Application of green concept on mixed-use building design

M D Lubis¹*, H T Fachrudin¹, F A S Lubis² and P W Dari²

¹ Architecture Department, Engineering Faculty, Universitas Sumatera Utara, Jl. Almamater Kampus USU, Medan 20155, Sumatera Utara, Indonesia
² Student at Architecture Department, Engineering Faculty, Universitas Sumatera Utara, Jl. Almamater Kampus USU, Medan 20155, Sumatera Utara, Indonesia

*m.dolok@usu.ac.id

Abstract. Green concepts are important things to apply on buildings. The application of the green concept on mixed-use buildings must consider several criteria, one of which is the comfort aspect. The density of commercial buildings in Medan City causes a reduction in green open space, and even many buildings do not comply with the minimum green open space requirements on their buildings, which can support the development of this city to reduce environmental temperatures. The aim of this study is to analyze the green concept that can be applied to mixed-use buildings in urban areas. A mixed-use building design with the application of green building principles is the right choice to reduce the effects of climate. The green building concept can help reduce excess heat radiation inside and outside the building. The method used is qualitative with data collection techniques through observation. The analysis was carried out descriptively to obtain a mixed-use building model with the green building concept. The results show that land use efficiency, energy conservation, materials and water conservation can be applied to provide comfortable on buildings.

1. Introduction

The green concept should be a consideration in building planning, especially commercial buildings. Green building assessment by Green Building Council Indonesia [1] has several criteria namely appropriate site development; energy efficiency and conservation; water conservation; indoor air health and comfort; material resources and cycle; and building environment management. Based on Tamiami et al. [2], there are three variables of green building criteria that should be implemented, in this case on the campus to improve student’s quality of life, namely energy conservation, indoor health and comfort, and building environment management.

According to Haughton and Hunter [3], a city is a region in which there are people and their activities that continually improve the natural, man-made and social environment of the region, from small scale up to regional scale, and always support the goals of sustainable development globally. Increasing the economy and population quantity is one factor in the increasing number of concrete buildings in the form of buildings and shophouses that function as residential and commercial centers. The building erodes the amount of green open space, where green open space is one of the contributors of oxygen needed by the community. Nowadays, multi-story buildings are familiar, because they are considered more effective and efficient with the current land
conditions. Storied buildings consist of low, medium, and high rise buildings. Urban areas become a place for some rural communities to find work, resulting in fairly high urbanization from rural to urban areas. The increase in population growth in urban areas is one of the factors supporting the rise of multi-story buildings, in addition to the minimal land conditions, especially in urban areas is the reason for the establishment of multi-story buildings.

Trade is one of the economic activities that are able to make a major contribution to the economy of the City. The needs of trading activities are adjusted to the residential area in the form of traditional markets and malls (supermarkets). The mall is one of the fast-growing trade centers in urban areas. The construction of the mall is a sign of the development of the city towards the metropolis. Mall development too means building a culture of globalization and the culture of urban society which is sensitive to the use of technology, information, and modernity. Beddington [4] states that people visit shopping centers not only for shopping but also for recreation. Combining the functions of shopping with recreation will lead to a profitable activity. In Haryono the advantages of combining the two functions are [5]:

- Increase the effectiveness of all the potential possessed.
- Reducing business risk, due to the economic ups and downs of the number of visitors/consumers.
- More lively atmosphere and increase competitiveness.
- Efficiency of leasing facilities and decreasing the percentage of operating costs by increasing revenue volumes.
- The advantages and advantages of combining the two potentials are separate assets that can be utilized further for the development of trade centers.

Office buildings are one place to carry out economic activities. In planning an office building it is necessary to pay attention to security, cost, usability, shape, architecture, structure, and services available. Supporting facilities such as space for machines, filing rooms, canteens, and other supporting activity rooms are factors that cause office space for office buildings not to move. In designing a multi-story building either a single/multi-mass building with a mixed function (mixed-use), a medium-rise building/mid-rise building located in a public space located on an urban scale must pay attention to several mature criteria both in terms of strength, comfort, and economic aspects. In addition, the ease factor, the quirk, and the relationship between functions in buildings must also be considered. Multi-story buildings generally have various functions such as shops, offices, and recreation. The function can be associated with outdoor facilities such as parks, promotional spaces, sidewalks, and so forth. With a variety of building functions both inside and outside the room can maximize the increasingly narrow use of land in urban areas. Based on previous studies regarding green concepts in commercial buildings and mixed use buildings, this study aims to analyze the green concept that can be applied to mixed-use buildings in urban areas.

2. Methods
This study uses a qualitative method. Data collection was carried out by observation in the research area, namely Pandu Street and Pemuda Street, Medan City. Observation made to determine the natural conditions and physical conditions of the area, activities, and documentation. Benchmarks in determining the green architecture index of a mixed-use building that is adopting the measurement of the GREENSHIP rating system by the Green Building Council Indonesia is modified based on needs related to research aspects. Data analysis using descriptive analysis to develop a green concept that is suitable for application in mixed-use buildings.
3. Results and discussions

According to Priatman [6], green architecture is an architecture that is environmentally sound and based on concern about the conservation of the natural global environment with an emphasis on energy efficiency (energy-efficient), sustainable patterns (sustainable) and a holistic approach.

Green Architecture is a design process by reducing adverse environmental impacts, increasing human comfort with efficiency and reducing the use of energy resources, land use and effective waste management in the architectural order [7].

Green building is very appropriate to be used in designing public commercial buildings on the Pandu Street and Pemuda Street, Medan Maimun Sub-District, which is a part of the city center of Medan and is a CBD area because it minimizes adverse effects on nature, the environment and humans to produce a healthy place to live. This building can contribute positively to commercial public areas in the center of Medan.

Judging from the function of buildings that will be commercially public, of course the location chosen must have several criteria that support the main function as a commercial public building. In addition, the determination of location must also be based on government policy on the allocation of urban land. Based on the RUTRK (General Spatial Plan for the City), the level of the Second Level Municipality of Medan is divided into 5 WPPS (Development Areas).

3.1. Application of two functions in mixed use building

According to Jo Gause [8], mixed-Use Building is a multi-functional business area part of the city area that accommodates several different activities in it, each activity is complementary and closely related and interact with each other, its development must have a clear and accurate role raised from each function of the activity. According to the decree of the minister of public works number 441/KPTS/1998, the classification of mixed residential buildings is a place of residence within a building that is included in the classification of office buildings, trade buildings, storage buildings, or public buildings and has a residence in the building.

In this mixed use building, it will implement 2 functions, namely offices, and recreation facilities (malls). A leasing office is a space or a building/building as a place to carry out administrative activities for each company or user, the procurement of which is intended to be leased to the company/user within a certain period of time according to the mutual agreement between the user (the lessee) and the owner (manager). The function of the leasing office is to accommodate the tenant companies in carrying out or carrying out services, administrative activities together to achieve the main objective, namely to obtain financial benefits.

According to Suharso [9], a place of recreation is a place to refresh the body and mind or something that is joyful and refreshing like entertainment or a picnic. Activities commonly used in recreational facilities such as sports, shopping, arts, culinary, social, knowledge, travel, health, spiritual, etc. There are several factors that influence recreational facilities (which in buildings function as malls) according to Bovy and Lawson [10], namely: Socio-economic factors in people with certain social groups (elite) will be different from public recreation in general due to differences in facilities owned; gender, age and family factors; teenage recreation activities may be different from young men and also different from adult recreation activities; leisure time availability factors time for housewife recreation will be different from working women; institutional factors associated with achievement, the amount of funds owned, changes in attitudes towards recreation; factors of technological change associated with the emergence of new types of recreation and ease of achievement with recreational facilities with high technology.
To fulfill the activities of the 2 functions contained in the mixed-use building, the following are the space requirements criteria based on each function:

### 3.1.1. Rental office

There are several types of activities carried out in the rental office. The Table 1 show the activities carried out by users and the required space requirements.

**Table 1. Activities in rental office.**

| User | Activity | Space |
|------|----------|-------|
| Tenant | Coming (in, out), work, eat and drink, worship | Office employee parking, canopy/entrance, hall, elevator, emergency stairs, living room, work space, meeting room, pantry, musholah, lavatory |
| Visitors/Guests of work relations/shareholders/Board of Directors | Coming (out, in), looking for information, vertical circulation, destination office/office facilities, meetings, worship | Parking for guest office rent, Entrance, hall, information, waiting room, meeting room, elevator, emergency stairs, mosque, lavatory |
| Employee/attendant (parking, service, EEC, security) | Come (in, out), change clothes, work (valet parking, security, cleaning, utilities, storing tools, eating and drinking, worshipping, resting, storing cleaning equipment | Parking, dressing room, work space (valet parking room, security/security room), utility room/MEE, warehouse, pantry, musholah, break room, janitor, lavatory |

### 3.1.2. Mall/shops

Spaces in malls or shops consist of several functions. The following is explained in Table 2 activities carried out in the mall/shops and their space requirements.

**Table 2. User activities and mall/shop space needs.**

| Activity | User | Facility | Nature | Space Needs |
|----------|------|----------|--------|-------------|
| Traveling, looking at exhibitions, looking for information, gathering, resting and sanitizing | A visitor | Mall, Plaza (public facilities) | Public and open | information room, show room, toilet, corridor, rest area |
| Storing goods, arranging goods, conducting buying and selling transactions, serving buyers | Traders, visitors | Retail/tenant (indoor/outdoor) | Semi public and easy to access | Display room, cashier, fitting room and warehouse |
| Using services, offering services | Visitors, traders | Retail tenant | Semi public and easily accessible | Tailor, Bank, Salon, Laundry, Fitness Center, ATM arcade |
| Worship, smoking | Visitors, traders | Mushola, smoking area | Public and easily accessible | Mushola, smoking area |
| Look around, buy tickets, watch, sanitation, sell food | A visitor | Food Court, cafe and restaurant (retail tenants) | Public and a little calm | Lobby counters, auditoriums, tickets, counters, projector halls, cafeterias |

### 3.2. Analysis and application of themes

Although new technologies are constantly being developed to complement the needs in creating green architecture, the general goal is that green buildings are designed to reduce the overall impact
of the built environment on human health and the natural environment. This mixed-use building refers to the efficiency of saving energy and building that integrates with nature. The Green Architecture indication that will be applied to the mixed-use building is an indicator of the Green Building Council Indonesia (GBCI) on building green buildings in Indonesia. Examining the area's very limited environmental land, with natural and natural concepts, combined with the concept of high technology, this building allows it to continue to survive in the long run because it does not damage the surrounding environment.

3.2.1. Efficient land use. It would be very difficult to find large tracts of land in the downtown area. Therefore, it is important to use land efficiently. Especially in the Pemuda Street and Pandu Street area which are dominated by shops and private offices. The planning for the construction of a mixed-use building on this land must be adjusted to the Medan regional government stipulations on urban spatial planning. Minimize scattered urban systems and reduce development of valuable areas, habitats and green open spaces, resulting from inefficient development. It is necessary to encourage the development and structuring of a more compact city, as well as an increase in the vitality of the city with the aim of maintaining green open space [11]. In the appropriate land use category, there are criteria for requirements, namely a green base area of at least 10% of the total land area. And from the site planning on this building and following the rules of the city RDTR field the total green base area to be used is 20%. The green base area is not only used in the landscape area but also includes. Green roof can also be used as a water catcher as a natural air conditioner process because sunlight is not absorbed by concrete directly. It also lowers heat during the day and cool at night for the surrounding environment. In addition, the green roof can be used as an area for socializing. According to the architect, the green roof which is on the roof of the building floor that is not too high has more points in aesthetics, because the green roof will be seen from the Pandu or Pemuda Street. Green roof can also be used as a water catcher as a natural air conditioner process because sunlight is not absorbed by concrete directly. It also lowers heat during the day and cool at night for the surrounding environment. In addition, the green roof can be used as an area for socializing. According to the architect, the green roof which is on the roof of the building floor that is not too high has more points in aesthetics, because the green roof will be seen from the Pandu Street or Pemuda Street. Green roof can also be used as a water catcher as a natural air conditioner process because sunlight is not absorbed by concrete directly. It also lowers heat during the day and cool at night for the surrounding environment. In addition, the green roof can be used as an area for socializing. According to the architect, the green roof which is on the roof of the building floor that is not too high has more points in aesthetics, because the green roof will be seen from the Pandu Street or Pemuda Street.

3.2.2. Energy efficiency. The presence of light is useful for making humans able to see using the eye as one of the five human senses and is an important factor in buildings that are partially functioned as workplaces. If the lighting is good then visitors can do various things in the building. Light that is used in buildings not only comes from natural light, ie the sun that passes through the skylight roof, but can also come from artificial light or lights that can use the use of very large electrical energy. However, if the maximum use of natural light is used it can save electricity consumption [12] it all becomes a point for visual comfort. Air flow temperature control over the air conditioning system coupled with a well designed building envelope will also help in improving the thermal quality of the building. Creating a high-performance luminous environment through careful
integration of electricity and daylight sources will improve the lighting quality and energy performance of the structure. Therefore we need an additional energy source to support large energy needs. One of them uses Solar Cell to save energy installed on the side of the building which is much exposed to sunlight. Zoning of lighting for the entire workspace associated with motion sensors in accordance with GBCI [1] requirements. Using maximum natural air at certain times so as to reduce the use of artificial energy in buildings. Using openings that can provide maximum light during the day at the building. For energy use in other parts of the building, such as using energy saving features on the elevator, using a motion sensor, or sleep mode on the escalator can also reduce energy consumption in buildings. Figure 1 show the use of solar panels as an additional energy producer.

![Figure 1. Use of solar panels as an additional energy producer](image)

3.2.3. Material efficiency. The purpose of this parameter aims to minimize the use of non-renewable building materials, and other sources such as energy engineering, efficient design, planning and construction as well as recycling of building materials. Maximizing the use of materials that have been used, with recycled content. This concept is applied primarily to building renovation activities [11]. More detailed material and resource aspects are: use of refrigerants, products processed in an environmentally friendly manner, materials that do not destroy the ozone layer (Non-Ozone Depleting Substance = ODS), certified wood, and prefabricated materials. Selected of building materials will be very affect the building operation process. As a building with a green building theme, the materials used tend to be environmentally friendly, such as ceramic floor coverings with rough motifs to reduce heat reflection from glass walls. The use of natural red brick in buildings is maintenance free and does not need to be painted as a complement to environmentally friendly designs. The use of glass material in several parts of the building. Its function is to save electricity usage for buildings, especially in terms of lighting from lamps. Aluminum curtain walls can be used as UV protection for the building itself. Of course, these can all have a positive impact on life force [1]. The natural red brick material and Cuartinn wall can see in figure 2 and 3.
3.2.4. **Water treatment efficiency.** The prerequisite in the category of water treatment is the presence of water meters in buildings. So in the design of this building put a water meter in the plumbing room. One important issue of water consumption in the downtown area of Medan City is the demand for needs beyond its ability to fill itself. As much as possible, facilities in this mixed use building must increase dependence on water that is collected, used, purified, and reused on site. Water protection and conservation throughout the life of a building can be achieved by designing double pipes that recycle water in the toilet. The point for alternative water sources is the existence of a greywater recycling system into landscaping water needs, which also includes a sewage treatment system. Toilet building water is processed first through sewage treatment or Sewage Treatment Plant (STP). Making a ditch to drain rainwater into the infiltration land. Conduct rainwater runoff management with infiltration systems to reduce the flow of water to the channel or recyclable space. Recycled water can also be used as flushing in the toilet.

3.2.5. **Efficiency of accessibility and circulation.** Circulation spaces form an inseparable part of every building organization and take up a large enough space in the building space. The width and height of a circulation room must be proportional to the type and amount of traffic it holds. Not only the circulation paths at the site, the achievement of the time obtained between the mixed-use building and the surrounding buildings determines the smooth circulation paths on the building. Open pedestrian access other than to the main road outside the site that connects it to secondary roads and/or other people’s land so that access to at least three public facilities is provided 300 distance of pedestrian achievement. This is also stated in one of the points GBCI. One of the applications is by making underground circulation paths. This is done considering the density of circulation on the Pandu Street and Pemuda Street, so it is not possible to make a connecting circulation path by cutting the density of circulation on the Pandu Street and Pemuda Street.

4. **Conclusions**

In the planning of mixed-use building construction using the emphasis or the theme Green Architecture where this concept uses the approach of minimizing adverse impacts on nature by paying attention to the efficiency of land use, energy efficiency, material or material efficiency, water treatment efficiency, the efficiency of accessibility and environmental circulation to improve environmental quality and humans to produce a healthy place to live because they make use of
energy sources and resources used in green architecture buildings. Recommendations from the results of the study are utilizing a water recycling system for flushing toilets and watering plants, the efficient use of materials such as solar panels as an alternative energy producer, and the use of natural materials in the form of rocks originating from nature aims to reduce the temperature in buildings.

References
[1] GBCI 2015 Green Building Council Indonesia, Jakarta.
[2] Tamiami H, Khaira F and Fachrudin A 2018 TALENTA-CEST 2017 IOP Publishing IOP Conf. Series: Materials Science and Engineering 309
[3] Haughton G and Hunter C 1994 Sustainable Cities (London, U.K.:Jessica Kingsley Publishers)
[4] Beddington N 1982 Design For Shopping Centres (London: Butterworth Scientific)
[5] Al Haryono Jusup 2002 Dasar Dasar Akuntansi Jilid 1 Edisi 5 (Yogyakarta: Bagian Penerbitan STIE YKPN)
[6] Priatman J 2002 “Energy-Efficient Architecture” Paradigma dan Manifestasi Arsitektur Hijau Dimensi 30 2
[7] Futurarch 2008 Paradigma Arsitektur Hijau
[8] Jo Gause 1998 Office Development Hand Book (America: ULI-the Urban Land Institute)
[9] Suharso 2003 Kamus Besar Bahasa Indonesia (Jakarta: PT. Gramedia Utama)
[10] Lawson F and Bond-Bovy M 1977 Tourism and Recreational Development, Londyn.
[11] Syarif H M 2009 Konsep Penerapan Green Building di Jakarta. Biro Kependudukan dan Lingkungan Hidup DKI Jakarta. Laporan Akhir Proyek.United States Green Building Council (USBGC, 2009).
[12] Frick H and Suskiyatno F B 2011 Dasar-dasar arsitektur ekologis : Konsep pembangunan dan ramah lingkungan Semarang: Penerbit Kanisius. Leadership in Energy and Environmental Design.
[13] CNCB Indonesia [Online] Retrieved from: cnbcindonesia.com
[14] Alibaba [Online] Retrieved from: alibaba.com