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4th International Conference on Civil and Environmental Engineering for Sustainability (IConCEES 2017)

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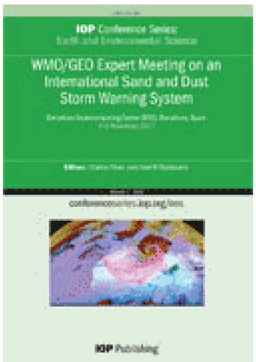

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PROF DR AHMAD TARMIZI ABD KARIM
Universiti Tun Hussein Onn Malaysia

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Japan's High Speed Rail: An Integral Part of Economic Growth

Started in 1964, the Japanese High Speed Rail (HSR) in Shinkansen, Japan was just in time for the Tokyo Olympic Game. The first line (515.4 km length) constructed between Tokyo an Osaka, the two-mega cities in Japan, the network include 2615.7 km of lines with a minimum speed of 320 km/h. With the growth in Japanese economy, the number of HSR passengers was also increased. Now, Japanese government has plans to build a next generation high speed rail "Maglev" to connect Tokyo and Nagoya by 2027. The main aim of the project is to:

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The spatial computable general equilibrium (SCGE) analysis can answer numerically above the requirements. Therefore, we apply SCGE model for East Asian HSR projects that contains Japanese Maglev, Korean KTX and Taiwan T-HSR.

Although benefits of Maglev are the largest, benefit-cost ratio (B/C). the investment of Maglev is the smallest due to the huge investment cost. However, all of B/C estimates of the three projects are over one, and therefore, all project has satisfied social efficiency criteria.
The benefits of GDP ratio (B/GDP) in KTX and T-HSR are 6.3 and 7.0 % respectively, which are much higher that Maglev (2.3%). Since the conventional HSR (Shinkansen) has already existed in Japan, marginal effects of the additional HSR investment should be small. That is why the B/GDP in KTX an T-HSR are relatively larger.

Regarding CO2 emissions from the transport sector, all three HSR project can reduce the emission successfully. The reduction in amount of CO2 and the reduction rate of CO2 in T0HSR are the highest among the three projects. This is because of the (exogenously given assumption) shift of modal split share from air and car to HSR, 100 and 52.7% respectively, is much higher that other countries.

On the other hand, improvement of inter-regional transport conditions by HSR develops the overall economic activity, and then CO2 emissions from the industrial sector will increase. From this result, we can point out following two environmental issues;

1) CO2 emission form HSR is good performance than air transport. However, in case of Maglev, the result of CO2 is dominated by electrical power generation. This result, calculated before Fukushima (last Japanese Great earthquake in 2011), sets unclear power generator. If we set this scenario, the result of CO2 emission might be more serious. Therefore, the scenario of what kind of electric sources is very important in these kinds of analysis.
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emission. Form our results, the amount could not be ignored. Therefore, we need comprehensive policy to reduce all CO2 emission in the entire society.

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Cost		US$ 97.1 billion	US$ 19.7 billion	12.9 billion US$
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CO_2 emission	Transport change of amount change of ratio change of price	−100,621 t-CO_2/ year	−525 t-CO_2/year	−1,694,555 t-CO_2/ year
		−0.9%	−3.4%	−30.4%
		−3.1 million	−0.01 million	−17.4 million US$/ year
		US$/year	US$/year	−610.0 million
		−284.0 million ¥/ year	−7.2 million won/ year	NT$/year
	Industrial change of amount change of ratio change of price	137,065 t-CO_2/year	66,969 t-CO_2/year	152,387 t-CO_2/year
		0.1%	0.3%	0.1%
		4.2 million US$/ year	0.821 million	1.57 million US$/ year
		387 million ¥/year	US$/year	55 million NT$/ year
			913 million won/ year	

PROF DR ATSUSHI KOIKE

Kobe University, Japan

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An observation of the walking speed of evacuees during a simulated tsunami evacuation in Padang, Indonesia

To cite this article: Yosritzal *et al* 2018 *IOP Conf. Ser.: Earth Environ. Sci.* **140** 012090

An observation of the walking speed of evacuees during a simulated tsunami evacuation in Padang, Indonesia

Yosritzal[1,*], B M Kemal[1], Purnawan[1], and H Putra[2]

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Abstract. This paper presents a simulation study to observe the walking speed of evacuee in the case of tsunami evacuation in Padang, West Sumatera, Indonesia. A number of 9 volunteers, 6 observers, 1 route with 5 segments were involved in the simulation. The chosen route is the easiest path and the volunteers were ordered to walk in hurry to a particular place which was assumed as a shelter. The observers were placed at some particular places to record the time when an evacuee passes their place. The distance between the observers were measured using a manual distance meter. The study found that the average walking speed during the evacuation was 1.419 m/s. Walking speed is varied by age and gender of the evacuee.

1. Introduction

Padang is one of the most earthquake and tsunami threatened places in the world because of its location closes to the ring of fire in the west part of Sumatera Island. The city is the capital of West Sumatera Province with population of about 900,000. Half of the population are living in the tsunami vulnerable area. Many massive earthquakes have been hit the west part of Sumatera Island during the last 100 years such as a M 9.1 in December 26, 2004; M 8.6 in March 28, 2005; M 8.5 in September 12, 2007 and M 7.8 in October 25, 2010. Some of the earthquakes triggered a substantial tsunami to the west coastal area of Sumatera Island and nearest islands such as Mentawai and Nias Islands. Nevertheless, experts predicted that a tsunami-generating earthquake is still a threat to the area and Padang may face up to 15 m tsunami inundation [1-3].

The authorities in Padang have put a tremendous effort in the tsunami preparedness such as developing tsunami early warning systems, increasing the capacity of tsunami evacuation routes, building new or retrofitting existing building for temporary evacuation sites and educating people about tsunami and evacuation [4]. However, the readiness of the system has not been properly evaluated. Even though simulation is one of the most important preparation in evaluating how does the system work, tsunami evacuation simulation conducted by the authorities (in this case Local Disaster Mitigation Agency or BPBD) was not well prepared. It failed to attract people to involve. However, in case of earthquake, people were rushing to the hilly land and triggering a massive traffic jam at all of evacuation routes (see Tribunnews, 2016).

One of the aims of the simulation is to study the walking speed of the evacuees during the evacuation. The walking speed is one of the most important variable in estimating the shelter demand and coverage area of a shelter. As the simulation failed, the walking speed data could not be obtained.

In order to fulfil the requirement of the walking speed data, a small simulation involving a paid volunteer was conducted. This paper presents the results of the simulation. The contribution of this study has been providing an addition of literature on the walking speed during a simulated tsunami evacuation. Many studies have been conducted to investigate the pedestrian behaviour on sidewalk, crosswalk or on the pedestrian corridor, however, little attention has been paid on the behaviour of pedestrian during the tsunami evacuation.

2. Literature Review

2.1. Feature of Padang City

Padang is the capital city of West Sumatera Province, Indonesia. Astronomically, Padang is located between $0^o44'$ and 01^o 08' South Latitude and $100^o05'$ and $100^o34'$ East Longitude [5]. From the coast, the terrain of Padang has 3-4 km of flat land within zero to five-meter elevation above sea level and then rising toward hills further inland [1]. The population of the city in 2014 was 889,646 people [5] which about a half of them were living close to the coast. The map of Padang is shown in figure 1.

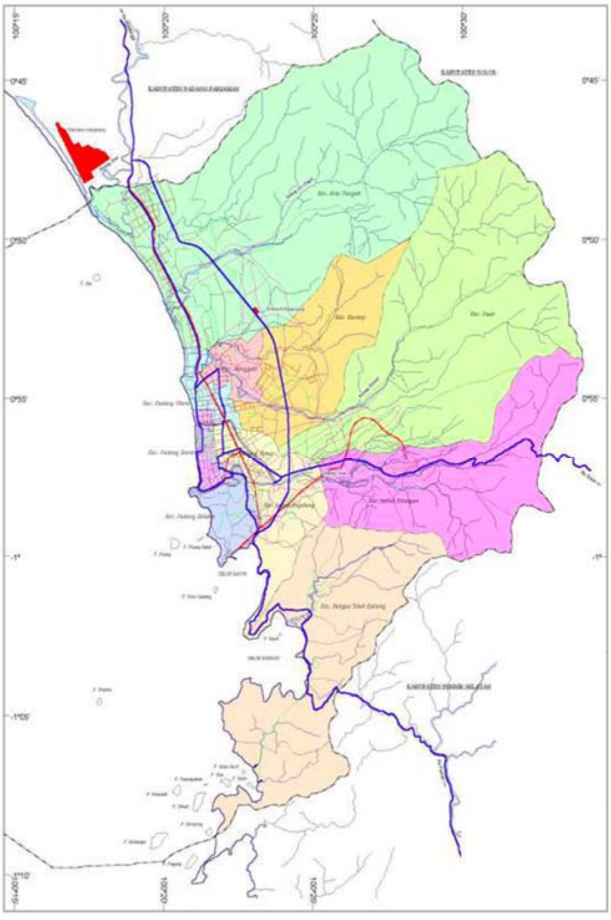


Figure 1. Map of Padang City [5]

The authorities in Padang are advising people to evacuate on foot immediately after the suspected tsunami generating earthquake hit. People have also been suggested to leave their cars and bring only a bag with emergency stuffs inside. Evacuation was suggested to be done to the nearest shelters or the safety zones [6]. The use of car was predicted to make evacuation more difficult due to traffic jam and bottleneck [7]. Learning the preferences of car users in parking their car, Yaldi et al. [8] found that majority of respondents were preferring to park on street. This will make the evacuation routes become more vulnerable to a massive traffic jam during the rush hour and during evacuation.

Learning from previous event, the authorities have been setting some multi-storey buildings as shelters. People who are predicted to fail reaching the safety zone using horizontal evacuation will be appeal to conduct a vertical evacuation to a nearest shelter. However, in fact, panic during previous earthquakes in Padang causes congestion in all of the tsunami evacuation routes. Everybody did horizontal evacuation using their cars but none of them could pass through the traffic and reach the safety zone within the available evacuation time (for example, see [9]).

The government has been educating people using religious words since the Aceh's tsunami in 2004, which was used in many countries during the earthquake in Japan to provoke emotions of the people to make it easier for them to understand the situation [10]. However, no evaluation has been done to investigate the impact.

2.2. Walking Speed Studies

Walking speed studies usually conducted in traffic engineering studies such as simulation of pedestrian movement in a corridor, sidewalk or crosswalk [11-15]. Sharifi et al. [11] investigated walking behaviour of individuals with disabilities through controlled video tracking. Iryo-Asano and Alhajyaseen [12] investigated the behaviour of pedestrian at signalised crosswalks under uncongested conditions. Bosina and Weidmann [13] compared many walking speed studies and determine the variables that influence the walking speed. Paschalidis et al. [14] studied behaviour of pedestrian when crossing at intersection and examined parameters affecting the walking speed adaptation. However, the behaviour of pedestrian movement during a normal condition would be different from in an evacuation condition.

2.3. Walking Speed in Disaster Mitigation Studies

Yosritzal et al. [16] used the average walking speed of pedestrian in normal condition as a variable in estimating the coverage area of a shelter. The same data was used in [4,17] in estimating coverage area, demand and the estimation of the capacity versus demand of a shelter. Given the effective available evacuation time has been estimated around 17 minutes, the walking speed will limit the distance could be reach by evacuee. Using normal walking speed, Yosritzal et al. [16] assumed the average distance could be reach by evacuee was 1.37 km. However, the normal walking speed was not the case for evacuation because during evacuation, evacuees are ordered to walk as fast as they can to the safety zone or to a shelter.

Yosritzal et al. [16] found that the tsunami arrival time at shoreline was 37.1 minutes, slightly slower than [18] which was 35 minutes. effective evacuation time was 17.1 minutes which was estimated to be 1.37 km walk distance. This walking speed is similar with [19] whose found 1.3 m/s for adult and 1.5 m/s for children. Using this walking distance, [3] found the suggested area for horizontal evacuation. Some of the areas are overlapping between the horizontal evacuation safe zone and vertical evacuation. Yosritzal et al. [3] and [17] found that many parts of Padang City could not be coverage by any of the evacuation plans. Therefore, Yosritzal et al. [3] and Kemal et al. [17] suggested to prepare more shelters to increase the possibility to safe the people in the areas.

Abustan [20] recorded average walking speed by observing people crossing at a crosswalk area and used the finding as a parameter in simulating a tsunami evacuation. The study found that the average walking speed of Malaysian is 1.16 m/s. The slowest is 1.04 m/s and belong to female senior adult and the fastest is 1.38 m/s and belong to male adult.

Wood et al. [21] estimated minimum walking speed of people in the vulnerable area in order to reach shelter before the tsunami wave reach the shoreline, instead of estimating the coverage area of shelter. Wood et al. [21] suggested different minimum travel speed to evacuate from hazard zone for each type of walking such as impaired adult (0.89 m/s), slow walk (1.10 m/s, fast walk (1.52 m/s), slow run (1.79 m/s) and fast run (3.85 m/s) depending on the evacuees' decision to start evacuation, their distance to the safety zone and the minimum available evacuation time. In this context, the decision to start evacuation is playing an importance role.

Regarding the start time of evacuation, Sugimoto et al. [22] argue that in general people start evacuation at difference time. Therefore, in their simulation model divided population into several groups and assigned different start time for each group [22]. Sato et al. [23] and Mas et al. [24] threated people individually based on psychological parameters. According to Sato et al. (23), delays of resident starting evacuation were caused by psychological factors such as cognitive dissonance and attitudes waiting for warning. This finding supported assumption that the evacuation will be started 20 minutes after the strong earthquake hit [3,4].

3. Methodology

Data for this study was obtained through a simulation. The tsunami evacuation route was set from a densely populated residential location to a shelter. The route is shown in the figure 2. The chosen route may not the shortest path to the shelter, but it is easy and safe for the volunteers. This route has two right turn and no left turn and it is following an inspection road which is 5 m wide and then turn right through a major road with pedestrian footpath and then turn right again to the shelter. The starting point was chosen as the farthest point based on the estimated distance could be travelled during 17 minutes, the effective available evacuation time [16]. Based on the distance measured by google map application, the distance is around 1.6 km. Observers were placed at 6 points along the routes to observe the time when the volunteers pass through their position. The volunteers were asked to do a hurry walking from a specified point to a specified point near to a shelter. Volunteers recorded the time when they were passing each observer point using a stopwatch application in their mobile phone. The timing data recorded by volunteer was used as main data and data observed by observers was used as a back up in case the volunteers fail to record their timing. Prior to the simulation, volunteers were asked to sign a consent letter that they are willing to involve in the simulation.

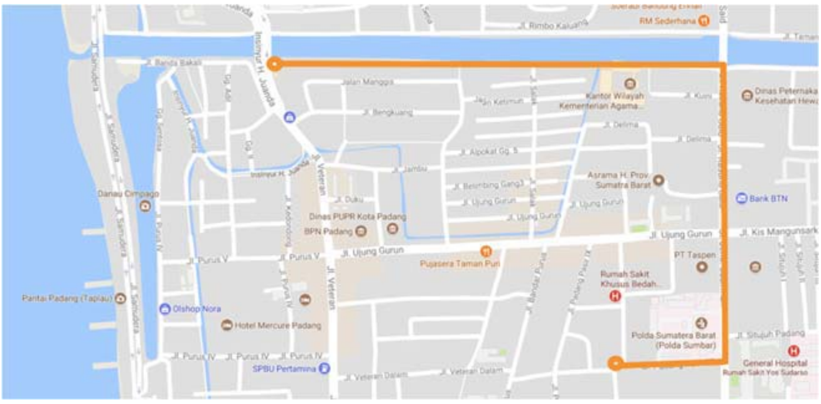
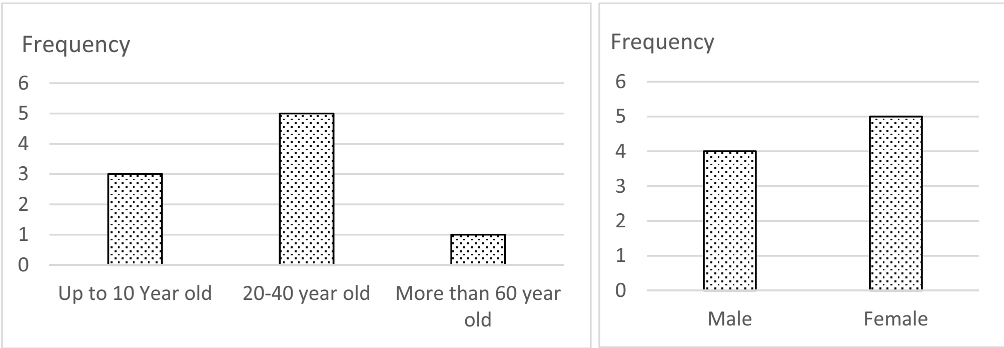


Figure 2. Simulated Routes.

4. Result and Discussion

4.1. Characteristics of the Volunteers

We invited a reasonable number of volunteers in order to fulfil the proportion of population. However, at the d-day, only 12 volunteers and 6 observers presented at the meeting place. As this is a simulation where volunteers were asked to walk through a particular route for about 1.5 to 1.6 km distance, children under 10 should be accompanied by one adult. There were three children involved in this study, therefore 3 of the adult volunteers will be the companion of the children and their data will not be considered in the analysis. The analysed data will be based on the 9 volunteers' data. The profile of sample is shown in figure 3.



(a.) (b.)

Figure 3. Distribution of Volunteers. (a.) Distribution of volunteers by age interval. (b.) Distribution of volunteers by gender.

Figure 3 shows that, in terms of age, most of the volunteers are in the second group with age interval between 20 to 40 years old. In terms of gender, male and female were almost equal. There are 5 segments of the simulated route as shown in figure 4. The distances between the segments are 515 m, 365 m, 315 m, 250 m, and 190 m respectively. At each segment, an observer was placed to record the time when the volunteer passing.

Figure 4. Segment of the simulated route.

It was found that in average, the walking speed was 1.419 m/s or equivalent to 85.14 m/minute. Data of the average walking time and speed among the age group interval is shown in Table 1. It can be seen in Table 1 that, the walking speed of the volunteers were varying by age group and by segment of the route. The mean of walking speed of those who are in the age group up to 10 years old was 80.94 m/minute or equivalent to 1.349 m/s. The mean of walking speed for age group 20-60 years old was 90.32 m/minute or equivalent to 1.505 m/s whilst age group > 60 years old was 84.13 m/minute or equivalent to 1.402 m/s. However, the standard deviation of the up to 10 and > 60 groups much larger than the 20-60 group (14.25 m/minutes and 22.26 m/minutes respectively compared to 3.01 m/minute). Overall the average walking speed was 85.13 m/minute or equivalent to 1.419 m/s.

Table 1. Distribution of the average walking time and speed by Age Group

No.	Distance (m)	Average Walking Time (minute)			Average Walking Speed (m/minute)		
		< 10	20-40	> 60	< 10	20-40	> 60
1	515	6.11	5.59	7.00	84.29	92.13	73.57
2	365	3.72	3.90	3.00	98.12	93.59	121.67
3	315	5.33	3.68	4.00	59.10	85.60	78.75
4	250	2.93	2.77	3.00	85.32	90.25	83.33
5	190	2.44	2.11	3.00	77.87	90.05	63.33
		Average			80.94	90.32	84.13

When the walking speed of male and female being compared, the walking speed of male was found to be 10% higher than female as shown in table 2. In this case, only male and female at the 20-40 age interval groups being compared. The average walking speed of male was 96.34 m/minute or equivalent to 1.606 m/s whilst female was 86.89 m/minute or equivalent to 1.448 m/s.

Table 2. Comparison walking speed of Male and Female

No.	Distance (m)	Average Walking Time (minute)		Average Walking Speed (m/minute)	
		Male	Female	Male	Female
1	515	5.20	5.86	99.13	87.88
2	365	3.57	4.12	102.38	88.52
3	315	3.37	3.88	93.61	81.12
4	250	2.82	2.73	88.65	91.46
5	190	1.94	2.22	97.94	85.46
		Average		96.34	86.89

The findings of this study are slightly higher then [19] and much higher compared to [20]. However, [19,20] observed walking speed on a normal situation where people walking at their normal speed.

5. Conclusion

This paper presents the result of a simulation of tsunami evacuation in Padang, West Sumatera, Indonesia. The study found that the average walking speed during the simulated evacuation was 1.419 m/s. The walking speed differs by age group and gender. Those who are in the age group 20 - 40 years old was found to walk 11% faster than young children and 7% faster than the elder groups. Male was found to be 10% faster than female at the same age group. As the evacuees were ordered to walk in hurry, the profile of the walking is higher than previous studies on walking speed of pedestrian on a normal day.

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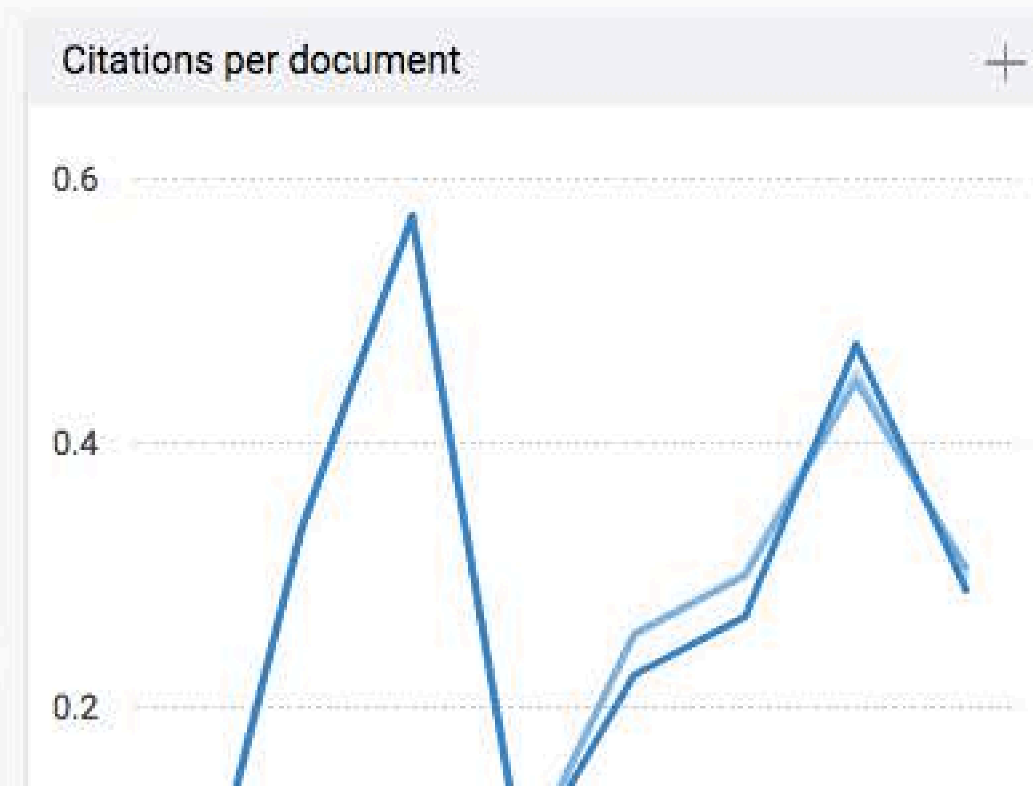

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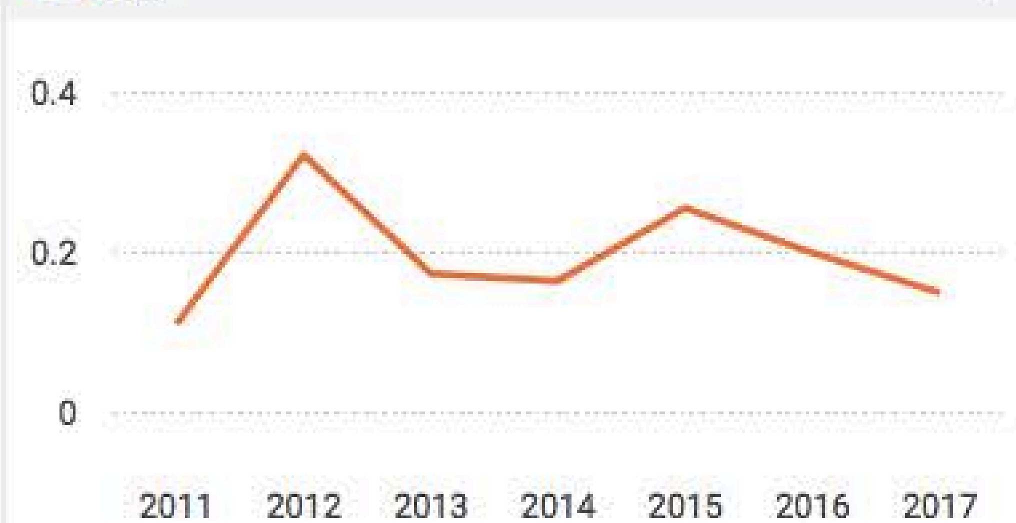

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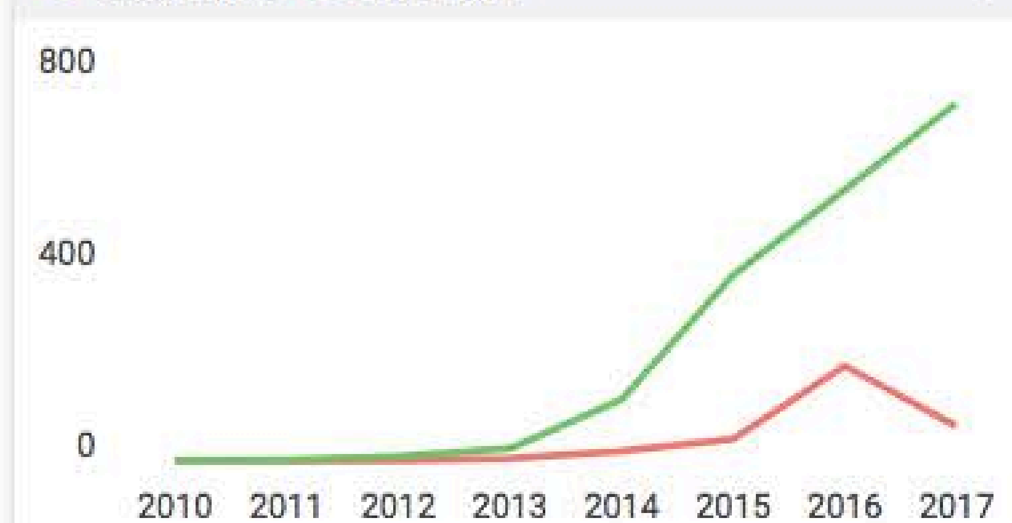

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