

The Potential of ‘Comprehensive Assessment System for Built Environment Efficiency for Cities’ in Developing Country: Evidence of Myanmar

Theingi Shwe, Riken Homma, Kazuhisa Iki, Juko Ito

Abstract—The growing cities of the developing country are characterized by rapid growth and poor infrastructure management inviting and accelerating relative environmental problems. Even though the movements of the sustainability had already been developed around the world, it is still increasing in the developing countries to plant sustainable practices. Aligned with the sustainable development actions, many sustainable assessment tools are also developed to rate and evaluate the sustainability performances through the building to community level. Among them, CASBEE is developed by Japanese organizations and is recognized as one of the international well-known assessment tools. The main purpose of the study is to find out the potential of CASBEE tool reflecting sustainability city level performances in developing countries. The research framework was designed with three major phases: Quantitative Approach, Qualitative Approach and Evaluation Reflection. The first two approaches were based on the investigation of tool's contents and indicators by means of three sustainable dimensions and sustainability categories. To know the reality and reflection on developing country, Patheingyi City from Myanmar was selected and evaluated by 2012 version of CASBEE for Cities. The evaluation practices went through assigned indicators and the evaluation outcome presents the performances of Patheingyi city's environmental efficiency as a very good in current conditions. The results of this study indicate that the indicators of this tool have balance coverage among three dimensions of sustainability but it has not yet counted enough for some indicators like location, infrastructure and institution which are relative to society dimension. In the developing countries' cities, the most critical issues on development such as affordable housing and heritage preservation which are already planted in Patheingyi City but the tool does not account for those issues. Moreover, in some of the indicators, the benchmark and the weighting coefficient are strongly linked to the system birth region. By means of this study, it can be stated that CASBEE for Cities would be potential for delivering sustainable city level development in developing country especially in Myanmar along with further inclusion of the indicators.

Keywords—Assessment tool, CASBEE, developing country, Myanmar, Patheingyi city, sustainable development.

I. INTRODUCTION

At the end of the 20th century, the global environment problems are becoming more tangible, following the trends, the United Nations introduced the concept of

“Sustainable Development” by releasing Brundtland Commission report, “our common future”, in 1987 [1]. This has subsequently served as a significant paradigm for society, the economy and politics [1]. Gradually since that time to till now, there has been a growing movement towards sustainable development especially in construction field following the various methods for evaluating the environmental performance of buildings [1]. In some countries around the world, several tools have been developed to assess the sustainability performance of these developments and their success in planting of sustainability [2]. Fig. 1 shows the assessment tools developed and used as per worldwide. The initial focus of these assessment tools was on single buildings. Nowadays, the development programs and assessment systems have been already established for various scales; from an individual building to city level [3]. For assessing consistency of these programs, numerous tools are also developed to fix as respective development levels with the principles of sustainable development.

II. OVERVIEW OF CASBEE

Comprehensive Assessment System for Built Environment Efficiency (CASBEE) is developed by the research committee collaborative with Japan Sustainable Building Consortium and the Institute for Building Environment and Energy Conservation as part of a joint industrial/government and academic project [1]. Reference [1] says that “CASBEE has provided a unique role and contribution within the evolving theory and practice of building environmental assessment, primarily respect to its structural and operational features relative to those of other major systems”. As shown in Fig. 2, it is comprised of assessment tools tailored to different scales: Construction (houses and buildings), urban (town development) and city management all those known as CASBEE family. These family tools were developed based on three principles: comprehensive assessment throughout the life cycle of the building, assessment of the built environment quality and built environment load and assessment based on the newly developed built environment efficiency indicator.

Governments and municipalities became highly aware of the importance of actions at the city level for the creation of low carbon societies. In order to estimate the effectiveness of these city-led policies, there are necessary to develop an assessment tool for cities level by means of that CASBEE for Cities is developed based on the methodology of CASBEE. CASBEE for Cities, also CASBEE-City, is a system for

Theingi Shwe, Kazuhisa Iki and Juko Ito are with the Department of Architecture and Environment Planning, Graduate School of Science and Technology, Kumamoto University, Japan (e-mail: tgi.shwe@gmail.com).

Riken Homma was with the Architectural History and Urban Planning, Faculty of Advanced Science and Technology, Kumamoto University, Kumamoto, Japan.

comprehensively evaluating the environmental performance of cities. The system intends to approach from the aspects of environment, society and economy [4]: Three pillar of

sustainability that is why it is also well known as sustainable assessment tool.

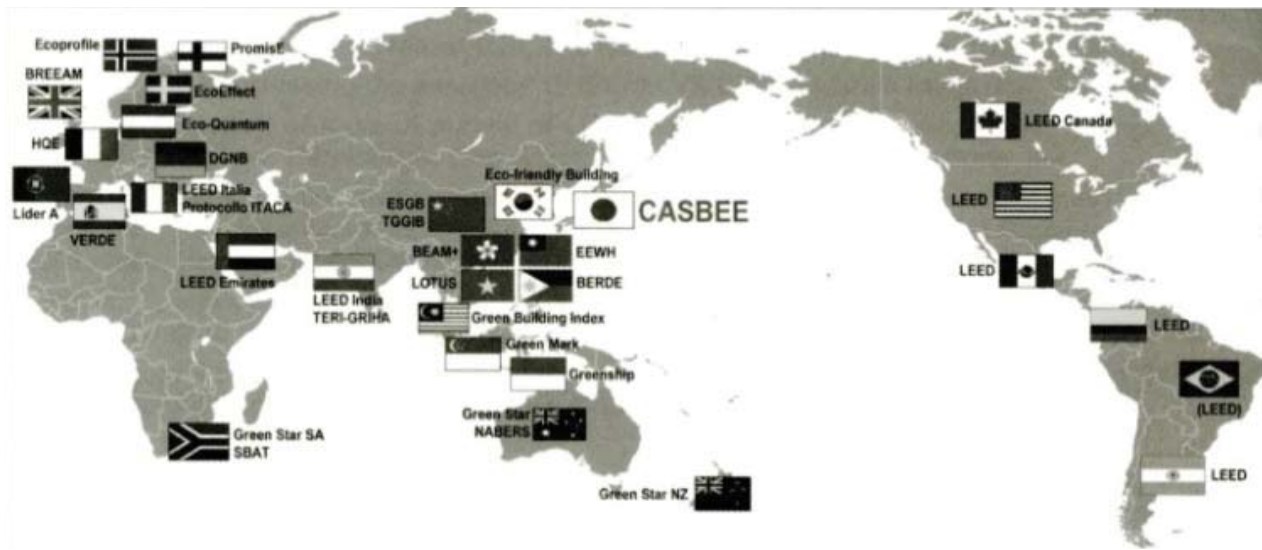


Fig. 1 Assessment Tools Developed Worldwide as of September 2012 [1]

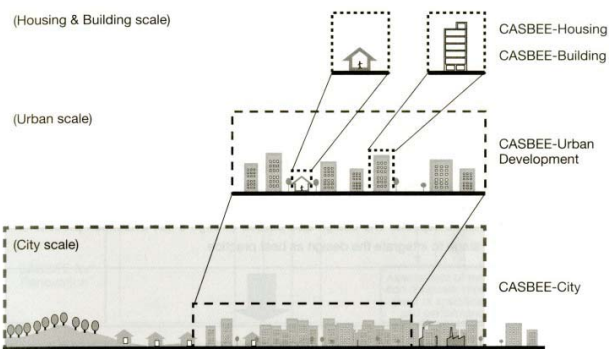


Fig. 2 Stratified Structure of a Scale of Defined Areas for CASBEE Assessment [1]

While the assessment is conducted at the city level, a hypothetical boundary is set around the city to be evaluated as shown in Fig. 3. Reference [4] states that by means of the improvement in environmental quality (Q) within the enclosed space and reduction in negative environmental impact (L) on the area beyond the boundary, built-environment efficiency (BEE) of the city can be evaluated due to CASBBB-City.

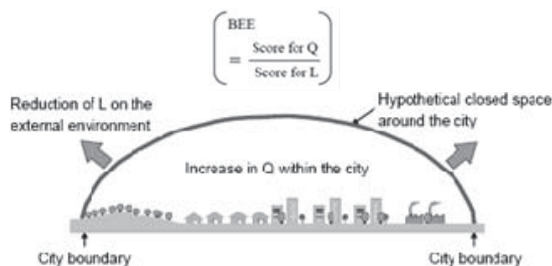


Fig. 3 Concept of a Hypothetical Closed Space in CASBEE-City [4]

III. CHALLENGES IN DEVELOPING COUNTRIES

From developing countries, there are increasingly reporting on the failure of sustainable development that might be facing the challenges on planting the sustainable practices [5]. Reference [5] also says that the purpose of sustainable development in developing countries seems to be lost because of the persistent nature of poverty and the scale of spontaneous urbanization, lack of access to basic services, rapid deterioration of the natural environment, unemployment, growing informal economic activities, urban sprawl and burgeoning informal settlements. To the best of our knowledge, there is no peer-reviewed research exploring the practice of city level assessment through surveying current city development from developing countries.

In an increasingly urban world, there are almost 400 cities around the world that contain more than a million residents and about seventy percent of these are in less developed countries moreover the United Nations also predicts that those of developing world urban areas will be growth greater in the future [6]. Unfavorably, the emergence of informal settlements is the main characteristic of these rapidly growing cities by means of the severe poverty of the developing world [5]. Those informal settlements are confronted with in the form of a lack of sanitation facilities and services, a lack of access to potable water, high levels of unemployment, insecurity, environmental degradation, pollution and natural hazards [5]. According to that, the challenges of developing countries will also be serious to international challenges and the sustainable failures would lead to global failure. Due to those evidences, there is an urgent need for a concerted and holistic approach to manage these challenges and achieve sustainable development globally.

IV. RESEARCH OBJECTIVES AND METHODS

This research aims at exploring the practice of city level assessment through surveying current city from developing countries by means of international well-known assessment tool. The main aim is intended to find out the potential of assessment tool reflecting sustainability performances in the cases of developing countries, especially in Myanmar. The specific aims and objectives are (1) to conduct the literature review on the principle of sustainable development and the principle of evaluating assessment tool itself, (2) to conduct the contents analysis of CASBEE for Cities and (3) to conduct the sustainability performance of Patheingyi City by evaluation practice.

In this research, the latest version 2012 version of CASBEE-City was taken account to explore in depth analysis with combination of quality and quantity techniques. To conduct the practical assessment action, Patheingyi City from Myanmar was selected and evaluated. Content analysis was the main method used for analyzing the tool focusing on both of existing case study and assessment tool itself throughout the assessment process. Fig. 4 presents step by step research flow and design which includes three major frameworks.

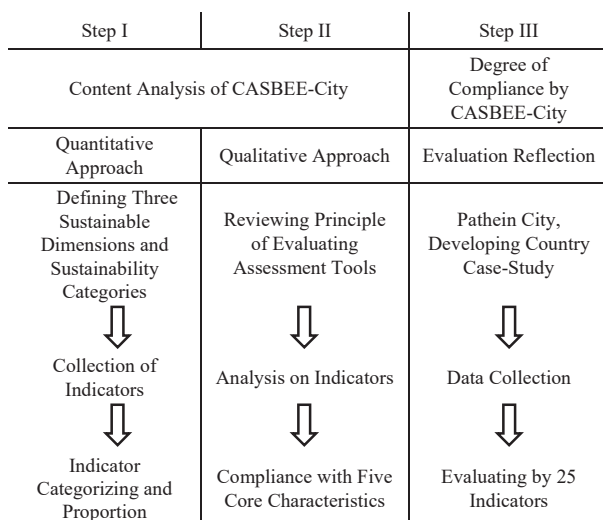


Fig. 4 Research Flow and Design

Firstly, as a quantitative approach, the indicators used in CASBEE-City were investigated by categorizing to respective indicator types based on nine sustainability categories; Building, Society/ Community, Environment/ Ecology, Economic, Location, Infrastructure, Institution, Resources and Energy and Transportation. These nine sustainability categories were defined by the mostly common use in other academic research [2], [7]-[11]. The proportion of indicators was also conducted by their capability to integrate and measure the environmental, economic and social dimensions of sustainability by means of sustainable principle in [10], [12].

As the principle of evaluation on assessment tool, many researches state that the indicators should be set out with five

core characteristics [13]. The first core characteristic is integrating which means indicators proportion should be balanced among sustainability dimensions. The second one, forward looking is time dimension for inter-generational equity. The intra-generational equity is the third core which means the distribution fair enough across for all citizens. The tool should be developed with input from multiple stakeholders as for procedural equity. The fifth is context-specificity which target on how they reflect of the development characteristics. Therefore, the contents of CASBEE-City were investigated how they compliance with these five core characteristics in a second phase.

Finally, practical assessment action was conducted on selected case study with the whole urban context, to know evaluation reflection with degree of compliance by CASBEE-City. This step of analysis can also echo the strength and weakness of case study in persuading the sustainable certification. Discussion in final step represents the report of assessment results, the rating range of the system and an overall performance of case study.

V. OVERVIEW OF THE SELECTED CASE STUDY

Patheingyi is the capital city of the Ayeyawady Region and the fourth largest city in Myanmar. It is one of the international port cities in Myanmar lying at the western edge of the Ayeyawady River delta, on the Patheingyi River. Patheingyi is accessible to large vessels and despite its distance from the ocean. The city is also a terminus of a branch of the main railroad line which connects it to other cities within the region and also to economic hub of Myanmar, Yangon. The road network along the Ayeyawady River has also spread to central region of Myanmar. The population of Ayeyawady Region ranks second largest representing 12% of total population of Myanmar [14]. It is also the third most densely populated Region having population density of 176.5 person per sq.-km [14]. Among other cities within the Region, having 287,071 populations [14], Patheingyi city stands as the most populated city and economic center. Patheingyi City has the area of 66.82 sq.-km within township area of 644.88 square-miles. Over one-third of the city's areas are devoted for residential purpose. As shown in Fig. 5, the city still has a large amount of green spaces and water bodies having greater access to River. Along with Fig. 5 (c), Fig. 6 also represents the land utilization ratio of Patheingyi City with the same color usages.

VI. PREVIOUS INVESTIGATIONS

According to SHWE [16], previous evaluation of Patheingyi City by CASBEE-City version 2011, the city was "Poor" in built environmental efficiency. As the presence of Patheingyi city, the environment qualities like as nature conservation, living environment and social vitality was good but very poor in other qualities such as social services, environment vitality and policies. The previous investigation just only focused on the evaluation practices and so, in this study, the methodology was applied to analyze on the content of the tool in depth for inquiry the potential of CASBEE-City 2012 version.

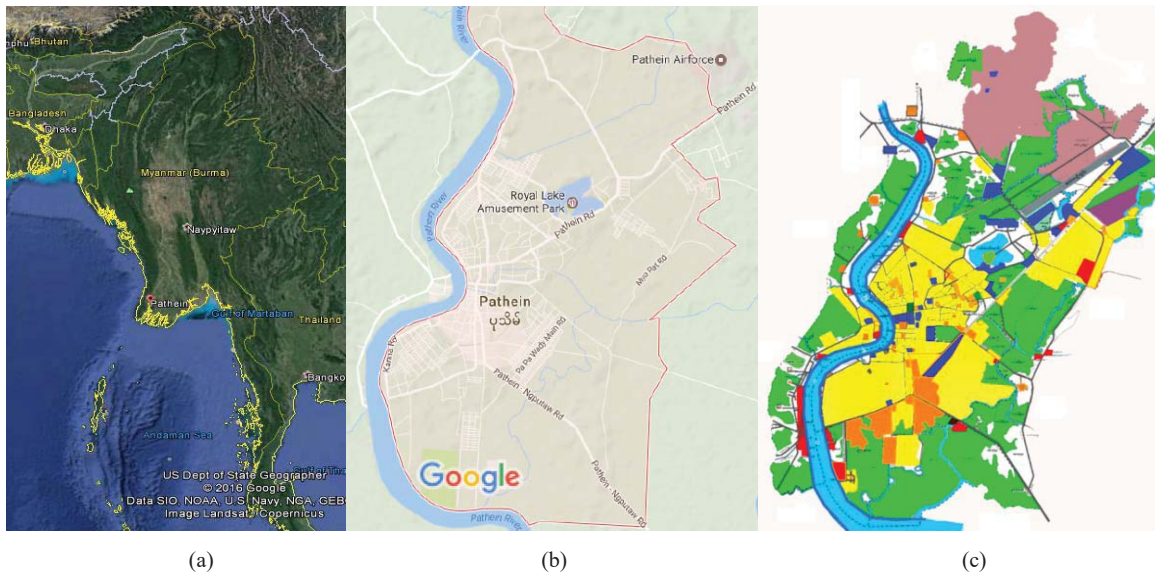


Fig. 5 (a) Location of Patheingyi in Myanmar Map. Source: Google Earth, (b) Patheingyi City Map. Source: Google Maps and (c) Color Mapping for Land Utilization [15]

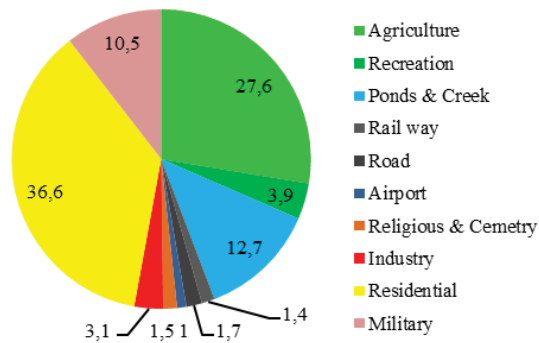


Fig. 6 Land Utilization Ratio of Patheingyi City [15]

For the Patheingyi City, SHWE [17] also conducted the overview analysis on City by using SWOT analysis approach which is a tool designed to be used in the preliminary stages of decision-making often as a precursor to strategic planning. The results indicated that Patheingyi city had its own strengths on maritime transport location and extensive local products that can be expected for economic development with further cooperated industrialization based on local rich. It also had great opportunities to become tourism city having attractiveness of scenic spots, historic places and beautiful beaches. The main challenges were poor infrastructure and management that cannot be served enough for current conditions. Reference [17] said that Patheingyi city was urgently needed to enhance the master planning with long term perspective for development.

VII. RESULTS AND DISCUSSIONS

According to the research flow and procedure, the results would be discussed the two approaches of content analysis firstly and then the evaluation reflection later.

A. Quantitative Approach

According to the structure of tool system, the main inputs, quality and load can be also called theme. Each theme is comprised 4-6 medium-level categories, criteria, and each medium-level category is further divided into minor categories, indicators. Fig. 7 shows the structure and contents of the CASBEE-City that there is no mandatory indicator. For each indicator, credit comprises one to five points but the weighting coefficient is different on each other. As an environmental quality, environment, society and economy are categorized but for load calculation, it is only focus on environmental load, CO₂ emission.

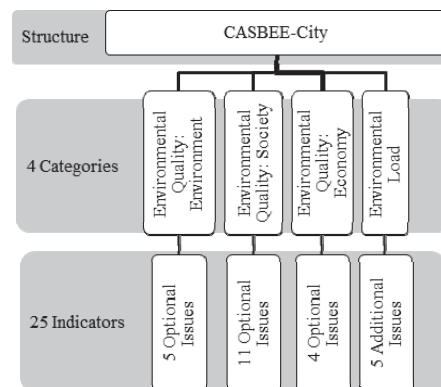


Fig. 7 Structure of CASBEE-City

When the total 25 indicators are grouped into concerning category by means of nine sustainability categories, the most targeted is environment and economy but there is no indicator for location, infrastructure and institution as shown in Fig. 8.

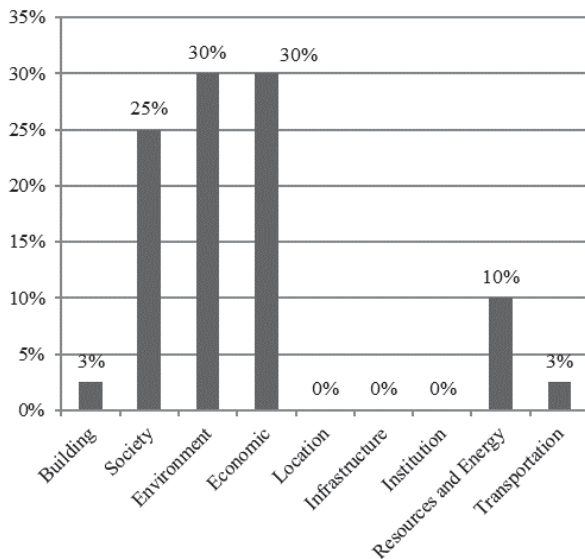


Fig. 8 Percentage Distribution of Weighted Indicators across Sustainability Categories

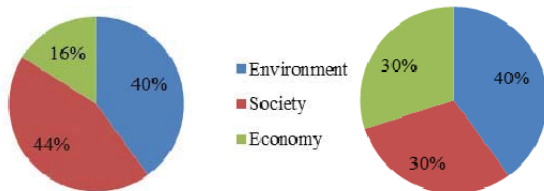


Fig. 9 Percentage Distribution of Indicators across Three Sustainable Dimensions: (a) By Numbers of Indicators, (b) By Indicator Weights

As presented in Fig. 9 (a), according to three dimensions of sustainability, the numbers of indicator used in social aspect is the most targeted of and the economic aspect is the least presented. Though some of the indicators are not mandatory and can be applied as additional credit, it is still seen as unbalance among each other. To balance among them, CASBEE-City used weighting coefficient, Fig. 9 (b) presents the percentage distribution of weighted indicators. Although environment/ ecology is the most target due to those weighted proportion, the 2012 version of CASBEE-City is approaching to balance across three sustainable dimensions.

B. Qualitative Approach

As a qualitative approach, the contents of CASBEE-City were investigated how they compliance with five core characteristics. As the first core, although CASBEE-City has balance across three sustainable dimensions, it can be only earned as fair being lack of account in location, infrastructure and institution. It is good in forward looking cause of identifying current as well as future conditions. For intra-generational equity, the tool widely emphasis on children,

elder person and disable person but not well accounted for different income people. The tool is developed by collaborating with industry, government and academia but public participation does not have evidence. In final one for context specificity, the tool is bounded with its birth region characteristics in most of the indicators that is why it earns only poor. Table I shows the summarized degree of CASBEE-City compliance with five core characteristics.

TABLE I
DEGREE OF COMPLIANCE WITH FIVE CORE CHARACTERISTICS

Core Characteristics	Degree of Compliance	
<i>Integrating</i>	Balance of CASBEE-City's list of addressed indicators: Strong in environmental/ ecological but the difference is quite low	★★
<i>Forward Looking</i>	Identified normal condition at present time and forward looking for future	★★★★
<i>Intra-generational Equity</i>	Concrete measures regarding equal accessibility but not for different income	★★
<i>(Procedural Equity</i>	Cooperation between industry, government and academia but low in public participation	★★
<i>Context-specificity</i>	No consideration for local-specificity requirements	★

Good ★★; Poor ★★; Fair ★★★★★

C. Evaluation Reflection

Investigating each indicator shows that there need some more indicators regarding sustainable principle in the system on the other hand Pathein City successfully persuaded some indicators with high score and also failed in some. The bar charts in Fig. 10 present the output of evaluation for each quality of Pathein City and below the level three performances are highlighting the areas of improvement needed. The city has the strength in local environment quality, living environment, and social vitality then the weakness is the resources recycling and financial quality. This result presentation helps the end user to get a better knowledge of those areas doing well and those needing improvement. Fig. 11 presents the result output radar chart of Pathein city for the three qualities and load in current and future conditions.

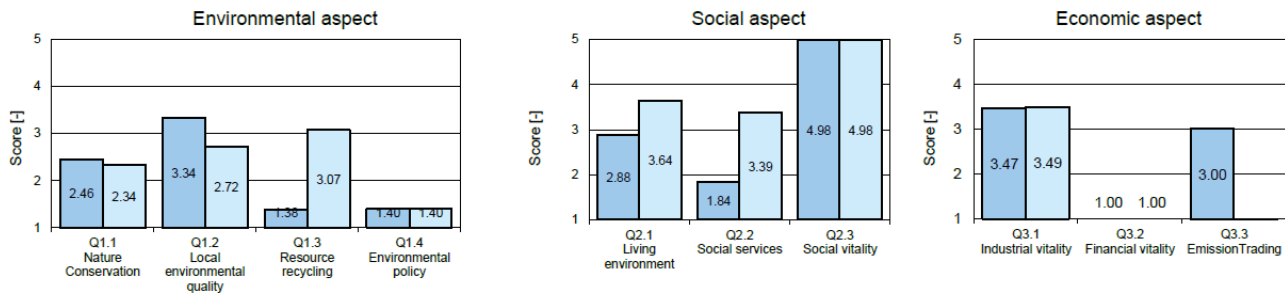


Fig. 10 Result Output Bar Chart for Each Quality of Pathein City

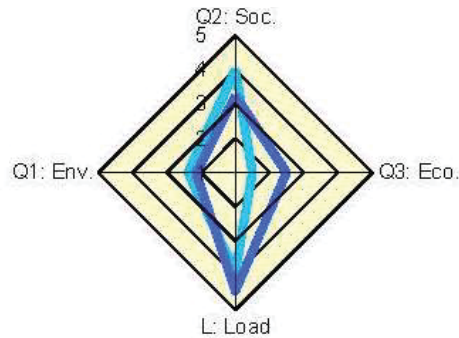


Fig. 11 Result Output Radar Chart for Pathein City

To be more precise, the city has a good contribution in nature conservation having 44% occupation of green spaces and water bodies seen in Fig. 12. As a living environment, it gets good score in provision of park because of several recreation areas.



Fig. 12 Nature Conservation and Some Recreation Facilities of Pathein City

It has a poor contribution in environmental quality and

policy especially in waste recycling seen in Fig. 13. There have some background law by National but nothing by follow up laws in local level. According to recorded data, traffic and crime are also a good condition comparing with city total population. Sewage system is also poor because the current condition is not developed enough for the whole city while the system looks for the back-up system.



Fig. 13 Poor Environmental and Infrastructure Management of Pathein City

For social services, it has good contribution in cultural services by means of facilities and participants seen in Fig. 14. To cite for education services, number of facilities means number of school is good but the ratio of students and staffs is still poor.



Fig. 14 Some Cultural Sites and Famous Handicrafts of Patheingyi City



Fig. 15 Economic of Patheingyi City

According to gross regional product of Patheingyi City, CASBEE-City ranks the city fair enough as in industrial vitality. Lack of public transportation efficiency, low motorbike users and low density also lead to high score for emission trading.

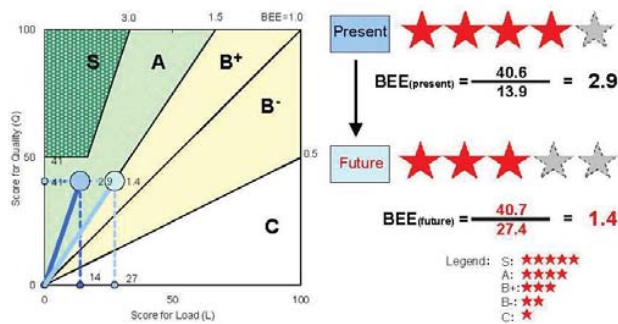


Fig. 16 The result BEE chart of Patheingyi City

Finally, BEE is expressed as the gradient of a straight line on a graph having L plotted on the horizontal axis and Q on the vertical axis as shown in Fig. 16. According to the value corresponding to the gradient, the degree of the environmental performance is labeled and color-coded in five grades; S rank, A, B+, B- and C. The results in Fig. 16 show that BEE chart shows not only the current environmental performance but

also future prediction.

Although Patheingyi City is well-known as “Granary of Myanmar” and export center within the region, it cannot be defined specifically as industrial city having only rice mills and garment factories. Because of its location, human resources and local products within the region, it has also the opportunities to develop and industrialize in the near future. The opportunities also found in tourism development because of the attractiveness of scenic spots, historic places, beautiful beaches and famous handicraft. According to those reasons, the final result presents that the city earns “Very Good” certification in current conditions and just only “Good” certification for the future estimations by CASBEE-City. All these results give better understanding for improvement possibility of the city for the future by comparing the current value with the future value regarding Q, L and BEE.

D. Discussions

For the effective understanding, percentage proportion of CASBEE-city and achievements of Patheingyi City are compared by means of sustainability categories and three sustainable dimensions. Apart from transportation indicators, the gaps between CASBEE-City proportion and Patheingyi City’s achievements are large in most of the categories as shown in Fig. 17. Lack of tool’s content in location, infrastructure and institution, Patheingyi city cannot be evaluated in these categories. Fig. 18 shows that the tool has the most target in environment and the city has the strongest in society. The environment performance of the Patheingyi is also strong following by society and the economy is the lowest performed. The gap between CASBEE-City proportion and Patheingyi City’s achievements is seen quite low only in society dimension.

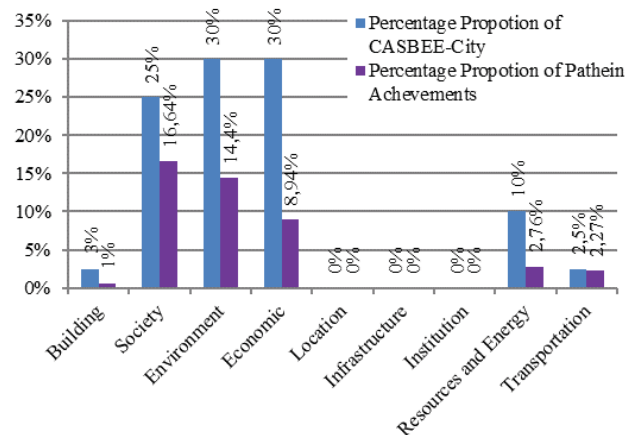


Fig. 17 Comparison on Percentage Proportion of CASBEE-City and Achieved of Patheingyi City in Sustainability Categories

To do justice for CASBEE-City 2012 version, the first two approaches show that the tool itself has weakness in some indicator composing especially in location, infrastructure and institution indicators that would be lead to society dimension. According to Patheingyi City experiences, though several

affordable housing estates for low income people are provided in Patheingyi City, there is no applicable indicator in system while this is critical as an economic dimension for sustainability and also for intra-generational equity. Those kinds of development such as affordable housing provision and heritage preservation are very important to mean as sustainable but the tool does not account for those issues. Accounting the load to the outside of designated area, some impacts are also missed out like as heritage impact consideration and that is the most critical issue on development of heritages blossom city. For load calculation, the system has very strong link to region characteristics. Another challenge is selection of benchmark for each indicator, according to predetermined criteria, and weighting coefficients are applied between assessment fields to calculate the results. The benchmark and the weighting coefficient are strongly depending on the system region of origin. There can be summarized that CASBEE-City tool does not fulfill enough of five core characteristics for sustainable assessment tool principles.

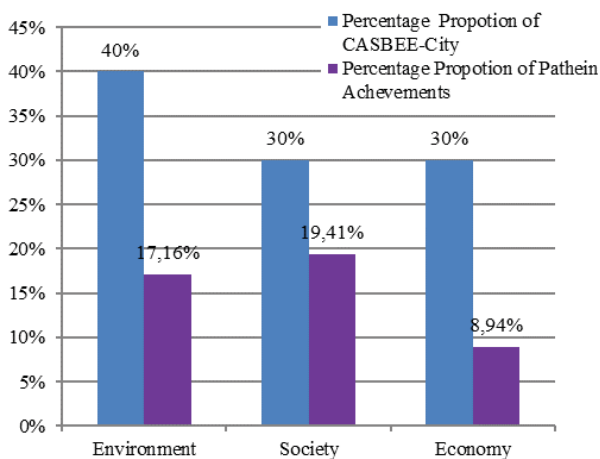


Fig. 18 Comparison on Percentage Proportion of CASBEE-City and Achieved of Patheingyi City in Three Sustainable Dimensions

In previous investigation, although [16] and [17] presented that the significant weakness of Patheingyi City is poor infrastructure and environmental management, the CASBEE-City 2012 version results present the City has good quality in local environment. Although Patheingyi City earns "Poor" certification in CASBEE-City 2011 version [16] because of low quality in environment, CASBEE-City 2012 version gives Patheingyi city "Very Good" certification. These evidences also show that the changes of benchmark within different version and CASBEE-City 2012 version could not present for the actual conditions of Patheingyi City in environmental management. To delivery in developing country, CASBEE-City should be strengthened in the indicators of economic and social dimensions and should be capable of the local context reflection in benchmark composition. This study results will support the inclusion of CASBEE-City and diffusion to developing country as well as will guide the tool development for developing country itself.

VIII. CONCLUSION

This paper presents the strength and weakness not only of the CASBEE-City but also of the Patheingyi City, case study of developing country. As the results of the study demonstrate, the tool CASBEE for Cities is considerable balance among three dimensions of sustainability but some indicators are neglected though those can give good quality for society and economic dimensions of the sustainable development. This absence also leads to failure of achieving in five core characteristics of sustainable assessment tool. This study also mainly finds out that the important of benchmark level in persuading of sustainability certification. Even though some sustainable practices are performing in Patheingyi city, the tool cannot reflect for those specific local contexts.

Although Patheingyi city is very poor in physical infrastructure management, environmental management and monitoring, CASBEE-City assigned the performances of environmental efficiency is very good in current conditions. By means of this, the assessment system from developed country cannot reflect the city level sustainability of developing country. In other way, with advanced inclusion of the indicators and benchmarks, CASBEE for Cities would be possible to delivery in developing countries especially in Myanmar. To apply in developing country, the further inclusion of the indicators in the systems should be strengthening in the economic and social dimensions of sustainability and benchmark and weighting coefficient classification also need to reflect the local context.

REFERENCES

- [1] Shuzo Murakami, Kazuo Iwamura, Raymond J. Cole. Edited by Japan Sustainable Building Consortium (JSBC). "CASBEE: A Decade of Development and Application of an Environmental Assessment System for the Built Environment". Institute for Building Environment and Energy Conservation (IBEC), Tokyo, Japan, 2007.
- [2] Sharifi A., Murayama A. "A critical review of seven selected neighborhood sustainability assessment tools". *Journal Environ Impact Assess Review*, Vol. 38, 2013, pp. 73-87.
- [3] Sharifi A., Murayama A. "Neighborhood sustainability assessment in action: Cross-evaluation of three assessment systems and their cases from the US, the UK, and Japan". *Building and Environment* 2014;72:243e258.
- [4] Committee for the Development of Environmental Performance Assessment Tools for Cities. "CASBEE for Cities. Technical manual 2012 edition". Japan Sustainable Building Consortium, Japan, 2012.
- [5] Patrick Brandful Cobbinah, Michael Odei Erdiaw-Kwasie, Paul Amoateng. "Rethinking sustainable development within the framework of poverty and urbanisation in developing countries". *Journal Environmental Development*, Vol. 13, 2015, pp.18-32
- [6] Cohen B. "Urbanization in developing countries: current trends, future projections, and key challenges for sustainability". *Journal Technol Society*, Vol. 28, 2006, pp. 63-80
- [7] Haapio A., "Towards sustainable urban communities", *Journal Environ Impact Assess Review*, Vol. 32, 2012, pp. 165-169.
- [8] Berardi U., "Sustainability assessment of urban communities through rating systems". *Journal Environment, Development and Sustainability*, Vol. 15, 2013, pp 1573-1591, doi:10.1007/s10668-013-9462-2.
- [9] Orova M., Reith A., "Comparison and evaluation of neighbourhood sustainability assessment systems". 29th Conference Sustainable Architecture for a Renewable Future, Munich, Germany 10-12 September 2013.
- [10] Reith A., Orova M., "Do green neighbourhood ratings cover sustainability?". *Journal Ecological Indicators*, Vol. 48, 2015, pp. 660-672.
- [11] Komeily A., Srinivasan Ravi S., "A need for balanced approach to

- neighbourhood sustainability assessments: A critical reviews and analysis". *Journal Sustainable Cities and Society*, Vol.18 2015, pp. 32-43.
- [12] Singh R. K., Murty H.R., Gupta S.K., Dikshit A.K., "An overview of sustainability assessment methodologies". *Journal Ecological Indicators*, Vol. 9, 2009, pp. 189-212.
 - [13] Sharifi A, Murayama A. The potential of "CASBEE for urban development" for delivering sustainable communities: a case study from the "Koshigaya Lake Town" planning experience. In: *International symposium on urban planning 2012*. Taipei, Taiwan: Taiwan Institute of Urban Planning; 2012. pp. 703e13.
 - [14] Department of Population, Ministry of Immigration and Population, "The 2014 Myanmar Population and Housing Census"
 - [15] Department of Land Statistic, "Land Utilization in Patheingyi City", September, 201
 - [16] SHWE Theingi, HOMMA Riken, IKI Kazuhisa, ITO Juko, "The Potential of "CASBEE for Cities" for Delivering Sustainable Development in Developing Country: in the Case of Patheingyi City", 55th Architectural Institute of Japan, Kyushu Branch Research Meeting 2015, 6 March 2016, Okinawa, Japan
 - [17] SHWE Theingi, THAW Kaungset, HOMMA Riken, IKI Kazuhisa, ITO Juko, "SWOT Analysis Approach to Current Development of Patheingyi City: Studies of Town Planning in Patheingyi City, Myanmar (I)", Architectural Institute of Japan, Annual Convention 2016, 24-26 August 2016, Fukuoka, Japan