Does ICT make city compactness higher? Evidences from compact city attributes in Yogyakarta City’s districts.

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Abstract. From discourse to implementation compact urban development has grown rapidly in nearly two decades. In the era of information communication technology use and popularity of smart city concept, inevitably compact city has entered a new phase: Compact City Version 2.0. In Indonesia, the smart city concept is also flourishing in some cities, even though they are still in early stages of exploring some appropriate strategies. This study aims to look at the effect of the use of ICT in the Yogyakarta City’s districts, proven in previous research to be categorized as districts with high compactness, especially on the attributes of density of population, concentration of activities and social welfare. This research continuously examines how far the influence of ICT is able to give effects on making urban compactness higher. Three districts in the city of Yogyakarta generally with high to very high-density score of compactness were taken as objects of this research. Furthermore, the compact city attributes and its indicators were explored in more detail associated with the use of additional criteria, the ICT usage. The result informs that ICT was able to improve performance for a better compactness. Some of the attributes that were previously weak, such as local public transport services and range of public services were capable of being upgraded by the use of ICT. Meanwhile, attributes that had good performance previously also became stronger. This suggests that ICT with various applications that are appropriate for the life of the urban residents significantly help the performance of the city to be more compact. Welcome to the Compact City Version 2.0!

Keywords: compact city attributes, urban compactness, high-density district, information and communication technology, Yogyakarta City

1. Introduction
Although it has been initiated more than three decades ago, sustainability still faces major challenges, especially its realization in the urban level. Cities in developing countries, for instance, still face various fundamental problems. This issue is quite difficult in terms of where the initiation of sustainable cities supposed to start. Nonetheless, discussions related to compact city as one of opportunities toward sustainable cities are responded positively by the cities in developing countries. They are optimistic that some of key attributes either academically or practically in the compact city have already existed naturally in their cities, including, those with high population density or various activities concentrated in their area.
In the few existing studies, population density and concentrated activities indeed have been one of the advantages of cities in developing countries to accelerate the realization of a compact city. There are also indications that support the use of technology, especially information and communication technologies that may also push the speed of realization in a city to be more compact. This indication recently tends to be more intensified with the increasing proliferation of concept and implementation strategies related to smart city, where ICT becomes one of the backbones of its manifestations.

In this case, ICT has provided a new picture that compactness has been determined by not only the physical performance, but also the city's performance in using resource (technology) in their city management. This research aims to provide a preliminary picture related to this new paradigm. Index of compactness today should not depend only on the input of physical city, but the most important thing is outputs or achievements. One of them may be through ICT usage.

1.1. Compact City as Sustainable City: Smart Requirement
Sustainable city is possible not through a formal or normative process, but on capacity and uniqueness of each city. Using various strategies to achieve sustainable performance of the city, any city is able to adjust this purpose based on its own potential and capacity.

The question is whether a sustainable city must have a compact urban performance, or automatically compact. In this case the degree of compactness is also believed as a representation to illustrate an achievement of sustainability. From other perspective, compactness is a requirement prior to becoming a sustainable city. Scenarios built by Jenks et al. [1] illustrated that a sustainable city is a city that has a certain level of degree of compactness, because it concerns with some essential consideration of urban space, like balance, efficiency, and effectiveness.

Thus, as shown in Figure 1, the compact sustainable city can be achieved through a variety of strategies, such as smartness, health, resiliency, green, creativity, inclusivity, and so forth. This paper is set to concentrate on achieving a compact city by smartness strategy, through the use of ICT.
1.2. Transformation of Compact City
As revealed by Dantzig and Saaty [2], first compact city is solely determined by form or morphology of the city. For the next development, compact city is more associated with set of indicators directly related to the urban form, physical performance of the city. At this stage, these indicators have been linked to the assurance of sustainability achievement. While at recent time, in the third stage, many indicators have undergone more various and complex processes. They are not only associated with sustainability itself, but also unique or special aspects owned or being developed in the city.

![Diagram showing the transformation of compact city](image)

**Figure 2.** Trend of compactness indicators

As shown in an illustration in Figure 2, the development of compact city concept should not be separated from the history of urban development and the influence of existing industries, ranging from use of machinery to electronics. Today the world has entered the final stage of the third stage of industries, namely use of computer technology and cyber physical era. Thus, the compact city also needs to be approached through the indicators, which are more sensitive in the realization of compact city in the era of ICT.

2. Methods

2.1. Urban Compactness Index in Yogyakarta City (2015)
This study used urban compactness index (UCI) measurement in 14 districts of Yogyakarta City in 2015. Yogyakarta (see Figure 3) is an important medium city in Indonesia, located in the middle of Java Island with about 480 thousands inhabitant. The variables consist of 5 variables: densification of the population, concentration of activity, intensification of public transport, size and access to the city, and socio-economic welfare respectively [3]. These variables were developed through several related indicators as shown in Table. Generally, the UCI of Yogyakarta City and other cities in Indonesia have strong results in densification of the population, concentration of activities, and socio-economic welfare.
Based on the analysis as shown in Table 1, Gondomanan has the highest index of urban compactness (79.63) and Kotagede has the lowest (54.04). This showed that population density, mobility, and activities in each district have become key achievements of UCI in Yogyakarta City. Furthermore, urban compactness index was grouped into three ranks of UCI (high, medium and low). From each rank, a district took as representative of the rank, and these three districts were used as a case study. They were Gondomanan District as representation of high rank, Gondokusuman District as representation of medium rank, and Kotagede District as representation of low rank of UCI.

Table 1. Urban Compactness Index (UCI) of Yogyakarta City  
(Source: Roychansyah, 2015)

| No | Districts | Popdens | Actons | Pubtrans | Citysize | Sosecwel | UCI | Class of |
|----|-----------|---------|--------|----------|----------|----------|-----|---------|
| 1  | Kotagede  | 81.97   | 43.91  | 48.91    | 14.81    | 80.62    | 54.04|         |
| 2  | Ngampilan | 88.33   | 29.85  | 54.17    | 27.78    | 79.39    | 55.9 |         |
2.2. Development of ICT Related Indicators in Compact City

Principally, the new set of indicators was added as set indicators of smart city considered to be suitable to strengthen the condition of compactness, from the view point of ICT usage. Each attribute was elaborated with several ICT related indicators as presented in Table 2. Some of indicators were developed from smart city studies pioneered by Giffinger, et al. [4] when he measured rank of European medium city size for their smart city performance.

Table 2. Development of ICT Related Indicators

| No. | Attributes of Compactness | ICT Related Indicators |
|-----|---------------------------|------------------------|
| 1   | Population densification  | Rate of HP user in the area/total population |
|     |                           | Rate of mobile internet user/total population |
| 2   | Activity concentration    | Rate of creative industry or IT related/total industry |
|     |                           | Rate of online shop located in the |
| 3   | Public transport intensification | Rate of resident using internet based transport service/total population |
|     |                           | Rate of resident using GPS or geo-location |
| 4   | City size and access consideration | Number of telecommunication antenna in the area |
|     |                           | Number of hotspot or wi-fi |
| 5   | Social economic welfare target | Rate of elderly who use gadget/total population |
|     |                           | Rate of facilities where serve online or phone/total population |
|     |                           | Rate of communication budget in |

3. Result and Discussion

The calculations depicted the three districts as representation of various class of UCI that were measured, namely Gondomanan, Gondokusuman, and Kotagede. All showed improved performance of UCI when indicators related to the use of ICT were added. Even in some weak attributes, such as public transportation intensification and size and access consideration, the indicators related to the ICT use were very helpful in improving the performance of district compactness. More results of these calculations are shown in Figure 4.
This result also showed that ICT as well as new media strategy in triggering and accelerating development of the regions seem to be very promising. For example, Kotagede District located on suburban of Yogyakarta City looks was helped by the use of ICT in improving non-personal transport services. Innovations in car taxi and motorcycle taxi service that use user-friendly applications to support ICT sector attract the public.

Participations of public or community and private sectors in increasing provision of hotspots or access points in urban areas also became key factor to reach higher UCI. This phenomenon can be seen from the size and access in the urban area, from low to high level when ICT related indicators were taken into account. Currently, the availability of access points has become requirement from the markets when investors attempt to open new business and if they want to smoothly continue to gain public favour, especially from the younger generation.

4. Conclusion
This study confirmed compact city position and achievement of sustainable development in the city. This study emphasized that the compact city was a representation of sustainable cities that can be approached from the unique aspects of cities or the themes that had become trends in the worldwide today. A smart city strategy is an example that may be one way to achieve a better compact city in the future, through the intensification of existing use of ICT (information and communication technology).

This study also indicated the needs for new approach in viewing the compact city. Complex resources of city formed the compact city as a product and its process required a more comprehensive approach, including the application of ICT in the city. This study also proved that the elaboration of ICT indicators in the new set of indicators in measuring the urban compactness index had produced better results. This has obviously been due to the current position of ICT as a key role that receives a lot of attention as a priority in the urban development. This study, however, still requires a lot of development, especially to see the important findings of negative impacts regarding the use of ICT, its media and data, as well as its target for urban efficiency and effectiveness.

5. References
[1] Burton E, Jenks M and Williams K 2003 The compact city: a sustainable urban form?
[2] Dantzig G B and Saaty T L 1973 Compact city: a plan for a liveable urban environment (WH Freeman San Francisco, CA)

[3] Roychansyah M S, Ishizaka K and Omi T 2005 Considerations of Regional Characteristics for Delivering City Compactness J. Asian Archit. Build. Eng. 4 339–46

[4] Giffinger R, Fertner C, Kramar H, Meijers E and others 2007 City-ranking of European medium-sized cities Cent. Reg. Sci. Vienna UT 1–12