Multi Land Use Approach towards Sustainable Baghdad City: Bab Al-Muatham Garage as a Case Study

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Abstract. Baghdad city suffers from random urbanized expansion and highly congested roads. The city environment has been badly affected by its air pollution and low green coverage. Through this paper, a Multi Land Use (MLU) approach is presented to provide areas for commercial and domestic purposes without needing to consume more green coverage of the city and also transform the neighbour land use to one place and change them to green areas. According to the results of this research, it was found that the bus terminals is the best choice for MLU and there are many places in Baghdad available to be MLU. Towards this, satellite images and CAD software have been used to find these terminal places and areas saving possibility. This is done by transforming neighbour land uses to be MLU in one place. These terminals were classified according to their areas into small (less than 10,000 m²), medium (between 10,000 to 40,000 m²) and big (more than 40,000 m²). For terminals of small and medium areas, shopping centres and hotels can be constructed over them, while for the big terminals, student accommodations and flats for domestic purposes can also be built over these terminals, in addition to shopping centres and hotels. As a case study for this research, the Bab Al-Muatham bus terminal was illustrated. The results showed that this bus terminal can be changed to be MLU and can save an area of more than 50,000 m² through transforming the surrounding land uses to be MLU and change the transformed lands to be green areas.

1. KEYWORDS: congestion, multi land use, public transportation, sustainability.

2. INTRODUCTION
Baghdad is the capital of Iraq and one of the oldest cities since more than one thousand years ago (Alobaydi and Mahhub, 2015); (Saleh, 2010). Baghdad’s climate is subtropical, extremely hot summers.
and cold winters (Ali et al., 2017). It comes after Tehran as the second largest city in the west part of Asia, and after Cairo as the biggest Arabic city. It has a very bright past as a capital of the world during Islamic caliphate (Bosker et al., 2008). Currently, and according to cities classification, Baghdad lies at end of the list to live in due to its congestion and pollution with a number of population, more than seven millions people in an area equal to nearly 734 Km2 (Population, 2013).

The absence of improvement plans, the accumulation of decades of wars and corruption lead to increase the problems of the city such as traffic congestion, pollution and random expansion of urbanisation. Saleh (2010) focused on urbanization phenomenon in Baghdad city and found that build-up areas have increased about five times during the last 40-year period. All these problems have adversely affected the city environment and as a result, Baghdad city has lost a lot of its vegetation areas (Saleh, 2010); (Hussain, 2018). The weather temperature reached more than 50 ⁰C during summer with high frequency of sand storms. This research is a trial to propose a solution that can help in improving the city conditions using the MLU approach.

According to literatures the bus terminals is the best choice for MLU. The using of these terminals to be MLU will encourage the people to use public transport rather than the private transport, which means less vehicles in the roads network that can reflect positively in decreasing the congestion, related travel time and pollution, as well as helping the city to be sustainable. Moreover, the profits come from these investments can be used to improve the public transport of the city.

Through this study, Baghdad has been surveyed to find places that can be modified to MLU without affecting the original use of these places. New satellite images, site investigation and CAD software have been used to determine the suitable places for this purpose. These places must have an access to public transport and should be close to attracted zones to decrease using the passenger cars and encourage the public transport. According to these requirements, it has found that the current public bus terminals are suitable to be MLU by constructing a multi-storey building over them without changing their original use (Cervero and Murakami, 2009). Accordingly, these multi-storey buildings can gather the adjacent land-use in them vertically rather than being horizontally spread. This change can save many areas to regenerate new green zones. In addition, these multi-story buildings must be smart enough and sustainable to serve their users smoothly with minimum interruptions.

3. IMPORTANCE OF THE STUDY

This paper is devoted to find a solution that can help Baghdad city to be sustainable. In Baghdad, the population growth was reported throughout the last 60 years. It has been noticed that the percent of Baghdad’s population compared to the total Iraqi cities was increased from 10% in 1947 to about 25% in 2010. In addition, the population density in Baghdad is about 5233 person/km2, while it is between 6-190 person/km2 in other Iraqi cities (Saleh, 2010). Due to this high population, random expansion of urbanization with the absence of expanding plans. Baghdad city had lost substantial areas of its green zones (Hussain, 2018). This had a negative effect on the city that resulted in highly congested roads and air pollution (Hashim and Sultan, 2010); (Al-Akkam, 2012). The study of Cervero et al., (2009) revealed that there is an effective relation between public transport and urban development in many countries such as Hong Kong, and they highly recommended the use of MLU approach.

This study tries to integrate the investment of public transport and the urban development, and introduce a solution for sustainable Baghdad city by saving areas to regenerate green areas, and decrease the random urbanization using the vertical expansion instead of the current horizontal expansion. Moreover, the MLU approach decreases the traffic congestion through encouraging the public transport rather than the private transport via make the proposed MLU places very close to public transport terminals.
4. BAGHDAD GEOGRAPHIC INFORMATION
Baghdad is the capital of Iraq. The geographical coordinates of the city are 33.312805 latitude and 44.361488 longitude, with an area of more than 700 km² (Population, 2013); (Hashim and Sultan, 2010). Its mean elevation is 39m above the mean sea level. The Tigris River divides the city into two parts (Saleh, 2010); (Hashim and Sultan, 2010): Al Rusafa (east of Tigris) and Al Karkh (west of Tigris) as shown in Figure (1).

The classification of land cover in Baghdad city is shown in Figure 2. It shows that the green area is only limited to the North West, South and South East of the city, while the built-up area is concentrated in the centre of the city (Ali et al., 2017).

![Figure 1: Al-Rusafa and Al-Karkh in Baghdad City, Bing map (2019).](image-url)
The percentages of classified areas in Baghdad city is shown in Table 1. It includes built-up area, vegetation, soil and water as percentages from the total area. The built-up area has the biggest percentage; which is nearly twice of the vegetation and soil areas. This means there is a need to increase the green areas that plays a significant role in the reduction of air pollution (Gheorghe and Barbu, 2011); (Al-Jawadi and Al-Bayati, 2014).

Table 1: Percentages of Classified Areas in Baghdad (Ali et al., 2017)

| Classified Area | Percentage |
|-----------------|------------|
| Built-up        | 43.62%     |
| Vegetation      | 28.15%     |
| Soil            | 25.30%     |
| Water           | 2.93%      |

5. The places suitability for MLU requirements
Integrating the investments of public transport and urban development is a successful approach which has been proved in many countries such as Hong Kong (Cervero and Murakami, 2009). Many bus terminals for public transportation are found in Baghdad city, these include Bab Al-Muatham, Bab Al-Sharqi, Al-Khilani, Al-Tairan, Al-Alawi, Al-Nahda, Baghdad Al-Jadida, Tessah Nissan, Al-Amana, Al-Midan, Al-Bayaa, Al-Sadder, Al-Shulla and Al-Jihad (Hashim and Sultan, 2010). Although there is a large number of bus terminals used for transportation, private cars have increased quickly in Baghdad city through the last years. Such increase is the main reason of various environmental problems (Linda,
2003), such as emissions of toxic vapours, traffic noise and vibration. This study encourages using the public transportation facility instead of the private facility to decrease the mentioned negative effect through using the MLU approach and changing the horizontally urban expanding to vertically expanding. The areas of public transportation (bus terminals) of Baghdad city are classified into three sizes, small (up to 10,000 m²), medium (10,000 – 40,000 m²), and big (more than 40,000 m²), as shown in Table 2. The bus terminal of Bab Al-Muatham has been chosen as a case study for this research to illustrate the influence of using the MLU approach in gathering the different land uses in one place. The use of this approach will help to evacuate the adjacent areas in order to change them to be green zones that lead to increase the green lands in Baghdad city.

Table 2: Areas of Public Transportation (bus terminals) in Baghdad City

| Terminal’s Name         | Area Rounded to Nearest 500m (m²) |
|-------------------------|-----------------------------------|
| Small                   |                                   |
| Less than 10,000 m²     |                                   |
| Al-Hurra                | 4,000                             |
| Baghdad Al-Jadda        | 5,500                             |
| Bab Al-Sharqi           | 7,800                             |
| Al-Tairan               | 9,500                             |
| Medium                  |                                   |
| 10000 – 40000 m²        |                                   |
| Al-Midan                | 11,000                            |
| Al-Jihad                | 11,500                            |
| Al-Khilani              | 17,000                            |
| Al-Shulla               | 18,500                            |
| Al-Kadhimiya 1          | 19,000                            |
| Al-Amana                | 20,000                            |
| Al-Sadder               | 20,000                            |
| Al-Kadhimiya 2          | 23,500                            |
| 9 Nissan                | 35,000                            |
| Al-Bayaa                | 35,000                            |
| Big                     |                                   |
| More than 40,000 m²     |                                   |
| Bab Al-Muatham          | 59,000                            |
| Al-Nahda                | 70,000                            |
| Al-Alawi                | 82,000                            |

6. Public Transport VS Private Transport
The private car is more convenient to its user than public transport but it consumes higher energy (fuel) per person (KII and Hanaoka, 2003), while the public transport facility decreases the environment pollution (Newman and Jeffrey, 1999); (Hayashi and Roy, 2013); (Burton et al., 2003), but consumes higher costs for investment and management. All mentioned advantages and disadvantages do not take into account the population size and density. The higher population density causes traffic congestion and inconvenience for private car users and this may cause an increase in the demand for public transport.
7. Case Study
Bab Al-Muatham is one of the oldest district in Baghdad. It lies in Al-Rasafa, east part of Baghdad. The most land uses of this region are educational institutes, while the rest are industrial and commercial uses. Bab Al-Muatham is served by a big bus terminal (shown in figure 3) located in the centre of this region with an area equals to about 60,000 m2 that estimated using satellite image and CAD software.

Figure 3: Bab Al-Muatham Garage

As a destination for a huge number of students, Bab Al-Muatham is a very congested region with a limited green coverage. This means a high percentage of pollution and urbanization. According to the literature presented in this study such as (Al-Akkam, 2012); (Cervero and Murakami, 2009), this region can be improved to be more sustainable using the MLU approach. The bus terminal can be developed to be MLU by constructing a multi-storey building over it to contain some of the neighbourhoods and shifting the existing uses of these neighbour to green zones. Figure 4 shows the possibility of transformation of these neighbours to be over the bus terminal, which saves an area of more than 50,000 m2 that can be changed to be a green area. In addition to transforming neighbour lands and generating green zones, the new building can also be used for domestic purpose by dedicating some floors to be flats and hotels in addition to the students’ accommodation. All these uses and more, increase the profits come from this MLU approach; which can be used to improve the public transport. The presence of people very close to the bus terminal can certainly encourages them to use the public transport rather than the private transport (Keijer and Rietveld, 2000). This means a decrease in the number of vehicles that use the roads network i.e. decrease the road congestion, related pollution and travel time. Moreover, the building itself can be constructed based on sustainable aspect with little energy consumption through using the renewable energy and green roof and walls. The management of land using a multi-uses building is a common idea that balances the need of increasing land use with the limited available land area (Li and Yeh, 2002). Figure 5 shows the main achievements of using the MLU approach that satisfy the sustainability requirements.
Figure 4: Bab Al-Muatham Garage and It’s Surrounded Area (Bing map, 2019)
Figure 5: The Main Achievements of proposed MLU that satisfying the sustainability.

8. Discussion
Baghdad has been noticed as a highly growth and changes during the last years (Alobaydi and Mahbub, 2015); (Hussain, 2018). It suffers from highly traffic congestion and environmental pollution, especially in the centre of the city as presented in different studies (Al-Akkam, 2012); (Chaichan et al., 2018); (Al-Jabbar et al., 2011); (Sarsam, 2013). Accordingly, the methodology presented in this research is innovative to solve one of the city’s problem to be more sustainable city. The using of multi-land use on the bus terminals offers saving in land area dedicated for urbanization to provide much green zones and to decrease the use of private transport facility as well. These projects will provide an additional area for urban development without the need to shift existing land use areas. In addition, it will encourage improving the infrastructure of the public transport through using the profit came from the developed projects. Encourage the use of public transport rather than the private transport will decrease the traffic congestion and air pollution of the city that help the city to be more sustainable. Moreover, these projects will generate more job opportunities for people.

9. Conclusion
The following conclusion may be drawn:
1. There are many places in Baghdad can be modified to be MLU.
2. MLU means saving a lot of lands to reshape the city’s master plan toward sustainability.
3. Places chosen for MLU will have a significant importance due to:
a- Adding a substantial amount of urban developed area without the need to use more existing green places in the city.
b- Reducing the current horizontally expanded urbanization.
c- Transforming the neighbour markets and residential land areas into a green area to improve the city environment through decreasing the pollution resulted from very dense urban developed area.
d- Encouraging the people to use the public transport rather than the private transport.

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