East Java Maritime Connectivity and Its Regional Development Support

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Abstract. The study presents an evolution of maritime connectivity index of East Java which is associated with accessibility and mobility index of regions in East Java. The findings show that East Java increased connectivity more than three times from 1996 to 2011. Initially, the East Java is importer but then become exporter to national territory. For accessibility, the inland regions of East Java in general is higher than the coastal areas. And for mobility, inland regions initially have a small index, but in subsequent years its index is greater than the coastal areas.

1. Introduction
A region in need of other regions to develop [1]. Interaction between the regions will result in specialization, economic growth, efficiency, and lead to the development of the region. Christaller stated in [2] that there are three elements in the development of the region, namely the central nodal, sphere of influence, and transportation networks. The transportation network serves to connect or meet dependency between the central and the area surrounding them. This interaction may be the movement of people, goods and factors of production one region to another. Road infrastructure is important in regional development because it is considered to be a key prerequisite of social and economic development [3].

Seaport is one link of the transport process from the point of origin to point of destination for movement of goods, people, or other production factors [4]. Economic theory considers the port as an important factor in economic development. As evidence, many large cities in the world which is a port city [5]. Marine transportation led to the expansion of the market involving various sectors of the economy, including the extractive sector of natural materials (primary), manufacturing (secondary), and trade (tertiary). Seaports can be categorized as a mouthpiece of economic development due to its nature as a catalyst and driving the development of other economic sectors. The ports support economic development by enhancing competition through market expansion [6], so as to stabilize prices for consumers. More broadly, the port is the point of the central node relationships on a support area (hinterland) and liaison with the remaining areas. By doing so, it can be called a maritime connectivity (connectivity territory by sea) is one indicator of economic growth in the region.

East Java is the province with the highest number of main port (pelabuhan utama) in Indonesia, and its port production is the third in Indonesia ports production. East Java’s role in the national maritime connectivity is quite important. To maintain or even to increase its role, good regional development in East Java province is needed. For this research, regional development will be associated with the road infrastructure. So, this paper will reveal how the accessibility and mobility index both in the coastal and inland areas are related with the maritime connectivity index. The districts/city in East Java province are:
The paper will answer the questions below:
1. How much change the maritime connectivity index of East Java Province?
2. How is the growth of accessibility and mobility index in the coastal areas without ports, the coastal areas with port, and in the inland areas in East Java province?

2. Methods and Data
Analysis is divided into two scopes as summarized in the table below

| No | Question on                                      | Method                        | Data                                                                 |
|----|--------------------------------------------------|-------------------------------|----------------------------------------------------------------------|
| 1  | Maritime connectivity of East Java province      | Analysis of maritime connectivity index | - Origin-Destination of goods between provinces, 1996 (Ministry of Transportation, 1998)  
|    |                                                  |                               | - Origin-Destination of good between seaports 2011 (Ministry of Transportation, 2013) |
|    |                                                  |                               | - Distance between provinces.                                         |
| 2  | Regional Accessibility and mobility in East Java province | Region of East Java province is divided into 3 areas/ | -Length of roads for each class category of kabupaten (regency)/ city, 2010 and 2014 (East Java in Number ((Jawa Timur dalam Angka), 2016) |
- Analysis-1

Analysis of Connectivity Index is an analysis that calculates the number of links between the various points (nodes) divided by the number of nodes that can reflect the connectivity of the region. This analysis is useful to know how good the transportation network connecting points of origin and destination [7]. Link is a relationship between 2 nodes, while the node is a point that can be either terminal, ports, airports, stations, cities, and so on. Here is the formula connectivity index [8]:

$$CI = \sum_{j}^{n} c_{ij}$$  \hspace{1cm} (1)

Note: CI = Connectivity Index; c_{ij} = Presence link = 0 or 1; n = number of nodes

In this study, link is coupled the number of movement of goods between the two nodes, and the distance between nodes is given by a bird's eye distance, so that the formula in maritime connectivity index is as follows:

$$CI_{k} = \frac{\sum_{i=1}^{n}(a \times q_{kn})}{\sum_{i=1}^{n}(a \times d_{kn})n}$$  \hspace{1cm} (2)

Modified from Oxera, 2015

Note:
- CI_{k} = Connectivity Index node-k
- a = 0 or 1 (depends on the existence of link/);
- q_{kn} = The movement of goods from node k to node n (Ton);
- d_{kn} = distance from node k to node n (Km);
- n = number of nodes

Additional information: Analysis of connectivity index requires data connectivity matrix (link) between nodes; matrix of goods movements between nodes; matrix of distance between nodes; and the number of nodes in the region. Calculations using Microsoft Excel. The index does not have a notation.

- Analysis-2

Accessibility Index Analysis is an analysis by calculating the length of a divided by road-square kilometre area. Analysis of accessibility index indicates the size of the ease of an area to be accessed [9]. This index represents the number of available road network system in the region. In addition, there are other variables to determine the level of accessibility of a region that is the number of means of transport, road capacity, and quality of roads [10].

In this study, the accessibility index is approached by weighting for each class of road. For the National Road (11 m) = 1.1; Provincial Roads (9.5 m) = 0.95; District/ City Roads District / City (7.5 m) = 0.75; and Rural Roads (Jalan Desa) / Local (6.5 m) = 0.65. Weighting is based on a minimum
width of the road on the technical requirements of the Government Regulation No. 36 of 2006 on the road. Calculations using Microsoft Excel. The index does not have a notation. Here is the formula to calculate the accessibility index districts / cities in East Java province:

$$\text{Accessibity}_{it} = \frac{(1.1) L_{it} \text{ Nas} + (0.95)L_{it} \text{ Prov} + (0.75)L_{it} \text{ Kab Kota} + (0.65) L_{it} \text{ Desa/Lokal}}{A_{it}}$$

(3)

Modified from Miro, 2010

Note:

- $\text{Accessibity}_{it}$ = Accessibility Index on District/City in year $t$
- $L_{it}$ = Length of National Class Road on District/City $i$ in year $t$ (Km)
- $A_{it}$ = Area on District/City $i$ in year $t$ ($\text{Km}^2$)

Analysis Mobility Index is an analysis to assess a person’s ability to move in the region [11]. Mobility can be determined by dividing the length of the road with a total population of the region. The index does not have a notation. Formula to determine the mobility index is as follows:

$$\text{Mobility}_{it} = \frac{(1.1)L_{it}\text{ Nas} + (0.95)L_{it}\text{ Prov} + (0.75)L_{it}\text{ Kab Kota} + (0.65)L_{it}\text{ Desa/Lokal}}{N_{it}}$$

(4)

Modified from Syahban, 2005

Note:

- $\text{Mobility}_{it}$ = Mobility Index on District/City in year $t$
- $L_{it}$ = Length of National Class Road on District/City $i$ in year $t$ (Km)
- $N_{it}$ = Population on District/City $i$ in year $t$

3. Result and Discussion

3.1. Maritime Connectivity of East Java Province

Maritime connectivity of East Java province is represented by maritime freight movement and connectedness of the link between the East Java province with other provinces. Here is the data maritime movement of goods of East Java province in 1996 and 2011:

| PROVINCE      | 1996 Import | 1996 Export | 1996 Total | 2011 Import | 2011 Export | 2011 Total | 96-11  |
|---------------|-------------|-------------|------------|-------------|-------------|------------|--------|
| ACEH          | 0           | 0           | 0          | 26378       | 48920       | 75298      | +      |
| NORTH SUMATERA| 0           | 0           | 0          | 363764      | 910400      | 1274164    | +      |
| WEST SUMATERA | 403995      | 403995      | 808000    | 12570       | 148666      | 314364     | -      |
| RIAU          | 9716        | 23          | 9739       | 11952141    | 16267       | 11968408   | +      |
| JAMBI         | 11952141    | 16267       | 11968408   | 12860       | 20005       | 32865      | +      |

Table 2. Maritime movement of goods of East Java Province with other provinces, 1996 and 2011.
### Table 3. Accessibility and Mobility of District/City in East Java Province

| City/District   | Accessibility Index | Mobility Index | 2010-2014 | 2010-2014 |
|-----------------|---------------------|----------------|-----------|-----------|
|                 | 2010    | 2014    | 2010-2014 | 2010-2014 |
| Ngawi           | 0.345   | 0.345   | +         | 0.000587  | 0.000580  | -         |
| Bojonegoro      | 0.613   | 0.678   | +         | 0.001174  | 0.001275  | +         |
| Mojokerto       | 0.621   | 0.757   | +         | 0.000590  | 0.000689  | +         |
| Jombang         | 0.724   | 0.870   | +         | 0.000671  | 0.000785  | +         |
| Nganjuk         | 1.095   | 1.094   | =         | 0.001382  | 0.001354  | -         |

3.2. Accessibility and Mobility of District/City in East Java Province

Table 3. Accessibility and Mobility of District/City in East Java Province
| City/District | Accessibility Index | Mobility Index |
|---------------|---------------------|----------------|
|               | 2010 | 2014 | 2010-2014 | 2010 | 2014 | 2010-2014 |
| Ponorogo      | 0.880 | 1.115 | +          | 0.001455 | 0.001821 | +          |
| Kediri        | 1.082 | 1.196 | +          | 0.001098 | 0.001183 | +          |
| Batu City     | 1.595 | 1.5947 | =         | 0.001694 | 0.001622 | -          |
| Magetan       | 1.747 | 1.7467 | =         | 0.001988 | 0.001968 | -          |
| Madiun        | 1.862 | 1.8617 | =         | 0.003146 | 0.003091 | -          |
| Bondowoso     | 0.801 | 2.808 | +          | 0.001708 | 0.005828 | +          |
| Kediri City   | 3.503 | 3.530 | +          | 0.000900 | 0.000876 | -          |
| Mojokerto City| 4.588 | 4.9558 | +         | 0.000763 | 0.000795 | +          |
| Malang City   | 7.341 | 7.480 | +          | 0.000985 | 0.000973 | -          |
| Madiun City   | 7.395 | 8.9257 | +         | 0.001471 | 0.001740 | +          |
| Blitar City   | 20.893 | 20.8932 | =        | 0.005225 | 0.004988 | -          |
| 1. Inland Region |     |        |          |          |          |          |
| (Total)       | 3,443 | 3,741 | +         | 0.001552 | 0.001848 | +          |
| Lumajang      | 0.490 | 0.490 | =         | 0.000879 | 0.000862 | -          |
| Jember        | 0.095 | 0.565 | +         | 0.001316 | 0.000783 | +          |
| Blitar        | 0.212 | 0.560 | +         | 0.000334 | 0.000916 | +          |
| Trenggalek   | 0.617 | 0.617 | =         | 0.001139 | 0.001119 | -          |
| Pacitan       | 0.808 | 0.808 | =         | 0.002121 | 0.002088 | -          |
| Situbondo     | 0.891 | 0.894 | +         | 0.002272 | 0.002216 | -          |
| Sidoarjo      | 1.063 | 1.109 | +         | 0.00394 | 0.00383 | -          |
| Tulungagung   | 1.274 | 1.274 | =         | 0.001481 | 0.001443 | -          |
| Pasuruan      | 1.192 | 1.633 | +         | 0.001171 | 0.001547 | +          |
| 2-1 Coastal Area |     |        |          |          |          |          |
| Non-Port      | 0.738 | 0.887 | +         | 0.001103 | 0.001262 | +          |
| Banyuwangi    | 0.102 | 0.102 | =         | 0.000236 | 0.000232 | -          |
| Lamongan      | 0.211 | 0.274 | +         | 0.000315 | 0.000406 | +          |
| Tuban         | 0.489 | 0.489 | =         | 0.000865 | 0.000844 | -          |
| Bangkalan     | 0.474 | 0.519 | +         | 0.000681 | 0.000716 | +          |
| Gresik        | 0.159 | 0.533 | +         | 0.000167 | 0.000531 | +          |
| Sumenep       | 0.600 | 0.604 | +         | 0.001200 | 0.00118 | -          |
| Sampang       | 0.630 | 0.633 | +         | 0.000886 | 0.000844 | -          |
| Probolinggo   | 0.309 | 0.777 | +         | 0.000482 | 0.001171 | +          |
| Pamekasan     | 0.569 | 0.818 | +         | 0.000570 | 0.000779 | +          |
| Malang        | 1.703 | 1.703 | +         | 0.002406 | 0.002329 | -          |
| Pasuruan City | 2.100 | 2.100 | =         | 0.000428 | 0.000413 | -          |
| Probolinggo City | 3.060 | 3.084 | +         | 0.000887 | 0.000734 | -          |
| Surabaya City | 3.097 | 6.759 | +         | 0.005391 | 0.00079 | -          |
| 2-2 Coastal Area with Port | 1.039 | 1.415 | +         | 0.001117 | 0.000844 | -          |
| 2. Coastal Area Total | 0.916 | 1.199 | +         | 0.001111 | 0.001015 | -          |
The growth of maritime connectivity index reflects the increase of seaport performance to distribute the freight from internal area to the external one and vice-versa. Ideally the increase of external connectivity should be supported by internal province accessibility and mobility to balance the freight movement. Therefore, it is important to measure the road availability using index of accessibility and index of mobility in internal province area. To know better internal condition of East Java province in term of those two indexes, the province region divided into coastal area and inland area. The coastal area provide the location of seaport. Accordingly, to support export and import activities through seaport, this area should have good accessibility and mobility indexes.

In 1996, the index of maritime connectivity of East Java province to the other provinces in Indonesia is 17.95, while in 2011 significantly increase to 65.34. It means, there are 364 percent growth of sea transport between East Java to other provinces. In line with the fact that the East Java province during those periods was getting connected with other provinces in Indonesia, the total number in tonnage of export-import activities via its seaports increases from 7,014,701 to 115,172,727 or more than 15 times. So, the interdependency of East Java province in maritime connectivity was increase.

From the internal province view from 2010 to 2014, accessibility index is increased in all areas. Accessibility index in inland areas increases (from 3,443 to 3,741) more than in coastal area non-port (from 0.738 to 0.887) and also in coastal area with port (1,039 to 1,415). It indicates that during 2010-2014 there were the construction of new roads in all areas with different total length of the road per area. In term of mobility index, it grows differently. Mobility index in inland area increases from 0,001552 to 0.001848, in coastal area non-port increases from 0.001103 to 0.001262, and in coastal area with port decreases from 0.0011117 to 0.000844. It indicates that the ratio between population growth and new road constructed in coastal area with port is higher comparing with other areas. So, it can be said that the movement of traffic in coastal area with port experienced more disruption caused by the movement of its population comparing to other areas. Therefore, movement to the port to be less supported in the coastal area with port and also in the coastal area in general. In other word, the increase of maritime connectivity relates to the increase of accessibility, but is less supported by the increase in the number of population that are not balanced with the addition of new road.

4. Conclusions
This study shows that from the external conditions, by using maritime connectivity index, the development of East Java province increases during the period of 1996-2011. The growth of maritime connectivity ideally should be supported by regional infrastructure to balance the freight movement. The coastal area serves the freight transport from all East Java area including its inland area to the external area via seaport. But from the internal conditions, based on accessibility and mobility index, the coastal areas where the seaports are located, in general, have road infrastructure supply lower than inland areas. Whereas, the road availability in coastal area has vital support to a whole freight transport and economic activity. Broadly speaking, it can be said that East Java province has poor support for regional development. Thus, a recommendation that can be issued is increasing number of road infrastructure for both the length and the capacity of the road, especially in the coastal area of East Java province.

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