classrooms and incubators for sustainable development, sustainable lifestyles, appreciation of cultural diversity and the promotion of peace.

Goal 5 : Achieve gender equality and empower all women and girls (especially target 5.5)

UNESCO Global Geoparks strongly emphasize the empowerment of women through educational programmes or the development of women's cooperatives which provide an opportunity for women to obtain an additional income in their own area and on their own terms.

Goal 8 : Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all (especially target 8.9)

The promotion of sustainable local economic development through sustainable (geo) tourism is one of the key pillars of a UNESCO Global Geopark. This creates job opportunities for the local communities through tourism, but also through the promotion of local culture and products.

Goal 11 : Make cities and human settlements inclusive, safe, resilient and sustainable (especially target 11.4)

Protecting, safeguarding and celebrating our cultural and natural heritage are the foundation of the holistic approach of the UNESCO Global Geoparks. UNESCO Global Geoparks aim to give local people a sense of pride in their region and strengthen the identification with the area.

Goal 12 : Ensure sustainable consumption and production patterns (especially target 12.8 and 12.b)

UNESCO Global Geoparks educate and create awareness on sustainable development lifestyles. They teach the local communities and visitors to live in harmony with nature.

Goal 13 : Take urgent action to combat climate change and its impacts (especially target 13.3)

All UNESCO Global Geoparks hold records of past climate change. Through educational activities awareness is raised on the issue and people are provided with knowledge to mitigate and adapt to the effects of climate change.

Goal 17 : Strengthen the means of implementation and revitalize the global partnership for sustainable development (especially target 17.6, 17.9 and 17.16)

UNESCO Global Geoparks are all about partnership and cooperation, not only between local stakeholders, but also internationally through regional and global networks were knowledge, ideas and best practices are shared. Experienced geoparks guide aspiring geoparks to reach their full potential.

3.3 UNESCO Global Geoparks : protection with sustainable development

UNESCO Global Geopark promotes that best geopark should have 4 essential dimentions including geological heritage of international value, management, visibility and networking. [3]

According to the publication of UNESCO on UNESCO Global Geopark, the fundamental features which are an absolute prerequisite for an area to become a UNESCO Global Geopark including :

1) International value of Geological Heritage: This is the most important part of all goepark in order to become the UNESCO Global Geopark. UNESCO Global Geoparks must have the geological heritage of international value. This will be assessed by scientific professionals as part of the “UNESCO Global Geopark Evaluation Team”. Based on the international peer-reviewed, published research conducted on the geological sites within the area.

2) Management: UNESCO Global Geoparks are managed by a body having legal existence recognized under national legislation. This management body should be appropriately equipped to address the entire area and should include all relevant local and regional actors and authorities. UNESCO Global Geoparks require a management plan, agreed upon by all the partners, that provides for the social and economic needs of the local populations, protects the landscape in which they live and conserves their cultural identity. This plan must be comprehensive, incorporating the governance, development, communication, protection, infrastructure, finances, and partnerships of the UNESCO Global Geopark.

3) Visibility: UNESCO Global Geoparks promote sustainable local economic development mainly through geotourism. In order to stimulate the geotourism in the area, it is crucial that a UNESCO Global Geoparks has visibility. Visitors as well as local people need to be able to find relevant information on the UNESCO Global Geopark. As such, UNESCO Global Geoparks need to provide information via a dedicated website, leaflets, and detailed map of the area that connects the area’s geological and other sites. A UNESCO Global Geopark should also have a corporate identity.

4) Networking: A UNESCO Global Geopark is not only about cooperation with the local people living in the UNESCO Global Geopark area, but also about cooperating with other UNESCO Global Geoparks through the Global Geoparks Network (GGN) , and regional networks for UNESCO Global Geoparks, in order to learn from each other and, as a network, improve the quality of the label UNESCO Global Geopark. Working together with international partners is the main reason for UNESCO Global Geoparks to be a member of an international network such as the GGN.Membership of the GGN is obligatory for UNESCO Global Geoparks. By working together across borders, UNESCO Global Geoparks contribute to increasing understanding among different communities and as such help peace-building processes.

According to the 4 pillars of UNESCO Global Geoparks, All pillars are very important part of all UNESCO Global Geoparks to confirm that geopark has the international value of geological heritages and managed in long term by management body regally. Management body should concern and focus on 10 key elements including : natural resources, geological hazards, climate change, education, science, culture, women, sustainable development, local community, indigenous knowledge and geoconservation. For eco-socio-economic development of the area, geotourism is key issues so visibility should be provided properly for visitors including infrastructures, interpretation panels, sign board, parking lodges, public transportation, websites, leaflets, brochures, maps and etc. UNESCO Global Geopark integrates both tangible and intangible heritages of the area together and promote as ideal destinations for educational activities but distraction or sale of original ornamental geological material is not permitted. [13] Networking is also a key feature of UNESCO Global Geopark both internal and external networking. Internal networking means the cooperation among local stakeholders and key partners including local communities within geopark area. External networking is the collaboration between geopark and other networks included national or international networks. Networking is

very important activity especially for capacity building, learning from other geopark experiences and practices, sharing the knowhow and knowledge among researchers, geologists, teachers, students, managers or local enterprises.

UNESCO has provided and published the Statutes and Operational Guidelines of the UNESCO Global Geoparks via the official website to assist the area to set up the the UNESCO Global Geopark including application dossier, self-evaluation form, template of geological and geographical summary and the timelines for UNESCO Global Geopark proposal and evaluation procedure [14] After the Aspiring Global Geopark submit the application dossier and pass the verification check. The experts form IUGS will do desktop evaluations then 2 nominated field assessors from UNESCO will visit Geopark for 3-4 days. The assessors' report will be recommend by the UNESCO Global Geoparks Council in September and decision will be finalized by the Executive Board of UNESCO during its spring session. After reward the UNESCO Global Geopark label, all geoparks shall be subjected to a thorough revalidation every 4 years.

3.4 UNESCO Global Geopark in Thailand : Satun Aspiring UNESCO Global Geopark

Satun province has been known widely as the destination of palaeontologists, geologists geomorphologists, and stratigraphers from around the world since 1951. It was a part of the Shan-Thai (Sibumasu) paleocontinent during the Lower and Middle Paleozoic. The Lower to Middle Paleozoic rocks with a variety of fossils outcrop in this area including the oldest fossils are represented by trilobites in the Upper Cambrian of the Tarutao Group, especially five new species of trilobite, i.e., Thailandium solum, Eosaukia buravasi, Saukiella tarudaoensis, Pagodia thaiensis, and Coreanocephalus planulatus. [15] Based on stratigraphical and paleontological studies on brachiopods, trilobites, conodonts, microvertebrates and gastropods of many paleontologists from Australia, England, Japan and the USA, it is verified that Thai fauna can be correlated with those of Myanmar, China, Australia and South America. Fossils are protected by the Fossil Protection Act, B.E. 2551(2008).

The Satun Aspiring UNESCO Global Geopark is located exclusively within Satun province, adjacent to the Andaman Sea. It covers Thung Wa, La-ngu, Manang, and part of Mueang Satun District (Tarutao National Park and Mu Ko Phetra National Park), with a total area of 2,597.21 km^2.

Figture 1 Satun Geopark Map
Source: Department of Mineral Resources

Satun Aspiring UNESCO Global Geopark consists of four main topographical features as 1) Karst topography is karst landscape of Ordovician limestone such as monadnocks, karst towers, caves, sinkholes, lapies, springs, waterfalls, and stromatolite lapies unique to the locality. 2) The Undulating Plain are younger sedimentary rock units (Silurian to Carboniferous including Quaternary) resulting in undulating terrain. 3) The Coastal Plain in the western and southern portion of the Satun Aspiring Geopark, is covered by Holocene

alluvial sediments flowing from rivers also occur in this area to the sea. 4) Islands: All islands are located in Phetra National Park and Tarutao National Park consisting 20 islands in Phetra and La-ngu Districts and 51 islands in Mueang District, respectively. The Phetra and Tarutao islands are scenic topographic features of the proposed Geopark. Tarutao Islands is already the ASEAN heritage. Some area of geopark are protected by the National Park Act B.E. 2504 and some are managed by communities.

The population living within Satun Aspiring Geopark area, excluding Pethra and Tarutao National Parks, is about 113,110 people. In addition to ethnic Thai (including Buddhists, Muslim, and Christians), there are minority groups of indigenous people living in the proposed geopark, such as the Semung or Maniq ethnic group, which is a nomadic forest dwelling tribe thriving within inland evergreen forests and the Urak Lawoi or "Chao le" in Thai language who reside on the islands of LiPe and Adang, in the Adang Archipelago. The current population of the Maniq group in Satun Aspiring Geopark (Thungwa and La-ngu Districts) is approximately 100 people. The population of Chao le or sea dwellers is approximately 1,000 people. They live simply and independently on boats near the coastal area. The two ethnic groups live their lifestyle simply and closely connected to nature with their own languages, traditions, cultures, and beliefs

According to the rich uniqueness of geological heritages, Subdistrict Administrative Organizations, local Schools - Kamphaeng Witthaya School and Thungwa Worawit School, Satun provincial Administrative Organization, Satun office of Natural Resources and Environment, Songkhla Rajabhat University, Nakhon Ratchasima Rajabhat University Department of Mineral Resources and many stakeholders created the special event as the 1st Satun Fossil Festival, aimed to promote the fossils and geoheritages to the public in 2014. It was success, more than 30,000 visitors attended. Then all stakeholders realized that this unified area must be protected and promoted to the public for education and tourism internationally. Geopark concept presented by Department of Mineral Resources in the early of 2014. Therefore, Satun Geopark was established and celebrated as the provincial geopark since August 14th, 2014.

Satun Aspiring Geopark has the management organization which appointed by the governor of Satun province and led by Mr. Narongrit Thungprue, director of Satun Geopark. Satun Geoapark signed the memorandum of understanding in term of formal collaboration and strengthening the network among many stakeholders and partners in multi-levels from local to central government services including Provincial Admistrative Organizations, Subdistrict Administrative Organizations, schools, universities, community college, research institutes, tourism agencies, national parks, wildlife sanctuary, communities, local enterprises, hotels, restaurants and etc. for the sustainability of the whole project.

Satun Geopark encourage local communities especially women group to participate the project in many dimensions including creating new products as geoapark products such as the fossils and natural dye batik and bateh by Panya Batik group. New batik and bateh geopark products have the identity and create higher price which geological story and natural friendly. Chim's melon with special taste and texture from Chim Melon Farm. It is a geopark agricultural product relates to the underground water of Karst landscape which contain high concentrate of calcium and magnesium substances. These both elements are important substances for the plants' cell wall development. The fossil pattern on Chim's melon creates the business extra price at least 30% per one melon. A sweet sticky rice in nepenthes pitcher plant is local traditional sweet which local community bring it back. Nepenthes pitcher plant farm has been established and opened for visitors as a learning center for 3 years. The old pitchers are cut for cooking - steamed sticky rice with coconut milk. This is traditional culture of locals. Many unique menus are created and provided by the local restaurants, geopark hotels, local homestay by Stegodon Homestay group – group of women nearby stegodon cave provide their houses as the certified homestay for visitors including local foods and some traditional cooking or handicraft short course, local geopark guides – local people who have additional trained by local community college in term of geological and natural heritage of the area. Kayaking group – local communities who have the para rubber wood farm in the geosite area. After work, they provide kayaking boat and kayaking trails for visitors. They can get additional income from kayaking service in many geosites, more than 40% additional income monthly.

Satun Geopark encourages and supports local school to get involved in this project – Thungwa Worawit school, geopark school is one of the best practiced school which integrated a regular class curriculum with local heritages education. Geological learning centre established and developed by Department of Mineral Resources then, this centre is later operated and supported by Science program of Thungwa Worawit school. Learning centre provides education materials, exhibition and fossils which were found locally by students and teachers. According to the uniqueness of geological heritages (especially rich of fossils), some students were trained to be local guides by local geologist so they can provide some simple information on local geological heritage including the evolution of their land too. Expanding passion and knowledge from one student to other

student, parents, family members and public, more people understand about their area and proud of their heritage. Raising awareness to more and more people to take care of their natural resources for next generation.

Satun Geopark has been well known by school, colleges, universities in the region. It is one of the best outdoor classroom and laboratories of Earth sciences about 500 million years ago. It is the simple evidence for students and visitors to understand the revolution of Earth and create awareness on sustainable development lifestyles, live in harmony with nature and take care of their earth for the next generations.

Satun Geopark has a strong network among the existing UNESCO Global Geoparks including international experts from UNESCO, Global Geopark Network and Asia-Pacific Geopark Network (APGN) and European Geopark Network (EGN) especially Langkawi UNESCO Global Geopark, Chinese Geopark Network and Japanese Geopark Network. Networking is very important issues for Satun Geopark development and management especially in the beginning stage of geopark establishment. Networking is the basic features to strengthen all partners and stakeholder together. It is the best practice for learning from other geopark experiences and knowledge sharing. Geopark is a dynamics process. New activities and projects need implementation and stepping forward.

Satun geopark is one of the best jigsaw to learn about our Earth evolution about 500 million years ago, the best international value outdoor classroom and laboratories of Paleozoic ocean accompany with abundant varieties of fossils. This is the heritage of all mankind. It is a sense of pride for Satun people to share with others. It should be protected and promoted globally. Therefore, on November 8th, 2016, the Thai Carbinet approved the Satun Geopark application dossier to be nominated as the UNESCO Global Geopark. The evaluation mission was done between July 24th - 29th , 2017 by the UNESCO nominated assessors from Portugal and People Republic of China. Recommendations on applications by the UNESCO Global Geoparks Council has been done since September 2017. The final decision by the Executive Board of UNESCO will be decided during its spring session.

Satun Aspiring UNESCO Global Geopark can be one of the best model for Thailand sustainable development empowering local communities involvement according to 2030 Agenda for Sustainable Development and one of the model, which support the development approach on Sufficiency Economy Philosophy (SEP) which has great relevance and wide applications for all people and sectors both poor and affluent alike based on societal and geographical conditions. [16]

4. Conclusions

Geopark is the new integrated management concept which created and developed by Chinese and European networks. Global Geopark is part of the International Geoscience and Geopark program of UNESCO. UNESCO Global Geopark promotes sites of International Value and are the basis of local sustainable development. It is one of the sustainable development tools to ensure the balance between conservation of heritage, development of tourism and infrastructure and enhancement of local participation and socio-economic development. There are 127 UNESCO Global Geopark in 35 countries around the globe in 2017.

UNESCO Global Geoparks support 8 Sustainable Development Goals of the United Nations 2030 Agenda for Sustainable Development including Goal 1 : End poverty in all its forms everywhere, Goal 4 : Ensure inclusive and equitable quality education and promote life long learning opportunities for all, Goal 5 : Achieve gender equality and empower all women and girls, Goal 8 : Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all, Goal 11 : Make cities and human settlements inclusive, safe, resilient and sustainable, Goal 11 : Make cities and human settlements inclusive, safe, resilient and sustainable, Goal 12 : Ensure sustainable consumption and production patterns, Goal 13 : Take urgent action to combat climate change and its impacts and Goal 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development.

UNESCO Global Geoparks has 4 essentials which support the aims of geopark including geological heritage of International Value, management, visibility and networking. UNESCO Global Geoparks are focusing on both tangible and intangible Resources of the area including natural resources, geological hazards, climate change, education, science, culture, women sustainable development, local and indigenous knowledge and geoconservation. In order to achieve the standard of UNESCO Global Geopark, Aspiring Geoparks should follow the Statutes and Operational Guidelines of the UNESCO Global Geoparks. Visibility is very important part. Aspiring Geopark should provide the visibility in the area for visitors and local communities. Management requires a solid, efficient, flexible and capable structure, system and process which cover protection, promotion, education, socio-economic development and progress of the geopak.

Satun Aspiring UNESCO Global Geopark, located in Southern Thailand with a total area of 2,597.21 km^2 is the 1st Thai National Geopark nominated as the UNESCO Global Geopark by Thai government in 2016.

It was formed by the requirement of communities, aimed to protected and promoted their heritage sustainably. It is action from the bottom up. It took at least 3 years to reach the UNESCO Global Geopark criteria by the strongly support of many stakeholders and strategicf partner including the Satun governor office, Satun office of Natural Resources and Environment, Provincial Administrative Organization, 14 subdistrict Administrative Organizations, 2 subdistrict municipalities, Department of Mineral Resources, national parks, wildlife sanctuary, universities, community college, schools, local enterprises, hotels, restaurant, travel agencies, local communities and etc. Satun UNESCO Global Geopark has a strong network among the existing UNESCO Global Geopark including international experts from UNESCO, Global Geopark Network and Asia-Pacific Geopark Network (APGN) and European Geopark Network (EGN)

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Managing Sustainable Development

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Abstract

Appropriate management strategies can be advanced for sustainable development using broad-based development strategies that benefit most humans throughout the world for the foreseeable future without causing harm to humanity, resources and environment. Gradually new approaches to development are taking place in the increasing number of wind turbines and solar panel installations, planting new trees and introducing eco-literacy curricula in schools and in many other intuitive ways. Sustainable development may be relatively slow, but it does not do long term harm to environment and humanity. Any nation can play a leading role in developing management strategies for sustainable development with good local applications within a global framework. Population groups in various parts of the world practiced in sustainable development before industrialization, elements of which can be revived now. Modern technology of war, internal combustion engines, deforestation, toxic waste, and other assaults on sustainability often cause long term harm to our environment and dampen our spirit of sustainable development. Despite these obstacles, peoples are rededicating themselves to replace wars by peace and hate by love for the planet and humanity and measurable progress towards sustainable development goals. Sustainable development needs to be supported by careful selection of technology, investment in peace, education and research. Deceptive paradoxical claims about accelerated development should be rejected and their impact on environment needs to be investigated. Development of mathematical models of sustainability for specific applications can be key to identifying which variables to manage for the best results. Research on sustainable development is challenging, because it requires robust multidisciplinary approaches and without a large multidisciplinary team of experts it is difficult to treat various research aspects adequately. However, collaborative research teams of experts can be created taking participants from multiple nations and disciplines in order to serve humanity with a long term view of sustainable development.

Keywords: air pollution, automobiles, environment, economy, global warming

1. Introduction

From our collective knowledge and experience of the past few thousand years we have come to realize that we have a profound relationship with Planet Earth: we need the Earth as the Earth needs us. We need the Earth for sustainable development so that our next generation can live on it without facing catastrophic environmental disasters. The Earth needs us to take friendly actions for cleaning its air and environment for sustaining habitat for life. Every nation wants to achieve and maintain healthy economic development with strong GDP (gross domestic product) growth. However, high GDP growth rates must not be an end in themselves. For example, high GDP growth accompanied by high growth in environmental hazards is not desirable. It is always important to consider potential side effects of growth processes. For example, processes which cause cancer or other health hazards to us or our children, are not likely to be acceptable. In a shared environment, wealth creation that is accompanied by damaging each-other's children's long term health or potentials, is not acceptable. We live in a society. We depend on each-other in so many ways. We share the air we breathe, the seasonal changes, and the planet earth in so many intricate ways that are often not immediately perceived. In consideration of these shared interests, concerns, potentials and risks, we need to reconsider our global citizenship, shared responsibilities, and sustainable development goals. When we think about development we must take into consideration related issues such as possible chemical hazards, climate change, environmental consequences and long-term benefits.

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Human groups often do not agree on these issues. However, collegial discussions with mutual respect need to be conducted for the benefit of all. Hopefully, our discussions will lead to better understanding of each-other's concerns as well as information exchange and exchange of mutually beneficial ideas. The problem is global and we need to appeal to global citizenship. The United Nations and other organizations often sponsor multicultural events for better understanding of the relationships among environmental concerns, economic development, social progress and health and human issues [1].

The spirit of humanity, to which we aspire, rises to challenges and sacrifices for the good of the coming generations. The UN 2030 Agenda for Sustainable Development says, "We are determined to protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations" [1]. This can be considered, without any hostile feelings, as one of the perspectives among many others without any prejudgments.

The fact that our concerns are shared is fundamental. In addressing shared concerns we need to listen to each other. During the industrial revolution impacts on the environment, such as air pollution, were noticed even by common people. Air pollution increased rapidly with the growth of coal consumption and rapid growth of the automobile industry and other factors. According to David Wallace-Wells, unless there is a significant change to how billions of humans conduct their lives, "parts of the Earth will likely become close to uninhabitable, and other parts horrifically inhospitable, as soon as the end of this century" mainly due to climate change [2]. Many scientists who study the subject give similar warnings about internal combustion engines, use of coal, deforestation, global warming etc. with some variations. At the same time, excellent progress on reducing air pollution has been made in some parts of the world, and this should be encouraging to those parts of the world that are currently plagued with severe pollution.

In this paper, we suggest some mechanisms for developing management strategies that can be effective in reducing the impact of climate change and promoting sustainable growth. Information technology will play an important role in raising awareness about climate change. We discuss below the development of detailed mathematical models to identify specific variables that can be managed to improve sustainability. Using Information Technology to disseminate how the models work may also help in exchange of ideas and coordinating actions of various groups towards achieving the goals stated in United Nations documents [1].

The sustainable development paradigm comes with many studies. It presents a workable "alternative that supports economic viability and healthy ecosystems by modifying consumption patterns and implementing a more equitable social framework" in a pragmatic way [3]. Scientific studies about environment and climate change come with some range of uncertainties. Reasoning with uncertainties presents some challenges. However, our goal is to benefit from these studies with proper understanding and manage the risks. We want to prevent deterioration of the ecosystems on which we depend for our well-being. Taking the uncertainties into proper perspective from multiple studies is important.

2. Review of literature with perspectives

Robust exchange of ideas, views and information on sustainable development is important. Conferences, debates, journal articles, books and magazines should raise sustainable development issues and will allow scientists, engineers, policy makers and political leaders to participate in the discussions. Management of sustainable development is extremely challenging and requires carefully developed well-balanced approaches.

Most experts believe that "the popular interest in management as a discipline and a field of study is fairly recent" [4, page 12]. However, there were several pioneers such as Henry Gantt who developed planning and control techniques with a chart, popularly known as the Gantt chart as early as 1919 [5].

Modern concepts of management were developed in the U.S.A. after World War II and these are currently taught all over the world in institutions of higher education. The four main management functions one may learn in school are "planning, organizing, leading, and controlling" [6, page 5]. One may argue for adding to the list more functions and skills such as communicating, decision making, meeting ethical standards, analytical thinking, coaching, listening, negotiating, visioning and mitigating risks. There are many perspectives on sustainable development and one must be ready to listen to others to find common ground, because it is through the shared views and concepts that initial progress can be made.

One of the challenges for sustainable development is coordinating regional and national development with international institutions and other nations because some aspects of sustainable development requires global cooperation [1, 7, 8]. The United Nations published several articles related to the goals of sustainable development [1, 7, 8]. It continues to sponsor important conferences and symposia addressing very important issues about sustainability. The United Nations conferences provided forums for discussing important issues and for exchanging ideas about managing development. It became apparent that there might not be any centralized global management strategies acceptable to all nations as national leaders were primarily interested in serving their national interests only. The United Nations continued its efforts in coordinating the

development of the distributed decentralized management strategies in a global framework. In the meantime, various global conferences allowed discussions of the global nature of issues of climate change and related challenges of sustainable development. One example is the Earth Summit held in Rio de Janeiro in 1992 as the United Nations Conference on Environment and Development (UNCED) [9]. The United Nations Agenda 21 started some useful debates and critical thinking about sustainable development with objectives such as "To promote patterns of consumption and production that reduce environmental stress and will meet the basic needs of humanity;" [10]. Making statements about global sustainable development goals the United Nations promoted constructive thinking about management issues in this area. As a result, there is a better understanding of the issues today and a greater awareness that The United Nations is calling on everybody to play a role in meeting the sustainable development goals.

We can all benefit from good examples. There are some excellent examples that can be followed in order to replicate their success in many areas. Sweden, Denmark and Norway are among the top performers in sustainable development making excellent progress towards UN (United Nations) 2030 sustainable development goals [11]. "Asia-Pacific's top performers Japan, Singapore and Australia rounded off the list at 18th, 19th and 20th, respectively" [11]. There are opportunities for following some of the management strategies of these countries with appropriate adjustments for local applications.

Nevertheless, it is inevitable that some will feel threatened by proposed management changes, and some may actually be threatened. Ways need to be identified to phase in changes needed for sustainability so that organizations and individuals can absorb the changes without being forced into a position of having their "backs against a wall." If they believe the changes endanger their survival they will fight. This implies compromise, and is part of what the authors meant above when they talked about "listening to each other." Unfortunately, some of the current debate is more like a war than a dialog. Everyone loses in a war.

An important aspect of managing sustainable development is to manage waste and environmental aspects. Management of recycling plastics, metallic cans, containers, and used clothing helps our environment in addition to bringing awareness of sustainability to the general public. Many K-12 schools participate in recycling projects where students' involvement is encouraged. Some schools have an introductory course on sustainability that introduces certain basic aspects of the field in a proper context. Students who develop interests in this area may pursue an undergraduate degree in sustainability which is offered in many colleges and universities. One of the largest global recycling industries that has come into being over the last several decades is recycling of used clothing. The size of this global industry is estimated at over US$4 billion today [12] This is one example of upcycling - the process of changing and transforming waste materials into good products for better environmental value [13]. So-called eWaste is another example. Creatively developing new products from old electronic components is demonstrating excellent service to many communities in several parts of the world. Upcycling creatively makes a positive impact on the environment. Developing appropriate management strategies in more industrial sectors for upcycling will contribute towards more and better sustainable development goals.

3. A mathematical model of sustainability

Most of us have an intuitive understanding of sustainability and we are motivated to have some sustainable development goals for ourselves for our own benefits. We all practice sustainability all the time on an individual basis. To do otherwise would be foolish. We manage our finances so that we do not run out of funds. We conserve our clothing so that it will last until we have sufficient funds to replace worn out items. We manage our food, so that we have enough to last until we can replenish our supply. These few examples are sufficient to illustrate that managing sustainability is a natural and instinctive practice for survival on an individual basis. On an individual basis, we do this precisely, typically using budgets for ourselves and our families. We consider various ways in which we could spend our money and then make choices among the various alternatives. This is a relatively primitive form of mathematical modeling. Problems arise when we begin to address sustainability collectively. It is at that point that competition arises for resources whether or not they can be replenished. One person, group, or nation seeks to use a resource faster than it can be replenished, usually to gain short term profit. At a macro level, non-sustainable practices are counterproductive, because, while they may produce high levels of profit for a short time, they then produce zero or negative profits after resources are depleted. One issue is what is meant by "short time". For sustainability, "short term" probably implies decades and sometimes even centuries. Another issue is whether the resource being depleted is renewable, in other words temporary depletion versus permanent depletion.

From this perspective, the process of sustainability can be viewed as an economic issue, driven by depletion rates, time constraints, cost constraints, and renewability constraints. The time constant is related to the time to replenish key resources being consumed or to find acceptable alternatives (such as replacement). This may be a linear process, or it may involve some more complex relationship. Ideally, we can look at a simple equation stating that the amount we use of a particular resource over a particular time must not be greater than the amount of resource that can be replenished in the same amount of time. This can be stated as:

$$\int_{t1}^{t2} D(t)dt \leq \int_{t1}^{t2} R(t)dt$$

Where D(t) = the depletion as a function of time for a resource and R(t) = the replenishment as a function of time for the resource. t1 = the starting point in time for sustainable management of the resource and t2 = the end point for a particular management period. The variables, "D(t)" and "R(t)", can be quite complex functions, reflecting various approaches to production and to replenishing or replacing resources that are being consumed over the same time period. This simple equation can be extended to multiple resources, but it must be at the heart of any sustainable management practice. Both sides of the equation are functions not only of time, but of many other variables as well.

Managing the quantity of a resource is only part of the picture. Costs must also be addressed. Businesses seek to minimize the cost of processing resources, and this drives things like economic lot sizes, which, in turn, drives the form of the function for "D(t)" in the equation above. From a societal perspective, the cost of replenishment must not exceed the cost of consuming (or depleting) a particular resource. However, the cost of replenishment may not be a cost to the organization which is using the resource; it may be a cost to another organization, or even to a single country. As a result, there may not be a business motivation for ensuring that depletion and replenishment are synchronized.

Cost is a powerful motivation for sustainability on an individual basis, but when the cost accrues to someone other than the individual or organization using up the resource, that missing or mismatched cost motivation makes sustainable management practices difficult. This implies that the integration on the left side of the equation (the depletion side) must go over all individuals and organizations contributing to the depletion, while the integration on the right hand side of the equation must go over all who are concerned with the corresponding replenishment and/or replacement processes. This implies that, in addressing sustainability, we must take a "big picture" view of the process, or at least a "bigger picture" view than is apparent to many organizations.

If the "cost of replenishment" is viewed as a cost to society, it may be treated as a cost to an entire country. It may then be possible to transfer the cost to the organization(s) responsible for the depletion. This could be in the form of taxes, but taxation is a very contentious process, and fraught with political issues. Carbon offsets are an example of an only slightly less contentious approach to transferring responsibility for the cost of "depletion" in the form of pollution of the atmosphere, to entities responsible for the depletion. In this case, we are all responsible for production of excess CO_2 but some activities produce much more CO_2 than others.

True management of sustainability requires identification of a correct set of variables for each side of the equation. In reality the process is too complicated to be reduced to such a simple equation. Instead, each side of the equation must be replaced with mathematical simulations of the depletion process on the left hand side and the replacement or repair process on the right hand side. By developing such simulation models, we can analyze variables on both side of the equation to identify the most important ones; these will be the variables that we seek to manage. Exploring options for the variables requires complex simulation models, using information technology.

A number of simulation models for sustainability have been developed, and more are needed in the future. One example is the work done by Jason Phillips in applying a mathematical model of sustainability to an environmental impact assessment of iron ore opencast mines. This very detailed work, employing the Folchi method [14], suggests how mathematical models can be developed to identify critical variables to be managed for sustainability [15]. Another example is the work done Galal and Moneim [16] in their mathematical analysis of an optimal sustainable product mix for the process industry. They devised a complex mathematical model "to help decision makers in setting up their product mix and other vital operating parameters, so as to maximize manufacturing sustainability." These are but a few of many encouraging examples of detailed mathematical models for managing specific aspects of sustainability. Technology will help in the process of sustainable development in many ways [17].

A geoengineering approach to reduction of global warming is considered by some scientists [18-19] which involves spraying reflective particles into the stratosphere using airplanes or tethered balloons. A "simple model to account for the potential effectiveness of solar radiation management" is presented in [18]. Cost-effectiveness is considered to be one of the main advantages of this approach; however, it has potential environmental risks.

4. Conclusions

A consensus on sustainable development is likely to emerge soon. However, deeper understanding of underlying commonalities among multiple threads and viable models is being achieved due to persistent efforts. Such models represent a modest beginning of sustainable development that is underway in many parts of the world with enormous potentials. Its long-term implications include some profound socioeconomic transformations with global supports for building healthy ecosystems. Managing sustainable development is challenging; however, it also presents opportunities for the future. One of the challenges is that the fruits of sustainable development cannot be usually realized in a short period, because it often takes decades to see measurable effects. So, now is the time to get started. We have a profound realization that we need to work together with everybody in a cooperative friendly manner for a very long time in order to achieve our brilliant goals. Let our sustainable development journey begin with joy. A possible direction of study could be further development of a model of sustainable development management.

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Promoting Sustainable Development Goals through Corporate Social Responsibility (CSR) Practices: Cases of Rural Hotels in Bali, Indonesia

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Abstract

Sustainability issue is gaining its significance worldwide as the United Nation sets 17 sustainable development goals (SDGs) to be achieved by 2030. Various approaches have been undertaken by many countries to promote SDGs. Many studies have also been conducted to find out the appropriate model, mechanism and method in promoting SDGs. The aim of this paper is to investigate how SDGs are promoted through CSR practices. Case studies of three big rural hotels in Bali, Indonesia were conducted. The results show that the three hotels align their business and social goals through long-term partnerships with the local society. By doing so, the economy of the local society thrives as the hotels grow. Some prominent practices are: (1) assisting the locals in cultivating organic fruits and vegetables to ensure the continuity of supply of organic produces for the hotels' restaurant, (2) green-bank initiative whereby the locals are assisted in reducing, reusing and recycling the wastes to maintain the cleanliness of the hotels environment, (3) employing the locals to obtain support from the local society, (4) English course program for the locals to enable better interaction between the hotel guests and the locals. CSR practices of the three hotels have contributed to the effort to combat poverty and hunger, improve the health and wellbeing, improve quality education, promote decent work and economic growth. However, promoting the 17 SDGs requires not only the private sectors but also the government efforts. This paper contributes to the body of knowledge related to the SDGs by revealing how SDGs could be promoted through CSR practices. This paper also shows that it is possible to align business and social goals through CSR practices.

Keywords: sustainable development goals, corporate social responsibility practices, rural hotels, emerging economy

1. Introduction

On September 25th 2015, the United Nations (UN) sets 17 Sustainable Development Goals (SDGs) to be achieved by 2030. The goals are: 1. No poverty, 2. Zero hunger, 3. Good health and well-being, 4. Quality education, 5. Gender equality, 6. Clean water and sanitation, 7. Affordable and clean energy, 8. Decent work and economic growth, 9. Industry, innovation and infrastructure, 10. Reduce inequalities, 11. Sustainable cities and communities, 12. Responsible consumption and production, 13. Climate action, 14. Life below water, 15. Life on land, 16. Peace, justice and strong institution, 17. Partnerships for the goals. The UN stresses the importance of involvement of many parties, such as governments, private sectors, NGOs and civil society in reaching the goals by 2030.

The academia and researchers contribute in promoting SDGs by conducting research to investigate various approaches, models and mechanisms applied to promote SDGs. One stream of research related to this matter is research on Corporate Social Responsibility (CSR). Altough the number of research on CSR has increased significantly in the last few decades, until now there is no agreed single definition of CSR. The definition of CSR spans from a mere philanthropy activities [1-3] to a complex business strategy [4, 5]. However, the components of CSR are consistently being discussed in the literature, such as concern for economics, legal, ethical, people/ stakeholders and the environment. Among those definitions, the CSR definition used by The Commission of the European Communities is the most cited [6, 7]. CSR is defined as "a concept whereby companies integrate social and environmental concerns in their business operations and in their interactions with their stakeholders on a voluntary basis" [6]. This paper adopts CSR definition defined by The Commission of the European Communities.

The concept of CSR is closely related to the idea of sustainability whereby a company bears responsibility to *take full account of its current and future economic, social and environmental impacts. Hence,*

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investigating CSR practices of certain companies could reveal alternative method in promoting UN SDGs. With this regard, this paper contributes by revealing how UN SDGs are promoted through CSR practices.

2. Objective

The objective of this paper is to investigate how Sustainable Development Goals (SDGs) are promoted through Corporate Social Responsibility Practices (CSRPs)

3. Methods

In order to achive the objective of this paper, case studies were conducted on three big rural hotels in Bali. Two hotels are located in Ubud - Gianyar and one hotel is located in Manggis - Karangasem. Ubud is well known as a favourite tourist destination for spiritual retreats and holistic healings. Most hotels in Ubud are located along the bank of the Ayung River. Manggis is famous for its pristine beaches and authentic traditional culture. Big rural hotels are chosen as the object of the case studies for several reasons: 1. Big hotels bring about greater impact to the society and the natural environment, 2. Rural hotels are much dependent on the natural environment, and 3. As most rural hotels are nested in traditional villages, maintaining harmonious relationship with the locals is very important for these hotels. By choosing big hotels that have great dependency on the natural environment and the local society, rich information related to Corporate Social Repsonsibility Practices (CSRPs) is expected can be obtained.

Case study is one type of qualitative study which focus on investigating certain issue or problem exist in certain setting or context [8]. In a case study, certain phenomenon is explored deeply through in-depth data collection from various sources of data. This study collects data through hotels' websites and interviews with hotels' general managers. All participants had been informed prior to the interview that they are guaranteed anonymity. This procedure is applied to minimise social desirability bias, i.e., the participants possibly inaccurately answer questions to present themselves in a more favourable light [9]. The interviews ranged from 45 to 90 minutes in duration. The interviews were conducted in English, Bahasa Indonesia, and some Balinese language. The translations of the interview transcripts to English were checked by a professional translator.

The interview transcripts were coded with the help of NVivo11. Segments of the interview transcripts were then organised according to the core themes identified and quotations that represent a particular theme were extracted from these transcript segments to add richness to the findings.

4. Results and Discussion

4.1. The Context of Bali

Bali is one of 33 provinces in Indonesia. Administratively, the province of Bali is divided into nine regions, namely Denpasar, Badung, Gianyar, Klungkung, Karangasem/ Amlapura, Bangli, Buleleng/ Singaraja, Tabanan and Jembrana/ Negara. Denpasar is the capital city of the Bali province. The locations of the regions are circled in Figure 1.

Figure 1. Bali Map (Source: www.balitravelhound.com).

The tourism industry has been the major driver of the economy of Bali. The number of international tourists visit Bali is almost 92% of the total population of Bali and made up 40% of the total international visitors visit Indonesia [10]. As such, it is clear that Bali has been the main driver of the tourism industry in Indonesia. Hence, the context of Bali is significant for tourism research in Indonesia.

Although the vast development of mass tourism in Bali brings benefits to the economy of Bali, it also creates numerous problems. The problems can be categorised as social, cultural and environmental problems. Therefore, it is very important to investigate the hotels efforts in maximising their contribution to the local society and economy without imposing negative impacts to the environment. Such efforts are discussed deeply in the following sub sections.

4.2. Case 1

Hotel 1 promotes itself as a premium residential health retreat combining holistic healing with exceptional villa accommodation. The hotel is located along the bank of the Ayung River where the natural environment is still pristine. It is also nested in the traditional Balinese villages. The hotel management realises the importance of preserving the natural beauty of its environment and maintaining harmonious relationship with the local society in ensuring the sustainability of the hotel operation. As stated by the general manager, "*I think definitely nowadays more people will come to a resort if they know you care about the environment. They are coming more if they know that you have got the CSR programs in place*". In general there are two types of Corporate Social Responsibility (CSR) practised by the hotel, namely CSR to the local society and CSR to the environment.

The hotel employs many local people. More than 75% of total staff are local people living in the surrounding villages. This policy is driven by motivation to support the villages by providing the opportunity to the locals to get a better future. The hotel also contributes to the economy of the local society by supporting the local entrepreneurs. The hotel is committed to source hotel supplies from the local community, "*We're buying products from local suppliers so we're supporting local entrepreneurs. We're not gonna sourcing outside from Bali. It's a sort of social responsibility in terms of taking care about local production plus reducing the footprint as well*". Besides contributing to the economy of the local society, the hotel also actively engages in various educational programs, such as health education, English language and literacy, and support for primary schools and kindergartens.

In terms of effort to preserve the environment, the hotel involves the local farmer. The hotel provides technical assistance and support for the local farmers to produce organic produces. By doing so, the hotel could ensure sustainable supply of organic produces for its kitchen, at the same time fosters the economic growth of the villages and contributes to the environment preservation effort. The hotel is also committed to use natural products only in its property. It is not just because it is good for the environment but also because it is expected by the guests, "*When you go to the room you'll find that we don't use any chemical. We try to use natural products as much as possible. Our guests frequently ask what kind of product you use for cleaning, what kind of product you use for mosquitos for example*".

In case 1, the management of the hotel practises CSR as a strategic means to ensure the sustainability of the hotel operation and at the same time contribute to the society and the environment. The hotel has contributed in promoting sustainable development goals by: 1. Providing jobs and supporting the local entrepreneurs, therefore contibuted in combating poverty and promoting sustainable economic growth, 2. Delivering health education to the locals, hence promoting good health and well-being, 3. Offering support for primary schools and kindergartens → promoting quality education, 4. Promoting organic farming and using natural products → action to minimise the impact of climate change.

4.3. Case 2

Similar to hotel 1, hotel 2 is also located beside the Ayung River. It is surrounded by lush forest greenery and working rice paddies. The hotel market itself as a special place to restore body, mind and soul. The management acknowledges the interdependencies of the hotel with its surrounding. The general manager stated, *"The successful of the company depends on the surrounding, the local community, the taxi drivers, the people that do the rafting, the art gallery, the restaurant, the local villagers, suppliers and vendors. We are relying on these people. They need us also. It's a kind of mutual benefit. In the long run everybody gains and that's how the company thinks. We cannot work in the environment and being selfish. That's a short term. Maybe in the short term it helps but in the long run you start to get isolated"*. With this understanding in mind, the hotel engages in several CSR practices that bring benefits to the hotel, the society and the environment. Similar to hotel 1, hotel 2 also employs many local people and support local entrepreneurs by sourcing from within the community, as mentioned by the general manager, *"We've got 209 employees here, 207 are Balinese and we are the only two foreigners"*. Partnership with the local farmers is also practised by hotel 2. The hotel assists the farmers to cultivate rosela and cashew nut on dry and unproductive lands. By doing so, the hotel improves the economy of the local farmers and at the same time saves significant amount of money by buying produces from the local

farmers insted of importing from other areas. In terms of contribution in promoting health and well-being, the hotel is committed to regulary conducting events to raise money for cancer research in Indonesia, *"Every year we do run to collect money to support research on cancer in Indonesia"*

To sum-up, hotel 2 contributes in promoting the UNSDGs, particulary combating poverty, promoting decent work and economic growth, good health and well-being, and minimising the impact of climate change by employing the locals, supporting the local entrepreneurs, assisting the local farmers to cultivate high value produces and raising money for cancer research.

4.4. Case 3

Hotel 3 is a seaside resort in Manggis, nestled between the sea and Mount Agung. Unlike hotel 1 and hotel 2, the management of hotel 3 did not explicitly acknowledge the importance of living in harmony with the locals and the environment to the success of hotel operation in the long-run. Even though it is not explicitly acknowledged, the hotel conducts various practices to maintain good relationship with the locals and to preserve the environment. As well as hotel 1 and 2, hotel 3 also employs many local people, supports local entrepreneurs, promotes health and well-being, supports local kindergartens and uses eco-friendly products.

Hotel 3 has 2 unique programs related to the effort to preserve the natural environment, namely: green-bank initiative and coral-reef conservation program. In the green-bank initiative, the hotel educates the locals to do reduce, reuse and recycle their own wastes. The hotel also assists the villagers to make handicrafts from recycle materials and then sells their products in the hotel. The general manager explained, *"We train the locals to create handicrafts from recycle papers. We are also committed to promote and sell their handicrafts through all hotel chains"*. By doing so, the hotel could maintain the cleanliness of the hotel environment and obtains support from the locals. Hotel 3 has high concern on preserving the coral-reefs, as diving and snorkeling program is the hotel's most favourite tour program. To align business and environmental concern, hotel 3 invites their guests to participate in the coral-reefs conservation program while enjoying diving and snorkeling.

5. Conclusions

This paper shows that the United Nation Sustainable Development Goals (UNSDGs) could be effectively promoted through Corporate Social Responsibility Practices (CSRPs). Analysis of the three cases of big rural hotels in Bali – Indonesia reveals that the hotels could significantly contribute to the effort to combat poverty, to achieve zero hunger, to promote good health and well-being, to promote quality education, to promote decent work and economic growth, to minimise the impact of climate change, and to preserve life below water by engaging in CSR practices. Interestingly, by engaging in certain CSR practices the three hotels could align their business and social goals. This paper focuses on the private sectors contribution only in reaching the UNSDGs. To be more effective, efforts to promote the UNSDGs need to involve many parties, such as government, academia, NGOs and civil society. Future research could explore further how various parties promoting the UNSDGs.

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Diversity of birds in Hlawga Park, Republic of the Union of Myanmar

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Abstract

Hlawga Park, 22 miles (35 km) north of Yangon was chosen as study site. This study lasted from June 2014 to May 2015.Twenty five study sites were selected for record the bird species. Point count method was utilized to study the birds. One hundred and twenty nine species belonging to 45 families of **17** orders were recorded during the study period. Of these recorded species 99 species were terrestrial birds and 30 species were waterbirds. In the recorded waterbirds, Ciconiformes was the largest order with 10 species and Passeriformes was the largest order comprising 66 species in the terrestrial birds. In these 27 species were migratory species and 102 species were resident. Shannon Weiner Diversity Index was 2.21, Simpson's index was 0.72, Shannon evenness was 0.46 respectively. Number of bird species was largest in November and smallest in July. Species number of birds gradually declined in monsoon. In present study, maximum observed species were *Dendrocygna javanica, Anastomus oscitans, Anas poecilorhyncha* and *Garrulax pectoralis*. In total 129 bird species comprised one endemic species, three near-threatened and one endangered were identified.

Keywords: Diversity of birds, Hlawga Park, Diversity Index

1. Introduction

Myanmar has been wildly regarded as one of the biodiversity richest countries in the Asia and Pacific Region. Biodiversity is very special for our welfare since it is the major component of life supporting system. With extraordinary tropical variation, there is an unusual ecological diversity and these ecosystems are home to numerous species of fauna and flora. Myanmar supports at least 1,096 bird species, a greater diversity than any other country in mainland Southeast Asia. Despite its high species richness, Myanmar's avifauna contains six national endemic species: Hooded Treepie (*Crypsirina cucullata*), White-browed Nuthatch (*Sitta victoriae*), White-throated Babbler, (*Turdoides gularis*), Burmese Bushlark (*Mirafra microptera*), Jerdon's Minivet (*Pericrocotus albifrons*) and Burmese Tit (*Aegithalos sharpie*) [1]. Four hundred and thirty-three species of birds are recorded in Yangon. In these fourteen species are globally threatened and one species are introduced from other place [2].

2. Materials and Methods

2.1 Study Area: Hlawga Park is situated in 17°00′17″N 96°06′44″E. It is a National Park located in Mingaladon, Yangon Division, Myanmar. It is 22 miles (35 km) north of Yangon. The area of the park is 623-hectare, includes Wildlife Park, 313 hectare, a mini-zoo, 25-hectare and a buffer zone, 267-hectare .First established as an Environmental Education Center in 1982, the National Park is a popular day-trip destination with Yangonites and ecotourists [3].

The Hlawga Park is in coastal Yangon Division, and has a monsoonal climate. Annual average rainfall is about 240 cm most of which is received between late May and October. The coolest months are from November to February (average high: 32°C and average low: 18°C) and the hottest months are from March to May (average high: 37°C and average min: 24°C). The mean relative humidity is 87%. The vegetation type of Hlawga Park is Semi-evergreen forests, Mixed deciduous forests and Swamp forests [3].

2.2 Study period: This study was conducted from June 2014 to May 2015. Twenty five study sites were selected for record the bird species. Data records were taken starting from 6:00 am and continued until 11:00 am. Species abundance and population sizes of the birds were noted on monthly basis using point count method. Point count method was conducted [4].

To establish a representative collection of Myanmar indigenous wild life species of birds, and to measure the richness, evenness and diversity of bird species, Hlawga Park is selected as study site.

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2.3 Methodology:

Point count: Point count method was utilized to study the birds in Car parking, Gate 1, Gate 4, Gate 6, Gate 9, Kan Tha ya, Dam 1, Dam 4, Dam 5, Dam7, Dam 8, Lake near Dam 7, plain near Dam 7, Picnic site 1, Picnic site 2, Picnic Site 3, Picnic Site 4, feeding place 1, feeding place 2, Lake in Buffer Zone, Buffer Zone , Log cabin 1, Log cabin 2, mini Zoo, and other place. When a bird is spotted, size, color, behavior, call and time were recorded [5, 6].

Shannon-Weiner Index: Species evenness, richness, and diversity indices as Shannon-Weiner [7] and Simpson Index were used to evaluate the bird species diversity [8]. The value of Shannon-Weiner Diversity Index usually falls between 1.5 and 3.5, only rarely it surpasses 4.5. A value near 4.6 would indicate that the numbers of individuals are evenly distributed between all the species. Equitability or evenness index value was computed using Shannon's equitability index (J') method [9].

3. Results and discussion

One hundred and twenty nine species belonging to 45 families of **17** orders were recorded during the study period. Of these recorded species 99 species were terrestrial birds and 30 species were waterbirds. In the recorded waterbirds, Ciconiformes was the largest order with10 species and Passeriformes was the largest order comprising 66 species in the terrestrial birds. In these 27 species were migratory species and 102 species were resident [5,6].

Table 1 Bird species recorded during the period of study

No.	Common name	R / M	Scientific name	Family	Order
1	Quail	R	*Coturnix* sp.	Phasianidae	Galliformes
2	Red Junglefowl	R	*Gallus gallus*	Phasianidae	Galliformes
3	Green Peafowl	R	*Pavo muticus*	Phasianidae	Galliformes
4	Lesser Whistling-Duck	R	*Dendrocygna javanica*	Anatidae	Anseriformes
5	Spot-billed Duck	R	*Anas poecilorhyncha*	Anatidae	Anseriformes
6	Cotton Pygmy-goose	R	*Nettapus coromandelianus*	Anatidae	Anseriformes
7	Little Grebe	R	*Tachybaptus ruficollis*	Podicipedidae	Podicipediformes
8	Lineated Barbet	R	*Megalaima lineata*	Megalaimidae	Piciformes
9	Coppersmith Barbet	R	*M. haemacephala*	Megalaimidae	Piciformes
10	Green Bee-eater	R	*Merops orientalis*	Meropidae	Coraciiformes
11	Blue-tailed Bee-eater	R	*M.philippinus*	Meropidae	Coraciiformes
12	Chestnut -headed Bee-eater	R	*M. leschenaulti*	Meropidae	Coraciiformes
13	White-throated Kingfisher	R	*Halcyon smyrensis*	Alcedinidae	Coraciiformes
14	Black capped Kingfisher	R	*Halcyon pileata*	Alcedinidae	Coraciiformes
15	Drongo Cuckoo	R	*Surniculus lugubris*	Cuculidae	Cuculiformes
16	Indian Cuckoo	R	*Coculus micropterus*	Cuculidae	Cuculiformes
17	Plaintive cuckoo	R	*Cacomantis merulinus*	Cuculidae	Cuculiformes
18	Violet Cuckoo	R	*Chrysococcyx xanthorhynchus*	Cuculidae	Cuculiformes
19	Asian Koel	R	*Eudynamys scolopacea*	Cuculidae	Cuculiformes
20	Green-billed Malkoha	R	*Phaenicophaeus tristis*	Cuculidae	Cuculiformes
21	Greater Coucal	R	*Centropus sinensis*	Cuculidae	Cuculiformes
22	Dollarbird	R	*Eurystomus orientalis*	Coraciidae	Coraciiformes
23	Grey headed Parakeet	R	*Psittacula finchii*	Psittacidae	Psittaciformes

Table 1 (continued) Bird species recorded during the period of study

No.	Common name	M /R	Scientific name	Family	Order
24	Blossom-headed Parakeet	R	*Psittacula roseata*	Psittacidae	Psittaciformes
25	Asian Palm swift	R	*Cypsiurus balasiensis*	Apodidae	Apodiformes
26	House Swift	R	*Apus affinis*	Apodidae	Apodiformes
27	Asian barred Owlet	R	*Glaucidium cuculoides*	Strigidae	Strigiformes
28	Green Imperial Pigeon	R	*Ducula aenea*	Columbidae	Columbiformes
29	Mountain Imperial Pigeon	R	*D. badia*	Columbidae	Columbiformes
30	Orange-breasted Green Pigeon	R	*Treron bicincta*	Columbidae	Columbiformes
31	Thick-billed Green Pigeon	R	*T. curvirostra*	Columbidae	Columbiformes
32	Spotted Dove	R	*Streptopelia chinensis*	Columbidae	Columbiformes
33	Red collared Dove	R	*S. tranquebarica*	Columbidae	Columbiformes
34	Common Moorhen	R	*Gallinula chloropus*	Rallidae	Gruiformes
35	Common Coot	R	*Fulica atra*	Rallidae	Gruiformes
36	White-breasted Waterhen	R	*Amaurornis phoenicurus*	Rallidae	Gruiformes
37	Bronze-winged Jacana	R	*Metopidius indicus*	Jacanidae	Charadriiformes
38	Green Sandpiper	M	*Tringa ochropus*	Charadriidae	Scolopacidae
39	Common Sandpiper	M	*Actitis hypoleucos*	Charadriidae	Charadriiformes
40	Curlew Sandpipper	M	*Calidris ferruginea*	Charadriidae	Charadriiformes
41	Black-winged Stilt	M	*Himantopus himantopus*	Recurvirostridae	Charadriiformes
42	Little ringed Plover	M	*Charadrius dubius*	Charadriidae	Charadriiformes
43	Red –wattled Lapwing	R	*Vanellus indicus*	Charadriidae	Charadriiformes
44	Osprey	M	*Pandion haliaetus*	Pandionidae	Falconiformes
45	Crested Serpent Eagle	R	*Spilornis cheela*	Accipitridae	Falconiformes
46	Black Kite	R	*Milvus migrans*	Accipitridae	Falconiformes
47	Shikra	R	*Accipiter badius*	Accipitridae	Falconiformes
48	Oriental Honey Buzzard	R	*Pernis ptilorhynchus*	Accipitridae	Falconiformes
49	Little Egret	R	*Egretta garzetta*	Ardeidae	Ciconiformes
50	Purple Heron	R	*Ardea purpurea*	Ardeidae	Ciconiformes
51	Great Egret	R	*Casmerodius albus*	Ardeidae	Ciconiformes
52	Intermediate Egret	R	*Mesophoyx intermedia*	Ardeidae	Ciconiformes
53	Cattle Egret	R	*Bubulcus ibis*	Ardeidae	Ciconiformes
54	Chinese Pond Heron	R	*Ardeola bacchus*	Ardeidae	Ciconiformes
55	Black -crowned Night-Heron	R	*Nycticorax nycticorax*	Ardeidae	Ciconiformes

Table 1 (continued) Bird species recorded during the period of study

No.	Common name	M /R	Scientific name	Family	Order
56	Oriental Darter	R	*Anhinga melanogaster*	Phalacrocoracidae	Pelecaniformes
57	Little Cormorant	R	*Phalacrocorax niger*	Phalacrocoracidae	Pelecaniformes
58	Indian Cormorant	R	*P. fuscicollis*	Phalacrocoracidae	Pelecaniformes
59	Glossy Ibis	R	*Plegadis falcinellus*	Threskiornithidae	Ciconiformes
60	Spot-billed Pelican	R	*Pelecanus philippensis*	Pelecanidae	Pelecaniformes
61	Asian Openbill	R	*Anastomus oscitans*	Ciconiidae	Ciconiformes
62	Woolly-necked Stock	R	*Ciconia episcopus*	Ciconiidae	Ciconiformes
63	Blue winged Pitta	R	*Pitta moluccensis*	Pittidae	Passeriformes
64	Brown Shrike	M	*Lanius cristatus*	Laniidae	Passeriformes
65	Gray -backed Shrike	M	*L.tepbronotus*	Laniidae	Passeriformes
66	Black Drongo	M	*Dicrurus macrocercus*	Dicruridae	Passeriformes
67	Ashy drongo	M	*D. leucophaeus*	Dicruridae	Passeriformes
68	Greater Racket-tailed Drongo	R	*D. paradiseus*	Dicruridae	Passeriformes
69	Lesser Racket-tailed Drongo	R	*D. remifer*	Dicruridae	Passeriformes
70	Spangle Drongo	R	*D. bottentottus*	Dicruridae	Passeriformes
71	Crow- billed drongo	M	*D. annectans*	Dicruridae	Passeriformes
72	Bronze Drongo	R	*D. aeneus*	Dicruridae	Passeriformes
73	Racket-tailed Treepie	R	*Crypsirina temia*	Corvidae	Passeriformes
74	House Crow	R	*Corvus Splendens*	Corvidae	Passeriformes
75	Large-billed Crow	R	*C. macrorhynchos*	Corvidae	Passeriformes
76	Black-naped Oriole	M	*Oriolus chinensis*	Oriolidae	Passeriformes
77	Slender-billed Oriole	R	*O. tenuirostris*	Oriolidae	Passeriformes
78	Common Iora	R	*Aegithina tiphia*	Irenidae	Passeriformes
79	Rosy minivet	R	*Pericrocotus roseus*	Campephagidae	Passeriformes
80	Swinhoe's minivet	M	*P. cantonensis*	Campephagidae	Passeriformes
81	Ashy minivet	M	*P. divaricatus*	Campephagidae	Passeriformes
82	Black -naped monarch	M	*Hypothymis azurea*	Muscicapidae	Passeriformes
83	Asian browned Flycatcher	M	*Muscicapa dauurica*	Muscicapidae	Passeriformes
84	Brown -streaked Flycatcher	R	*M. williamsoni*	Muscicapidae	Passeriformes
85	Taiga Flycatcher	M	*Ficedula parva*	Muscicapidae	Passeriformes
86	Grey-headed Canary Flycatcher	R	*Culicicapa ceylonensis*	Muscicapidae	Passeriformes
87	Orange headed Thrush	R	*Zootbera citrina*	Muscicapidae	Passeriformes
88	Tickel's Blue Flycatcher	R	*Cyornis tickelliae*	Muscicapidae	Passeriformes
89	Blue-throated Flycatcher	R	*C. rubeculoides*	Muscicapidae	Passeriformes

Table 1 (continued) Bird species recorded during the period of study

No.	Common name	R/ M	Scientific name	Family	Order
90	Oriental magpie Robin	R	*Copsychus saularis*	Turdidae	Passeriformes
91	White-rumped Shama	R	*C. malabaricus*	Turdidae	Passeriformes
92	Chestnut-tailed Starling	R	*Sturnus malabaricus*	Sturnidae	Passeriformes
93	Common myna	R	*Acridotheres tritis*	Sturnidae	Passeriformes
94	Jungle myna	R	*A. fuscus*	Sturnidae	Passeriformes
95	White-vented myna	R	*A. cinereus*	Sturnidae	Passeriformes
96	Crested Myna	M	*A.cristatallus*	Sturnidae	Passeriformes
97	Barn Swallow	M	*Hirundo rustica*	Hirundinidae	Passeriformes
98	Black-winged cuckoo-shrike	R	*Coracina melaschistos*	Campephagidae	Passeriformes
99	Black-headed Bulbul	R	*Pycnonotus atriceps*	Pycnonotidae	Passeriformes
100	Black-crested Bulbul	R	*P. melanicterus*	Pycnonotidae	Passeriformes
101	Red-whiskered Bulbul	R	*P. Jocosus*	Pycnonotidae	Passeriformes
102	Red-vented Bulbul	R	*P. cafer*	Pycnonotidae	Passeriformes
103	Stripe-throated Bulbul	R	*P. finlaysoni*	Pycnonotidae	Passeriformes
104	Streak eared Bulbul	R	*P. blanfordi*	Pycnonotidae	Passeriformes
105	Brown Prinia	R	*P.polychroa*	Pycnonotidae	Passeriformes
106	Plain Prinia	R	*Prinia inornata*	Sylviidae	Passeriformes
107	Common Tailorbird	R	*Orthotomus sutorius*	Sylviidae	Passeriformes
108	Dark-necked Tailorbird	R	*O. atrogularis*	Sylviidae	Passeriformes
109	Arctic Warbler	M	*Phylloscopus borealis*	Sylviidae	Passeriformes
110	Dusky Warbler	M	*Phylloscopus fuscatus*	Sylviidae	Passeriformes
111	Two-barred Greenish Warbler	M	*P. plumbeitarsus*	Sylviidae	Passeriformes
112	White crested Laughing Thrush	R	*Garrulax leucolophus*	Leoithrichidae	Passeriformes
113	Greater Necklaced Laughing Thrush	R	*G. pectoralis*	Leoithrichidae	Passeriformes
114	Lesser Necklaced Laughingthrush	R	*G. monileger*	Leoithrichidae	Passeriformes
115	Abbott's Babbler	R	*Malacocinla*	Pellorneidae	Passeriformes
116	Puff throated Babbler	R	*Pellorneum ruficeps*	Pellorneidae	Passeriformes
117	White-throated Babbler	R	*Turdoides gularis*	Timallidae	Passeriformes
118	Scarlet-backed Flowerpecker	R	*Dicaeum cruentatum*	Dicaeidae	Passeriformes
119	Ruby-cheeked Sunbird	R	*Chalcoparia ingalensis*	Nectariniidae	Passeriformes
120	Olive-backed Sunbird	R	*Nectarinia Jugularis*	Nectariniidae	Passeriformes

Table 1 (continued) Bird species recorded during the period of study

No.	Common name	R/ M	Scientific name	Family	Order
121	Purple Sunbird	R	*Cinnyrisa siaticus*	Nectariniidae	Passeriformes
122	Paddyfield Pipit	M	*Anthus Rufulus*	Motacillidae	Passeriformes
123	Olive-backed Pipit	M	*A. hodgsoni*	Motacillidae	Passeriformes
124	Forest Wagtail	M	*Dendronanthus indicus*	Motacillidae	Passeriformes
125	White wagtail	M	*Motacilla alba*	Motacillidae	Passeriformes
126	Grey wagtail	M	*M. cinerea*	Motacillidae	Passeriformes
127	Eurasian Tree Sparrow	R	*Passer Montanus*	Ploceidae	Passeriformes
128	Scaley breasted munia	R	*Lonchura punctulata*	Ploceidae	Passeriformes
129	White rumped munia	R	*L. Striata*	Ploceidae	Passeriformes

Remark: R=resident, M=migrant

One hundred and twenty nine species were monthly recorded. Of these 47 species of birds were sighted in plain near Dam 7 and 45 species were in picnic site 2 (Figure 1). The relative abundance of bird species might be related to the available of food and habitat condition. Whereas Win [10] recorded 147 species of terrestrial birds and 34 species of aquatic birds in her study period at Hlawga Park. Bird watching and counting were conducted monthly for two years starting from 2000 to September 2002. Community structure, resource utilization, habitat preference and seasonal occurrence of birds were also recorded.

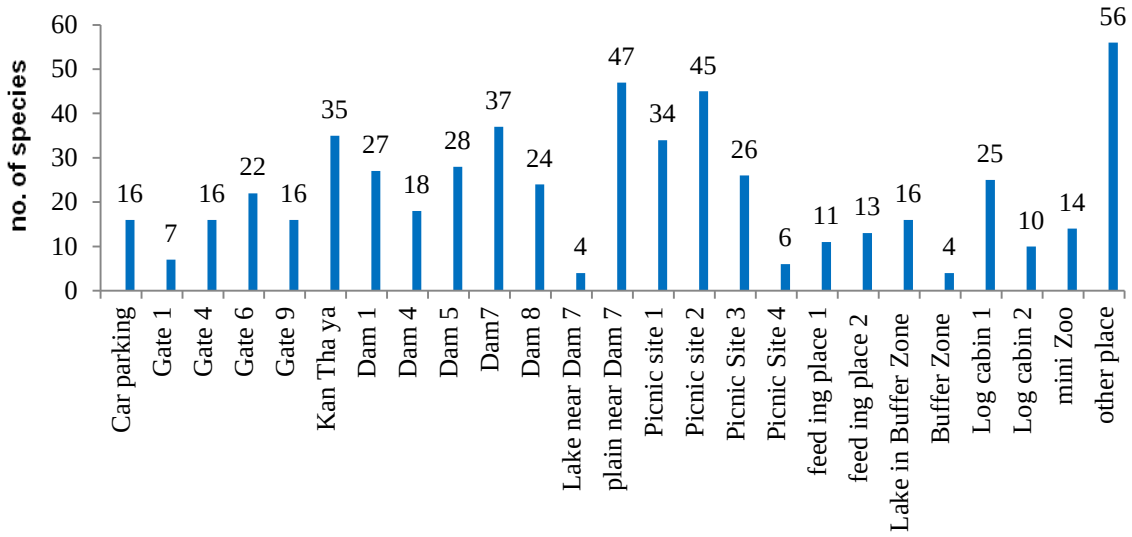

Figure 1 Bids species recorded in each study site in Hlawga Park

Number of bird species was largest in November and smallest in July (Figure 2). Seasonal change of bird species occurred due to the movement of migratory birds. Species number of birds gradually declined in monsoon. These results are in agreement to Paker *et al*. [11] who also observed similar bird species diversity was higher during spring and fall because of the presence of migrating bird species, and found that most bird species were found where trees and shrubs species richness was high.

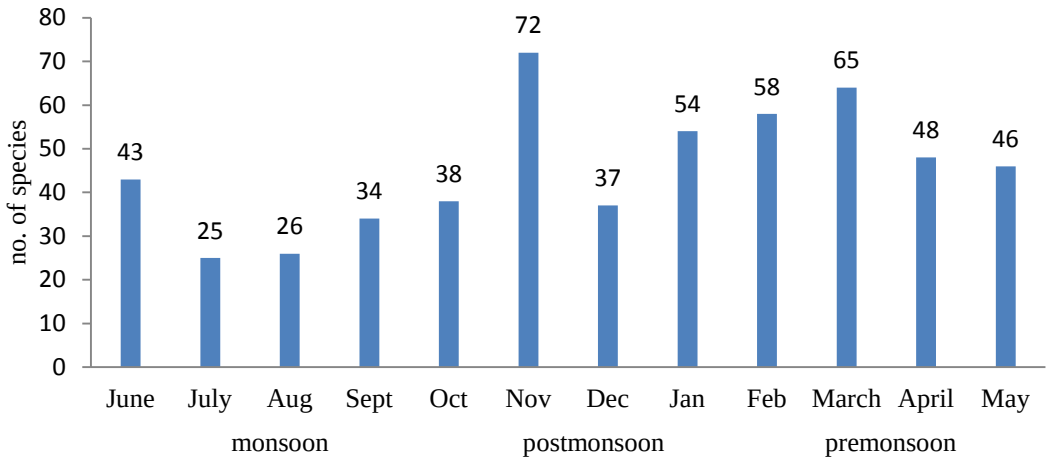

Figure 2 Monthly occurrence of bird species in Hlawga Park

Evenness of bird species compare in the month of 2014 June to 2015 May was 0.95 in 2014 June and 0.86 in 2014 August. Shannon Weiner Index value encountered avifauna was estimated to be 3.56 in 2014 June and 3.28 in 2014 August as shown in Table 2.

Table 2. Diversity of avian-fauna of Hlawga Park

Month	Diversity index (Shannon Weiner Index)	Equitability index (Evenness j')	species richness index
2014 June	3.56	0.95	0.97
July	2.67	0.83	0.89
August	2.43	0.75	0.80
September	2.45	0.695	0.83
October	2.23	0.62	0.79
November	2.75	0.64	0.80
December	0.84	0.23	0.29
2015 January	1.17	0.29	0.38
February	1.28	0.32	0.54
March	1.55	0.37	0.51
April	2.47	0.64	0.83
May	3.28	0.86	0.94

In present study, maximum observed species were *Dendrocygna javanica* (1490), *Anastomus oscitans* (1000), *Anas poecilorhyncha* (100) and *Garrulax pectoralis* (55). Least observed Species of birds (n=1) were Quail , *Coturnix* sp. , Lineated Barbet, *Megalaima lineate*, Large hawk Cuckoo, *Hierococcyx sparverioides* ,Indian Cuckoo, *Coculus micropterus*, Violet Cuckoo, *Chrysococcyx Xanthorhynchus*, Asian Koel, *Eudynamys scolopacea*, Dollarbird, *Eurystomus orientalis*, Blossom-headed parakeet, *Psittacula roseate*, Red collared Dove, *Streptopelia tranquebarica*, Common Moorhen, *Gallinula chloropus*, Common Coot, *Fulica atra*, Bronze-winged Jacana, *Metopidius indicus* , Green Sandpiper, *Tringa ochropus* , Crested Serpent Eagle, *Spilornis cheela*, Black Kite, *Milvus migrans* , Bronze Drongo, *Dicrurus aeneus*, Hooded Treepie, *Crypsirina cucullata*, Asian Browned Flycatcher, *Muscicapa dauurica*, Brown-streak Flycatcher, *M. williamsoni*, Orange headed Thrush, *Zootbera citrina* and Blue-throated Flycatcher, *Cyornis rubeculoides*.

Of these recorded species 102 species were terrestrial birds and 28 species were waterbirds. In the recorded waterbirds, Ciconiformes was the largest order with 10 species and Passeriformes was the largest order comprising 66 species in the terrestrial birds. In these 26 species were migratory species and 104 species were resident. Whereas Zin [12] undertook for two years (July 2002 to June 2004) on species richness and distribution of birds around Yangon area. Eight study sites were selected around Yangon area. Waterbirds of 45 species and 121 species of terrestrial birds were recorded.

In total 129 bird species of Hlawga Park comprised two endemic species, four near-threatened and one endangered were identified according to Avibase - Bird Checklists of the World [2] as shown in Table 3.

Table 3. Status of birds in Hlawga Park

Common name	Scientific name	Status
Green Peafowl	*Pavo muticus*	Endangered
Blossom-headed Parakeet	*Psittacula roseata*	Near-threatened
Darter	*Anhinga melanogaster*	Near-threatened
Spot-billed Pelican	*Pelecanus philippensis*	Extirpated Near-threatened
White-throated Babbler	*Turdoides gularis*	Endemic

4. Conclusions

One hundred and twenty nine species belonging to 45 families of 17 orders were recorded during the study period. In these 27 species were migratory species and 102 species were resident. Shannon Weiner Diversity Index was 2.21 Simpson's index was 0.72, Shnnon evenness was 0.46 respectively. Number of bird species was largest in November and smallest in July. Species number of birds gradually declined in monsoon. In total 129 bird species comprised one endemic species, three near-threatened and one endangered were identified. However one of the foremost threats to bird population in the Hlawga Park was monkey. Number of monkey population size was found to be high gradually. They destruct bird nests and eat bird eggs. For the stability of species and population of birds, control the monkey population size and protecting natural habitat is to be needed.

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Diversity of Culinary Herbs and Ethnobotany in Hlawga Wildlife Park, Yangon City, Republic of the Union of Myanmar

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Abstract

This research studies, the diversity of culinary herbs and ethnobotany in Hlawga Wildlife Park in Yangon City, Republic of the Union of Myanmar from July, 2013 to October, 2014. A walking survey of plant diversity and three sizes of exploration blocks of the forest areas are conducted: 400 square meters, 16 square meters and 1 square meter, to collect data on trees, shrubs, climbers, and herbaceous plants. The survey revealed that there are 29 families, 59 genera and 62 species of plants. The plants with density, frequency, dominance, relative density, relative frequency, relative dominance and importance value index are *Microcos paniculata L.*, *Gmelina arborea Roxb.*, and *Markhamia stipulata* (Wall.) Seem. eg. K. Schum. from the interview with the locals, the results revealed that there are 5 types of plants according to their utilities and some are used for multiple purposes as follows: 1) culinary herbs: 8 families 9 genera 9 species; 2) edible plants: 9 families 16 genera 17 species; 3) medicinal plants: 9 families 11 genera 11 species; 4) construction materials: 17 families 25 genera 25 species; and 5) other purposes: 20 families 30 genera 31 species. The parts of plants which widely used are stems. The parts of plants which widely used for consumption are fruits. Medicinal plants also used in the treatment of hematologic diseases.

Keywords: culinary herbs, ethnobotany, Hlawga Wildlife Park

1. Introduction

Myanmar, a country with strong cultural heritage, is the largest in South-East Asia. This country is rich in diversified flora and fauna and has unique traditional medicine (TM) culture, which plays an indispensable role in promoting the health care system. A rich heritage of traditional medicine knowledge and the use of plants as medicine still exist in Myanmar which have been inherited from earlier generation [1].

Hlawga Wildlife Park is located in Mingladadon Division, Yangon City, Republic of the Union of Myanmar. The area of this park is 1540 acres comprising a wildlife park, a buffer zone and a mini-zoo including other various recreation centers. It is at 17°00′17″N96°06′44″E. There is more than 295 species of plant in Hlawga which is a significant source of medicinal plant supply. [2]

Ethnobotany is the local traditional knowledge of utilizing indigenous plants, such as for foods, medicines and tools which local people have been practicing for a long time. The utilization of plant species found in nature varies in each region [3]. The development of ethnobotany is expected to bring significant economic benefits, and scientific research is required to provide the evidence base for the development of the active ingredients of traditional medicines. Ethnobotany also protects cultural heritage, inspire more studies of traditional medicines, and provides a basis for the discovery of new drug [4].

Today, rapid socioeconomic development, continued deforestation and environment degradation in many parts of Myanmar result depletion of medicinal plants and their associated knowledge. Therefore, the main objective of this study is to assess the diversity of ethnobotany plants used by local people in Yangon for the conservation of biological resources and their sustainable utilization.

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2. Materials and methods

1. The study area is conducted in Hlawga Wildlife Park, Yangon City, Republic of the Union of Myanmar between July, 2013 to October, 2014.

2. To study the ecology of culinary herbs and ethnobotany in 15 exploration blocks using purposive random sampling. The classification and analysis techniques of Kutintara (1998) [5] are applied to analyze the density, frequency, dominance, relative density, relative frequency, relative dominance and importance value index of plants.

3. Collect voucher specimens and transfer to the laboratory for further identification. Plants specimens are identified as belonging to families and species base on Flora of Thailand, Flora of the Malay Penisular, Flora of British India and specialists.

4. Studies the utilization of plant using the knowledge and wisdom of local citizen and folk medicine by interview and rapid ethnobotanical appraisal (REA).

3. Results and discussion

Ethnobotany plants

The studies in diversity of culinary herbs and ethnobotany in Hlawga Wildlife Park, Yangon City, Republic of the Union of Myanmar revealed that there are 29 families, 59 genera, and 62 species which divided into 6 groups according to life form such as tree, small tree, scandent shrubs, climbing and herb. The useful plants species are mostly trees of 43 species where as 10 are shrubs, 4 are scandent shrubs, 3 are climbing and 1 for shrub and herb (Table 1).

The Hlawga Wildlife Park is dry evergreen forest. The plants with highest density, frequency, relative dominance, relative frequency, dominance, relative dominance and importance value index are *Microcos paniculata* L., *Gmelina arborea* Roxb. and *Markhamia stipulata* (Wall.) Seem. ex K. Schum. The results of interview in the utilization of plants indicated that there are 5 categories as follows; 1) culinary herbs: 8 families 9 genera 9 species; 2) edible plants: 9 families 16 genera 17 species; 3) medicinal plants: 9 families 11 genera 11 species; 4) construction materials: 17 families 25 genera 25 species; and 5) other purposes: 20 families 30 genera 31 species (Table 1). Additionally, some are used for multiple purposes with various parts of plant as root, stem, leaf, flower, fruit, seed, and whole plant (Table 2).

Table 1 The classification of plant by the utilization of local resident and habit

Category	**Taxonomic rank**			**Number of species categorized by habit**					
	Families	**Genera**	**Species**	**Tree**	**Small tree**	**Shrub**	**Scan S**	**Climbing**	**Herb**
All ethnobotanical	29	59	62	43	10	1	4	3	1
Culinary Herb	8	9	9	3	3	1	-	1	1
Edible	10	16	17	12	5	-	1	1	1
Medicinal	9	11	11	6	2	2	1	-	-
Construction materials	17	25	25	21	3	-	-	1	-
Other purposes	20	30	31	27	2	1	-	1	-

Notes: Some species overlapped among these five categories

Table 2 The utilization composition of plant in Hlawga Wildlife Park, Yangon City, Republic of the Union of Myanmar

Category	No. of species of plant parts						
	Root	**Stem**	**Leaf**	**Flower**	**Fruit**	**Seed**	**Whole plant**
Culinary Herb	1	3	6	-	3	-	1
Edible	-	-	2	3	14	-	-
Medicinal	-	5	1	-	3	1	1
Construction materials	-	25	-	-	-	-	-
Other purposes	1	25	-	1	4	-	-

Culinary Herbs

From the results, there are 8 families, 9 genera 9 species of culinary herbs. The most parts which widely used are leaf (*Combretum latifolium* Blume, *Bridelia tomentosa* Blume., *Tamarindus indica* Linn., *Clatoxylum neriifolium* Kurz, *Microcos paniculata* L., *Premna amplectens* Wall., *Clerodendrum serratum* Spreng.), fruit (*Bridelia tomentosa* Blume., *Microcos paniculata* L.), root (*Combretum latifolium* Blume) and whole plant (*Peperomia pellucida* (L.) H.B.R., *Premna amplectens* Wall.), respectively (Table 3). There are 7 species of culinary herbs that found in Thailand but not utilize as culinary herb in Myanmar (*Spondias mangifera* Willd., *Bridelia ovata* Decne., *Terminalia bellerica* (Gaertn.) Roxb., *Careya arborea* Roxb., *Senna siamea* (Lam.) Irwin & Barneby, *Ziziphus rugosa* Lam., *Bauhinia acuminata* L.) [6-12].

Edible Plants

From the results, there are 9 families, 16 genera 17 species of edible plants. The most parts which widely used are fruit (*Swintonia floribunda* Griff., *Spondias mangifera* Willd., *Stereospermum neuranthum* Kurz, *Terminalia bellerica* (Gaertn.) Roxb., *Baccaurea flaccida* Muell. Arg., *Bridelia ovata* Decne., *Dalbergia volubilis* Roxb., *Bauhinia acuminata* L., *Flacourtia cataphracta* Roxb., *Neolitsea umbrosa* (Nees) Gamble, *Artocarpus chaplasha* Roxb., *Ficus glomerata* Roxb., *Ziziphus rugosa* Lam., flower (*Radermachera glandulosa* (Blume) Miq., *Markhamia stipulata* (Wall.) Seem. ex K. Schum., *Senna siamea* (Lam.) Irwin & Barneby) and leaf (*Dalbergia lakhonensis* Gagnep, respectively (Table 3). The use of edible plant is closely similar in Thailand [6, 7, 9, 10].

Medicinal Plants

From the results, there are 9 families, 11 genera 11 species of herbal plants. The most parts which widely used are bark and wood (*Holarrhena pubescens* Wall. ex G. Don, *Dipterocarpus alatus* Roxb., *Salacia chinensis* L., *Celtis tetrandra* Roxb., *Gmelina arborea* Roxb.), fruit (*Holigarna kurzii* King, *Phyllanthus emblica* L., *Bridelia ovata* Decne.), seed (*Cassia fistula* L.), leaf (*Uvaria cordata* Schum. & Thonn.), and whole plant (*Chromolaena odorata* (L.) R.M.), respectively (Table 3). The 18 species are not reported as medicinal plants in Myanmar but applied in Thailand (*Strychnos nux-vomica* L., *Vitex peduncularis* Wall., *Mitragyna rotundifolia* Roxb., *Ficus hispida* Linn. L. f., *Lannea coromandelica* (Houtt.) Merr., *Spondias mangifera* Willd., *Markhamia stipulata* (Wall.) Seem. ex K. Schum., *Garuga pinnata* Roxb., *Schleicera oleosa* (Lour.) Oken, *Diospyros ehretioides* Wall., *Salacia chinensis* L., *Butea monosperma* (Lam.) Kuntze, *Garcinia cowa* Roxb., *Lagerstroemia floribunda* Jack, *Ixora pubirama* Bremek., *Nephelium ramboutan-ake* (Labill.) Leenh., *Celtis tetrandra* Roxb., *Gmelina arborea* Roxb.). The 3 species have same properties *Chromolaena odorata* (L.) R.M., *Bridelia tomentosa* Blume. and *Phyllanthus emblica* L. [8-12].

Construction materials

From the results, Bignoniaceae (3 genera, 3 species) and Euphorbiaceae are the most common tree for timber in making houses and utensil (Table 3). The 6 species have the same utilization as Thailand (*Dipterocarpus alatus* Roxb., *Neolitsea umbrosa* (Nees) Gamble, *Lagerstroemia floribunda* Jack, *Homalium tomentosum* Benth., *Berrya ammonilla* Roxb. and *Celtis tetrandra* Roxb.) [13].

Other Purposes

From the results, there are 31 species of plants are used for other purposes. The most common purposes are to sculpture the Buddha images; 3 species (*Syzygium cumini* (L.) Skeels, *Ziziphus rugosa* Lam., *Ixora pubirama* Bremek.), to make dyeing color for textile and hair; 3 species (*Holigarna kurzii* King, *Anogeissus acuminata* Wall., *Engelhardtia spitata* Blume), to make refreshment; 2 species (*Strychnos nux-vomica* L., *Ficus*

hispida Linn. L. f.), to make bird food; 1 specie (*Vitex peduncularis* Wall.) and to make fishing bait; 2 species (*Butea parviflora* Roxb., *Strychnos nux-vomica* L.) (Table 3). The use of plant is similar to Thailand except *Holigarna kurzii* King, *Anogeissus acuminata* Wall. and *Engelhardtia spitata* Blum [13].

Table 3 Ethnobotanical plants in Hlawga Wildlife Park area used by villagers

Families/Species	Habit	Category					Plants/Application
		Cu	Ed	Me	Co	Ot	
Anacardiaceae							
1. *Holigarna kurzii* King	T			+		+	Stems , barks and leaves for relieve inflammation pain and fever Bark for dye
2. *Lannea coromandelica* (Houtt.) Merr.	T					+	Wood for firewood
3. *Swintonia floribunda* Griff.	T		+				Fruits were eaten
4. *Spondias mangifera* Willd.	T		+				Fruits were eaten
Annonaceae							
5. *Uvaria cordata* Schum. & Thonn.	S			+			Leaves for catarrh
Apocynaceae							
6. *Alstonia scholaris* (*L.*) *R. Br*.	T	+					Bark for bakery and for carminative and Malaria
7. *Holarrhena pubescens* Wall. ex G. Don	ST			+			Fruits and fruits for indigestion, dysentery, flatulence
Asteraceae							
8. *Chromolaena odorata* (L.) R.M.	S			+			Whole plant for wound healing
Bignoniaceae							
9. *Markhamia stipulata* (Wall.) Seem. ex K. Schum.	T		+		+		Flowers and fruits use for vegetable salad, Wood for constructions
10. *Radermachera glandulosa* (Blume) Miq.	T		+		+	+	Flowers and fruits use for vegetable salad, Wood for constructions and firewood
11. *Stereospermum neuranthum* Kurz	T		+		+	+	Leaves were eaten, Wood for constructions and fire wood
Burseraceae							
12. *Garuga pinnata* Roxb.	T					+	Wood for firewood
Combretaceae							
13. *Anogeissus acuminata* Wall.	T					+	Bark for dye
14. *Combretum latifolium* Blume	C	+					Leaves were eaten, Roots for anaplastic thyroid cancer
15. *Terminalia bellerica* (Gaertn.) Roxb.	T					+	Fruits used for fuel oil
Crypteroniaceae							
16. *Crypteronia paniculata* Blume	T				+	+	Wood for constructions and firewood

Table 3 (continue)

Families/Species	Habit	Category					Plants/Application
		Cu	Ed	Me	Co	Ot	
Dipterocarpaceae							
17. *Dipterocarpus alatus* Roxb.	T			+	+	+	Barks use for external lotion, Wood for constructions and firewood
Ebenaceae							
18. *Diospyros ehretioides* Wall.	T				+	+	Wood for constructions and firewood
Euphorbiaceae							
19. *Baccaurea flaccida* Muell. Arg.	T		+		+		Fruits were eaten, Wood for constructions
20. *Bridelia ovata* Decne.	ST		+		+		Fruits were eaten, Wood for constructions
21. *Bridelia tomentosa* Blume.	ST	+				+	Leaves were eaten, Fruit for blood disease, Wood for firewood
22. Phyllanthus emblica L.	T			+			Fruits for common cold, fever, common cold, fever, tonic, stomatic, antipyretic, hair tonic, anti-inflammatory, peptic ulcer, dyspepsia, digestive, wound healing, detoxification and rejuvenation
23. *Salacia chinensis* L.	Scan S			+			Roots, barks, stems for antidiabetics, rheumatism, skin disease
Fabaceae							
24. *Albizia odoratissima* (L. f.) Benth.	T					+	Wood for firewood
25. *Bauhinia acuminata* L.	ST		+				Leaves were eaten
26. *Butea monosperma* (Lam.) Kuntze	T					+	Wood for firewood
27. *Butea parviflora* Roxb.	C					+	Fruits were bait for fishing
28. *Cassia fistula* L.	T			+			Fruits and seeds for constipate
29. *Dalbergia lakhonensis* Gagnep	T		+			+	Young leaves were eaten, Wood for fire wood
30. *Dalbergia volubilis* Roxb.	C				+		Wood for constructions
31. *Senna siamea* (Lam.) Irwin & Barneby	T		+			+	Flowers were eaten, Wood for firewood
32. *Tamarindus indica* Linn	T	+			+		Leaves and fruits were eaten, Fruits for digestive, carminative and laxative Wood for constructions
Flacourtiaceae							
33. *Flacourtia cataphracta* Roxb.	T		+		+		Fruits were eaten, Wood for constructions

Table 3 (continue)

Families/Species	Habit	Category					Plants/Application
		Cu	Ed	Me	Co	Ot	
34. *Homalium tomentosum* Benth.	T				+	+	Wood for constructions and firewood
Hypericaceae							
35. *Clatoxylum neriifolium* Kurz	T	+					Leaves were eaten and for laxative
36. *Garcinia cowa* Roxb.	T				+	+	Wood for constructions and firewood
Juglandaceae							
37. *Engelhardtia spitata* Blume	T					+	Barks were used dye for hair and clothes
Lauraceae							
38. *Neolitsea umbrosa* (Nees) Gamble	ST		+		+		Fruits were eaten, Wood for constructions
Lecythidaceae							
39. *Careya arborea* Roxb.	T				+		Wood for constructions
Loganiaceae							
40. *Strychnos nux-vomica L.*	T					+	Roots for brew and baits for fishing
Lythraceae							
41. *Duabanga grandiflora* Walp.	T				+	+	Wood for constructions and firewood
42. *Lagerstroemia floribunda* Jack	T					+	Wood for firewood and charcoal
Moraceae							
43. *Artocarpus chaplasha* Roxb.	T		+			+	Leaves were eating, Wood for firewood
44. *Ficus glomerata* Roxb.	T		+		+		Fruits were eaten, Wood for constructions
45. *Ficus hispida* Linn. L. f.	ST		+		+		Fruits were eaten, Wood for constructions
Myrtaceae							
46.*Cleistocalyx nervosum* (DC.) Kosterm.	T					+	Wood for firewood
47.*Syzygium cumini* (L.) Skeels	T					+	Wood used to sculpture the Buddha images
Piperaceae							
48. *Peperomia pellucida* (L.) H.B.R.	H	+					Whole plant were eaten, Whole plant for asthma
Rhamnaceae							
49. *Ziziphus rugosa* Lam.	ST		+			+	Fruits were eaten, Fruits were used to sculpture the Buddha images
Rubiaceae							
50. *Ixora pubirama* Bremek.	S					+	Flowers were used for worship to Buddha

Table 3 (continue)

Families/Species	Habit	Category					Plants/Application
		Cu	Ed	Me	Co	Ot	
51. *Mitragyna rotundifolia* Roxb.	T				+	+	Wood for constructions and firewood
52. *Stephegyne parvifolia* Korth.	T				+	+	Wood for constructions and firewood
Sapindaceae							
53. *Nephelium ramboutan-ake* (Labill.) Leenh.	T		+		+		Fruits were eaten, Wood for constructions
54. *Schleicera oleosa (Lour.) Oken*	ST			+			Fruits for menstrual disorder
Sterculiaceae							
55. *Pterospermum semisagitatum* Buch.-Ham.	T				+	+	Wood for constructions and firewood
Tiliaceae							
56. *Berrya ammonilla Roxb*.	T				+		Wood for constructions
57. *Microcos paniculata* L.	ST	+					Fruits were eaten, leaves used for wound cleaning lotion
Ulmaceae							
58. *Celtis tetrandra* Roxb.	T			+			Seeds used for indigestion
Verbenaceae							
59. *Clerodendrum serratum* Spreng.	S	+					Leaves were eaten and menstrual disorder
60. *Gmelina arborea* Roxb.	T			+	+		Flowers for blood disease, Wood for constructions
61. *Premna amplectens* Wall.	ST	+					Leaves were eaten, Whole plants for menstrual disorder
62. *Vitex peduncularis Wall.*	T				+	+	Wood for constructions, Fruits for feeding birds

***Remark** Cu: Culinary Herbs, Ed: Culinary Plant, Me: Herbal Plant, Co: trees for timber in making houses and utensils, Ot: plants for other purposes

4. Conclusions

Myanmar has a rich biodiversity including plant genetic resources which result from altitude and climate also rich heritage of traditional knowledge of the use of plants as medicine. However, only 29 families, 59 genera and 62 species of plants used were recorded in Hlawga Wildlife Park which are lower than expected compares to the rich of natural resources. This might result from the change in the life style of people in new generation. However, the result of study would be benefit as fundamental knowledge to discover new medicine.

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Comparison of Radiation Interaction of Clay and Autoclaved Aerated Concrete Bricks for Radiation Shielding Properties

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Abstract

This research studied the radiation interaction of gamma rays with clay and autoclaved aerated concrete bricks. The clay and autoclaved aerated concrete bricks were determined by used gamma rays spectrometer with Compton scattering arrangement for energy variation and analyzed the composition by X-ray Fluorescence Spectroscopy (XRF). The results were determined mass attenuation coefficient values from theory by WinXCom program and experiment respectively. The Z_{eff} and the N_{el} value were studied for radiation shielding properties of the clay and autoclaved aerated concrete bricks. This research was found that the clay brick had good radiation properties than autoclaved aerated concrete. The experimental values had good agreement with theoretical values.

Keywords: autoclaved aerated concrete, clay brick, mass attenuation coefficient

1. Introduction

Humans have studied and researched in many ways. To make advances in science and technology Science and technology have a role in human's daily life in both industrial aspect agricultural aspect medical aspect including how to use the ray to preserving food by using solar powered oven ,Nuclear power plant by using radioactive substances ,X-raying ,Radiation destroys cancer cells , MRI or CT Scan and so on[1]. As mentioned Radiation is very useful to humans ,However we have to know and understand the correct way to using because radiation also dangerous to a creature, for example, the explosion of nuclear reactor of Chernobyl nuclear power plant in Ukraine on date 26 April 1986 and Earthquake in Japan on date 11 March 2011 which makes reactor lack of coolant the increasing of heat is making melt and radiation leakage ,but radiation is a particular that unable to be known by the human senses, so it unable to know that you already got radiation into your body or not for the safety a person who concern about radioactive need to find the solution to protect damage from radioactive for reduce risk from receiving radioactive by unreasonable based on the principle from International Radiation Protection Organization ALARA (As Low As Reasonably Achievable) by spend the least time to work Use the longest distance and use radiation shielding for protect the body to gain the excessive radiation standard[2]. Nowadays for prevent X-ray and gamma rays materials used for radiation shielding include lead, concrete, steel[3]. From the principle as said so study Interaction between gamma rays and clay bricks and autoclaved aerated concrete. Which used for housing to study radiation shielding properties [4].

In the present there is a high amount of usage gamma rays. It needs to prevent the danger of gamma rays, coupled with the utilization. The residency or house in the present are made from clay bricks or and autoclaved aerated concrete, hence house is a very important factor for prevent radiation that cannot be avoided such as Living near industrial plants or a place where the source of radiation[5]. This research takes 2 of clay bricks and autoclaved aerated concrete to study interaction between ray with clay bricks and autoclaved aerated concrete.

2. Research objective

2.1 Study radiation interaction between clay and autoclaved aerated concrete bricks for radiation shielding properties.

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2.2 Compare the value from experiment and theory values of clay and autoclaved aerated concrete bricks.

3. Materials and methods

3.1 Measurement of physical properties of samples

The samples, while the measurement of physical properties was measured density of samples following the relation:

$$\rho = \frac{W_a}{w_a - W_b}\rho_b \tag{1}$$

where ρ is density of sample, W_a is the weight of sample in air, W_b is the weight of sample in water and ρ_b is the density of water.

The analysis of element composition to identify the weight percent in the samples were measured with X-ray fluorescence spectrometer (XRF), Minipal-4, Panalytical. XRF is helpful and accurate analytical instrument widely used for determining element composition in unknown materials. The present weight percent of element composition of samples.

3.2 Gamma-ray shielding studies procedure

The shielding properties of samples were calculated with two processes, first: theoretical calculation were calculate with WinXCom program, second: experimental calculation were calculation with the data from experimental procedure.

3.2.1 Theoretical and Experimental calculation

In this part, the data from XRF, weight percent of element composition of each samples were input in WinXCom. The mass attenuation coefficient (μ_m) in unit (cm^2/g) were calculated with energy range from 223 - 662 keV, based on the rule of mixture:

$$\mu_m = \sum_i w_i (\mu_m)_i \tag{2}$$

where w_i is the weight fraction of element i in samples and $(\mu_m)_i$ is mass attenuation coefficient for individual element i in samples. The value of mass attenuation coefficient μ_m depends on density of the samples, can be used to determine the total atomic cross-section ($\sigma_{t,a}$) following relation:

$$\sigma_{t,a} = \frac{(\mu_m)_{soils}}{N_A \sum_i^n (w_i / A_i)} \tag{3}$$

where N_A is Avogadro's number and A_i is the atomic weight of each element i of the samples. Furthermore, the total cross-section ($\sigma_{t,el}$) is following relation:

$$\sigma_{t,el} = \frac{1}{N_A}\sum_i^n \frac{f_i A_i}{Z_i}(\mu_m)_i = \frac{\sigma_{t,a}}{Z_{eff}} \tag{4}$$

where f_i is the number of atoms of element *i* relative to the number of atom of all elements in samples, Z_i is the atomic number of element *i* in element composition in samples and Z_{eff} is effective atomic number of samples explain with following relation:

$$Z_{eff} = \frac{\sigma_{t,a}}{\sigma_{t,el}} \quad (5)$$

The electron density (N_e) can be defined as the number of electrons per unit mass, and it can be mathematically written as follows [4-9]:

$$N_e = \frac{\mu_m}{\sigma_{t,el}} \quad (6)$$

4. Results and discussion

1. The component element of samples by XRF are result show in table 4.1 and 4.2.

Table 4.1 clay bricks's component elements

Compound	**Si**	**K**	**Ca**	**Ti**	**Mn**	**Fe**	**Zn**	**Rb**	**Sr**	**Zr**	**Pb**
Conc (%)	48.387	13.275	4.985	3.058	0.476	28.988	0.095	0.297	0.055	0.255	0.128

Table 4.2 autoclaved aerated concrete brick's component elements

Compound	**Si**	**K**	**Ca**	**Ti**	**Mn**	**Fe**	**Cu**	**Zn**	**Rb**	**Sr**	**Zr**
Conc (%)	13.776	1.073	78.162	0.547	0.098	6.013	0.025	0.039	0.031	0.139	0.098

2. The density of samples by Archimedes is principle with 4-position scales from AND company model HR-200 are show in Table 4.3.

Table 4.3 The average density of samples

Sample (brick)	**Density (g/cm^3)**
AAC	2.5241
Clay	2.5239

3. The mass attenuation coefficient of clay and autoclaved aerated concrete bricks for theoretical and experimental values are show in Table 4.4, Figure 1 and Table 4.5, Figure 2 respectively.

Table 4.4 Mass attenuation coefficient, μ_m of clay brick

Energy (Mev)	Theoretical value, μ_m (cm^2/g)	Experimental value, μ_m (cm^2/g)
0.228	1.22E-01	1.21E-01
0.249	1.17E-01	1.17E-01
0.29	1.10E-01	1.09E-01
0.341	1.02E-01	1.02E-01
0.415	9.41E-02	9.41E-02
0.488	8.78E-02	8.74E-02
0.573	8.18E-02	8.11E-02
0.662	7.66E-02	7.61E-02

Table 4.5 Mass attenuation coefficient of autoclaved aerated concrete

Energy (Mev)	Theoretical value, μ_m (cm^2/g)	Experimental value, μ_m (cm^2/g)
0.228	1.27E-01	1.27E-01
0.249	1.22E-01	1.19E-01
0.29	1.13E-01	1.12E-01
0.341	1.05E-01	1.04E-01
0.415	9.57E-02	9.57E-02
0.488	8.90E-02	8.86E-02
0.573	8.28E-02	8.21E-02
0.662	7.75E-02	7.71E-02

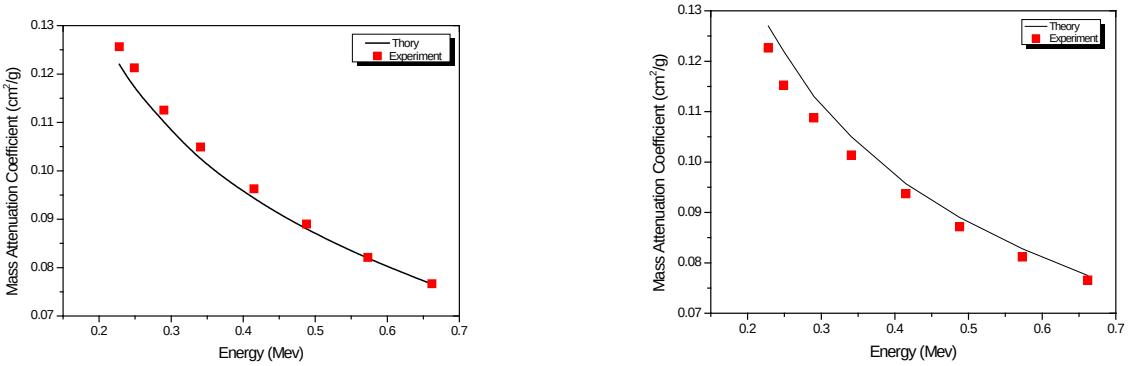

Figure 1 Mass attenuation coefficient and energy of clay brick (left) and autoclaved aerated concrete (right)

The mass attenuation coefficient and energy of clay brick and autoclaved aerated concrete were decrease with increasing gamma-rays energy. The two samples had same trend. The clay brick has more mass attenuation coefficient at all of the same gamma-rays energy.

4. The effective atomic number of clay and autoclaved aerated concrete bricks for theoretical and experimental values are show in Table 4.5, Figure 3 and Table 4.6, Figure 4 respectively.

Table 4.6 Effective atomic number, Z_{eff} value of the clay bricks.

Energy (Mev)	Theoretical value, Z_{eff} (electron/atom)	Experimental value, Z_{eff} (electron/atom)
0.25	1.14E+01	1.14E+01
0.29	1.14E+01	1.13E+01
0.34	1.13E+01	1.13E+01
0.42	1.13E+01	1.13E+01
0.49	1.13E+01	1.12E+01
0.57	1.13E+01	1.12E+01

Table 4.7 Effective atomic number, Z_{eff} value of the bricks of autoclaved aerated concrete.

Energy Mev	Theoretical value, Z_{eff} (electron/atom)	Experimental value, Z_{eff} (electron/atom)
0.23	2.08E+01	2.07E+01
0.25	2.04E+01	2.00E+01
0.29	2.00E+01	1.98E+01
0.34	1.97E+01	1.96E+01
0.42	1.95E+01	1.95E+01
0.49	1.94E+01	1.93E+01

Table 4.7 Effective atomic number, Z_{eff} value of the bricks of autoclaved aerated concrete.

Energy Mev	Theoretical value, Z_{eff} (electron/atom)	Experimental value, Z_{eff} (electron/atom)
0.23	2.08E+01	2.07E+01
0.25	2.04E+01	2.00E+01
0.29	2.00E+01	1.98E+01
0.34	1.97E+01	1.96E+01
0.42	1.95E+01	1.95E+01
0.49	1.94E+01	1.93E+01

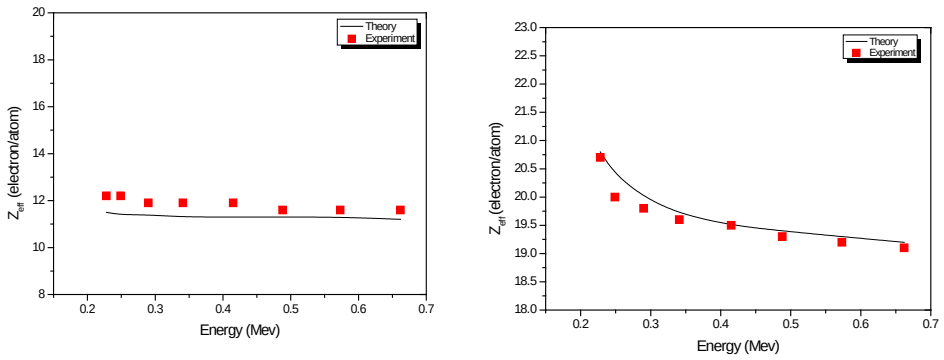

Figure 2 Effective atomic number, Z_{eff} value and energy of the clay bricks(left) and autoclaved aerated concrete(right).

The effective atomic number and energy of clay brick has small decrease with increasing gamma-rays energy and autoclaved aerated concrete was clearly decrease with increasing gamma-rays energy. The autoclaved aerated concrete has more effective atomic number at all of the same gamma-rays energy.

5. The electron density of clay and autoclaved aerated concrete bricks for theoretical and experimental values are show in Table 4.8, Figure 5 and Table 4.9, Figure 6 respectively.

Table 4.8 Electron density, N_{el} value of clay bricks.

Energy (Mev)	Theoretical value, N_{el} ($x10^{23}$electron/gram)	Experimental value, N_{el} ($x10^{23}$electron/gram)
0.228	3.04	3.02
0.249	3.03	3.02
0.29	3.01	2.99
0.341	3.00	2.98
0.415	2.99	2.99
0.488	2.98	2.97
0.573	2.98	2.96
0.662	2.98	2.96

Table 4.9 Electron density, N_{el} value of autoclaved aerated concrete.

Energy (Mev)	Theoretical value, N_{el} ($x10^{23}$electron/gram)	Experimental value, N_{el} ($x10^{23}$electron/gram)
0.23	3.24	3.23
0.25	3.19	3.13
0.29	3.13	3.09
0.34	3.08	3.06
0.42	3.04	3.04
0.49	3.03	3.01

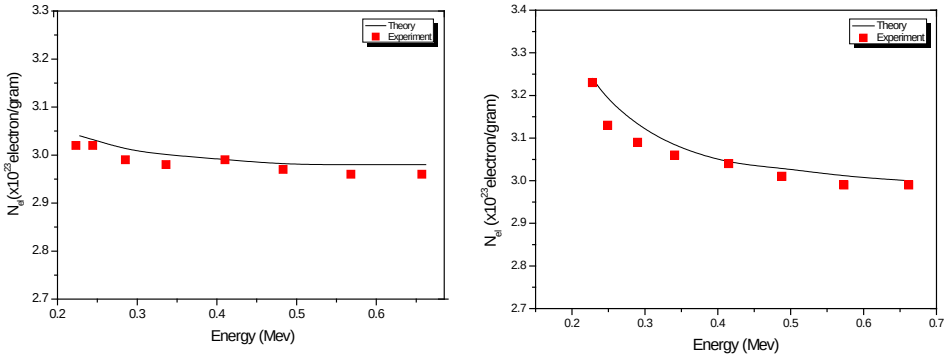

Figure 3 Electron density, N_{el} value and energy of clay bricks(left) and autoclaved aerated concrete.(right).

The electron density and energy of clay brick has small decrease with increasing gamma-rays energy and autoclaved aerated concrete was clearly decrease with increasing gamma-rays energy. The autoclaved aerated concrete has more electron density at all of the same gamma-rays energy.

5. Conclusions

This research has made an experiments for study interaction between radiation of gamma-rays and the clay brick aerated bricks to compare that which one has a best radiation shielding property from 2 samples are clay brick and aerated brick without chemical added then begin the experiments study property of both bricks the result can be concluded that

Property of clay brick and aerated brick from component analysis in both samples of bricks by using spectrometer x-rays energy distribution type. The result of chemical component in samples found high amount of Si , Ca and Fe which are the main components of both bricks ,but clay brick has Pb(0.128%) which not found in aerated brick and aerated brick contain Cu(0.025%) which this not available in clay brick.

Density (ρ) of clay brick and aerated brick from measurement of density of clay brick and aerated brick sample by used Archimedes' s principle with 4-position scales obtain the density of clay brick is 1.7 density value is 2.5241 and density of aerated brick is 1.8 density value is 2.5239 respective.

Mass attenuation coefficient from measurement of gamma-rays spectrometer then calculate mass attenuation coefficient of experiment and compare from theory which get from program winxcom we found that mass radioactive attenuation coefficient of clay brick and aerated brick are in the energy period 0.228 ,0.249 ,0.29 ,0.341 ,0.415 ,0.488 ,0.573 ,0.662 respective. The result shows that clay brick has a better shielding property than aerated brick.

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Investigating Electric Vehicle (EV) Charging Station Locations for Agartala, India

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Abstract

Selecting the location for installing electric vehicles charging stations is important to ensure EV adoption and also to address some of the inherent risks such as battery cost and degradation, economic risks, lack of charging infrastructure, risky maintenance of EVs, problems of its integration in smart grid, range anxiety, auxiliary loads and motorist attitude. In this article, we investigate these problems by studying three aspects – 1) three types of electrical vehicle charging stations (Level 1, Level 2 and DC), 2) different types of batteries and 3) different types of electric vehicles. We compared and contrasted the features of these charging stations, batteries and EV to identify the best choice for a given scenario. We applied the framework proposed in [1], and used Agartala, India as a case study to identify location for charging stations in and around Agartala suburbs.

Keywords: Electric vehicle, charging stations, electric vehicle battery, charging stations location conditions, infrastructure

1. Introduction

An electric car is actually an alternative-design automobile that basically uses an electric motor to provide power to the car, with the electricity being provided by a battery. On the other hand, a conventional car does have a lead-acid battery as part of its standard equipment but this battery is used for operating the starter and not providing power to the vehicle. This technology works in this way that the electric vehicle uses a motor just like conventional, internal combustion engine cars. The main difference is that the electric vehicle power supply is derived from its battery-stored electricity and not from the mechanical power derived from burning gasoline. The electric vehicle replaces the traditional gasoline or diesel engine and fuel tank with an electric motor, a battery pack and controllers. The vehicle uses a controller that provides power to the electric motor that uses rechargeable batteries as its energy source. The motor itself can be either AC or DC. The main advantage of electric vehicle is mainly the motor and battery configuration. This allows the vehicle to run more fuel-efficiently. PHEV (plug in hybrid electrical vehicle) is a hybrid vehicle that can be plugged into the power grid for charging the battery. In this vehicle, a medium-capacity battery is available that helps the electrical vehicle in allowing it in all-electric modes , to achieve several kilometers , and acceleration rates and also it help to attain top speeds comparable to those of gasoline-powered vehicles. Examples: Chevrolet Volt (often classified as an E R E V), Ford C-Max and Fusion Energi, Cadillac E L R and Toyota Prius P H E V. On the basis of different types of power trains (or drive trains), hybrid electric vehicles can be classified into three categories: (1) Parallel hybrid, (2) Series hybrid, and (3) Power-split hybrid. Among these, the *parallel hybrid electric vehicle* is commonly adopted. PHEVs are usually consists of an electric motor and an additional ICE for propulsion. This mixed propulsion system helps in enabling PHEVs to be driven in two modes: charge depleting (CD) mode and charge sustaining (CS) mode. When this type of electric vehicles operated in CD mode then it mainly drawn energy from on-board battery packs. If the battery state of charge (SOC) has been depleted to a pre- determined level, PHEVs will then switch to CS mode and utilize the ICE system for further propulsion. When it is operated in CS mode, PHEVs combine both power sources so that it can operate as efficiently as possible. Meanwhile, the controller can monitor the battery SOC level and then maintain it with in a pre- determined band.

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2. Objectives

Global warming is becoming a major problem and the best way to combat it is to reduce air pollution. Electric vehicles (EVs) are considered a best option to reduce air pollution and making environment safe again. In order to operate, electric vehicles need charging stations at suitable places. If appropriate and recommended places are not chosen then it will decrease the utilization, visibility and effectiveness of a charging station, which results in adoption of traditional carbon- emitting gasoline vehicles and a decrease in EV sales. Hence, it is very essential to carefully select locations for EV charging stations for promotion of EVs and the cause of avoiding global warming.

The main objective of this study is to determine the best locations for installing EV public charging stations in Agartala, India. Our selection for EV charging station location will depend on the set of conditions that have to be met in order to qualify for a place to be established as an EV public charging station. In addition, we will also determine the best type of charging station based on the type and charging duration of the particular EV type. Finally, this research will provide a specific and thorough insight of establishing EV public charging station in growing cities like Agartala, India.

3. Research Methodology

The framework proposed by [1], is used as a guideline to assess the implementation of EV charging infrastructure for Agartala city. To achieve this, 3 areas are studied 1) Different types of charging stations, 2) EV types, 3) battery types. First of all, different types of charging stations are studied and compared. Next, various types of EVs are analyzed thoroughly. Moreover, the charging vehicle location selection conditions, infrastructure and the best suitable places in Agartala are selected based on the electric vehicle charging station location selection conditions and the map of Agartala.

Preliminary Concepts

We know that as the global benefits of a serious energy crisis, alternative energy for sustainable development is renewable energy .The generation of this energy is pollution free and so this is the first choice of many countries of the world like the United states, Japan and Europe and so the development of electric vehicles is a way to save nature and to resolve important issue of planning the national grid. An electrical vehicle requires charging station and so the locations of charging station have to be determined carefully. A charging station is a location where an electric vehicle can be plugged in to have electric charge deposited in to their batteries. They are not chargers, but can be considered as an electrical energy source.

Different types of charging stations:

There are mainly three types of charging stations which are categorized as Level 1, Level 2 and DC charging stations.

LEVEL 1 Charging Station (120 volts and up to 16 amps):

In all electrical vehicles, an on-board Level 1 charger is equipped that can be plugged into any normal power outlet (C S A 5-15R*). It gives an advantage of not requiring any electrical work, or at least minimizes any installation costs. Table 1 shows the charging time using a Level 1 charger based on distance driven. 12-A charging cable and 120-V outlet is considered. Charging cable rated less than 12A require longer charging times [3].

LEVEL 2 Charging Station (240 volts and 12-80 amps):

In this type, the charging time of Level 2 charging stations can be limited by the specifications of the on-board charger and the state of the battery, irrespective of the rated power of the charging station. It is believed that the charger capacity is going to increase in future, for example, Tesla already offers on-board 10 kW and 20 kW chargers. Table 1 shows that level 2 charging stations takes less time to charge as compared to the level 1 charging stations even though the distance traveled is similar. Level 2 charging stations have smart and timeless design. It is simple to use (plug the EV in and let it charge). It helps in reducing energy consumption. In addition, it offers Ethernet network for Radio Frequency Identification (RFI) authorization and vehicle ground monitoring circuit. The cord holder keeps the cord organized and out of the way of parking spaces, sidewalks and streets, etc. One example of this is Schneider EV link Indoor Charging Station, which has ground monitor and user friendly LEDs to display status like charging, detected fault, power etc. It has the capability for automatic recovery and restart after ground fault interrupt or main power loss [1].

DC Fast Charging Station (480 volts and up to 125 amps):

DC fast-charge stations generally support two standards:

The North American S A E J 1772 Combo standard and the Japanese J E V S G105-1993* standard. The configuration of the charging plug and the electrical vehicle socket follows the same basic principle compared to the communication protocol between the charging station and the electrical vehicle but have different standards [1]. Table 1 shows the time required to charge a battery with a 100-km range to 80% of its full capacity.

Analysis of Different Charging Stations

Table 1 shows the comparison of different charging stations which are categorized as Level 1, Level 2 and DC charging stations based on electric vehicle distance travelled in km, estimated energy consumption of electric vehicle in kWh, charging station power of electric vehicle in kW, approximate charging time in hour.

Table 1: The comparison between different charging stations levels (Adopted from [1])

Different types of charging stations	DISTANCE TRAVELED (km)	APPROXIMATE ENERGY CONSUMPTION(kWh)	CHARGING STATION POWER(kW)	APPROXIMATE CHARGING TIME(h)
LEVEL 1(120 volts and up to 16 amps)	25	5.2	1.4	4
	50	10.4		8
	100	20.7		15
LEVEL 2 (240 volts and 12-80 amps) for 15-A station (240-V, 20-A two pole circuit breaker)	25	5.2	3.6	1.5
	50	10.4		3.0
	100	20.7		6.0
LEVEL 2 (240 volts and 12-80 amps) for 30-A station (240-V,40-A two pole circuit breaker):	25	5.2	7.2	0.75
	50	10.7		1.5
	100	20.7		3.0
DC fast charging (480 volts and up to 125 amps):	25	5.2	40	8
	50	10.4		16
	100	15.6		25

Why Level 2 charging station is more suitable?

The answer to this question lies in this fact that the most important condition for selecting an electric vehicle charging station location is that how much time is spend by the consumer for charging his vehicle in the charging station. So the time spend is an important factor.

From these charts, it is clear that for the same amount of distance travelled in km, electric vehicle required different charging time in each type of charging station .Also it is shown that Level 2 charging station provides facility to consumer to charge his vehicle in a very short time as compared to other types of charging station. The charts that are shown above prove this.

Types of Electric Vehicles (EVs)

EVs can be divided into the following categories. First, on-road highway speed vehicle that is an electrical vehicle capable of driving on all public roads and highways. The performance of these electrical vehicles is similar to Internal Combustion Engine vehicles. Second, the city electric vehicles, normally, the city electric vehicles have been BEVs (Battery Electric Vehicle - these vehicles can be powered 100% by the battery energy storage system available on-board the vehicle) that are capable of driving on most public roads, but basically not driven on highways. The maximum speed is typically limited to 55 mph. Third category of EVs is also known as low speed vehicles (LSVs). Actually they are BEVs that are limited to 25 mph and are allowed in certain jurisdictions to operate on public streets posted at 35 mph or less. Commercial On-Road Highway Speed Vehicles is the last category of EVs. The commercial electric vehicles include commercial trucks and buses.

These vehicles are available in both BEVs and PHEVs (Plug-in Hybrid Electric Vehicle – the vehicles utilizing a battery and an internal combustion engine (ICE) which is powered by either gasoline or diesel). Table 2 provides information on several different on-road highway speed electric vehicles, their battery pack size, and charge times at different power levels to replenish a depleted battery.

Table 2: Different types of EVs with battery pack size and charging times at different power levels (Adopted from [1])

EV Configuration	**Battery Size (kWh)**	**110 VAC, 15 amp kW[2]**	**110 VAC, 20 amp 1.5[1]**	**220 VAC, 40 amp** 6 kW[1]	**440 VAC, 85 amp 55 kW[1]**
PHEV-10	4	230 minutes	160 m	40 m	n/a
PHEV-20	8	440 m	320m	80 m	n/a
PHEV-40	16	870 m	640m	160 m	17 m
BEV	24	1308 m	960 m	240 m	26m
BEV	35	1910 m	1400 m	350 m	38m
PHEV Bus	50	n/a	n/a	500 m	55m

Note: Power delivered to battery is calculated as follows: 110VAC x 12Amps x.85 eff.; 110VAC x 16Amps x .85 eff.; 220VAC x 32 Amps x.85 eff.; 480VAC x √3 x 85 Amps x .85 eff. From Table 2, it is clear that different electric vehicle configuration require different charging time for different battery size at different power levels to replenish a depleted battery. This helps to find out the charging time in minutes required by different electric vehicle configurations of different battery size at different power levels. Using Table 3, we study the charging time for 100km of BEV range with power supply, power (in kW), voltage (in V) and maximum current (in A). It helps to show the relation of charging time of fixed 100km distance with its power supply, power (in kW), voltage (in V) and maximum current (in A). Thus, the driver finds charging an electric vehicle as simple as connecting a normal electrical appliance. In addition, Table 12 provides comparison between different recharge times of BEV for 100km range. Consequently, it seems clear that charging through single phase takes longer time then 10 minutes of direct current charging, that is the reason for advocating for DC charging infrastructure for EVs.

Table 3: Charging time for BEV range of Electric Vehicles (Adopted from [1])

Charging time for 100km of BEV range	**Power supply**	**Power(in kW)**	**Voltage(in V)**	**Maximum current (in A)**
6-8 hours	Single phase	3.3	230 V AC	16
3-4 hours	Single phase	7.4	230 V AC	32
2-3 hours	Three phase	10	400 V AC	16
1-2 hours	Three phase	22	400 V AC	32
20-30 minutes	Three phase	43	400 V AC	63
20-30 minutes	Direct current	50	400- 500 V DC	100-125
10 minutes	Direct current	120	300-500 V DC	300-350

ELECTRIC VEHICLE BATTERY

The electric vehicle battery is the core component of an electric vehicle with one of the two propulsion sources of HEV and PHEV. Basically, the battery is the sole propulsion source for BEV. There are still some constraints on present EV battery technology, which works as a barrier for wider EV uptake. The current EV battery has relatively low energy density. This low energy density directly affects the maximum all-electric drive range of the EV. In addition, high battery cost of EV is also a big disadvantage as the purchase cost of EV is considerably

higher than conventional internal combustion engine vehicle. Some concerns are also present about the battery life cycle and its safety features. However, EV battery goes through some tremendous improvements in the past decades. EV battery technology goes through a few development phases for inventing the battery with high-energy density, high power density, inexpensive, safe and durable. Lead-acid battery was the initial battery technology used in transportation and its name comes from the combination of lead electrodes and acid used to generate electricity. Lead-acid battery is a really a matured technology and also cheap. However, some apparent drawbacks of lead-acid battery are present, such as low energy density, heavy, require inspection of electrolyte level and are not environmentally friendly.

Table 4: Comparison of EV Battery Types and their specifications (Adopted from [3])

Battery type	**Nominal voltage (V)**	**Energy density (Wh/ kg)**	**Volumetric energy density (Wh/L)**	**Specific power (W/kg)**
Lead acid(Pb-acid)	2	35	100	180
Nickel-cadium(Ni-Cd)	1.2	50-80	300	200
Nickel-metal hydride(Ni-MH)	1.2	70-95	180-220	200-300
ZEBRA	2.6	90-120	160	155
Lithium-ion (Li-ion)	3.6	118-250	200-400	200-430
Lithium-ion polymer (LiPo)	3.7	130-225	200-250	260-450
Lithium-iron phosphate (LiFePO4)	3.2	120	220	2000-4500
Zinc-air (Zn-air)	1.65	460	1400	80-140
Lithium-sulfur (Li-S)	2.5	350-650	350	-

Table 5: Comparison of EV Battery Types and their specifications (Adopted from [3])

Battery type	**Life cycle**	**Self-discharge (% per month)**	**Memory effect**	**Operating temperature (1C)**	**Production cost ($/kWh)**
Lead acid(Pb-acid)	1000	<5	No	-15 to +15	60
Nickel-cadium (Ni-Cd)	2000	10	Yes	-20 to +50	250-300
Nickel-metal hydride(Ni-MH)	<3000	20	Rarely	-20 to +60	200-250
ZEBRA	>1200	<5	No	+245 to +350	230-345
Lithium-ion (Li-ion)	2000	<5	No	-20 to +60	150
Lithium-ion polymer (LiPo)	>1200	<5	No	-20 to +60	150
Lithium-iron phosphate (LiFePO4)	>2000	<5	No	-45 to +70	350
Zinc-air (Zn-air)	200	<5	No	-10 to +55	90-120
Lithium-sulfur (Li-S)	300	8-15	No	-60 to+60	100-150
Lithium-air (Li-air)	100	<5	No	-10 to +70	-

Charging Vehicle Location Selection

The sites of the charging station have a very significant impact loads, at this point, charging station is very similar to traditional gas station, charging station requires a higher penetration of electric vehicles in areas surrounding the construction of a natural high, such as new urban planning to support key enter prices and so on. Our work contributes to identify suitable locations for construction of public charging stations. In this paper we have analyzed possibilities of establishing a public EV charging station in Agartala, India in particular. Charging stations located along the highways are also in high demand since high speed EVs usually requires fast charging.

Public Charging Stations

In this section we will list and describe the most suitable charging locations for the installation of public charging stations. These charging stations can be located at parking lots that serve train stations, shopping

centres, restaurants, hotels and resorts. When selecting a potential charging station, the following criteria should be considered.

Traffic density

The first criterion is traffic density. Traffic density is a necessary factor because the size of the installation should be related to be expected number of users. If the charging station is located near a major road, with high traffic density, then maximum number of people may use it for charging their electrical vehicles. However, areas with high traffic density are in densely populated locations, where the land value is significantly higher. One way to address this concern is to use land that is already allocated for traditional parking lots and convert them to EVSPLs (Electric vehicles solar parking lots) [4]. Further, these lots can also be converted to multi-level parking's where the EV can be on the top where they receive sunlight whereas the traditional vehicles can be underneath.

EV Charging Duration

The second criterion is EV charging duration; i.e. how long does it take to charge an electric vehicle. Electric vehicle need time to charge so it is necessary that the charging stations should be located near public places like shopping centres, work places, educational institutions so that people do not have to wait while their EVs are charging. The charging can happen while they are doing their usual activity such as being at work, weekly shopping etc. As (Nunes et al., 2016) suggests that public charging stations should be installed on worksites and public parks. This allows EV users to charge their EVs without having to wait [4].

Surrounding Vehicle Movement

The third criterion is the surrounding vehicle movement. This is important because charging vehicles must not hinder normal traffic flow, as it will become a hurdle, which may even cause accidents. Further, this location must not hinder pedestrian traffic or be subject to high pedestrian traffic because of the associated risk of vandalism. Public EV charging stations have numerous effects on its surrounding environment, transportation and energy needs and hence these implications have to be examined carefully [4]. One way of implementation would be along the street side parking bays. Electric vehicles (EV) have a very diverse characteristic, as it can act both as consumer and producer. In first case, EV's act as consumer, it is depended on renewable energy resources, batteries, smart grid (G2V- Grid to vehicle) and electric chargers to recharge. In second case, it is producer as well, as EVs can be an essential part of the smart grid. It can act as an energy producer since it stores energy and can provide it back to smart grid when the demand is at peak, this process is known as discharge or (V2G- vehicle to grid). Whereas, there are some concerns about customers' behaviour in participating in V2G programs that is uncertainty about their participation. Describing the solar panels on parking panels and its impacts on energy in the surrounding areas, it is evident that parking lots are a lot more visible and hence can attract potential customers for electric vehicles making EV adoption much more easier [4]. Consequently, EV adoption can have significant positive impacts on human health [4]. Another impact of solar parking lots is their benefit to local market. Since customers will choose a shopping centre with solar parking lots because it will charge their cars while they do their shopping. This will boost the local economy [4]. In addition, there will be lots of employment opportunities for the local technicians to install and maintain a solar parking lot [4]. Hence, installing a solar parking lot is beneficial in a number ways for a particular location like Agartala, India and its surrounding areas.

Winter Accessibility

The fourth criterion is winter accessibility. The location must be cleared and accessible during winter since some countries have severe winters [1]. The use of EVs should not depend on weather and hence EV public charging stations should be available at all times. Photovoltaic covered EV charging stations protect it from severe weather conditions like condensation, freezing rain and frost etc. [5].

Protection from Collisions

The fifth criterion is protection from collisions. The location must provide protection against collisions. It is necessary to provide protection for avoiding accidents and public property damage. Also for maintaining peace in the environment of the road by avoiding fights which may occur due to the collisions of vehicles [1].

Cellular network

The sixth criterion is cellular network access. Access to a cellular network is necessary if required by charging station [1]. Charging stations need to be in line of communication with smart grid since utilities like load management, peak demand and V2G programs depend on the communication that requires cellular network and Internet access as well. These two facilities can attract customers also since they cannot be out of coverage while present at a charging station. WIFI access can also help them connect to apps associated with their EVs and charging stations. In fact, public stations may provide telecommunications features, which will be different for different manufacturers. Many models contain transmitters compatible with cellular telephone networks and do not require additional infrastructure, while others will require a local wireless network, such as a ZigBee protocol network, which involves careful sitting of stations and transmitters. Also many stations communicate over a wired link, such as a twisted-pair or fiber-optic Ethernet network, which should be included in the design of the electrical installation.

Visibility

The seventh criterion is visibility of charging station. Visibility of the charging station to encourage its use by drivers is an important factor [1]. It helps to increase number of users. If users can see the station from far places then it will help them to locate the charging station that increases the use of charging station.

Feasibility of required excavation work and Proximity of distribution panel

The eight criterion is feasibility of required excavation work and the ninth criteria are proximity of distribution panel [1]. Where a distribution panel is the component of an electric panel, its function is is to divide the electricity feed to the “subsidiary” circuits [5]. Both of them are very important factor, which help to make the location more suitable for charging station. The proximity to the electrical service is an important factor in locating the public parking areas.

Table 6: Prime locations in Agartala and their mapping in different criteria

Location	Traffic Density	Surrounding vehicle movement	Winter accessibility	Protection from collisions	Cellular network	Visibility
Holy cross school	✓	✓	✓	✓		✓
Don Bosco School	✓	✓	✓	✓	✓	✓
the Agartala international school	✓	✓	✓	✓		✓
Henry Derozio School	✓	✓	✓	✓	✓	✓
Momos n More	✓	✓	✓	✓		✓
Raaste Cafe	✓	✓	✓	✓		✓
Hotel Sonari Tori	✓	✓	✓	✓	✓	✓
Hotel invitation, Royal Veg,	✓	✓	✓	✓		✓
Curry Club Restaurant	✓	✓	✓	✓		✓
Coffee Tea and Me	✓	✓	✓	✓		✓
Tripura Sundari College of nursing	✓	✓	✓	✓		✓
Women’s College	✓	✓	✓	✓		✓
Maharaja Bikram College	✓	✓	✓	✓		✓
BBM College	✓	✓	✓	✓		✓
Tripura Government College.	✓	✓	✓	✓		✓
CBI Office	✓	✓	✓	✓	✓	✓
Agartala municipal council office	✓	✓	✓	✓		✓
Directorate of higher education office	✓	✓	✓	✓		✓
Tripura Public Service commission office	✓	✓	✓	✓		✓
Krishi Bhawan office.	✓	✓	✓	✓		✓
Office of the AG	✓	✓	✓	✓		✓
Hotel Welcome Palace	✓	✓	✓	✓	✓	✓

Location	Traffic Density	Surrounding vehicle movement	Winter accessibility	Protection from collisions	Cellular network	Visibility
Hotel City Center	✓	✓	✓	✓	✓	✓
Executive INN	✓	✓	✓	✓	✓	✓
Hotel Jaipur Palace	✓	✓	✓	✓	✓	✓
Rajdhani Hotel	✓	✓	✓	✓	✓	✓
Royal Guest House (Hotel)	✓	✓	✓	✓	✓	✓
Ginger Hotel.	✓	✓	✓	✓	✓	✓
ILS Hospital	✓	✓	✓	✓	✓	✓
GB Pant Hospital	✓	✓	✓	✓		✓
Devlok Hospital	✓	✓	✓	✓		✓
GB Hospital Medical College	✓	✓	✓	✓		✓
Tripura Medical College	✓	✓	✓	✓		✓
Agartala Government Medical College	✓	✓	✓	✓		✓
GB Hospital	✓	✓	✓	✓		✓
Green Touch Resort	✓	✓	✓	✓	✓	✓
Shyamali Tourist Resort	✓	✓	✓	✓	✓	✓
Hotel Woodland Park	✓	✓	✓	✓		✓
Rose Valley Amusement park.	✓	✓	✓	✓		✓
Laxminarayan Bari Mandir	✓	✓	✓	✓		✓
Jagannath Mandir	✓	✓	✓	✓		✓
Iskcon Bari, Durga Bari	✓	✓	✓	✓		✓
Ummaneshwar temple	✓	✓	✓	✓		✓
Fourteen Gods Temple	✓	✓	✓	✓		✓
Tripura Sundari temple	✓	✓	✓	✓		✓
M L Plaza, Metro Baazar	✓	✓	✓	✓	✓	✓
Bag Bazar	✓	✓	✓	✓	✓	✓
Agartala City Center,	✓	✓	✓	✓	✓	✓
Femme Zone/FEM Salon and spa	✓	✓	✓	✓		✓
Saradamani Shopping mall.	✓	✓	✓	✓	✓	✓
Agartala airport parking place	✓	✓	✓	✓	✓	✓
Railway station parking place	✓	✓	✓	✓		✓
Rupasi cinema hall	✓	✓	✓	✓		✓
Balaka cinema hall	✓	✓	✓	✓		✓
Tripura puppet theatre	✓	✓	✓	✓		✓

Location Feasibility Analysis

For fast charging station infrastructure requires a concrete base and their installation is similar to that of street side locations. For this station, the conditions are:

The configuration of the station

The locations of any underground lines and tanks

The distance from the street(the charging cable must never extend over the sidewalk)

It required excavation work

The proximity of distribution panel

The planning of any underground conduits and excavation work.

It requires consultation with Info-Excavation before starting work.

The possibility of installing a concrete base

It requires contractor expertise (must have appropriate R B Q and C M E Q licenses).

For publicly available charging, the sitting requirements are involve many questions such as ownership, vandalism, payment for use and maintenance. Also we must take care that flood prone area restrictions must be

considered as well as issues of standing water or high precipitation. The people will not be comfortable when operating with the EVSE (Electric Vehicle Supply Equipment – these equipment helps in the transfer of energy between the electric utility power and the electric vehicle.) in standing water. The area designated for Public use should be in a preferred parking area.

Installation Flowchart for Public Charging

The above flowchart summarizes the whole process of installing an EV public charging station. It starts with step one which is "consultation with utility" it includes utility consideration. The second step is "consultation with the governing authority", it includes all the steps associated with public planning. Then, the constructors "consult with the EV enthusiasts", these are the individuals or parties who want to promote and advertise EV and public charging stations. Subsequently, step four the builders consults the EV suppliers and EVSE suppliers that is determining the level of charging stations i.e level- 1, level-2 or fast DC charging stations. The step five of this charging station installation flow chart includes consultation with the local business owners for examples determining the quantity of solar energy for EVs. Step six, involves communication with electric contractors to assess the safety and accessibility measures for electric vehicle parking lots. Step seven, includes consultation with property owners and EV promoters. Step eight, involves the major step of developing the site plan development. It includes drawing the designs for electric vehicles parking lots. Step nine, includes obtaining required permits from government. Here all particular building rules should be satisfied. Step ten is the second last step of conducting installation. Step eleventh, in this step the construction of completed charging station is inspected and if every required is fulfilled then it is approved.

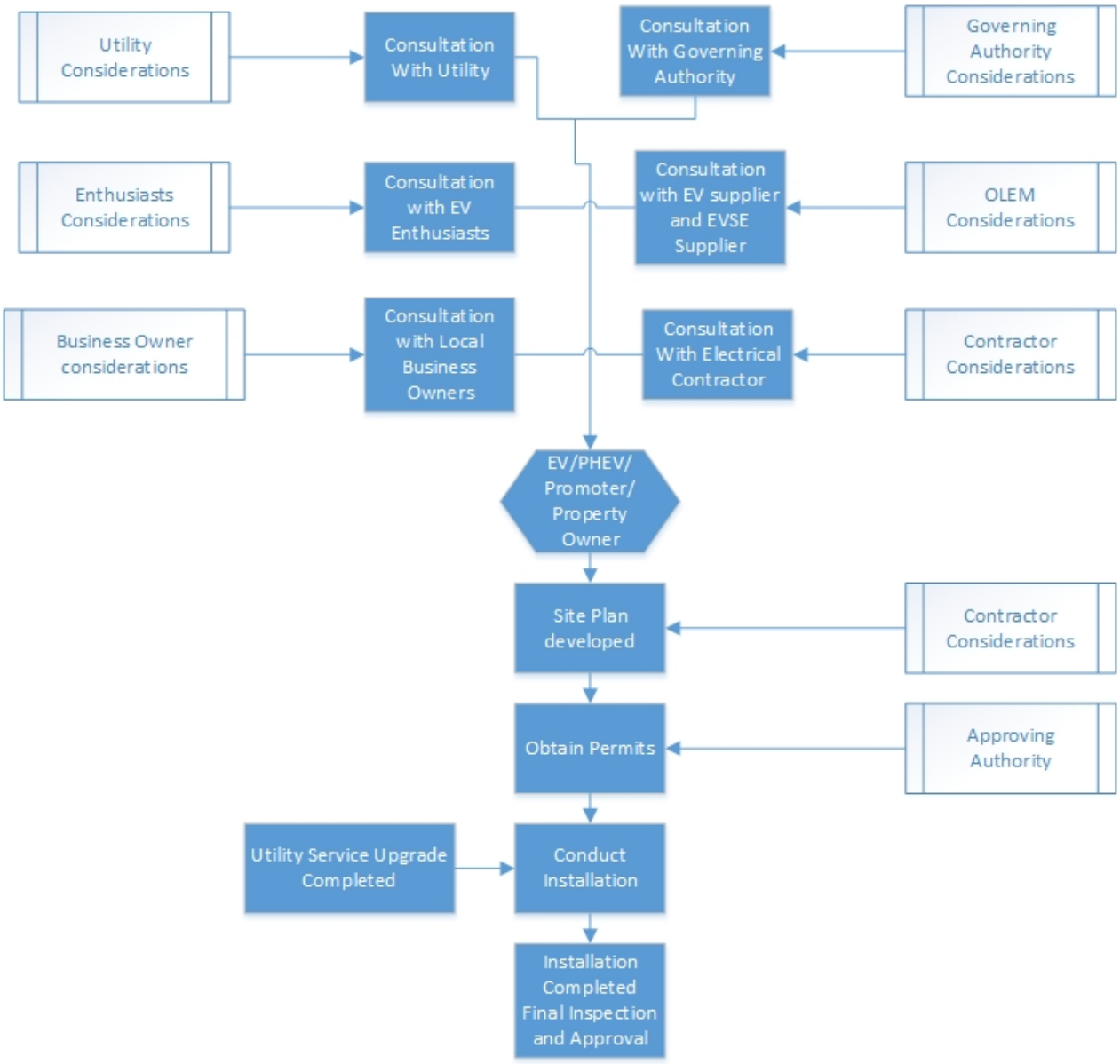

Figure 4 Installation flow chart for installing Public EV charging Station (Adopted from [6])

Proposed Locations for Charging Stations in Agartala

Based on the criteria discussed above, we have identified some places for placing an electrical vehicle charging station that is further divided into some categories:

Schools with parking place

Schools with parking places especially solar parking lots where EVs can recharge is one of the best scenarios. An EVSPL (electric vehicle solar parking lot) is suitable for schools since parents of the students can recharge their EVs while they come to school for any engagement. In the same way since schools have large parking lots specially so it can be an alternative place for recharging EVs when other solar parking lots are fully packed. In addition, number of schools are greater then rare EVSPLs so school locations with EVSPLs can be an effective of reducing “range anxiety” and can result in successful EV adoption.

Keeping in view the earlier mentioned criteria for EVPLs we have identified some schools. These schools’ parking lots can be transformed in to EVSPLs. These schools are Holy cross school, Don Bosco School, the Agartala international school, Henry Derozio School.

Restaurant with parking places

Similarly the following places are suitable for EVSPLs. Momos n More, Raaste Cafe, Coffee Tea and Me, Hotel Sonari Tori, Hotel invitation, Royal Veg, Curry Club Restaurant.

College with parking place: Colleges that are suitable for constructing EVSPL are : Tripura Sundari College of nursing, Women's College, Maharaja Bikram College, BBM College, Tripura Government College.

Government offices with parking places: Government offices with EV charging stations can be an effective solution as well for strengthening EV market. CBI Office , Office of the AG, Agartala municipal council office, Directorate of higher education office, Tripura Public Service commission office, Krishi Bhawan office.

Hotel with parking places

These hotels with EV charging stations is ideal since they are public and potential customers spend more hours there. Hotel Welcome Palace, Hotel City Center, Executive INN, Hotel Jaipur Palace, Rajdhani Hotel, Royal Guest House (Hotel), Ginger Hotel.

Hospital with parking place

Hospitals with EV charging stations can be count on in times of emergency as well. ILS Hospital, GB Hospital, GB Pant Hospital, Devlok Hospital, Apollo Gleneagles Hospital Information Center, GB Hospital Medical College, Tripura Medical College, Agartala Government Medical College.

Resort with parking place: Resorts are also a better place to install public charging stations. Since, not only visitors visit this place but hotel staff and general public can also come to resorts for festive seasons. Hence, it becomes a densely populated area with requirement for a electric vehicle public charging stations. Some are of the suitable places for this purpose in Agartala India are Green Touch Resort, Shyamali Tourist Resort, Hotel Woodland Park, Rose Valley Amusement Park.

Temple with parking place

Temples are best locations for installing public electric vehicles charging stations since this is one of the public places with good space. Some of the appropriate places for setting up EV charging stations in temples of Agartala are: Laxminarayan Bari Mandir , Jagannath Mandir, Iskcon Bari, Durga Bari , Ummaneshwar temple, Fourteen Gods Temple, Tripura Sundari temple.

Shopping center with parking place

In addition, shopping centers are one of the most suitable place for public charging stations due to its parking requirements and the frequency of potential EV customers' visit. Some public charging stations can be installed in these shopping centres in Agartala i.e ML Plaza, Metro Baazar, Bag Bazar, Agartala City Center, Femme Zone/FEM Salon and spa, Saradamani Shopping mall.

Agartala airport parking place

Agartala airport parking place is another example of suitable place of installation of EV parking place due to the availability of parking space and public reach. Agartala airport can provide convenience for airport visitors, cab owners and staff of the airport. A public charging station installed at airport can also attract new EV customers due to its convenience.

Other public places for EV public charging stations installation

Subsequently, railway stations, petrol stations and cinema halls with parking spaces are ideal for constructing public EV charging stations. Due to high traffic density, visibility, availability of cellular network and the entire criterion based on above table we can suggest that the EV public charging stations should not only be installed here but it will also strengthen EV customer base in Agartala, India. Some places identified in this regard are Rupasi cinema hall, Balaka cinema hall and Tripura puppet theatre.

4. Future Work

It is better to visit each parking place then make a record of the number of users using these place, infrastructure is needed to make favorable electrical vehicle charging station or making a website showing locations of private and public charging stations in Agartala. It will increase more users and a website can be developed displaying the cost ratings and quality of charging stations in Agartala. We further check which type of charging stations are more suitable for the location based on the number of users utilising it.

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Ontology-based Multi-agent Systems: An Overview of Existing Approaches

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Abstract

Software agent and multi-agent systems have attracted considerable attention and become active research areas in recent years. Furthermore, the advent of the Semantic Web technology has provided the underlying infrastructure that allows software agents to process data and performs sophisticated tasks on behalf of users. Consequently, the agent-based technology has become much more practical and the number of emerging real-world applications has increased, spanning a wide range of domains. In this paper, a survey of ontology-based multi-agent systems has been conducted and focused in particular on what they can assist users in software engineering domain. From the result of the survey, some open research issues that are used to outline the motivation for the future work are presented.

Keywords: Agent-based technology, Ontology-based multi-agent systems, Software agent

1. Introduction

The agent-based technology has become much more practical and has attracted considerable attention in recent years. Although an agent can work as a stand-alone entity to perform a particular task on behalf of a user, many of the agent-based applications are operated in environments that contain multiple agents collaboratively working together as a group, otherwise known as a multi-agent system. Multi-agent systems offer various advantages compared with a single agent, such as reliability and robustness, modularity, scalability, adaptability, concurrency, parallelism, and dynamism. They are employed in several real-world applications, spanning a wide range of domains such as e-learning, healthcare, web-services, supply chain management, etc.

This study is aimed at providing the understanding of ontology-based multi-agent systems and what they are used for in each domain. The main purpose is to identify the benefits and usefulness as well as the gaps or issues of the existing systems. The period of study is within the last ten years when those works have been presented in scientific conferences or journals. This paper is structured in the following manner. In Section 2, the background of software agent, multi-agent systems, and the integration of ontology and multi-agent systems are introduced. In Section 3, a survey of ontology-based multi-agent systems are presented. In Section 4, discussion of the surveyed systems and open research issues are described. In Section 5, conclusion and future work are presented.

2. Agent-Based Technology

2.1 Software Agent

The agent-based technology has attracted considerable attention and become active research areas in recent years. In addition, the advent of the Semantic Web technology has provided the underlying infrastructure that allows software agents to process data and perform sophisticated tasks on behalf of users. Regarding the term “agent”, the following definition is widely accepted:

“An agent is a computer system that is situated in some environment and that is capable of autonomous action in this environment in order to meet its delegated objectives.” [1]

Accordingly, the key properties of an agent are as follows [2, 3]

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- Autonomy: agents encapsulate some state and make decisions on what to do based on this state without the direct intervention of humans or others.
- Reactivity: agents are situated in an environment and are able to perceive this environment through their sensors. Then, through effectors, they respond in a timely fashion to changes that occur in their environment.
- Pro-activeness: agents do not simply act in response to their environment. They are able to exhibit goal-directed behaviour by taking the initiative.
- Social ability: agents are able to cooperate with humans and other agents in order to achieve their design objectives.

Software agents can be differentiated from traditional software applications in terms of certain characteristics. The differences between traditional software applications and software agents are presented in Table 1 which is adapted from [4].

Table 1 Differences between traditional software applications and software agents adapted from [4]

Characteristics	Traditional software applications	Software agents
Nature	Static	Dynamic
Autonomy	Follow instructions	Be able to perform tasks without direct control, or at least with the minimum of human intervention
Manipulation	User initiates every action	Sense the environment and react autonomously
Interactivity	Non-interactivity	Can interact with other agents, humans, or software programs
Temporal continuity	Terminate when process is complete	Continue to run over time (persistent)
Concurrency	Generate process in one dedicated server with limited processing power	Dispatch simultaneously to accomplish several parts of a task in parallel
Mobility	Stay in one place	Be able to travel from one machine to another

From Table 1, it is clear that the software agents are different from traditional software applications. Moreover, compared with the object-oriented paradigm, the agent technology can be considered as a descendant that improves the nature of passive objects with the notion of autonomous actors [5]. In contrast to simple objects with methods that can be invoked by other objects, an agent communicates with other agents by means of message-passing. In addition, it can act proactively to accomplish its individual goal. Agents can work as stand-alone entities to perform particular tasks on behalf of a user. However, many agent applications are based on environments that contain multiple agents collaboratively working together as a group. This is also known as a multi-agent system.

2.2 Multi-Agent System

Even though an individual agent can perform a task on behalf of a single user, its capacity is limited by its knowledge and resources. Thus, agents are usually implemented in a multi-agent context. A multi-agent system (MAS) consists of multiple agents acting in an environment to achieve a common goal or their individual goals [6]. There is an increasing interest in MAS research because of its significant advantages including its ability to solve problems that may be too large for a single agent. MAS allows a complex task to be decomposed into sub-tasks, each of which is then assigned to an individual agent to undertake independently, but which can be supported by a knowledge base. They have distributed architectures which control distribution by utilising the mechanisms of cooperation and coordination.

MAS have various advantages over a single agent, such as reliability and robustness, modularity, scalability, adaptability, concurrency, parallelism, and dynamism [7]. When a system is implemented based on

MAS architecture, it is easy to add a new functionality or to modify an existing functionality. Within MAS, the functionality is created by calling the service that a particular agent offers. Therefore, in order to add a new functionality, a new agent responsible for a new service can be added into a system. In order to modify or improve the functionality of the system, the existing agent can be modified or substituted with a new one. In this case, a system is loosely coupled which means that it is easy to extend, remove, and modify without breaking down the system. In addition, MAS can make the system more fault-tolerant by replacing an agent that has crashed with a new agent that can be launched on the fly as a substitute for a failing agent [8].

MAS are suitable for applications that require distributed and concurrent processing capabilities. They are employed in the applications in several domains such as supply chain management [9-11], web-services [12, 13], healthcare [14-16], e-learning [8], etc. When a group of individual agents constitutes MAS, it is crucial to have a mechanism that can control such a group. Communication is a key for MAS to exhibit social behaviour (e.g., share information, coordinate their tasks). Individual agents in MAS interact with one another by exchanging messages using a specific Agent Communication Language (ACL). The purpose of ACL is to enable agents to convey messages to one another with meaningful statements [17]. Most ACLs are based on the speech-act theory. Speech acts are expressed by means of standard key words also known as communicative acts or performatives (e.g., request, inform, confirm, and propose). They are used to inform the intention of the communication from the sender to the receiver. The agent's message consists of various parameters such as sender, receiver, content language, ontology, and the actual content. Examples of well-known ACL languages are KQML (Knowledge Query and Manipulation Language) and FIPA-ACL (Foundations for Intelligent Physical Agents-Agents Communication Language) proposed by FIPA ([18]. FIPA is the relevant standardisation body that promotes agent-based technology and the interoperability of its standards with other technologies.

2.3 The integration of ontology and multi-agent systems

Ontologies play an important role in enabling knowledge representation, knowledge management, and knowledge sharing. Many applications benefit greatly from making use of ontologies as a means of achieving semantic interoperability among heterogeneous and distributed systems. They are considered as one of the key enablers for the emerging Semantic Web by making the Web content accessible to humans and computers [19]. Ontologies are in a machine-understandable and processable format, thereby enabling the software agents to understand the contents autonomously. Therefore, the integration of ontologies and multi-agent systems, also known as the ontology-based multi-agent approach, allows software applications to benefit from both technologies. For instance, ontologies can assist with data retrieval, while the agents can act as autonomous software entities that can interact with the environment and with other agents [20].

In recent years, the ontology-based multi-agent approach has attracted considerable interest in research to support various works operated in distributed and dynamic environments. The majority of research has focused on the use of ontology to facilitate agents' communication, represent domain knowledge and help to locate and retrieve information, and reasoning the knowledge.

- Facilitating agents' communication

In a multi-agent system, each agent usually cooperates with other agents to achieve a common goal; therefore, it needs the ability to communicate and interact with other agents by exchanging messages. The agent communication languages such as KQML and FIPA-ACL specify the syntax of the exchange messages but not the semantics of the messages. In this case, ontology can be additionally supplied in the messages to formalise the semantics of the exchanged message in a format that is understandable by agents in order to facilitate consistent communication and interoperability.

- Representing domain knowledge and helping to locate and retrieve information

Ontology can be used to describe domain knowledge and information content which is pertinent to that domain. With the use of ontologies in MAS, domain knowledge does not need to be embedded within the agents. Therefore, it creates an opportunity to share and reuse the domain knowledge and also has the potential to reuse the MAS infrastructure for other applications. Moreover, software agents have the ability to read and understand knowledge captured in ontologies. Therefore, they are able to locate and retrieve the information requested by their user.

- Reasoning the knowledge

The use of ontologies coupled with MAS can support knowledge representation and reasoning capabilities of software applications that are developed by deploying the MAS approach. The integration of ontologies in MAS

can lead to the creation of logic rules that can be applied by a semantic reasoner to infer new knowledge not explicitly defined in ontologies [21].

The benefits of both technologies can be had by integrating ontology and MAS. Ontology is used for knowledge representation, knowledge integration, knowledge sharing and reuse. The features of the software agent and MAS, such as autonomy, reactivity, pro-activeness, social ability, adaptability and dynamism, provide a potential solution for applications that are complex, dynamic and distributed. Therefore, they can be deployed in the application if only one of the approaches cannot satisfactorily resolve the problem. As the ontology and agent-based technology address different aspects of the same problem, they complement each other. Therefore, the ontology-based multi-agent system has been chosen in research as described in the next section.

3. Ontology-based Multi-agent Systems

From the literature, it is evident that considerable efforts have been put into the integration of ontologies and multi-agent systems, also known as 'ontology-based multi-agent' approaches in order to disseminate the knowledge captured in ontologies. Furthermore, some researchers have mentioned them as a means of facilitating knowledge assimilation by capturing and incorporating the knowledge into the ontology knowledge base. These works encompass various domains including software engineering, health, and education, to name a few.

In the software engineering domain, a series of researches related to ontology-based multi-agent systems to support software development activities have been undertaken. MAEST [22] is a multi-agent system that is intended to assist testers during the testing process. An ontology for software testing is developed to model several aspects related to testing software systems such as testing activities, testing methods, software artefacts, information about the environment in which testing is conducted, available resources, and the requirements of the test results. The agents use this information as a means of sharing knowledge and facilitating consistent communications.

In [23], the authors propose an ontology-based multi-agent system to provide support for remote collaboration in multi-site distributed software development environments. In this work, agents are structured into two agencies, namely, user agency and the project agency to create Collaborative Working Spheres (CSW) for software developers to obtain information related to other remote team members' activities. A shared component ontology is created and used by the agents to facilitate consistent communication between the agents in different agencies.

Lee and Wang [24] introduce an ontology-based computational intelligent multi-agent for Capability Maturity Model Integration (CMMI) assessment. This system consists of three main agents interacting with one another to achieve the goal of effectively summarising the evaluation reports of the software engineering process in regard to CMMI assessment. The CMMI ontology is developed specifically based on the fundamental knowledge of the Process and Product Quality Assurance (PPQA) process area of CMMI. The software agents make use of the defined concepts in this ontology to extract key sentences from the evaluated reports in order to enable the relevant team members to comprehend it easily and quickly.

The integration of multi-agent systems and Software Product Lines (SPL) is addressed in [25]. It provides a solution for producing higher quality software at lower development costs and less time-to-market by taking advantage of agent technologies. The ontology is used to model the Multi-agent System Product Lines (MAS-PLs) domain. The agents use this ontology to facilitate inter-agent communication.

The authors of [26] and [27] propose a context processing mechanism called ContextP-GSD (Context Processing on Global Software Development) that utilises contextual information to assist users during the software development process. This mechanism applies agent-based technology to process contextual information and support human resource allocation.

The OntoDiSEN ontology [28] is developed to represent context information in a global software development environment. The software agents use this ontology for context information retrieval and reasoning. In addition, the authors claim that the proposed ontology agent can manipulate the ontology instance knowledge such as updating contextual information or inserting new inferred action and facts. However, no details are provided to show how the ontology agent can perform these tasks.

In [29], the authors offer a case study of an ontology-based multi-agent system in which collaborative agents are interacting and mediating with the Software Engineering Ontology to support multi-site software development teams.

For the health domain, Hadzic, Wongthongtham, Dillon and Chang [30] propose a framework to unify the multi-agent approach with the human disease ontology in order to create an intelligent information retrieval system for human disease. The proposed ontology represents the knowledge regarding human diseases. The

agents make use of this ontology for information retrieval and information analysis and to facilitate consistent communications among agents and knowledge reasoning.

Wang, Lee, Hsieh, Hsu, Acampora and Chang [31] introduce an ontology-based multi-agent system for intelligent healthcare applications to assist users to evaluate diets. The ontologies have been developed to represent personal profiles and food models. Agents use these ontologies to analyse appropriate diet information based on a user profile. Li and Mackaness [32] develop a system that is based on a multi-agent architecture to support decision-making for epidemic management. The system is intended to enhance the performance of information retrieval in a dynamic decision-making environment. Inexperienced personnel can use this system to locate online data and to process services for spatio-temporal analysis of a specified environmental epidemic. Ontologies for dataset and service semantics are used to describe general concepts of GIS web service and epidemiology data management, while lightweight ontologies for simple spatial and temporal reasoning are used to add spatial and temporal semantics to the geospatial data. The agents utilise these ontologies to enable automated semantic service discovery and composition.

In educational domain, Oriche, Chekry and Khaldi [33] propose a semantic annotation system based on three main agents to manage the semantic annotation of educational resources. These agents utilise the domain ontology to assign domain knowledge to learning objects. Once these resources have been annotated, they are conceptualised and organised well so that they can be delivered to the users on demand according to their profiles and needs.

Dolia [34] presents an ontology-based multi-agent system to provide useful information regarding academic institutions such as course information, course registration and scheduling. The Academic Institute Ontology is developed to define concepts and relationships that exist in university teaching environments. The agents make use of this ontology to facilitate their understanding for consistent communication and to provide responses to various types of queries.

In [35] and [13], the authors propose an ontology-based multi-agent framework to automatically discover, compose, invoke and monitor web services. Several kinds of ontologies, namely, application and domain ontology, agent local knowledge ontology, negotiation ontology, and semantic web services ontologies are utilised in this framework. In these works, the agents make use of these ontologies to automatically discover, compose, and invoke the available web services, and to facilitate consistent agent communication. The researchers evaluated the proposed framework by applying it to the e-commerce and biology domains.

In [36], the authors develop an ontology-based multi-agent system to discover appropriate cloud services as requested by consumers. The system consists of three agents collaboratively working to provide dynamic searching for a cloud service. The Cloud Service Ontology is developed to represent cloud service description. The agents use this ontology for reasoning about the services and for information retrieval.

In addition to the abovementioned works, ontology-based multi-agent approaches have been used extensively in other domains. For example, Yang, Lo and Steele [37] introduce an ontology-based multi-agent system for the accommodation services industry to support the online accommodation market. The domain ontology is used to facilitate agent communication and collaboration as well as the development of an ontology-based data transformation mechanism for data structure translation.

Ying, Ray and Lewis [38] introduce MOMA, a framework for creating ontology-based multi-agent systems, and incorporated an experiment in financial application development. MOMA consists of two main development phases: ontology development and agent development. However, the researchers focus only on the development of ontology and the use of the ontology to drive the implementation of the agent application. The agent development part is treated as a black box, but no details are provided regarding the design of the agent's application. The agents make use of the ontology to facilitate consistent inter-agent communication and coordination.

Iribarne, Padilla, Ayala, Asensio and Criado [39] propose an ontological web trading agent approach for environmental information retrieval. This work attempted to address the complexity of information retrieval in the information system to support environmental management. The ontologies used in this system are intended for information retrieval and to facilitate agent communication. Table 2 provides a summary of the aforementioned ontology-based multi-agent systems.

Table 2 Review of some existing ontology-based multi-agent systems

Application Domain	Source	Objectives of ontology-based multi-agent systems	Purpose of agent's use of ontology
Software Engineering	(Maamri and Sahnoun 2007) [22]	Provide assistance to software testers by automating the process of test.	- Represent domain knowledge about software testing - Facilitate agent communication
	(Palacio et al. 2009) [23]	Assist software development team to identify or create opportunities for remote collaboration establishment	-Facilitate consistent communication between the agents in different agencies.
	(Hadzic et al. 2009b) [29]	Provide support for multi-site software development teams as a communication framework	- Represent software engineering domain knowledge - Information retrieval - Facilitate agent communication
	(Lee and Wang 2009) [24]	Summarise the evaluation reports of the software engineering process in regard to CMMI assessment	- Use defined concepts to extract the key sentences from the evaluated reports - Support reasoning of the term relation
	(Nunes et al. 2011) [25]	Provide a solution for producing higher quality software at lower development costs and less time-to-market	- Facilitate inter-agent communication
	(Monte-Alto et al. 2012) [26]	Process contextual information and support human resource allocation	- Contextual information retrieval - Knowledge reasoning
	(Teixeira and Huzita 2014) [27]	Support human resource allocation in globally distributed software projects.	- Information retrieval - Knowledge reasoning - Knowledge manipulation
Health	(Hadzic et al. 2009a) [30]	Intelligent and dynamic information retrieval of human disease information	- Represent medical domain knowledge regarding human diseases - Information retrieval and analysis - Facilitate agent communication - Knowledge reasoning
	(Wang et al. 2010) [31]	Evaluate the health of diets	- Represent personal profile and food model - Information analysis
	(García-Sánchez et al. 2008) [35]	Dynamically retrieve biological information	-Facilitate agent communication and coordination - Information retrieval
	(Li and Mackaness 2015) [32]	Enhance the performance of Epidemiology information retrieval in a dynamic decision-making environment	- Information retrieval - Spatial and temporal reasoning
Education	(Dolia 2010) [34]	Provide useful information for users in academic institutes	- Facilitate the interactions among different agents - Information retrieval

Application Domain	Source	Objectives of ontology-based multi-agent systems	Purpose of agent's use of ontology
	(Oriche, Chekry and Khaldi 2013) [33]	Automate the semantic annotation of educational resources	- Assign domain knowledge to educational resources
E-commerce	(Yang, Lo and Steele 2007) [37]	Support communication, interaction, and management among different parties engaged in the accommodation e-market	- Facilitate agent communication - Describe agent services
	(García-Sánchez et al. 2009) [13]	Facilitate the selection of the provider whose proposal best matches the users' preferences	-Facilitate agent communication and coordination - Information retrieval
Finance	(Ying, Ray and Lewis 2013) [38]	Automate some market analysis tasks	- Represent financial domain knowledge - Facilitate agent's communication and collaboration
Environment	(Iribarne et al. 2014) [39]	Address the complexity of information retrieval in the information system supporting environment management	- Information retrieval - Facilitate agent communication
Cloud service	(Parhi, Pattanayak and Patra 2015) [36]	Discover appropriate cloud services as requested by consumers	- Represent cloud service description - Reasoning - Information retrieval

4. Discussion and open research issues

In this section, with the survey conducted in the previous section, we will discuss the open issues that can be addressed to help to increase the quality of future ontology-based multi-agent systems. Although there is substantial literature on ontology-based multi-agent systems, the existing approaches have two shortcomings that this paper intends to address, namely, the ontology-based multi-agent system for manipulating ontology instances, and the ontology-based multi-agent system that can provide support covering various activities in the software development life cycle.

First, in the literature, most of the ontology-based multi-agent systems focus on facilitating the dissemination of knowledge captured in the ontology. However, very little attention has been paid to utilising the ontology-based multi-agent approach for assimilating knowledge captured in the ontology, i.e., the ontology instantiation manipulation. The purposes for which the software agents make use of the ontology can be categorised as follows:

- representing application and domain knowledge (e.g., [22], [29], [24], [31], [38], [36])
- locating and retrieving the information (e.g., [13], [26], [29], [30], [32], [35], [39])
- reasoning the knowledge (e.g., [26], [27], [29], [32], [35], [39])
- facilitating agents' communication (e.g., [22], [37], [13], [34], [25], [38], [39])
- Maamri and Sahnoun 2007; Yang, Lo and Steele 2007; García-Sánchez et al. 2008; Hadzic et al. 2009a; Hadzic et al. 2009b; Palacio et al. 2009; García-Sánchez et al. 2009; Dolia 2010; Nunes et al. 2011; Ying, Ray and Lewis 2013; Iribarne et al. 2014); and
- facilitating semantic annotation of resources (e.g., [33]).

Although some research (e.g., [26],[27]) mentions the utilising of software agents to manipulate the ontology instantiations, no details or supporting information are provided to explain how the agents work on the ontology manipulation task. Because software agents are able to read and reason published knowledge with the guidance of the ontology [29], it would be a challenge to utilise the ontology-based multi-agent approach for assimilating knowledge in order to manage the evolution of ontology instantiations.

Second, over recent years, the deployment of ontology-based multi-agent systems for effectively disseminating software development knowledge to support software team members has become more prevalent. Nevertheless, many of the works are specific in that they address only a particular task or a certain issue. Thus,

it would be a challenge to investigate the use of the ontology-based multi-agent approach to provide useful support for software development team that can cover several tasks spanning the software life cycle.

5. Conclusion and future work

In this paper, we have summarized state of the art ontology-based multi-agent systems proposed in several domains. From the survey, we identify some open research issues for the future research on the ontology-based multi-agent systems. In the future work, we outline the motivation of our research on developing a novel methodology to use utilise the ontology-based multi-agent approach for assimilating knowledge in order to manage the evolution of ontology designed for multi-site software development instantiations.

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Evaluation of Linux I/O Schedulers on SSD for HDFS

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Abstract

HDFS is base storage of Hadoop cluster and it directly affects Hadoop performance. This research focuses on HDFS storage and we purpose Linux disk scheduler for increasing HDFS storage performance in virtualization environment and SSD. We use TestDFSIO to evaluate Linux disk scheduler with HDFS storage over SSD and use Flexible IO to compare HDFS storage performance with local SATA disk and NFSv4-SSD. In HDFS storage, we use Linux disk scheduler include CFQ, NOOP and Deadline. The results show that HDFS storage performance has better performance than NFSv4-SSD with NOOP and Deadline schedulers. Also, their performance has a better than local with SATA disk. Moreover, we create a fail scenario which shot down one data node when use Flexible IO. The results present a similar performance as other HDFS storages. In TestDFSIO, Deadline has more performance than other disk schedulers. Moreover, the least IO performance of disk scheduler is CFQ. In Flexible IO, Hadoop's NFSv3 gateway is mounted by client and evaluated by FIO read command. The results show HDFS storage cases having similar performance to NFSv4-SSD.

Keywords: HDFS, CFQ, Deadline, NOOP, TestDFSIO

1. Introduction

Storage is a basic device for all computers. There are also various types of storage. The network attach storage is one of the most popular type since a study of the Internet Data Center (IDC) found that the capacity of a new storage can grows up to 100TB. In Big Data era, the new storage platforms or models has been proposed including Amazon (DynamoDB), MongoDB, DataStax (Distribution of Apache Cassandra), Amazon (EMR), Cloudera (Hadoop), Hortonworks (Hadoop), MapR (Hadoop), Microsoft (HDInsight), and Pivotal (HD). Nowadays, many open-source storages are based on Hadoop HDFS. It has a reliable disk cluster because its architecture is the distributed technology that distributed raw data across all nodes. HDFS is based on Google's GFS (Google File System), it combines all physical redundant storages to one logical amount of data. All Service of data center can attach HDFS storage with Network File System (NFS) or Filesystem in Userspace (FUSE). Moreover, it can provide data over HTTP which is called Hadoop HDFS over HTTP (HttpFS). The last one, NFS gateway of HDFS is easy to use and customize for all services similar to NFS server in data center. This research chooses NFSv3 gateway to evaluate the distributed network storage which is the most popular storage along others distributed storage (e.g. Ceph [7] and GlusterFS [8]) because HDFS use to store data for Hadoop. It has more challenge to improve the performance because its performance will directly affect Hadoop performance.

HDFS node must assign directory path for storing data. On each node, it has the various types of disk scheduler including CFQ, NOOP and Deadline. The Linux disk schedulers are one of the popular topics in Virtualization's researches [1][2] which found a better performance by using disk scheduler with virtual machine. They attempt to use disk scheduler with Solid State Disk (SSD) in the virtualization environment. SSD is a new type of disk storage providing high-IOPS for enterprise storage device. It also uses semiconductor devices (solid state memory). The benefit of using SSD is a fast-access like memory or RAM-disks because it is based on Dynamic Random Access Memory (DRAM). Even though it has a better performance than the magnetic disk, but its price is extremely expensive. In Big Data era with Linux I/O Schedulers, we can increase performance with the configuration of disk storage by using Linux disk scheduler on various types of the Big data processing including Terasort, Wordcount and TestDFSIO in Hadoop. In best practices of Hadoop performance-tuning [3], researchers suggested to use the Linux disk scheduler in OS Configuration Tuning

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topic. This research has the current hypothesis about using Linux disk scheduler with SSD in order to evaluate a storage performance of HDFS storage. In Young Jin Yu's research 0 can increase a disk performance of SSD with block I/O scheduler that not only SSD has a benefit from I/O performance but also we can investigate Linux disk scheduler to improve better than default performance with SSD. Linux disk scheduler is the most popular method which is intermediate software between operating system layer and physical storage device. In this research, we use the virtualization environment of Kernel-based Virtual Machine (KVM) which is the most popular of open-source virtualizations. It is also supported in OpenStack. In Amazon EMR, it is the most popular web service based on Hadoop on virtualization environment same environment as this research. Amazon's Hadoop services are fast and cost-effective to use Big Data analytic. By the motivation of the similarity of the idea to this research, we deploy test-bed architecture in the private cloud by using KVM.

This research is including Background review and related works, Materials and methods, Evaluation and Conclusion. This session related work and background information (e.g. HDFS, Linux disk scheduler and NFS). All Linux disk schedulers with HDFS storage are describe in our methodology. In evaluation, we use Hadoop benchmark and Flexible IO for file benchmark in every scenario. In concluding, we present a performance and future works.

2. Research objective(s)

To present a comparison of storage performance on SSD by using Linux disk scheduler in Hadoop HDFS storage.

3. Background and related work

This section, we review the related components of this research including Hadoop, Hadoop Distributed File System, Linux disk scheduler, Network file system and Flexible IO. In related work, we describe related topic in distributed storage with Linux disk scheduler.

3.1 Hadoop

Currently, Big data analytic is the most popular topic in Big data processing. Hadoop cluster is the best answer for this solution and widely used with commercial support which include Cloudera, Hortonworks and MapR. It is not only contributed by Apache which is the creator and the original developer of Hadoop. Hadoop is a portable program over the Java JDK. The Hadoop Distributed File System (HDFS) is a logical storage that is created from local directory on each node of Hadoop cluster. Moreover, Hadoop has more various softwares including Hive which is a relational warehouse, R Connectors for Statistic function with R language and Mahout which is machine learning. Hadoop architecture is shown in Figure 1. It has three frameworks include MapReduce, Tez and Spark for Big data process.

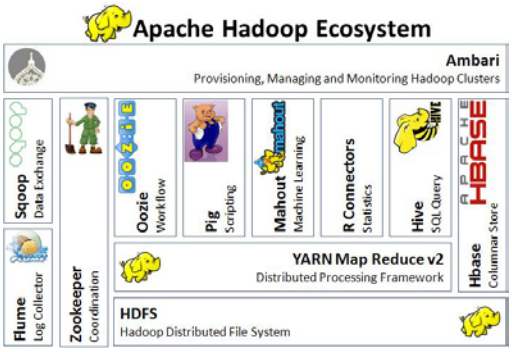

Figure 1 Hadoop Ecosystem [4]

3.2 Hadoop Distributed File System (HDFS)

Apache Hadoop is a cluster of nodes that is possible to scale. Hadoop Distributed File System (HDFS) [6] is the most popular storage service of Hadoop. It includes Name node for containing namespace of HDFS and Data node for storing block replicate of HDFS file. For high availability, data in HDFS cluster can lost in some blocks when a Data node downs and other Data nodes can distribute same blocks by using replicate. The goal of HDFS is to use available a lot of nodes in a large cluster with inexpensive disk storages for maintaining high availability and high performance. HDFS storage is known as data locality and can integrate to a storage area network (SAN), or network attached storage (NAS). It provides large size of storage by using inexpensive drive and server over Hadoop cluster. The data in HDFS is divided into blocks and copied to each Data node in

cluster. It is actually stored as small blocks and replicated on each Data node. HDFS architecture on cluster can described as follows:

NameNode is the HDFS namespace. It includes a hierarchy of files and directories in HDFS logical drive. HDFS's files and directories are represented by inode record. They are split into blocks and replicated to Data nodes.

Image and Journal represent inode and the list of blocks that define the metadata of image. It stored the entire namespace image of inode in memory. Journal represents location of block replicates. It is flushed and synced before acknowledging to client when each client initiated transaction.

DataNodes stored each block replicate that they are represented by two files in local filesystem or DFS's datanode folder as follows: The first file is raw block data and the second file stored the block's metadata with checksums.

3.3 Linux disk scheduler

Linux disk scheduler [5] is the best practice for disk performance in CentOS that has three I/O schedulers including Completely Fair Queuing (CFQ), NOOP and Deadline. We describe all I/O schedulers as follows:

Completely Fair Queuing (CFQ), this scheduler provides the fairness scheduler by supporting multiple processes integrated into Linux kernel 2.6.23 and selected to be default scheduler of Red Hat Enterprise Linux 6 I/O scheduler. It has 3 scheduler classes including real-time, best-effort and idle. The default of CFQ is the best-effort class. The real-time class can starve out I/O and perform with load, but idle class only serve if other I/O pending. CFQ assigns a time slice to each I/O process to take fairness. All I/O processes can have up to 8 requests and CFQ try to predict an application. Also, CFQ make more I/O processes.

Noop, the simplest I/O scheduler by using first-in first-out (FIFO) scheduling. It can merge individual request at block layer. Noop is the best I/O scheduler for making systems with fast storage.

Deadline, it aims to guarantee latency for I/O processes. Deadline assign an expiration time for each device by focusing on an expiration time of requests. For example, more similar requests at close disk locations will be serviced for better efficiency and reading processes have a high priority over writing processes.

3.4 Network File System (NFS)

NFS is the most popular network attach storage that uses mount command to attach server storage over a network with those file systems. Currently, NFS has three versions include NFS version 2 (NFSv2 use RFC-1094), NFS version 3 (NFSv3 use RFC-1813) and NFS version 4 (NFSv4 use RFC-7530). NFSv2 is older and widely use. NFSv3 has more features with 64 bits file and Async mode to write data. Latest, NFSv4 can work on firewall with port mapper and ALC.NFS use Transmission Control Protocol (TCP) over IP but NFSv2 and NFSv3 can use User Datagram Protocol (UDP) which their connection under normal conditions has less Protocol overhead than TCP.

3.5 Flexible IO

Flexible IO [9] is represented by fio command that is a special test case program. It can create workload in any number of threads or processes and simulate an I/O workload. It can measure both the quantity and depth of storage including high-performance storage devices such as PCIe or high-performance network storage over long time period. It can be tested in multiple thread with depth profiles and produce the results which include Throughput, Average Latency, Max Latency and Latency Standard Deviation. For enterprise, it has a synthetic workload analysis which includes different profiles as real-world tasks. For example, read and write speed 70/30 in 8k is widely used for enterprise hardware.

3.6 Related work

Linux disk scheduler on SSD is the most popular in a new data center with virtualization technology. In Shrinivas B. Joshi research [3] related to Haoop performance-tuning suggested by using I/O schedulers for improving the performance in OS Configuration Tuning. There were also other techniques proposed by him such as BIOS, OS, JVM and Hadoop configuration parameters. Those techniques are possible to increase performance of Hadoop cluster. Kenji Nakashima et al. [2] were improved I/O performance of Hadoop cluster by static method and striping layout ST2 with EXT3 file system. They evaluated I/O performance by using Hadoop benchmark including TeraSort and TestDFSIO in virtualized environment. In Big data, Abdelmounaam Rezgui et al. [1] used Hadoop cluster with Linux I/O schedulers including CFQ, Deadline, Noop and Anticipatory on the Global Environment for Network Innovations (GENI). Their results with Hadoop benchmark showed a little differences performance in default parameters on each scheduler. That research focused on Linux I/O schedulers on SSD for improving I/O performance in Hadoop cluster. The test-bed architecture used a virtualization of KVM and Hadoop NFSv3 gateway which used to share HDFS storage for

other services in data center. We do not only evaluate I/O performance on Hadoop cluster, but we also evaluate HDFS storage via NFSv3 gateway from client's mount with flexible IO benchmark.

4. Materials and methods

In this section, we describe our test-bed HDFS storage on Hadoop cluster architecture. We design the test scenarios to investigate the disk performance on virtualization with Linux disk scheduler on KVM virtual machines.

4.1 Experiment Setup

We investigate HDFS storage over Hadoop cluster by using 4 virtual machines (1 name node and 3 data nodes) on full virtualization of KVM hypervisor in 2 desktop computers. Each desktop computer has Intel i7-2600 Quad core @ 3.40 GHz which enabled Intel-VT, 4 GB DDR3, 500 GB SATA and 128 GB SSD shown in Figure 2. Our HDFS storage cluster architecture is described as follows:

Master Node employed only 1 big virtual machine in Host01 with 2 vCPU and 2 GB RAM

Data Node involved 3 virtual machines on each physical Host01 and Host02 with 2 vCPU and 2 GB RAM

In Software components of physical Host machine, they installed CentOS 7.2 64 bits with KVM virtualization software. The image of virtual machines stored in SSD with XFS partition. All of virtual machines installed CentOS 7.2 64 bits, Java JDK version 1.8 and Hadoop version 2.8.2

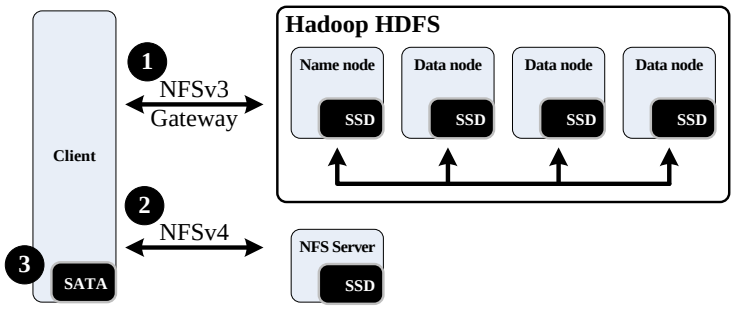

Figure 2 Test-bed architecture of the 3 storage scenarios

In Figure 2, it presents 3 scenarios of a comparison of storage performance which include HDFS storage, NFSv4 with SSD and local SATA storage. In No. 1, it is HDFS storage. We installed Hadoop 2.8.2 in Name node and three Data nodes with 3 replicates. Client can mount with "nfs ver=3". In this scenario, we compared the I/O performance of three disk schedulers which include CFQ, Noop and Deadline. In No. 2, we investigated NFSv4 on SSD storage. The last one used a local SATA disk showed as No. 3. We evaluated 3 storage scenarios by using Flexible IO's read feature.

4.2 HDFS with NFS3 gateway

NFSv3 gateway allows HDFS that can mount as part of client. It supports and enables as follows:

Client can browse HDFS's file and directory on NFSv3 mount path with compatible OS

Client can download and upload file from HDFS to local file system.

Client can stream data directly to HDFS. File append is supported but random write file is not supported.

HDFS used Name node for start NFSv3 gateway service with portmap as following command:

"hdfs start portmap" for initiation portmap

"hdfs start nfs3" for starting nfs version 3 service of HDFS root directory "/"

4.3 Workload

We have 2 scenarios of workload can described as follows:

TestDFSIO, it is native disk benchmark of Hadoop. We used 10 job with 500 Megabytes file for evaluate read performance of HDFS storage with three disk scheduler including CFQ, NOOP and Deadline

Flexible IO, it is the most popular file benchmark. We used 128 Megabytes file and 10 step for iodept to compared read performance between local SATA disk, NFSv4 with SSD and various HDFS storage cases.

In both scenarios, we used three disk schedulers which include CFS, NOOP and Deadline. Command of disk scheduler can be described as follows:

Checking disk scheduler command is "cat /sys/block/sdf/queue/scheduler"

Editing disk scheduler command is "echo 'cfq' > /sys/block/sdf/queue/scheduler"

For special case, we took a fail of one data node for evaluating an available performance of HDFS in Flexible IO.

5. Results and discussion

We conducted experiment to improve the I/O performance of HDFS with NFSv3Gateway by using Linux disk scheduler. Our system architecture uses Hadoop cluster in KVM as same as cloud solution including a single Master node virtual machine and multiple Data node virtual machines on a SSD storage. The results of I/O performance include average throughput of read data processes by using TestDFSIO shown in Figure 3, I/O throughput by Flexible IO shown in Figure 4, Bandwidth by Flexible IO shown in Figure 5 and IOPS by Flexible IO shown in Figure 6. In Flexible IO, we use 128 MB file for time base evaluation. The iodepth parameter is set as 10.

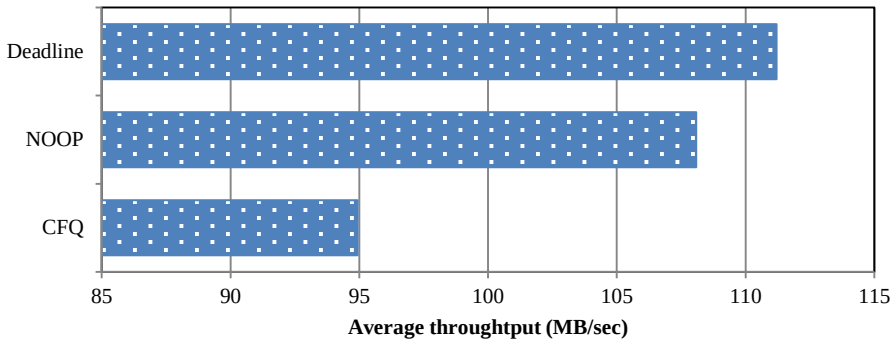

Figure 3 Average throughput of TestDFSIO in read data processes with three Liux disk schedulers

Figure 3 shows the average read rate by using TestDFSIO. This testing evaluates the three types of disk scheduler which include CFQ, NOOP and Deadline on SSD storage. Deadline provides the better performance than NOOP and CFQ around 110 MB/sec. CFQ has the least performance of disk scheduler around 95 MB/sec which is the same as the result in Abdelmounaam Rezgui et al. [1]. They also found that CFQ using default value providing poorer performance than others disk scheduler. The results represent NOOP and deadline schedulers can increase performance. Currently, CFQ is a default value of all operating system (e.g. CentOS, Redhat Enterprise and Fedora).

5.2 I/O results of Flexible IO

All of results of I/O performance with Flexible IO at 128MB that HDFS storage has a better performance as same as NFSv4 with SSD shown in
Figure **4**.

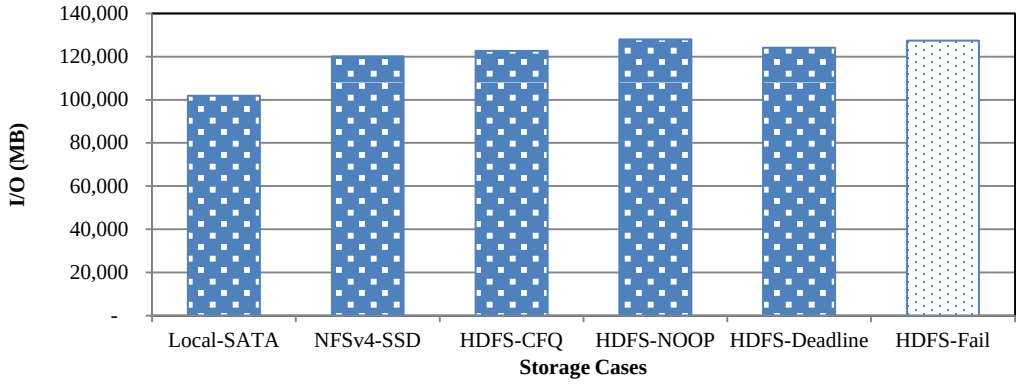

Figure 4 I/O throughput of storage cases

In
Figure **4**, the results show the best I/O in HDFS storage with NOOP disk scheduler 128,021 MB. The least performance in Local storage with SATA disk 101,790 MB. For HDFS storage with fail of one data node 127,387 MB that it can keep I/O performance during test period. HDFS with three scheduler have a quite similar I/O performance same as NFSv4 with SSD that they are around 120,000 MB.

5.3 Bandwidth results of Flexible IO

All of results of bandwidth by using Flexible IO at 128MB that HDFS storage has a better performance as same as NFSv4 with SSD shown in Figure 5.

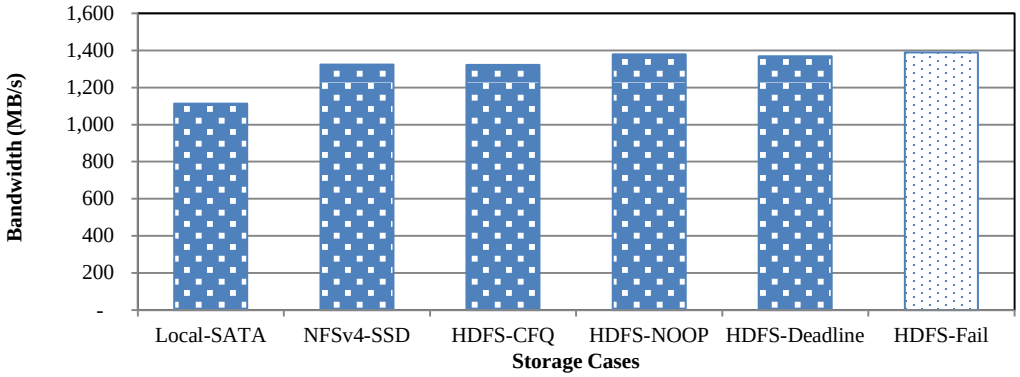

Figure 5 Bandwidth of storage cases

In Figure 5, the best bandwidth can show in HDFS storage with all types of disk scheduler and in case of fail of one data node. Their results are around 1,300 MB per second. The least performance is local with SATA disk same as previous results in I/O performance. All of HDFS storage cases are a quite similar to NFSv4 with SSD.

5.4 IOPS results of Flexible IO

The last one, IOPS results of Flexible IO at 128MB that HDFS storage still has a better performance as same as NFSv4 with SSD shown in Figure 5.

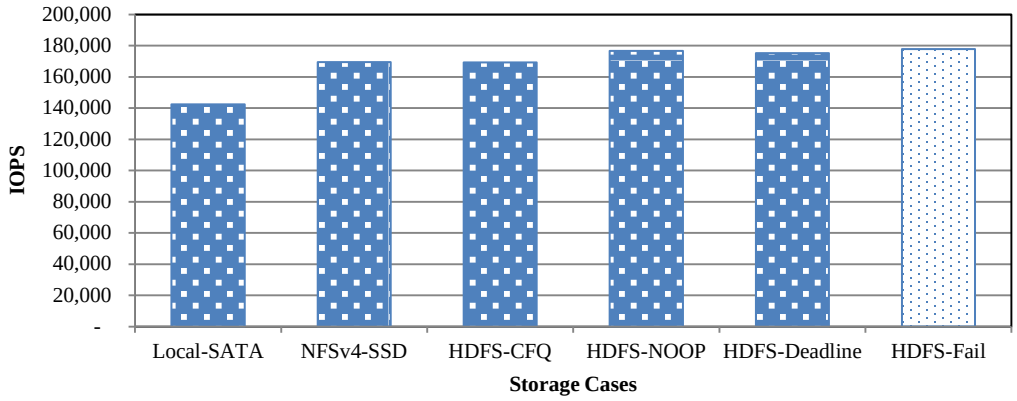

Figure 6 IOPS performance of storage cases

In Figure 6, the best bandwidth can show in HDFS storage with NOOP disk scheduler 176,554 IOPS and the least one still is local with SATA 142,345 IOPS. This result shows the available performance of HDFS in case fail of one data node that has a similar performance with other HDFS storage cases. All HDFS storage on SSD with schedulers has a similar performance with only SSD but HDFS storage has high availability and can keep IOPS in fail case.

6. Conclusions

In concluding, we investigated disk scheduler with SSD which is the fast storage device that can be used to improve IO performance of HDFS storage. The results show NFSv3 gateway with HDFS storage performance has a quite similar performance NFSv4 with single SSD. Moreover, HDFS fail case with SSD can keep performance like other storage cases. The results were represented by the two HDFS's benefits of purpose method including; First, NFSv3 gateway with HDFS storage can keep performance same as a single SSD with NFSv4. Second, Linux disk scheduler can improve I/O performance for HDFS storage shown in

Figure **4**, Figure 5 and Figure 6. The results show that the Noop and Dead line schedulers have better than CFQ and a single SSD with NFSv4. The I/O performance by using Flexible IO, we show a comparison between a local SATA disk with others HDFS storage case on SSD. This research only evaluated a HDFS disk performance with SSD. HDFS performance can increase with others method. For example, disk policy storage. It can swap block data on various disk types including DISK, SSD and RAM. Moreover, Nfsv3 software can use UDP protocol which is challenging to deploy and evaluate performance. The pass-through method with native storage device of QEMU is suggested to increasing storage performance in more researched field related to the performance of HDFS storage. It has more challenges to improve in the future.

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Social Media Framework Incorporating Fuzzy Regression for Affective Design: State-of-the-art, Challenges, and Opportunities.

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Abstract

Nowadays, social media has become an integral part of business, providing a platform to communicate, integrating customers directly into business procedures and acting as an information pool. However, to ensure the accuracy of information taken from social media sites, it is essential to combine information from multiple channels; this aids the legitimacy of the information extracted. Social media data analytics contribute to a variety of domains such as tourism, government, politics and product co-creation among others. In the ground of new product development, the key to the success of a new product is the ability to capture the voice of consumers. In recent years, users have become concerned not only with the basic functional attributes of a new product they might be purchasing, but also the affective attributes of the product. For example, users are more concerned about the colour, shape, look and feel, of a product (such as the affective design and quality of cars, smart phones etc.). Hence affective design is essential in new product development.

In the development or evaluation of a new product's affective design, the voice of consumers can be derived through various social media networks including product review blogs and product discussion groups. Using data from social media networks, it is possible to extract opinion information regarding the affective satisfaction of a product. However, as a user's opinion is subjective, social media data has a level of uncertainty. Therefore, the evaluation of human perception requires estimation of the amount of uncertainty in human evaluations. This paper utilises social big data to extract precise affective design values and uncertainty in evaluating affective quality from user's product related opinion. To evaluate the amount of uncertainty in human perception or subjective judgement of social media data, the proposed framework will incorporate fuzzy regression techniques. A novel algorithm based on fuzzy regression techniques is suggested to determine affective quality magnitudes and uncertainty factor in evaluating affective quality. Finally, the effectiveness of the proposed framework is proposed to be evaluated and validated based on a case study on affective car design by using car design attributes as independent variables to predict affective design value as dependent variable. Towards the study aim, this paper reviews four major streams of project i.e. (i) social media, (ii) data fusion, (iii) affective design, and (iv) fuzzy regression.

Keywords: Affective Design, Uncertainty, Social media analytics, Fuzzy Regression, Data Fusion.

1.Introduction

The rapid rise in social media use has revolutionised the power of expression in recent times. The development of the internet and expansion of mobile technologies have been the primary force behind the rise of social media use, providing technological platforms for information dissemination, content generation, and interactive communications [1]. Continually, social media is spreading worldwide at an exponential rate. For example, in 2016, 68.3% of internet users were social media users; these figures are expected to grow [2]. Facebook, YouTube, Twitter, Instagram and Wikipedia are just a few of the most popular social media web applications. The amount of time people spend on these sites is also constantly increasing. For instance, Australians are now spending more than half a day per week (12.5 hours) on Facebook alone [3]. Hence, social media landscapes can be viewed as widespread communication platforms for consumption and for sharing a rich source of day to day information.

Social media plays an ever-growing significant role in an individual's social life by introducing enhanced features concerning their emotions and behaviour. For example, Facebook allows users to update their status or post information not only in text but using graphic emotion icons. By way of illustration – suppose an individual driving a newly released model of a car had recently updated his views on a social media account. His feelings and behaviours toward that product can now be analysed based on his comments and the use of any emotion icons. Such information can collectively form online knowledge and insights related to products, services and brands that are shared by disparate users [4]. Rathore, Ilavarasan, and Dwivedi, also consider social

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media as a major factor influencing users' behaviour in the form of opinions, perceptions, feedback, usage, intention, purchase habits, depth of analysis and the variety of shared information. In this context, collecting information from these interrelated multiple sources opens opportunities for more reliable and accurate knowledge which can further contribute to better business insights [5], [6]. For instance, having uniform information from multiple sources are likely to build consumer trust in a product. It can also help authenticate the information. Therefore, the fusion of information from social media can be beneficial for effective organisational analytics.

Furthermore, social media has considerably altered the traditional way of communication and interaction between businesses and consumers. These virtual communities are now penetrating the mass public, transitioning social media communication into the main form of communication. As a consequence, social media has enhanced the ability for industries to integrate customers into their business model [4]. For example, in new product development, the key factor of success of a new product is to capture the "voice of the consumers" [7]. Consequently, satisfying consumers' requirements is not only a "need" but also a "must" for every company. In this context, it is suggested that to cover all emotional aspects of a user, a product must exhibit three categories: (1) it must be useful (it must perform the designed tasks); (2) it must be usable (easy to use and interact with); and (3) it must be desirable (provides feelings of pleasure and creates attraction) [8]. With social networks, designers can use online consumer data to understand their requirements, affections and desirability. Hence, extracting and incorporating emotional, behavioural and demographical social media texts into the product design process may contributing to enhanced affective design.

Affective design involves the processes of identifying, measuring, analysing and understanding the relationship between the affective needs of the customer and the perceptual design attributes in the design domain [9]. The purpose of affective design is to satisfy the affective needs of users, by integrating their affective requisites in the design attributes of a new product [10]. This gives designers the ability to generate designs which appeal more to their target market. Affective design has been shown to excite customers' psychological feelings and can help improve customer satisfaction [11]. Conventional methods of affective design focus on predicting or determining the amount of affective quality, such as Neural Networks [12] and the Kansei Methodology [13], [14] which predicts consumer perceptions when the perceptual design elements of the products are given. However, perceptions are subjective; hence uncertainties are inevitable. In this context, the estimation of the amount of uncertainty in affective quality has been of limited focus in previous literature. Major works in this area include Chan et al. [10], who proposed an intelligent fuzzy regression technique to generate models for relating design variables to affective responses in which both non-linearity and fuzziness are considered. Chan and Engelke [15] presented a novel fuzzy regression method to predict affective quality and fuzziness in human assessments, for given objective features.

This paper discusses the possible ways to predict human evaluation of affective quality as well as the uncertainties in evaluating the affective quality by incorporating a fuzzy regression technique. Social media data is suggested to create Data Fusion for affective design. This paper presents a literature review of existing literature presented in four major streams; (i) social media, (ii) data fusion, (iii) affective design, and (iv) fuzzy regression. The rest of this paper is organised as follows. In section 2, we address the existing literature on social media for affective design. In section 3, we focus on the existing literature on data fusion with a requirement to deal with social media data and related challenges. In section 4, we outline the existing literature on affective design demand and various existing approaches. In section 5, we focus on the existing literature on the use of fuzzy regression techniques in calculating affective quality values. In section 6, we present the prospect framework and the paper ends with conclusion and future work in section 7.

2.Social media

Social media is drawing significant attention from both application and research perspectives. Not only it is an integral part of information ecosystems, but also rapidly growing among users, consumers, corporations, governments and many other entities [1]. Breur [16] discusses social media as one of the four major streams of data analysis, which contains user generated data and sentiments. In addition, social media is considered a major factor influencing users' behaviour in the form of opinions, awareness, reviews, emotions, intention, purchasing habits, analysing and information sharing [4]. As a result, to leverage this, there arises a need to collect and analyse social media data to extract useful patterns and investigate current trends, user affective information etc.

Several works have been submitted for social media analytics techniques, as it plays a principal role in developing tools and frameworks to collect, analyse, summarize and visualise social media data. Zeng et al. [1] discusses various challenges involved with social media analytics processes such as, retrieving massive data and related metadata, computing dynamic streams of rapidly increasing data, the integration process, user generated

information mining etc. In addition, Zeng et al. explores social media intelligence as a source of more productive information, however this idea seems to be in the early stages of development. Similarly, Fan and Gordon [17] discuss the various scopes of social media analytics, by means of which useful patterns and users' affective information can be retrieved. In relation to this, a framework has been presented [18] for acute analysis of affective experiences to gain marketing insights. Grassi et al. [19] created a sentic web to manage affective information from social media by combining semantic analysis techniques and artificial intelligence methods, though the retrieval of dynamic emotions from social media presents as a limitation for this approach. In order to uncover these sentiments, Cambria [20] listed the major approaches for affective computing. These approaches did not clearly identify a common-sense knowledge base or reveal new affective knowledge in order to detect and perceive real emotions.

Another consideration is the co-creation of products through the use of social media networks, where consumers work online with company product designers to obtain user requirements [4]. It is also stated that, current patterns suggest social media could produce an additional $940 billion in annual consumption, particularly in relation to the sale of electronics, hardware, software, and mobile technologies [4]. Thus, social media results in significant possibilities for product design and other commercial needs. The significance and applications of social media data has been covered extensively in previous studies. However, from a decision perspective, social media data still contains a level of uncertainty and is inherent with subjective opinion based information [1].

In view of the fact that social media data is essentially a collection of user generated data i.e. blogs, posts, comments, reviews and other forms of social media which is created by consumers [21], it is based on, or influenced by, personal feelings, tastes, or opinions. Hence, it is inherently ambiguous and uncertain. Taking this into account, a significant need arises to estimate the amount of uncertainty in social media data when obtaining user information.

3.Data Fusion

These days, we are living in a digitized society where every single step is being recorded in some format, for which companies employ a number of social platforms in the market to stay in touch with their customers [16]. Social media data is generated from these wide range of internet applications and web portals. Example include, but are not limited to, Facebook, Twitter, LinkedIn and Instagram. These rapidly growing social sites allow companies to connect with users and has created a new generation of users who are enthusiastic about interacting, sharing, and collaborating, thereby forming a new mode of communication [22]. As a result, information dissemination through social media takes place in almost every area that includes business, education, tourism, day to day life and health among others. Hence, there arises a demand to collate and analyse data from these sources, to enhance the legitimacy and accuracy of the information.

Information Fusion ('IF'), involves the combination of information into a new set of information, aimed at reducing redundancy and uncertainty [23]. Along the same line, Data Fusion, which is a subset of Information Fusion, (or Information Integration), is the process of integrating multiple data sources to produce more consistent, accurate, and useful information than that which is provided by any individual data source [24]. It is applied in different fields where data is distributed and generated from diverse sources. Thus, to get a holistic view of customers, businesses ought to integrate information from multiple channels. In the field of literature related to data fusion, various methodologies have been proposed to accumulate heterogeneous information from a range of diverse sources. For instance, the crowdsourcing semantic big-data fusion approach has been used for heterogeneous media in the IoT environments, which provides higher-quality semantic fusion and more precise retrieval of information [25]. Breur discusses data fusion as one out of the four useful data analysis streams available to researchers [16]. Bello-Orgaz, Jung, and Camacho [22] summarise the challenges of data fusion which include: (1) obtaining more reliable methods for fusing the multiple features of multimedia objects for social media applications; and (2) studying the dynamics of individual and group behaviour, characterizing patterns of information diffusion, and identifying influential individuals within social networks.

Data fusion refers to resolving conflicts from different sources and identifying the truth that reflects the real world. Unlike schema mapping and- record linkage, data fusion is a relatively new field. Its motivation is exactly the veracity of data: the web has made it easy to publish and spread false information across multiple sources [26]. To overcome the challenges of data fusion, different techniques are being developed to suit real world applications. These intensive techniques are derived from different computing areas including artificial intelligence, statistical estimation, pattern recognition, and so on [6]. However, given the very large heterogeneous dataset obtained from social media, one of the major challenges is to identify the valuable data and determining how to analyse it to develop useful knowledge [22]. Emerging big-data applications can be

seen as a solution to the integration of the heterogeneous and dynamic stream of data from diverse social media channels.

4.Affective Design and Kansei Engineering

In today's competitive world, optimization of customer satisfaction is essential in new product development, in order to achieve optimal success [10]. To address customer satisfaction, Lee [27] developed a methodology to better understand user preferences based on perceived usability and perceived aesthetics. Results from this study show that before any actual use of a service or product, user preference was significantly affected by the aesthetics of the product rather than by usability factors. This is the reason why a lot of companies focus on the beauty of their products.

Affect, mood, and emotion are fundamental aspects of human beings and are found to influence, reflexes, perception, cognition, social judgment, and behaviour [28]. Fong [28] presents an approach for automatic generation of Personal Web Usage Ontology ('PWUO') of periodic access patterns from web usage logs. In this study, apart from efficiently providing users with periodic web personalisation patterns, Fong also discovered that emotional influence contributed positively to the results. Therefore, affective design plays an important role, in the development of designs which better appeal to their intended market. The sole purpose of affective design is to further satisfy user's affective needs rather than solely optimizing the functional needs for a product. This is done by integrating user's affective requisites within the design attributes of a new product [10]. Better affective design of a product increases that products' appeal to potential buyers and produces a more harmonious product [32].

Affective design draws its inspiration from Kansei engineering and attempts to relate subjective requirements to measurable product properties that can be tested and verified. Kansei Affective Engineering ('KE') [29] is defined as the technology of translating the consumer's Kansei into the product design domain. Nagamachi defined this process of performing Kansei Affective Engineering as: (1) grasp the consumer's Kansei in the specific product domain using psychological or psychophysiological measurements, (2) analyse the Kansei data by statistical, medical, or engineering methods in order to clarify the Kansei structure, (3) interpret the analysed data and transfer the data to the new product domain and (4) design a new Kansei product. KE methodology has successfully contributed to the development of many different products such as motor vehicles, coffee cans, beer cans, milk cartons and body cosmetics [9], [14], [30], [31].

Further, in relation to prioritising customer preferences, Chou [32] presents a Kansei evaluation approach based on the technique of computing with words ('CWW'), with the purpose of validating the classification of Kansei attributes using Kansei words, establishing priorities for customer preferences of product alternatives with respect to each attribute, and synthesising the priorities for the evaluated alternatives. Diego-Mas and Alcaide-Marzal [12] use a neural network based approach, to present a theoretical framework which enables single user responses to predict different product designs. Yadav et al. [33] utilises the application of the fuzzy Kano model into quality function deployment ('QFD') with the objective of analysing the customer's aesthetic feeling toward customer satisfaction. Jiang et al. [9] proposes and describes a methodology of simultaneous consideration of affective design and the determination of engineering specifications to determine design attribute settings and engineering requirement settings for a new product. An artificial intelligence (AI) based methodology [11], has been proposed for integrating the affective design, engineering, and marketing for defining design specifications, at an early product design stage. This study utilises the static market trend however, in the current technology climate, the world is evolving towards an era where online communities will define future products and services [4]. Hence, there arises a need to consume dynamic market in relation to affective design. In addition, inappropriate affective designs can only be determined by past affective information and data. Hence, there is a need for an approach that continuously updates user's affective quality information.

Much previous research has been conducted to estimate affective quality for better affective design. However, data relating to affective satisfaction is inherently vague or uncertain. The above-mentioned approaches are relatively unable to address this issue. In order to estimate the level of uncertainty or vagueness, recent research have shown that the fuzzy regression model is a more commonly used method for developing consumer preference models. The fuzzy regression model is explicit meaning that analytical information can be identified for use in new product development and developed models can address the fuzziness in consumer preferences [34]. Chan and Engelke [15] propose a novel fuzzy regression method to predict affective quality and estimate fuzziness (i.e. vagueness or uncertainty) in human assessments, when objective features are given. So far, studies have targeted fuzziness in observed survey data or static data yet there seems to be no research on

estimating the effect of fuzziness on affective design datasets, which varies with time and can be captured online through the use of social media.

5.Fuzzy Regression

Previous studies have anticipated the significance of good affective design in new product development. In order to evaluate affective design, researchers have introduced different methodologies to measure the amount affective quality/aesthetic quality by either 'surveying in order to obtain users' subjective perceptions of object aesthetics' or by 'predicting affective qualities by means of objective features based on product design attributes' [35]. Survey techniques were used for a number of studies. For example, Diego-Mas and Alcaide-Marzal [12] used a neural network-based mathematical model to present a theoretical framework which enables single user responses to predict different product designs. This is done using limited survey responses and thus offers less statistical power. Similarly, a large amount of research has been proposed using the Kansei engineering methodology [30], [13], [4] to better understand consumer perception and affective requirements. These studies are conducted using surveying techniques, that may contain too many subjective evaluation items in the questionnaires or survey questions, and there is a possibility for uncertainty to arise out of the subjective evaluations by participants. However, the uncertainty of interviewees in answering the survey data may not be analysed using traditional statistical methods. In addition, it is ambiguous to conduct a survey for every single design attribute of products. Surveying is time consuming and expensive, with limited access to the population of concern [35].

Another approach of predicting affective quality is based on the assumption that objective features of products are correlated with user's affective quality perception [15]. As a result, empirical models can be built using objective features such as colours, product style, outlook, interfaces etc. in order to determine the affective quality of a product. Statistical regression techniques are generally used to estimate the correlation and significance of variables [15], [35], however uncertainty in subjective human evaluation cannot be taken in account. Since human emotions are uncertain, crisp values from statistical regression does not correspond effectively when assessing affective quality. To overcome this, the fuzzy regression methodology was developed, which evaluates the uncertainty in human perceptions.

A number of studies have used fuzzy regression techniques to estimate affective quality and uncertainty in human perception [15], [32], [10], [33]. In this context, products with acute affective quality are easy to evaluate. However, products with relatively moderate affective quality have a significant level of uncertainty.

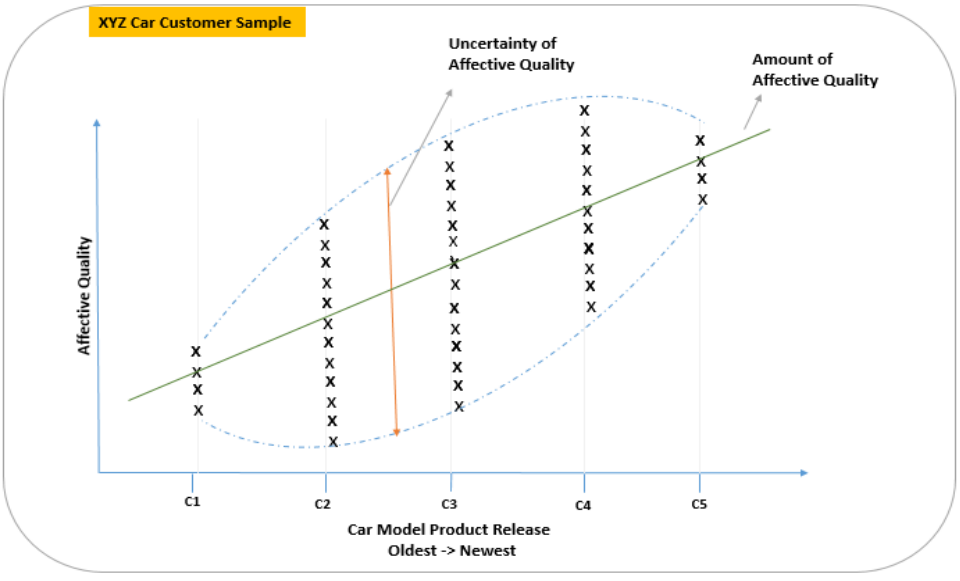

Figure 1 - Uncertainty of Affective Quality

Figure 1 illustrates the uncertainty of affective quality. For instance, suppose C1, C2, C3, C4, and C5 are different car models. C5 is the most recent model with the highest price and the highest affective design when compared to C4. C4 is the second most recent model with better affective quality than C3. C3 is

the third most recent model with better affective quality than C2, and so on. Likewise, C1 is the basic model vehicle with the lowest price and the lowest affective design. As the affective quality evaluation is subjective, users may have more confidence in determining the affective quality of C5 and C1. Hence the evaluation of uncertainty is low. On the other hand, for intermediary models i.e. C2, C3, and C4, users have less confidence in evaluating the affective quality. Therefore, the uncertainty in evaluating the affective quality is higher for the average model vehicles, which have average affective qualities. Although Chan and Engelke [15] have developed a fuzzy regression method for predicting affective quality and uncertainty when evaluating affective quality, fuzzy regression coefficients are determined based on heuristic algorithms, which are time consuming and indeterminate. A more time-effective and determinate approach is essential to determine fuzzy regression coefficients. This approach will determine affective design of a product and uncertainty in evaluating affective quality which will help in attaining affective design of the car.

6.Prospect Framework

This section discusses a prospect framework to determine the perceptual uncertainty in affective design evaluation, while incorporating a social media big data framework and fuzzy regression techniques. As part of the social media framework, data fusion for affective design will be produced first by integrating two or more social media platforms. Customer segmentation will be achieved by clustering social big data on the basis of users' geographic location or age, to match different demands. Then, an algorithm based on the fuzzy regression model is suggested to detect the amount of uncertainty in social media affective data. This will contribute to the development of an affective design framework for a dynamic market.

The design and development involve the creation of the objects and model that employ data fusion by integrating affective design data from multiple social media channels and incorporating it with a fuzzy regression algorithm to evaluate the uncertainty in affective design evaluation. Since social media data is a part of big data, it adheres to the big data ('BD') value chain presented by Hu et al. [36] which covers the big data life cycle. This chain consists of four main phases: (1) data generation (or data extraction), (2) data acquisition, (3) data storage, and (4) data analysis. The prospect framework will pass through the lifecycle of big data to achieve the key objectives of the study. Figure 4 illustrates the detailed design structure which includes four phases of the big data life cycle to handle data and affective design evaluation.

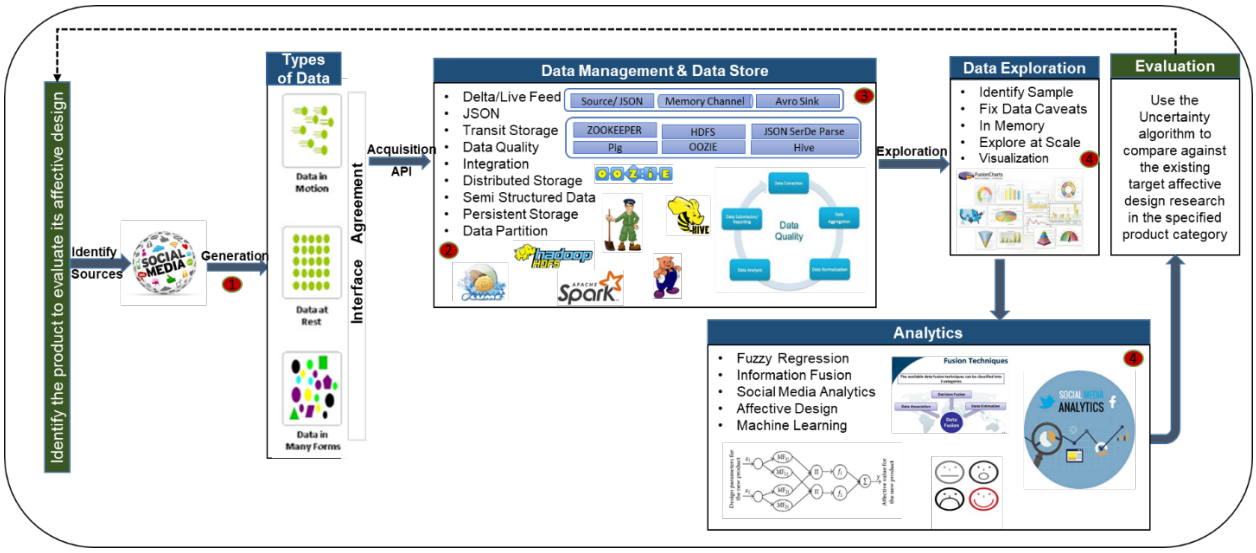

Figure 4 - Detailed Design Structure

- Data extraction

Every source (e.g. social media platforms) generates heterogeneous types of data which form a variety of dimensions of unstructured social media data. The scope of this research will focus on social media streams such as Facebook, Twitter, Instagram, and blogs.

- Data acquisition

In this stage of the study, using the interface agreement with social media (i.e. social big data) sources, the heterogeneous data is extracted in an unstructured/semi structured form, mainly in a JASON data format.
Accessing data requires a compatible Application Programming Interface ('API') which is a software program that has a defined way to access and retrieve data. Generally, social sites have their own compatible API's for connectivity. To capture a constant stream of data, a custom Cloudera Distribution Hadoop ('CDH') or an equivalent can be put together to build a data pipeline to ingest the data from the API to the Hadoop Distributed File System ('HDFS') [37].

Apache Flume is one of the data ingestion systems that consumes data delivered to it by an external web source. The concept on which it works involves processing the data through the following stages; Flume source; channel; sink; external repository. To elaborate, the external source sends data to Flume that is recognized by a Flume source; in this study, a JASON Flume flow agent or similar is required. When the Flume source receives the data, it will store the data in passive data storage channels and stay there until they are consumed by a Flume sink. The sink then removes the data and moves it into external repositories; this study uses the HDFS using a Flume HDFS sink [38].

- Data storage

A combination of HDFS, Hive and Oozie will be used to store, query and maintain the data partition. Once the Flume agent data loads the data into the HDFS (HDFS is NoSQL and hence difficult to query), it can be prepared for analysis by creating a table in the Hive using the Hive Serde interface to interpret the format. As the volume increases, it demands a need for partition which can be achieved by using Oozie [39].

SAS in its recent blog commented on the importance of the quality of big data. Data quality can be achieved within Hadoop. This is a critical aspect that requires consideration to ensure that data is well profiled and standardized [40].

- Data Exploration and Analytics

Hadoop will be used to interpret the unstructured and semi-structured data into a structured format which can be further analyzed using SQL or SQL equivalent queries. The next step is to understand the data, identify the sample for analysis, fix the data caveats and visualize the data for audit and visual interpretation. The following analytical tools are used; SAS Enterprise Guide, RStudio, SAS Visual Analytics, PostgreSQL, and Python. The ideal tool for this stage would be the SAS Visual Analytics tool, which works on memory concept.

An algorithm will be developed to evaluate the amount of uncertainty in this data by using fuzzy regression techniques. As part of fuzzy regression technique, independent variables will be taken as the design attributes of a car model i.e. body type, color, transmission etc to predict dependent variable i.e. magnitude of affective design and uncertainty in evaluating affective design. To deal with affective design attributes, keywords such as body configuration, color, automatic control will be selected from social media texts. This case study will segment customers to deal with different group interests. The tools in consideration include R and SAS Miner.

7. Conclusion and Future Work

In the current technology climate, the world is evolving towards an era where online communities will define future products and services [4]. This is the reason why, there arises a need to consume dynamic market trends in relation to affective design of products. Taking this into account, social media, majorly contributes to the big pool of online information, which is essentially a collection of user generated data i.e. blogs, posts, comments, reviews and other forms of media, created by consumers [21], also it is based on, or influenced by, personal feelings, tastes, or opinions. Hence, it is inherently ambiguous and uncertain. Thus, a significant need arises to estimate the amount of uncertainty in social media data when obtaining user information. In addition, with growing social media channels there arises a demand to collate and analyse data from these sources, to enhance the legitimacy and accuracy of the information.

Thus, an approach for determining the amount of perceptual uncertainty in human evaluation is required, while considering social media data analytics. The focus of this study is to develop a model using social media data and fuzzy regression techniques to estimate human uncertainty in evaluating the affective design of new products. To improve the effectiveness of the model, a case study will be performed, to evaluate

user's affective design preferences based on the research outcomes. Also using the suggested framework, customer segmentation based on age /ethnicity/geographic location can be generated in order to understand different group interests. Thus it can add value to product marketing as a future scope.

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Service Measurement Tool for Internet Service Provider

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Abstract

In this paper, we propose a new service measurement tool that ISPs can be used to assure their clients of the quality of service in different areas. Our tool uses PHP API of RouterOS to control MikroTik devices. The RouterOS allows us to verify network performance and control the network's service measurement both in manual mode and scheduled mode. In the latter mode, we can specify the data size, the network we want to measure or the interval to repeat the same operation then save the result to the database, our tool will send the notification to the ISP via SMS. We also use the Fullcalendar2 framework to visualize the result in a calendar depending on the selected date. The result is shown in form of the bandwidth graph, average upload-download speed and percentage of measurable data that obtained from Canvas.js. The result presents the connection map of devices made from Google Map. Our tool is divided into 3 parts: 1) MikroTik router management, 2) service measurement and 3) user management that we separate users into 3 levels: 1) Maintenance officer, 2) District chief and 3) central authorities.

The result indicates that 1) users at every level can use our tool over the internet 2) the district chief can manage users and verify devices' performance in every area 3) maintenance officer can install and register devices via our tool 4) the management and measurement the performance of the network in each area are centralized and controlled by central authorities. Our tool has the flexibility to measure the performance of the network and the results are reliable that we can use to improve the service and more than that we can apply our tool to the various organizations for a low-cost software package.

Keywords: Service Measurement, MikroTik, RouterOS, Network Probe, Software API

1. Introduction

The internet service provider (ISP) is the company we pay a fee to get the access to the internet. All internet connected devices send a service request through their ISP to access to servers, those servers themselves have to send a response to the request via their own ISP. To maintain the stability and availability of services, the ISPs have to measure frequently the performance of their service and they can use that information to improve the quality of service and manage their system. There are several criteria for measuring the network such as performance, reliability and security[1]. The main objective of service management is 1) to monitor and detect anomalies in the system 2) to collect service's statistics that can be used to upgrade management and organization of the system. In general, ISP uses the Active Monitoring to collect all statistics and use them to analyze and organize the network management, for example, the Multi Router Traffic Grapher (MRTG)[2] is used on large networks. It is required both software and hardware with high capabilities, that means we need to pay at a high cost to measure the performance of the whole system, in order to increase service quality.

The use of technology in the measurement and testing of telecommunications systems, the administrators must focus on the assurance of services qualities as follows:

1) We must measure and test the telecommunication system by verifying different performance aspects such as availability of the service, network congestion and time of errors detection, etc.
2) The measurement and testing of telecommunications systems should not perturb the performance of the system.
3) The maintenance of telecommunication devices must be always in place in order to make sure that the service will always available.

Moreover, the management of complex and numerous networks drives the many difficulties to the manager to verify the operation of their devices, that why we need a tool that helps us to understand the problems and how to solve them correctly and quickly. Since the system is in the failure state for a long time that can make a significant impact on their business. So that, the main objective of our research is to study and

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develop a service measurement tool for telecommunication networks using MikroTik devices. Plus, reduce the testing cost and add expressivity of service measurement tool by adding users and devices management.

In this research, we propose a new system that can measure the service performance based on the standard RFC2554[3] for the testing of Ethernet Service in Telecom Networks that the management is the Centralized Network Monitoring[4] using MikroTik[5] in each area in order to verify and measure the operation of the network. Our approach can reduce the cost of hardware that needs for the service measurement, and the mobility of measurement devices is easier. We can use our tool to verify the failure of the main communication devices without the interruption of service. Further details are presented in the following sections. Section 2 explains materials and methods used in this research, focusing on MikroTik devices and RouterOS, mechanism and architecture of our tool and the development of the system. Section 3 presents results and discussion on our work and Section 4 draw conclusions and suggestion for future works.

2. Materials and methods

2.1 State of the art

The monitoring of Quality of Service (QoS) in telecommunication infrastructure can be done via various methods such as 1) Using software agent to track and collect the information we need sometimes it can work with the Artificial Intelligence. The software Agent approach has a constraint that both monitoring software and the operating system must be compatible and we need to verify if the agent still active. The well-known software is ManageEngine OpManager, PRTG Network Monitor, Site24x7, SysAid and Spiceworks IT Desktop. 2) Sending a small program to the target device and waiting for the occurred anomalies signals for example, when the system is down. The program is customized to specific devices and specific proposes.

In our research, we use the second approach that named Action Packed that combines detailed network topology, device, and flow visualizations with direct interactive monitoring and configuration of QoS, NetFlow, LAN, Routing, IP SLA, Medianet and AVC features.

2.2 MikroTik and RouterOS

MikroTik[5] is a Latvian company which was founded in 1996 to develop router and wireless ISP systems. It provides hardware and software for internet connectivity from around the world. The well-known MikroTik's software, RouterOS, is a system that provides extensive stability, controls, and flexibility for all kinds of data interfaces and routing.

We can control MikroTik router using RouterOS via PHP API [6,7] named PHP_PEAR that we must install it on the server to use PEAR2_Net_RouterOS which is a package for sending a command via IP Address of the devices in the network. We can download the package from http://pear2.github.io/Net_RouterOS/ then enable API service for the devices.

2.3 System overview

We use GNS3[8] along with RouterOS to simulate the operation of the system that uses MikroTik devices before the application in the real environment as shown in figure 1.

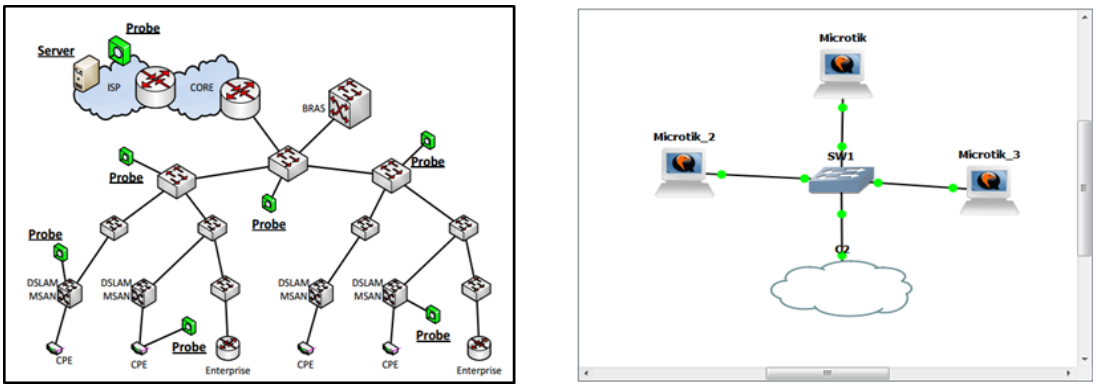

Figure 1 Simulation of MikroTik devices' connections

In the classic service measurement system[9] to measure a service performance, we need to write a script then send it to the device that we want to measure via FTP protocol then waiting for the result file sent to the server to display the result in the system as shown in figure 2. When we want to edit the script, we need to resend a new script to the target device that can drive us to the connection problem and we need more time to operate.

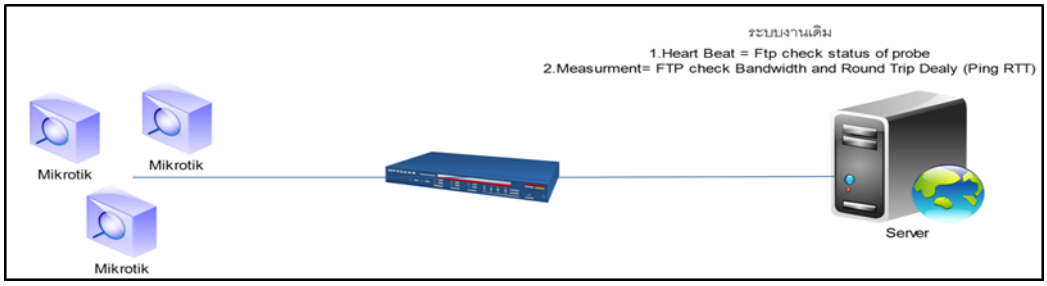

Figure 2 Classic service measurement system

In our method, the system is developed based on distributed approach. We distribute the control from central server to the core unit of each area (figure 3) to share the workload with the server. Moreover, we can easily control and manage devices in each sub-area.

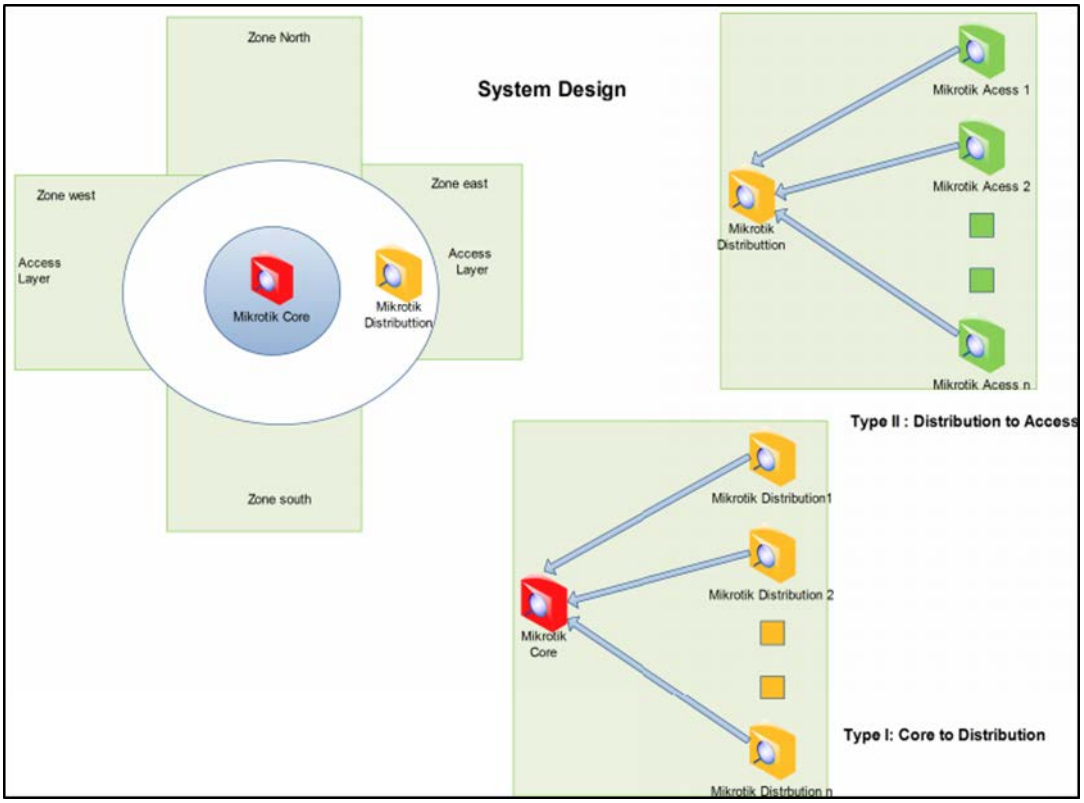

Figure 3 New service measurement System Overview

2.4 System's workflow

The operation flow of our system (figure 4) can be divided into 3 sections as follow:

1) User Management: we separate users into 3 levels, each has different right to control devices:

a. Maintenance officer can do a Probe's test within his zone

b. District chief can do a Probe's test across different zones

c. Central authorities can do which Maintenance officer and District chief can do

2) Probe Management: we can register every device and fix its IP Address to check its performance later, we can verify devices' status and set device's working time and point device's location on Google Map.

3) Performance measurement: we can measure various aspects such as Ping, Bandwidth and show the result in form of graph and we can set measurement timer and the interval of auto-testing.

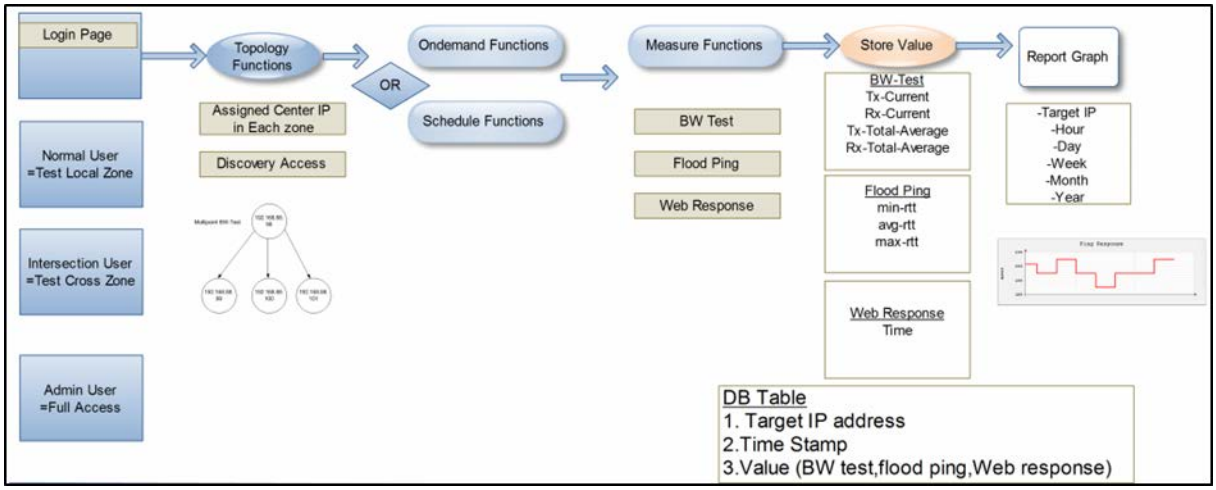

Figure 4 System's workflow

2.5 System development

```php
<?php
$sla_no=$_POST["sla_no"];
//$sla_no="sla01";
$comm=sprintf("php canvas_json_db_sh.php %s",$sla_no);
passthru($comm);
?>
```

Figure 5 Remote Code Execution

```php
 $probe_ip=mysql_result($rs1,0,2);
 $probe_user=mysql_result($rs1,0,3);
 $probe_pw=mysql_result($rs1,0,4);
$client = new RouterOS\Client($probe_ip, $probe_user,$probe_pw);
$responses= $client->sendSync(new RouterOS\Request('/tool/netwatch/print'));
$p1=count($responses)-1;
$sql4="select * from probe";
$rs4=mysql_query($sql4,$netview) or die ("x");
$p2=mysql_num_rows($rs4);
$sql2="Select probe.probe_ip from probe left outer join probe_ch_status on probe.probe_ip =
 probe_ch_status.status_ip where probe_ch_status.status_ip is NULL";
$rs2=mysql_query($sql2,$netview) or die ("x");
    while($row = mysql_fetch_array($rs2)){
    $com=sprintf('/tool/netwatch/add host="%s"',$row["probe_ip"]);
    $client->sendSync(new RouterOS\Request($com));
    }
$responses2= $client->sendSync(new RouterOS\Request('/tool/netwatch/print'));
foreach ($responses2->getAllOfType(RouterOS\Response::TYPE_DATA) as $response) {
```

Figure 6 PHP API for RouterOS

Figure 5 and 6 are code fragments of our system that shows how to use PHP_API to communicate with RouterOS installed in MikroTik devices. To communicate with RouterOS, we first create an object Client to send a command to the target device via its IP Address using function **sendSync()** with the syntax **"new RouterOS\Request('command that we want to send for example: /tool/netwatch/print')".** The waiting for the response. Then, the application will send the object of measurement in order to be stored in the database.

We can use function **time_sleep_until()** (figure 7) to make the system repeat the service measurement in specific interval then save the test in system's database in instance test mode or timer test mode and we can use the function curl() to send testing's notification via an SMS.

```php
if($t=="Now"){
    $t="+5 seconds";
}
//repeat
    while($rep!="")
    {
     $timestamp = strtotime($t);
     $time_go=date('Y-m-d H:i',$timestamp+($rep*60));
     if(time_sleep_until($timestamp)){
     $sql2="UPDATE  `netview`.`service_schedule_logs` SET `sv_time_start` =  '$time_go'
WHERE  `service_schedule_logs`.`sv_sla` = '$sla'";
    $rs2=mysql_query($sql2,$netview) or die ("x");
    $comm=sprintf("php canvas_json_db_sh.php %s",$sla);
    passthru($comm);
    $sql3="select * from service_schedule_logs where sv_sla='$sla'";
    $rs3=mysql_query($sql3,$netview) or die ("x");
    $t=mysql_result($rs3,0,7);
    $sla=mysql_result($rs3,0,2);
    $rep=mysql_result($rs3,0,11);
     }
    }
}
else{
    if($t=="Now"){
    $t="+5 seconds";
}
    //in time
     $timestamp = strtotime($t);
     if(time_sleep_until($timestamp)){
    $comm=sprintf("php canvas_json_db_sh.php %s",$sla);
    passthru($comm);
    }
}
  $sql3="select * from sms_message where sms_type ='2'";
    $rs3=mysql_query($sql3,$netview) or die (mysql_error());
    $sms_into=mysql_result($rs3,0,1);

   $sql4="select * from user where `user_login` = '$user_send'";
    $rs4=mysql_query($sql4,$netview) or die (mysql_error());
    $user_tel=mysql_result($rs4,0,7);
$sms=sprintf("[netview]%s[%s]successful",$sms_into,$sla);
//send sms
if($user_tel!="" and $sms!="")
{
$smsdata=sprintf(
"http://203.113.6.37/user=totpayphone&password=pathumthani&phonenumber=%s&sender=0893005740
&text=%s",$user_tel,$sms);
 $ch = curl_init();
        curl_setopt($ch, CURLOPT_URL, $smsdata);
        //return the transfer as a string
        curl_setopt($ch, CURLOPT_RETURNTRANSFER, 1);
        // $output contains the output string
        $output = curl_exec($ch);
        // close curl resource to free up system resources
        curl_close($ch);
}
?>
```

Figure 7 Service Measurement Control and testing's notification

3. Results and discussion

3.1 Dashboard

The dashboard (figure 8) is design based on Kaplan & Norton's concept[7] that allows the user to explore and follow the result of service measurement. Our dashboard is divided into 5 sections:

1) Area Management: show Probe devices in different areas and their information such as IP Address, name and location

2) User Management: manage users in system, show list of all users, specify their access right and modify users' attributes

3) Probe Management: manage Probe devices, show list of devices that user has a right to access and specific information about devices

4) Service Measurement: measure the performance of service, and test network performance

5) Report: export the testing report into the calendar format.

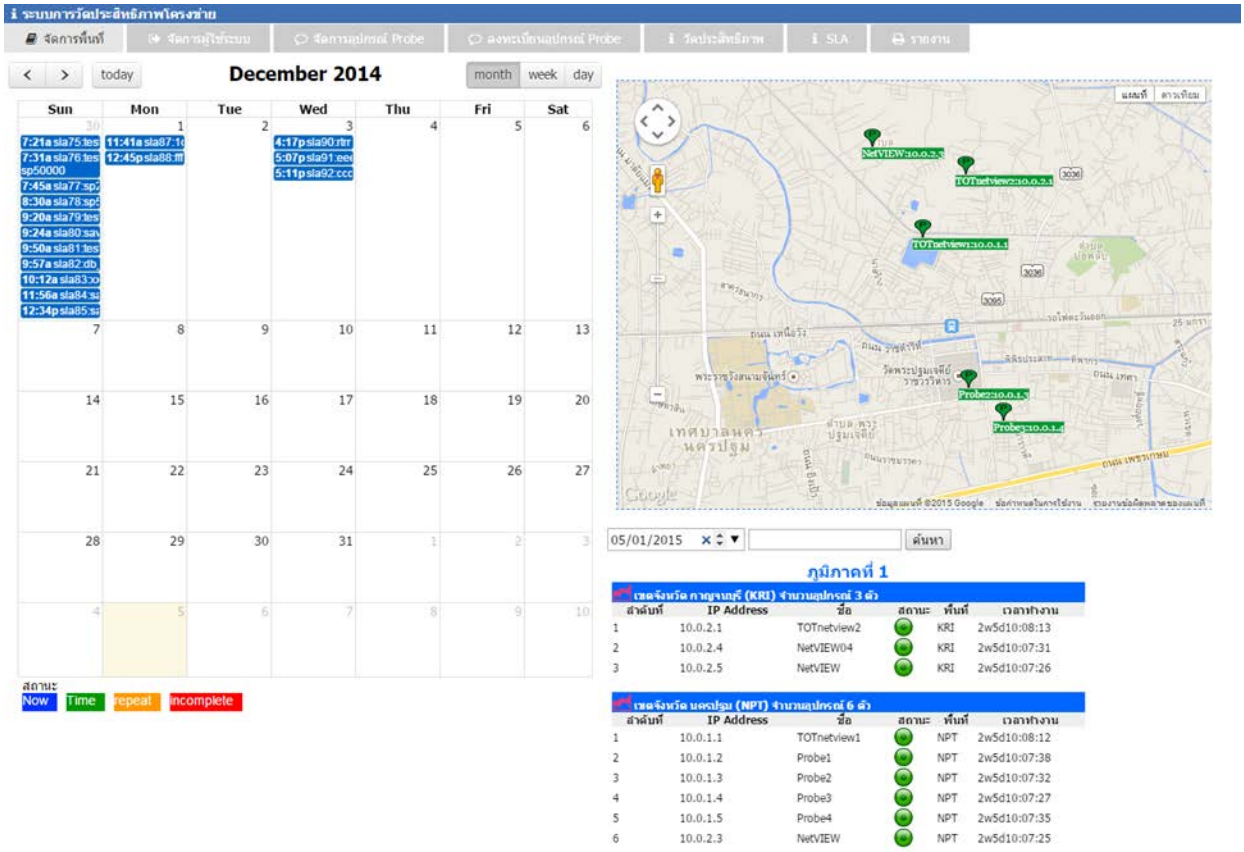

Figure 8 System Dashboard

3.2 Service measurement result

A Service Level Agreement (SLA)[10,11] is a contract between Service Providers and Customers that specifies what services the Service Provider will furnish, what transmission rate the Service Provider guarantee and what penalties the Service Provider will pay if he cannot meet the committed goals. The SLA will drive Service Provider to contribute to their customer's trust in terms of managed reliability and monitoring capabilities. To assure the availability and quality of their service, the Service Provider should verify in various aspect as shown in table 1.

Table 1 Service Measurement Testing aspects

Testing aspects	Result		Remark
	Correct	Incorrect	
Measurement in the same area	X		Depend on area
Measurement across areas	X		Depend on access right
Measurement with specific bandwidth	X		0.5-5 Mbps
Measurement with scheduled test	X		1-30 mins
Continuous measurement in different period	X		Starting from 1 mins
Repeat the measurement	X		every 5 mins
Measurement with many devices in the same time	X		More than 1 device

From Table 1, we implement our system as shown Figure 9 we have tested many times from 3 users in different areas with different access right as follows:

1) tko user at Nakhon Pathom (NPT) area as a maintenance officer
2) aue user at Kanchanaburi (KRI) area as a district chief
3) ana user at Bangkok (BKK) area as a central authority

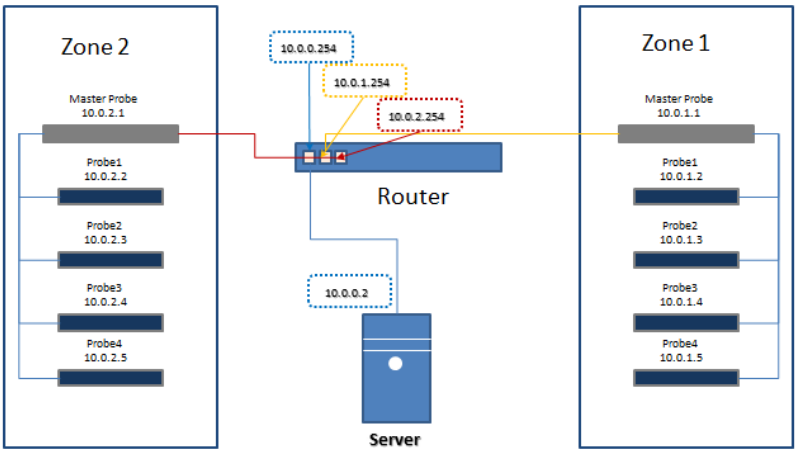

Figure 9 Overview of the network

The service measurement result is presented in the Table 1 that can show the correctness of different testing aspects.as shown in Figure 9. The result is presented in the Table 2 that show the service performance with different parameters.

Table 2 Service Measurement Result with specific bandwidth

Order	Source	Destination	Time	User	Area	Bandwidth	TX (Kbps)	RX (Kbps)
1	10.0.2.3	10.0.2.5,10.0.1.1	1 min	anan	BKK	1 Mbps	1019.53	1019.53
2	10.0.1.1	10.0.2.5	1 min	anan	BKK	1 Mbps	1019.33	1019.53
3	10.0.2.3	10.0.1.4	1 min	anan	BKK	1 Mbps	1019.33	1019.33
4	10.0.2.3	10.0.2.5	1 min	anan	BKK	1 Mbps	1019.73	1019.73
5	10.0.1.1	10.0.1.3	1 min	aue	KRI	5 Mbps	5110.99	5110.39
6	10.0.1.1	10.0.1.4	1 min	aue	KRI	6 Mbps	6142.04	6141.83
7	**10.0.1.1**	**10.0.1.4**	**1 min**	**aue**	**KRI**	**1 Mbps**	**1019.53**	**1019.53**
8	10.0.1.1	10.0.1.4,10.0.2.3	1 min	tko	NPT	1 Mbps	1019.33	1019.53
9	10.0.2.3	10.0.1.4	1 min	tko	NPT	2.5 Mbps	2554.48	2554.87

Figure 10 is the detail of the order 7 in Table 2. The source is 10.0.1.1 and the destination is 10.0.1.4. The output is shown in graph and in map location. In one minute of testing and bandwidth is 1 Mbps, the average value of Transmit Rate (Tx) is 1019.53 Kbps or 99.56%. The average value of Receive Rate (Rx) is 1019.53 Kbps or 99.56%.

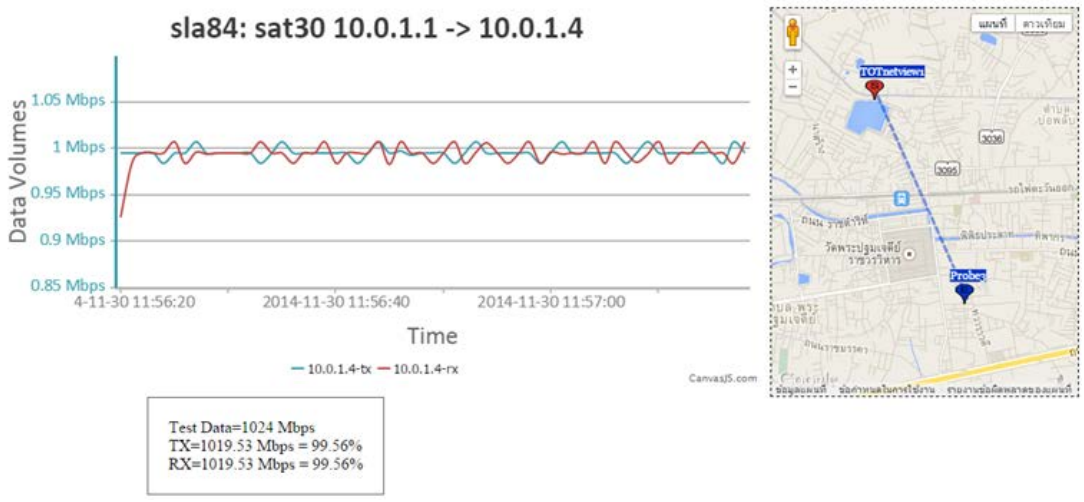

Figure 10 Measurement result Service Level Agreement

In order to evaluate tool, we have TOT Public Company Limited. TOT is a ISP, a Thai state-owned telecommunications company. TOT has applied our tool with TOT Netview within one year, the result has been shown that our tool can save the cost 133,261 baht per set of Probe and 13,0000,000 baht for the server needed for their own classic monitoring[9].

4. Conclusions & Future works

In this research, we develop a new service measurement tool for telecommunication networks using MikroTik devices and RouterOS and control these devices via PHP API that allows the user to manage the system, user, networks devices and allow users to measure the performance of the system.

In the future works, we can extend the expressivity of our tool by distributing the control to local control unit instead of using centralized control unit to share the workload and diffuse the risk of script working failures. We will try to use every functionality that came with the network device to improve the management of the system.

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Semantic Web-based Approach for Economic Performance Indicators Based on Global Reporting Initiative (GRI) G4

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Abstract

The aim of this research is to fill the gap by developing ontology for Economic Performance Indicators based on the latest guidelines (GRI G4). The chief research question is: What is the best approach to developing an Ontological Model for the knowledge domain Economic Performance Indicators? The main objective of this research is to develop ontology for Economic Performance Indicators based on GRI G4. The methodology used in this research is a merger of several existing methodologies. The methodology adopted as a result of this applied research includes four phases: specification, conceptualization, formalization, and implementation. A requirement specification for Economic Performance Indicators ontology was created by identifying the intended scope and purpose of scenarios for each of the phases of ontology. The classes, properties, and relationships for Economic Performance Indicators based on GRI G4 were also identified. A conceptual model was formalized using UML. The implemented ontology is based on OWL language. And protégé tool to encode competency questions and subsequent SPARQL Queries. The resulting ontology was tested using instances data collected for four Australian companies listed on the Australian Securities Exchange (ASX), namely: Origin Energy Limited (ORG), Amcor Limited (AMC), Transurban Group (TCL), and BHP Billiton (BHP).

As mentioned, the ontology of content was evaluated to meet the criteria of completeness, consistency, and conciseness, and SPARQL Queries' answers were obtained establishing its utility and rationality. As a consequence, the developed ontology for Economic Performance Indicators was validated. There is clear evidence that few Australian companies have adopted either GRI or other initiatives and standards for reporting and that this position needs to be addressed. The ontology as proposed in this research could be applied to correct this concern. The four companies used to test the ontology are from different industries and sub-industry classifications and, as a result, the findings are not generalizable outside of these industries. However, the main finding of this research demonstrates that the majority of instances contained within the GRI4 Guidelines was validated suggesting that the ontology framework is effective as a standardized form of reporting.

Keywords: Economic Performance Indicators, GRI Sustainability Reporting Guidelines G4, Ontology, Stakeholders

1. Introduction

Reporting by corporations on economic, environmental and social dimensions, referred to as "Sustainability", is seen as a step towards a sustainable global economy that combines long-term profitability with social justice and environmental protection [1]. The history of sustainability reporting began at the beginning of the 20th century with employee reporting, social reporting, environmental reporting, triple bottom line reporting and sustainability reporting [2]. Some authors contend that there is currently no suitable definition for sustainability reporting [3]. Kolk and Herzig and Schaltegger claim that since the mid-1990s the number of companies reporting on sustainability has increased substantially and new forms of corporate sustainability reporting are being developed, resulting in reporting contents and formats being subject to change from year to year [4].

Several theoretical approaches that explain the motivation for sustainability reporting include: accountability theory, legitimacy theory, and political economy and stakeholder theory [5] [2]. There are several national and international bodies that promote sustainability reporting and provide guidance; these include: Global Reporting Initiative (GRI), the International Standards Organization (ISO), the World Business Council for Sustainable Development (WBCSD), AccountAbility, and the Sustainability Integrated Guidelines for Management (SIGMA) Project [2]. Christofi, Christofi, and Sisaye argued that it was important to have standardized sustainability reporting by corporations [6]. The GRI guidelines are generally accepted as "best practice" reporting and are widely used by organizations around the world as the basis for their environmental and social reporting [5]. The guidelines provide guidance on how to write and what to write and present

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principles that guide report content and report quality [7]. An ontology methodology plays an important role in the design of information systems [8]. It provides a formal specification for the concepts within a domain and the relationship between those concepts [9]. There are many existing definitions of ontology, arguments about what the definition of ontology is or ought to be [10], and debates on what is the best definition [11]. Studer, Benjamins, and Fensel define ontology as a "formal, explicit specification of a shared conceptualisation" [12]. This is one of the most comprehensive definitions from those available in the literature [13]. A new information system for sustainability reporting is required as it has become an important source of monetary and non-monetary, quantitative and qualitative information [14]. There are several studies that develop ontologies in different aspects of accounting but little ontological research exists within the accounting domain. For example, Chou, Vassar, and Lin developed an ontology concept model for profit and loss accounts and implemented it for Microsoft's NET software [15]. Teller established ontology of accounting notions to represent the entire domain knowledge based on International Financial Reporting Standards (IFRS)[16]. Chou and Chi proposed an ontological model comprising Event, Principle and Account (EPA) for accounting principles [17]. Smeureanu et al. developed ontology for Corporate Social Responsibility based on the guidelines proposed by the 'ISO 26000 Standard for Social Responsibility' [18]. Weigand and Elsas introduced a model-based auditing approach as a design artefact that includes a corresponding business modelling language [19]. Weigand, Johannesson, and Bergholtz introduced a service accounting model based on a formal ontology approach and propose some adaptations to the Resource-Event Agent (REA) model [20]. From the literature review, ontology for economic performance indicators based on GRI G4 does not exist. Thus, the aim of this research is to fill the gap by developing an ontology for economic performance indicators based on GRI G4. The Economic performance indicators focus on the financial organization's performance and impacts on the stakeholders by clarifying the flow of capital among them; it does not focus on the financial status of the organization. In addition, they focuses on economic systems at local, national, and global levels [21].

In this research, the ontologies for Economic Performance Indicators based on the Global Reporting Initiative guidelines (GRI G4) are presented. This paper is structured in the following manner. In Section 2, Research objective is described and then followed by Materials and methods in Section 3. In Section 4, Results are presented. In Section 5, ontology evaluation is described and followed by discussion in Section 6. Section 7 is a conclusion and future work.

2. Research objective

The main objective of this research is to develop ontology for Economic Performance Indicators based on GRI G4, and this will be achieved through the following sub-objectives:

- Identifying the classes, data properties, object properties for Economic Performance Indicators based on GRI G4.
- Transforming a conceptual model into a formalized model by using the Unified Modelling Language (UML) to represent ontology for Economic Performance Indicators.
- Implementing ontology by using OWL language and Protégé tools to encode the competency questions. Subsequent SPARQL Queries will be created after implementing all classes, data properties, object properties identified within GRI G4 for Economic Performance Indicators. Data instances will be collected online for four Australian companies listed with the ASX, including Origin Energy Limited, BHP Billiton, Amcor Limited, and Transurban Group.
- Evaluating the developed ontology for Economic Performance Indicators by a process of verification and validation. Schema Metrics and Knowledgebase Metrics will be used to verify the ontology. To validate the ontology, the answers to SPARQL Queries are extracted and the ontology for an Economic Performance Indicators is validated.

3. Materials and methods

3.1 Background

3.1.1 Ontology

There are many existing definitions of ontology, arguments about what the definition of ontology is or ought to be [10], and debates regarding the best definition [11]. Studer, Benjamins, and Fensel definition of ontology as "a formal, explicit specification of a shared conceptualisation" is one of the most comprehensive definitions available [12]. They define the terms: Explicit, Formal, and Shared as follows:

- Explicit: all elements of ontology are obviously defined.

- Formal: refers to the fact that the ontology should be machine readable, which excludes natural language.
- Shared: refers to consensual knowledge agreed on to be accepted by a group of people.

The definition introduced by Studer, Benjamins, and Fensel [12] is one of the most comprehensive forms available in the literature [13]. This research is based on this definition. The main uses of ontology are to share common understanding of terms for specific domain in the real world between people and computers, and to reuse it; if it is not reused, it provides limited benefits.

It should be noted that Ontological Engineering (OE) refers to any activities involved in the ontology building process and also include lifecycle, principles and methodologies used for its construction [13]. The main methodologies and methods used to build ontologies from scratch. These methodologies are related to its lifecycle. The lifecycle as a development process consists of different activities to design and evaluate ontologies. Until the mid-1990s this process was an "art rather an engineering activity" [13].

Scholars agree that concepts, relations, instances and axioms are the main components or basic and typical elements of ontology. Because of different ontology languages, the exact specification of these elements may vary according to the underlying knowledge model [22] [23]. Concepts are also known as classes of objects. Classes have been defined as "abstract or concrete, elementary or composite, real or fictitious"; in short, a concept can refer to just about anything including speech, actions or activities, strategies or plans, or cognitive processes, to name a few [23]. Relations represent a "type of association between concepts of the domain" [13]. Binary relationships refer to the relational links involving two concepts; roles describe binary relations between concepts; inverse relationships refer to binary relation links between two concepts in the opposite direction. There are three types of relationships: association relationship, inheritance relationship, and composition relationship are used in this reseach. Properties are also known as slots or roles or attributes of classes. Properties represent relationships that describe various features and attributes of the concept [24]. Object properties and datatype properties are two main types of properties. Object properties are relationships between two individuals and they use "vocabulary" and "semantic" to describe this relationship. Instances are also known as individuals. Instances represent "real-world individuals" or are used to represent elements or individuals in ontology [25]. Horridge stated that individuals, are also known as instances or "objects" in the interested domain. Individuals can be defined as being "instances of classes"[26]. Axioms refer to constraints used on values for classes or instances; the properties of relations are types of axioms and they include more general rules [24] [27].

3.1.2 Global Reporting Initiative

A comprehensive Sustainability Reporting Framework that is the most widely used around the world has been established and improved by the Global Reporting Initiative or GRI. The GRI is a leading organization in the sustainability field. The GRI Sustainability Report is a report issued by organizations (private, public, or non-profit) that reports their economic, environmental and social impacts, and the performance of their activities, products and services. Such reporting takes a Triple Bottom Line (TBL) approach. GRI considers an organization's impacts and performance not only on in terms of its local economy but also in terms of its sustainable global impact. Many organizations, regardless of their type, size, sector or location, voluntarily use the GRI Framework to measure and report on their performance according to specific principles and indicators. This framework is a reporting system which includes the Reporting Guidelines, "the core document" or the "cornerstone" of this framework providing guidance on how organizations can disclose their sustainability performance and increase accountability [28] in addition to Sector Guidance and other resources. G4 is the latest version of GRI's Sustainability Reporting Guidelines released in May 2013 after several previous versions of the Guidelines: the first version in 2000; the second generation (G2) in 2002; and the third generation (G3) in 2006. In 2011, the GRI updated and published the G3.1. [29]. Global Reporting Initiative, the Global Reporting Initiative logo, Sustainability Reporting Guidelines, and GRI are trademarks of the Global Reporting Initiative [30]-[33]. GRI includes sustainability reporting that principally applies to environmental issues as well as economic and social impacts. However, in Australia, GRI guidelines are for voluntary use by business firms for reporting on the three aforementioned dimensions of their activities, products, and services [32].

3.2 Conceptual framework

The scenario is illustrated in Figure 1. In a real-world use scenario of Sustainability Reporting, small, medium or large enterprises engage in this reporting process by following Sustainability Reporting Guidelines. Because of a lack of a standard application for the report generation, ontology is used to solve this problem by generating an Ontological Model for Sustainability Reporting including Economic Performance Indicators. This

enables organizational sharing, communicating and reusing this Model for Economic Performance Indicators. The components of ontology are elicited from Sustainability Report that based on GRI G4 and they involved in ontology development process and resulted ontological model. The Ontology Development Process Model includes four phases: specification, conceptualization, formalization, and implementation [24] [34] [35] [36]. Through these steps, the purpose and the scope of the ontology are defined, the conceptual model is identified and formalized, and the formalized model is encoded. Then, to verify and validate the model, an outcome of this process is to create and assess an ontological model for Economic Performance Indicators based on GRI G4.

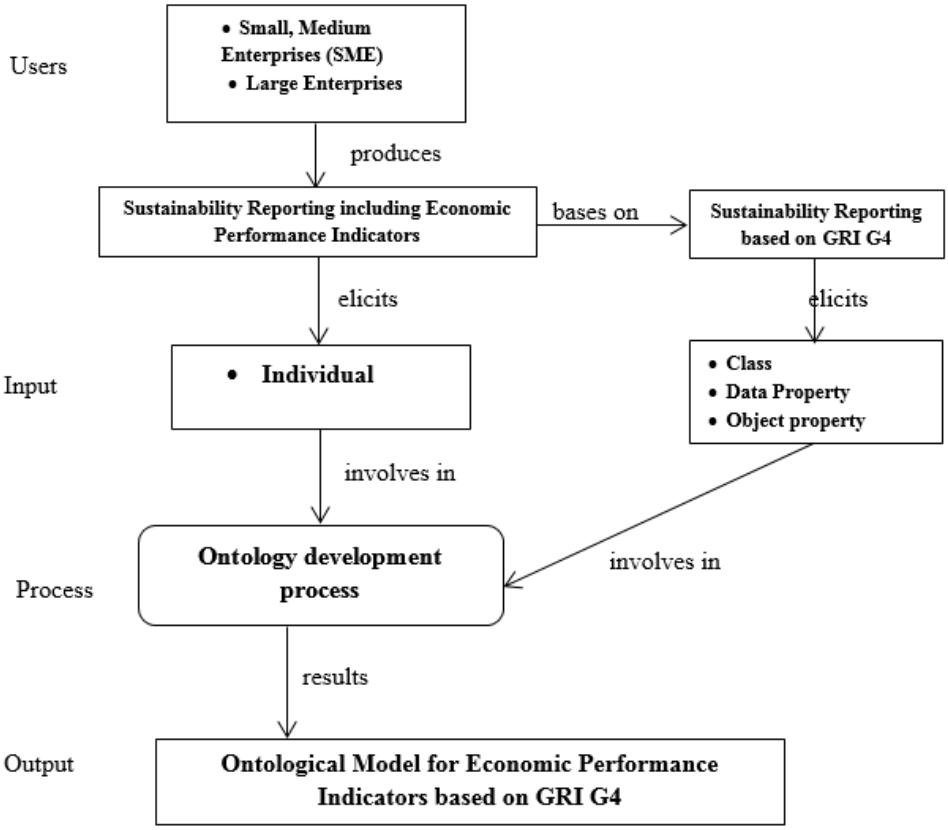


Figure 1 Conceptual framework

Figure 2 shows the contained tasks in each phase. In the specification phase, the motivation scenarios and competency questions need to be described. In the conceptualization phase, the conceptual models need to be defined. In the formalization phase, the conceptual models are required to be formalized. In the implementation phase, the ontology will be built by encoding [24] [34]-[38]. The following subsections will explain each phase.

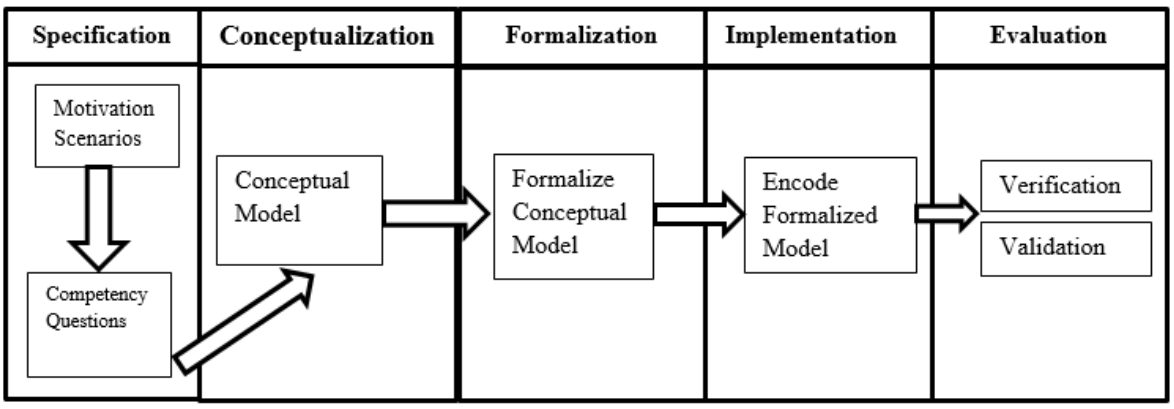


Figure 2 Tasks in each phase of the Economic Performance Indicator ontology development

3.2.1 Specification phase

The first development phase of ontology is the specification phase; this activity is ontology description (usually in natural language). The aim of this phase is to 'state why the ontology is being built, what is intended uses are, who the users are, and which requirements the ontology should fulfil' [39]. The first requirement is to describe the motivating scenario and present solutions to the problems arising in the scenario [40] as stated above. Uschold and Gruninger [36] and Uschold [37] identify the purpose and scope of ontology. Fernández-López, Gómez- Pérez, and Juristo [41] and Lopez et al. [35] show a brief example of ontology requirements specification document in the chemicals domain. The following information should be included in the specification phase. A detailed ontology requirements specification document (ORSD) is required in this phase as proposed by (Uschold 1996) [37]. The specifications of the Sustainability Reporting ontology are defined as follows:

Domain: Sustainability Reporting based on GRI Guidelines G4.

Purpose: Developing a Sustainability Reporting ontology-based knowledge base for software to automatically create GRI reports for the following reasons:

1) Enabling knowledge sharing among people, organizations, and software systems [24] [36] [42] [43] [44].

2) Reusing knowledge. The proposed ontology can be reused by organizations and can also be updated to adapt to new generations of GRI.

End users: Engaged stakeholder groups, for example, civil society, customers, employees, other workers and their trade unions, local communities, shareholders and providers of capital, and suppliers.

Level of formality of the implemented ontology: Semi-formal. This is the level of formality that will be used to codify the terms and their meanings in a language somewhere between natural language and a rigorous formal language [41]. Uschold and Gruninger [36] classify the level of formality into: highly informal, semi-informal, semi-formal or rigorously formal ontologies.

Scope: All components of Economic Performance Indicators defined according to GRI Guidelines G4.

Sources of knowledge:

1) Interviews with the experts in GRI Sustainability Reporting Guidelines because the ontologists and the GRI reporters are different jobs. However, in this research the ontology is used as a tool to design Economic Performance Indicators according to GRI G4. So, the reporters are the professionals experienced in the content of GRI reporting and the ontologists will structure the information of GRI G4 into: classes, properties, relationships, axioms and individual. Then Protégé is used to implement this ontology development process.

2) GRI Sustainability Reporting Guidelines G4: Reporting Principles and Standard Disclosures [21] and GRI Sustainability Reporting Guidelines G4: Implementation Manual [33].

The second requirement is to create 'competency questions' 'CQ' as the technique for establishing the ontology requirements [40]. Competency questions are queries written in natural language and the ontology to be built should be able to answer all questions raised by stakeholders and can be used to verify the correctness of the ontology with the ontology requirements identified (scope of the ontology) [39]. The main concepts and their properties, relations and formal axioms of the ontology are used to extract these questions and answers [45]. In this research, competency questions are created for data instances found in four Australian companies to implement ontology as can be seen two examples in this research.

3.2.2 Conceptualizations phase

The second step in the ontology lifecycle is conceptualization. The output of the first phase will be transformed into a conceptual model by means of conceptualization [46]. The aim of this activity is to structure the domain knowledge in a conceptual model in terms of the domain vocabulary identified in the ontology specification activity [41]. Weber [47] defines 'Conceptual modelling' as an 'activity undertaken during information systems development to build a representation of selected semantics about some real-world domain'. According to Noy and McGuinness [24], the requirements for the conceptualization phase are:

1. Identify terminologies for Economic Performance Indicators in the GRI G4 Guidelines; and
2. Identify the classes, their properties, and the relationships between them as defined in GRI G4 Guidelines and create instances from actual sustainability report.

3.2.3 Formalization phase

The formalization phase is the core of an ontology development process. It involves transforming a conceptual model into a formalized model or semi-computable model [22] [46] [25]. Colomb [48] explained that a formal ontology is an "advanced knowledge representation system". Guebitz, Schnedl, and

Khinast [49] stated that creating a neutral ontology formulation, independent of implementation languages is the goal of this phase. There are different levels of the transformative process in relation to the conceptual model ranging from semi-formal to rigorously formal. The greater the formality, the greater is the amount of automation required to support ontology [37]. It depends on the implementation requirements of the ontology. Guebitz, Schnedl, and Khinast [49] presented the object-oriented modelling language as an appropriate formalism to represent ontology by using the Unified Modelling Language (UML). Thus, for the development of the sustainability report ontology, the formalization requires a notation system to formalize the sustainability report ontology conceptual model.
To create a formal ontology, all main structural components and their constraints must be explicitly described [49]. The object oriented modelling language can be used for ontology modelling. Cranefield and Purvis [50] suggested that UML as a static modelling notation can be used to model the "formal semantics" of ontologies.
In this research, three types of relationships are identified between classes, which are: Association relationship, Inheritance relationship, and Composition relationship.

3.2.4 Implementation phase

This activity builds computable models in a formal language or representation of conceptual models by using an ontology language [46]. To implement computable models, there are tools used in different ontology languages as ontology editors. There are several languages: XML, RDF, OIL, DAML+OIL, OWL, CARIN, FLogic, Jess, and Prolog [25]. The requirements of the implementation phase are:
1. A formal language that can be used to encode the ontology; and
2. A tool that supports the ontology development activities.

In this research, Web Ontology Language OWL is used as a standard and broadly acceptable ontology language, which provides classes, data properties, object properties and individuals [51]. Protégé Onto Edit (protégé.standford.edu) is used as a tool to represent ontology in a machine readable format. Ontologies are stored as Semantic Web documents (W3C OWL Working Group)[3]. The full ontology coding is available at http://www.semanticweb.org/14174782/ontologies/2014/6/csr#.

3.2.5 Evaluation phase

Evaluation is a 'technical judgment of the content of the ontology with respect to a frame of which can be requirements specifications, competency questions or the real world during each phase and between phases of their lifecycle to guarantee to end users the consistency, completeness and conciseness of the ontologies definitions, documentations, and software' [52] – [55]. Ontology evaluation includes:

Ontology verification and
Ontology validation

In this research, all classes, data properties, object properties identified for Economic Performance Indicators according to GRI G4. All instances data as identified from actual sustainability report for 4 Australian companies. Most definitions of classes can be found in [33].

4. Results and discussion

There are four Aspects as classes within the 'Economic Category' class – the 'Economic Performance Aspect' class, the 'Market Presence Aspect' class, the 'Indirect Economic Impact Aspect' class, and the 'Procurement Practice Aspect' class. The following subsection explains the ontology for each Aspect class.

[3] http://www.w3.org/TR/2012/REC-ow12-overview-20121211

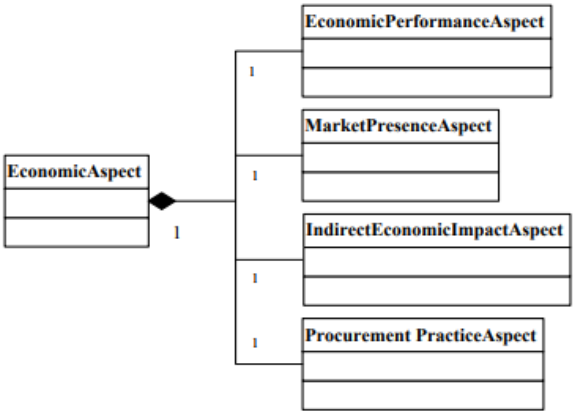


Figure 3 Ontology formalization for 'Economic Aspect' class

4.1 Ontology for Economic Aspect class

This is the first aspect which addresses the "direct value generated" [3] of the organization's activities and immediate consequences of monetary flows to stakeholders. There is a generic DMA and four indicators related to this indicator class as shown in Figure 4. In the following subsections, the ontologies for the four indicators of the class 'Economic Performance Aspect' are presented.

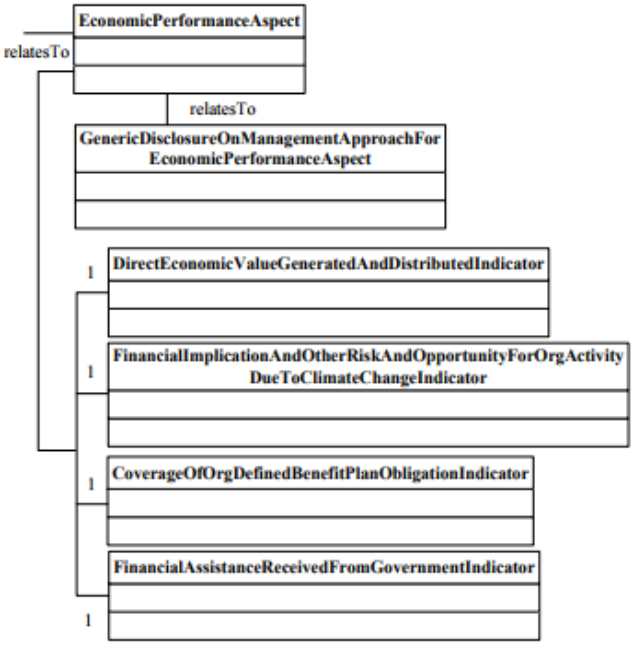


Figure 4 Ontology formalization for 'Economic Performance Aspect' class

4.1.1 Ontology for 'Direct Economic Value Generated and Distributed Indicator' class/ EC1

This indicator class concerns the economic value generated and distributed (EVG&D) (Figure 5). The concept that is related to this indicator is 'Economic Value Retained' class. The class 'Organization' retains 'Economic Value Retained'. This class is obtained from the 'Direct Economic Value Generated' class and 'Economic Value Distributed' class. The class 'Organization' generates the 'Direct Economic Value Generated' class. In addition, the class 'Organization' distributes 'Economic Value Distributed' class. The class 'Direct Economic Value Generated' is generated from 'Revenue' class. The class 'Economic Value Distributed' is distributed to: 'Operation Cost' class; 'Employee Wage and Benefit' class; 'Payment To providers of Capital' class; 'Payment To Government' class; and 'Community Investment' class [33].

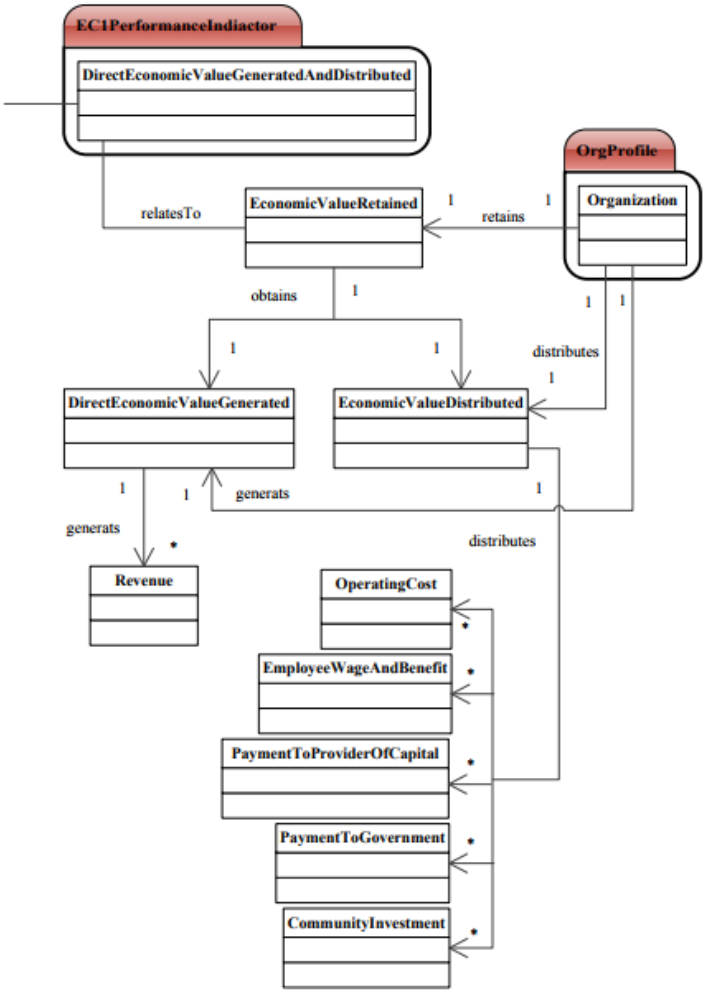


Figure 5 Ontology formalization for 'Direct Economic Value Generated And Distributed Indicator' class

4.1.2 Ontology for 'Financial Implication And Other Risk And Opportunity For Org Activity Due To Climate Change Indicator' class/ EC2

This indicator centres on how climate change affects economic performance. It is required to identify 'Climate Change Risk' class and 'Climate Change Opportunity' class that posed by 'Climate Change' class. The class 'Climate Change Risk' categorizes risk according to 'Physical Risk' class, 'Regular Risk' class, and 'Other Risk' class. The class 'Climate Change Opportunity' categorizes opportunity according to 'Physical Opportunity' class, 'Regular Opportunity' class and 'Other Opportunity' class [33].

4.1.3 Ontology for 'Coverage Of Org Defined Benefit Plan Obligation Indicator' class/ EC3

This indicator class focuses on structure of retirement plan offered to employee. The concept that is related to this indicator is 'Structure Of Retirement Plan Offered To Employee' class whether is based on 'Defined Benefit Plan' class; 'Defined Contribution Plan' class; and 'Other Type Of Retirement Benefit' class. For class 'Defined Benefit Plan' whether is funded by 'Org General Resource' class or by the class 'Separate Fund' which is used to pay to 'Pension Liability' class which is kind of 'Liability' class. For class 'Defined Contribution Plan' is required to report 'Percentage Of Salary' class and 'Level Of Participation' class. The 'Percentage Of Salary' class which is contributed by employee and employer as 'Contribution Of Employee' class and 'Contribution Of Employer' class. For the class 'Other Type Of Retirement Benefit' is specified where not fully covered by general resource and separate fund. In addition, the class 'Jurisdiction Regarding Calculation Plan Coverage' is required to identify calculations used to determine plan coverage [33].

4.1.4 Ontology for 'Financial Assistance Received From Government Indicator' class/ EC4

This indicator concerns the financial support received from government. The 'Financial Assistance' class is related to this indicator. The class 'Organization' receives 'Financial Assistance' class. It is received

from the class 'Government' which is part of 'Stakeholder Group Engaged By Org' class. It is received in 'Reporting Period' class. The data properties can be found in [33].

4.2 Ontology for 'Market Presence Aspect' class

This is the second Aspect that focusses on "entry-level wage by gender compared to local minimum wage" [3]. This Aspect comprises generic DMA and two indicators as following.

4.2.1 Ontology for 'Ratio Of Standard Entry Level Wage By Gender Compared To Local Minimum Wage At Significant Locations Of Operation Indicator' class/EC5

This indicator concentrates on entry level wage by gender compared to local minimum wage. The classes that are related to this indicator are: 'Local Minimum Wage'; 'Entry Level Wage'; and 'Ratio Of Standard Entry Level Wage' class which are presented at 'Location Of Operation'. The fourth class is 'Salaried Employment' which is offered by the class 'Organization' [33].

4.2.2 Ontology for 'Proportion Of Senior Management Hired From Local Community At Significant Location Of Operation Indicator' class/ EC6

This indicator concentrates on percentage of senior management at significant locations of operation that hired from the local community. So, the concept of 'Proportion Of Senior Management' class is related to this indicator class. It is required to report the 'Percentage Of Senior Management' class that is hired at 'Location Of Operation' class which is hired from 'Local Community' class [33].

4.3 Ontology for 'Indirect Economic Impact Aspect' class

This is the third Aspect that emphasizes "impact of infrastructure investments" in relation to local communities and regional economies [3]. There are generic and specific DMA classes and two indicators:

4.3.1 Ontology for 'Development and Impact of Infrastructure Investment and Service Supported Indicator' class/ EC7

This indicator focuses on significant infrestructure investment in terms of its development and impact or service supported. The concept related to this indictor is the 'Infrastructure Investment and Service Supported' class that has an impact on 'Community and Local Economy' class [33].

4.3.2 Ontology for 'Significant Indirect Economic Impact Including Extent Of Impact Indicator' class / EC8

The additional impacts that are generated by an organization through the economy in terms of financial flow are included in this indicator. It has indirect impacts as a participant or agent in socio-economic change, and in developing economies in terms of local communities and regional economies [33]. So, this indicator has significant positive and negative indirect economic impacts on 'Local Community and Regional Economy' class.

4.4 Ontology for 'Procurement Practice Aspect' class

This is the final aspect, the essence of which is "spending on local suppliers" [3]. There are generic and specific DMA classes associated with this aspect and only one indicator which is the Ontology for 'Proportion Of Spending On Local Supplier At Significant Location Of Operation indicator' class/ EC9. This indicator concentrates on ratio of local spending at significant locations of operation. The concept that relates to this indicator is 'Percentage of Procurement Budget Spent On Local Supplier' which is used for the class 'Location of Operation' [33].

In implementation phase, Web Ontology Language (OWL) is used as a standard and broadly acceptable ontology language which defines classes, data properties, object properties, and individuals. Protégé_5.0_beta (protégé.standford.edu) is used as a tool to create ontologies. Ontologies are stored as Semantic Web documents (W3C OWL Working Group)[4]. The full ontology coding is available at http://www.semanticweb.org/14174782/ontologies/2014/6/csr#.

In addition, only the following language elements are used: Owl:Ontology, owl:Class, owl: ObjectProperty, owl:DatatypeProperty, rdfs:subClassOf, rdf:datatype, rdfs:domain, and rdf:range [56].

Therefore, all classes' object properties, and data properties identified and formalized are created in Protégé_5.0_beta. The instances of classes are referenced from the four Australian companies mentioned before.

According to the scope and purpose of ontology for a Economic Performance Indicators specified in phase 1, stakeholders need information about an Economic Performance Indicators disclosures, and therefore they raise questions. Competency questions are prepared as a standard technique in ontology engineering methodologies

[4] http://www.w3.org/TR/2012/REC-ow12-overview-20121211/

[36]. Grüninger and M.S.Fox [57] proposed competency questions as a methodology for evaluating ontologies. The query language is required to encode the competency questions appropriately [58].

4.5 Competency questions and SPARQL queries for 'Economic Performance indicator' class

In this section, questions in natural language are detailed and covered all the instances in the ontology. All these questions are correct and complete. They are then transformed to SPARQL queries for inquiring the 'Economic Performance indicator'' class as shown for example in Table 1 and Table 2.

Table 1 Competency questions and SPARQL query for 'Direct Economic Value Generated' class

CQ60: What is the total value of direct economic value generated, by region, basis, and measurement unit currency for this company?
SPARQL query SELECT ?subject ?object WHERE { ?subject csr:directEconomicValueGeneratedBasis ?object } csr:regionNameForDirectEconomicValueGenerated ?object } csr:totalValueOfDirectEconomicValueGenerated ?object } csr:totalValueOfDirectEconomicValueGeneratedByRegion ?object } csr:measurementUnitCurrency ?object }

Table 2 Competency questions and SPARQL query for 'Revenue' class

CQ61: What is the total value of revenue by region, basis, and measurement unit currency for this company?
SPARQL query SELECT ?subject ?object WHERE { ?subject csr:revenueName csr:revenueandOtherIncomeBasis ?object } csr:regionNameForRevenueandOtherIncome ?object } csr:totalValueOfRevenueandOtherIncome ?object } csr:totalValueOfRevenueandOtherIncomeByRegion ?object } csr:measurementUnitCurrency ?object }

5. Ontology evaluation

Weller [22] considered the evaluation of ontology as an additional process. It incorporates verification and validation. It refers to "judging the quality of the content of the ontology" [22] [54]. To evaluate the ontology, there are many approaches based on the level of evaluation [59] and relevant criteria identified [54]. It is performed differently depending on the methodologies used to build ontology [54]. Grüninger and Fox [40] propose to evaluate ontology by identifying a set of competency questions. These questions need to be formalized in a query language to encode the competency questions using an appropriate tool [58]. The form of questions is used in this evaluation.

Ontology evaluation includes technical evaluation. The core of technical evaluation is the evaluation of the definitions that consider different aspects of ontology in terms of vocabulary, structure, content, syntax, semantic and representation that satisfy the criteria of completeness, consistency, and conciseness of definitions [58][54]. To assess specific features of ontology, technical evaluation methods are required.

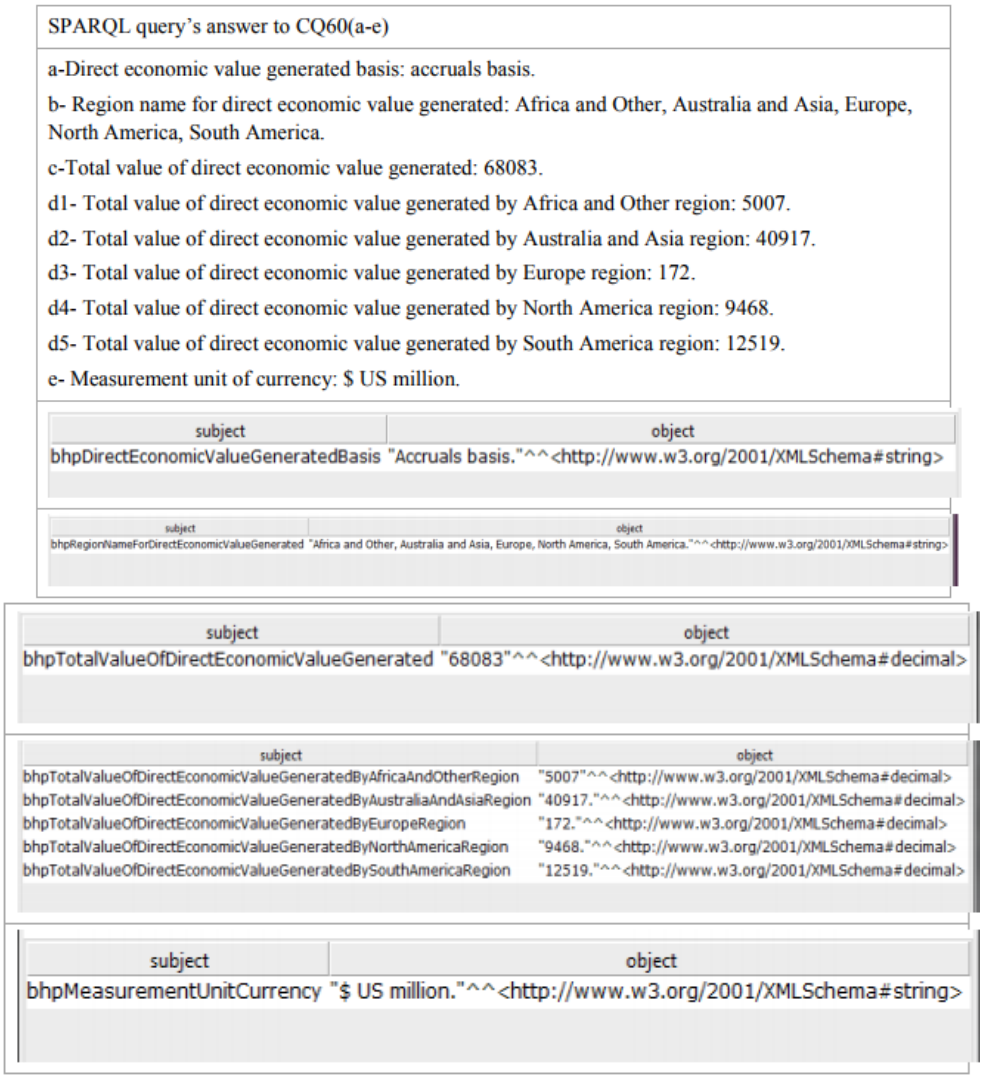
Verification is the process whereby the correctness of ontology is ascertained. The process involves the creation of an ontology whose definitions adequately meets its requirements and competency questions, and function correctly in the real world [52] – [55]. Ontology verification is quite distinct from ontology validation. Ontology verification ensures that the ontology was created correctly, whereas ontology validation determines whether the right ontology was created [58]. It deals with the problem of the three Cs: (consistency, completeness, and conciseness) [55] [53] [52]. Gómez-Pérez [55] defines the three Cs as follows:

Consistency refers to definitions in the ontology that are semantically consistent;

Completeness refers to the extension, degree, amount of or coverage of the information about the real world in the ontology;

Conciseness refers to the usefulness and precision of all the information gathered in the ontology.

It requires a common understanding between the domain knowledge experts and ontology engineering experts. For this purpose, SPARQL queries are used to extract answers for the competency questions after SPARQL queries are created as shown in Table 1 and Table 2. The extracted answers for the competency questions as shown in Figure 6 and Figure 7 are the correct answers that confirm that the reported data are instantiated and correctly describe all relationships between the data. Therefore, the developed ontology for the Economic Performance Indicators is valid.



SPARQL query's answer to CQ60(a-e)

a-Direct economic value generated basis: accruals basis.

b- Region name for direct economic value generated: Africa and Other, Australia and Asia, Europe, North America, South America.

c-Total value of direct economic value generated: 68083.

d1- Total value of direct economic value generated by Africa and Other region: 5007.

d2- Total value of direct economic value generated by Australia and Asia region: 40917.

d3- Total value of direct economic value generated by Europe region: 172.

d4- Total value of direct economic value generated by North America region: 9468.

d5- Total value of direct economic value generated by South America region: 12519.

e- Measurement unit of currency: $ US million.

subject	object
bhpDirectEconomicValueGeneratedBasis	"Accruals basis."^^<http://www.w3.org/2001/XMLSchema#string>

subject	object
bhpRegionNameForDirectEconomicValueGenerated	"Africa and Other, Australia and Asia, Europe, North America, South America."^^<http://www.w3.org/2001/XMLSchema#string>

subject	object
bhpTotalValueOfDirectEconomicValueGenerated	"68083"^^<http://www.w3.org/2001/XMLSchema#decimal>

subject	object
bhpTotalValueOfDirectEconomicValueGeneratedByAfricaAndOtherRegion	"5007"^^<http://www.w3.org/2001/XMLSchema#decimal>
bhpTotalValueOfDirectEconomicValueGeneratedByAustraliaAndAsiaRegion	"40917."^^<http://www.w3.org/2001/XMLSchema#decimal>
bhpTotalValueOfDirectEconomicValueGeneratedByEuropeRegion	"172."^^<http://www.w3.org/2001/XMLSchema#decimal>
bhpTotalValueOfDirectEconomicValueGeneratedByNorthAmericaRegion	"9468."^^<http://www.w3.org/2001/XMLSchema#decimal>
bhpTotalValueOfDirectEconomicValueGeneratedBySouthAmericaRegion	"12519."^^<http://www.w3.org/2001/XMLSchema#decimal>

subject	object
bhpMeasurementUnitCurrency	"$ US million."^^<http://www.w3.org/2001/XMLSchema#string>

Figure 6 SPARQL query result for CQ60 in Table 1 related to 'Direct Economic Value Generated' class

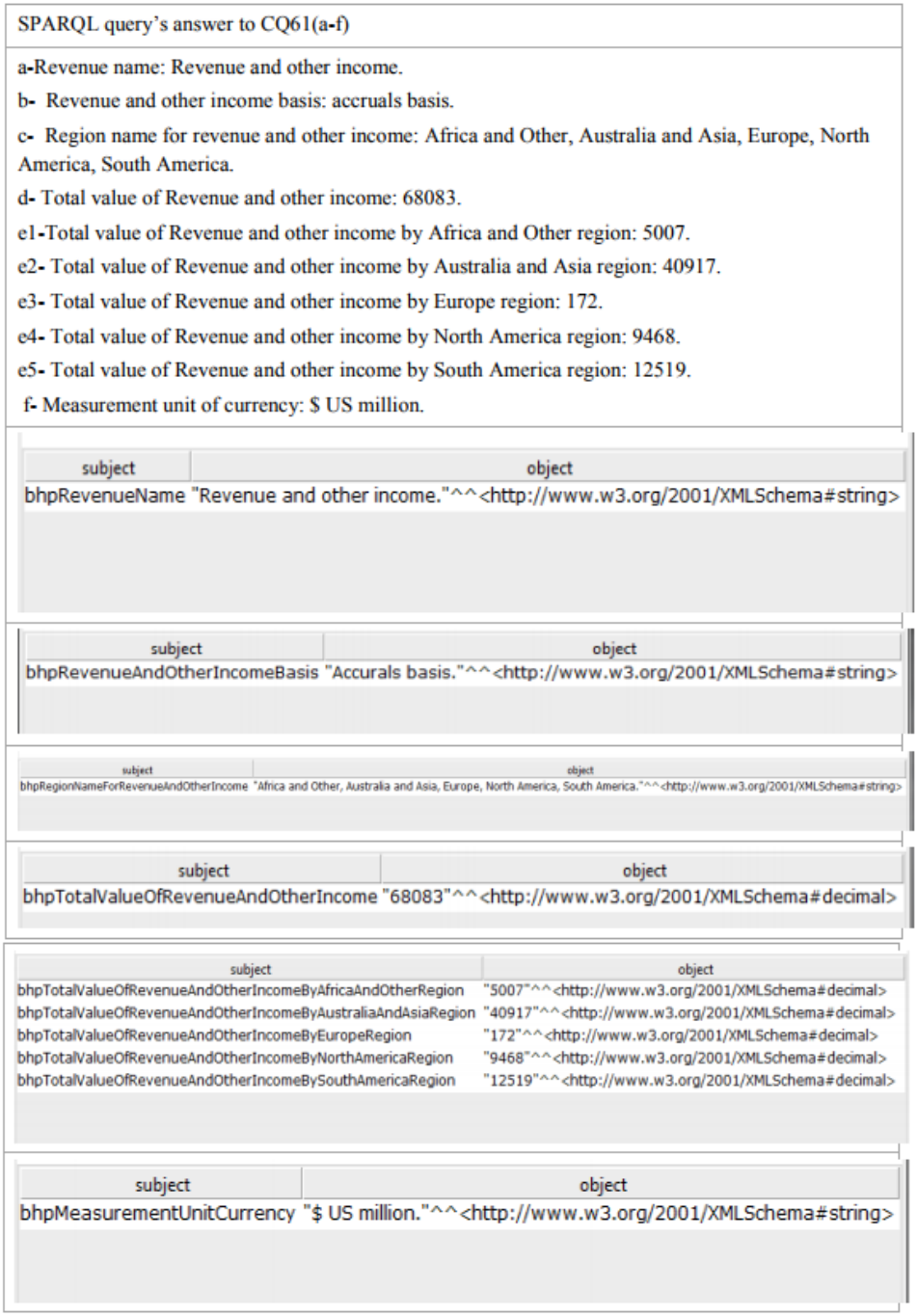


Figure 7 SPARQL query result for CQ61 in Table 2 related to 'Revenue' class

Moreover, Schema Metrics and Knowledgebase Metrics were the means used to verify the ontology for this research, [60] [61]. These metrics include:
Relationship Richness (RR)
Attribute Richness (AR)
Inheritance Richness (IR)
Class Richness (CR)
Average Population (P)

According to Table 3, the total number of classes, data properties, object properties, instances, sub-classes, and non-empty classes of Economic Aspects are 64, 193, 59, 173, 0, and 29 respectively. Therefore, the RR is 1.00 because the number of SC is 0. Each class on average has data properties of 3.02. In addition, the CR

is 0.45. Besides, each class has an average instance of 2.70 which shows the richness of instances in particular for EC1, EC2, EC9, EC3, EC7, and EC6.

Table 3 Schema Metrics and Knowledgebase Metrics for Economic (EC) Aspects

Definition of class	Class (C)	Data property (att)	Object property (P)	Instance (I)	Number of Sub-class (SC)	C`	RR	AR	IR	CR	Average Population (P)
EC Category	1.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
EC Aspect	4.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
Economic Performance Aspect	5.00	6.00	3.00	0.00	0.00	0.00	1.00	1.20	0.00	0.00	0.00
EC1	9.00	54.00	8.00	89.00	0.00	9.00	1.00	6.00	0.00	1.00	9.89
EC2	9.00	60.00	5.00	60.00	0.00	9.00	1.00	6.67	0.00	1.00	6.67
EC3	13.00	23.00	9.00	18.00	0.00	5.00	1.00	1.77	0.00	0.38	1.38
EC4	2.00	4.00	6.00	0.00	0.00	0.00	1.00	2.00	0.00	0.00	0.00
Market Presence Aspect	3.00	6.00	3.00	0.00	0.00	0.00	1.00	2.00	0.00	0.00	0.00
EC5	5.00	5.00	6.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00
EC6	2.00	4.00	4.00	1.00	0.00	2.00	1.00	2.00	0.00	1.00	0.50
Indirect Economic Impact	4.00	10.00	3.00	0.00	0.00	0.00	1.00	2.50	0.00	0.00	0.00
EC7	2.00	5.00	3.00	2.00	0.00	2.00	1.00	2.50	0.00	1.00	1.00
EC8	1.00	2.00	2.00	0.00	0.00	0.00	1.00	2.00	0.00	0.00	0.00
Procurement Practice	3.00	11.00	2.00	0.00	0.00	0.00	1.00	3.67	0.00	0.00	0.00
EC9	1.00	3.00	3.00	3.00	0.00	2.00	1.00	3.00	0.00	2.00	3.00
Total	**64.00**	**193.00**	**59.00**	**173.00**	**0.00**	**29.00**	**1.00**	**3.02**	**0.00**	**0.45**	**2.70**

6. Discussion

In this paper, the implemented ontology using OWL language and the Protégé tool is validated through the competency questions written in SPARQL Queries as shown in Table 1 and Table 2. Instances data were collected online for four Australian companies listed within the ASX for FY 2014; these are ORG, AMC, TCL, and BHP. The evaluation ontology of content to meet the 3Cs criteria of completeness, consistency, and conciseness was verified and the answers to the SPARQL Queries were obtained. These answers show that the reported data are instantiated and correctly describe all relationships between the data. Hence, the developed ontology for 'Economic Performance Indicator' is valid. Thus, the fourth objective of this research, which is to develop ontology for 'Economic Performance Indicator' class, was achieved. The main contribution of the

research is that it provides a formal framework for concepts, properties, and relationships for 'Economic Performance Indicator' class based on GRI G4 guidelines. The framework facilitates knowledge-sharing among stakeholders and computer software through a shared and common understanding of terms and vocabulary for 'Economic Performance Indicator' class. It also helps to store knowledge in a repository which can be automatically renewed to be compatible with the new generation of GRI.

The majority of instances relating to economic indicators' data instances was extracted from BHP, in particular for EC1, EC2, and EC9 (full disclosures), EC3 and EC6 (partial disclosures). This company is unique in terms of the quantity and quality of information disclosed. Whereas, the ORG data instances disclosure for EC7 was found to be optimal. There was a dearth of disclosure for EC4, EC5, and EC8 by any company in the sample. The valid answers are appeared. The summary of Schema Metrics and Knowledgebase Metrics for 'Economic Performance Indicator' class in terms of total number of classes, data properties, object properties, instances, number of sub-classes and non-empty classes were 64, 193, 59, 173, 0, and 29 respectively. Therefore, the RR is 1.00 because the number of SC is 0. Each class on average has data properties of 3.02. In addition, the CR is 0.45. Besides, each class has an average instance of 2.70 which shows the richness of instances in particular for EC1, EC2, EC9, EC3, EC7, and EC6. The content of the ontology was thereby validated. SPARQL queries were used to extract answers for the competency questions and correctly describe all relationships between the data within the inclusive set. Therefore, the developed ontology for the Economic Performance Indicator is active.

7. Conclusion and future work

This paper is aimed at formally modelling the real world of Economic Performance Indicators within Sustainability Reporting. Ontology has provided a shared and common understanding of terms and vocabulary that can be communicated among stakeholders in an organization, and computer software to facilitate the sharing and reutilization of knowledge. The methodology adopted included four phases: specification, conceptualization, formalization, and implementation. A requirement specification for Economic Performance Indicators ontology was created by identifying the intended scope and the purpose to address the various ontology scenarios. The classes, properties, and relationships for Economic Performance Indicators based on the GRI G4 were identified. A conceptual model was transformed into a formalized model using UML to represent the ontology formalization for 'Economic Performance Indicator' class. However, using SPARQL to access information in the ontology is sometimes too complicated for end users who have little knowledge of the language. Therefore, in the future work, we plan to develop an application that can support end users to effectively access and manage knowledge captured in the Ontology for Economic Performance Indicators Based on Global Reporting Initiative (GRI) G4.In addition, an inference and logic reasoning ability will be applied for this research in the future.

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