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RESEARCH ARTICLE

Spatial Analysis of Startup User Locations and Its Accuracy Values Using Spatial Data Modeling, Palembang City, Indonesia

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Abstract. Increasingly thriving businesses that utilize existing startups are a form of disruptive innovation. Today, these startup users can multiply the number of their customers online to include a broader population in downtown areas. This research aimed to analyze the locations of startup users in Palembang City, Indonesia, spatially using the Accuracy Values of Spatial Data Modeling. Frequency, a descriptive quantitative approach, and spatial data modeling analysis were the two methods applied to 364 sampling points distributed in Palembang City. The results indicated that single women with an average of high school or equivalent education dominated the demographics of the startup users. Also, on average, the startup users were 20–29 years of age. The spatial analysis revealed that their business locations formed a dispersed pattern, with an even density in the downtown area. Based on the sensitivity and specificity values on the ROC curve (receiver operating characteristic) and the accuracy level obtained from AUC (area under the ROC curve), the Spatial Data Modeling (SDM) of the density distribution showed very high-accuracy results, 98.8%.

1. Introduction

The research is based on the development of disruptive innovation that is revolutionary in nature (Thomond & Lettice, 2002) and is a system whose presence disrupts previous or established systems (Feder, 2018; Hardman et al., 2013; Saputra et al., 2020), thus bringing out business service innovations in a company to meet market demands (Pandit et al., 2018). To scholars and business practitioners, disruptive innovation is nowadays a phenomenon crucial to stimulating competitive strategies among business actors (Guo et al., 2018; Wan et al., 2015). It triggers technological advancement (Christensen & Bower, 1996) and economic growth by creating new businesses (Ahlstrom, 2015) and novel technologies (Feder, 2018). Newly established businesses, commonly called startups, have become increasingly popular among residents of Indonesia since the establishment of PT. Gojek Indonesia in 2021. Gojek is a company engaging in online transportation services. The burgeoning rise of startups creates new employment in different fields, including those of the informal sector.

Palembang is one of the Indonesian cities where many of the residents work in the urban informal economy. As the center of economy and industry in South Sumatra, the city has the most urban informal sector workers compared with other cities in this province from 2017 to 2021 (BPS, 2017, 2018, 2019, 2020, 2021). Statistics on these workers are summarized in Table 1.

a. Table 1 shows that from 2017 to 2021, the informal sector workers in Palembang were the highest among the cities in South Sumatra. Based on observations in the field, some are in the informal trade sector who run the business of selling food, beverages, and clothing using startups like Gojek, Grab, Shopee, and Tokopedia. The emergence of these technology-based startups is inseparable from the role of investors and technology entrepreneurs (The Startup Factories, 2011). For instance, although entrepreneurs can introduce their products quickly after adopting innovative strategies (Davila et al., 2003), business models and financial capitals are among the various aspects needed to build a startup successfully (Dessyana & Dwi Riyanti, 2017).

b. Technological advances that startup companies adopt enable entrepreneurs to market wares more intensively to customers online. This also applies to startup users in Palembang, for they can utilize the city's reliable internet connection in product sales. In the research, startups are newly established tech-based companies like Gojek, Grab, Tokopedia, and Shopee, and startup users are e-commerce businesses that transmit food, beverages, and clothing over the internet. Users find startups very helpful for more effective and efficient marketing. Moreover, they can easily access startup groups without having to build a new startup that undoubtedly requires enormous capital. Using existing startups for various trade purposes has become more common. Stemming from the above descriptions, the research sought to determine the distribution trend of startup users in Palembang: whether they spread widely or existed only in a limited number in a few parts of the city.

c. There have been previous relevant studies on the created platforms (Faizal, 2021; Hagiu & Wright, 2015), the number of startups (Hertina et al., 2021), the ability to use applications (Santoso & Wahyuni, 2018), interaction between startup users (Goldenberg et al., 2009; Rand & Rust, 2011), product adoption by startup users (Goldenberg et al., 2007) and the use of varied applications (Rand et al., 2018; Serrano & Iglesias, 2016). However, none have been

Table 1. Informal Sector Employment in South Sumatra, 2017–2021

City	Number of male and female workers by year				
	2017	2018	2019	2020	2021
	Male + Female	Male + Female	Male + Female	Male + Female	Male + Female
Palembang	204,837	221,240	155,168	335,155	329,392
Prabumulih	46,408	41,832	37,556	51,005	51,124
Pagaralam	49,815	50,492	51,345	52,010	56,930
Lubuk Linggau	45,101	44,662	37,521	53,131	52,603
Total	346,161	358,226	281,590	491,301	490,049

Source: BPS-Statistics of Sumatera Selatan Province (BPS, 2017)

centered around the distribution of startup users. To close this research gap, the study formulated a main research question, "How can the locations of the startup users in an urban area be analyzed spatially?" In other words, the novelty of the research lies in identifying if startup users tend to spread in a particular pattern, e.g., are they distributed widely throughout the city or limitedly in certain areas. In addition, the research used Getis-Ord General Gi* and the spatial data modeling's accuracy values to spatially analyze the startup users' locations. This updates the current methodologies of spatially analyzing point distribution within the context of disruptive innovation in urban areas, which can be a tool for scholars worldwide to investigate into emerging new markets in different geographies.

2. Methods

The research was focused in Palembang City, where startup users were ubiquitous in the downtown area. Accidental sampling was conducted to select users of startups such as Gojek, Grab, Tokopedia, and Shopee that engaged in e-commerce and sold food, beverages, and clothing in the city. Samples were determined based on the location of the startup users, while the sample size was decided using the Krejcie and Morgan formula (Singarimbun & Efendi, 2006). From a population of 329,292 informal sector workers in Palembang in 2021, the samples were 384 respondents consisting of 364 startup users and 20 local startup owners. The study was centered around startup users; thus, only 364 samples were analyzed. The variables observed were the demographic characteristics of startup users (sex, marital status, latest educational attainment, and age), the distribution pattern of startup users, and their density distribution. The research used primary data, which were collected directly from main sources through structured interviews with selected respondents using a set of questionnaires, and the coordinates of the startup users were recorded with GPS.

To understand the demographic characteristics of the startup users, the study employed a descriptive quantitative method, particularly frequency analysis (a type of descriptive statistics). In addition, spatial analysis was performed on Getis-Ord General Gi* to identify the distribution pattern of the sample points. Spatial analysis is instrumental in facilitating regional analysis (Sukmaniar, Kurniawan, et al., 2020). Next, the density distribution of the startup user locations was analyzed spatially using Kernel Density Analysis. In the final stage of the analysis, the accuracy of the derived density distribution was calculated from the ROC (receiver operating characteristic) curve and AUC (area under the ROC curve) using the Spatial Data Modeling (SDM) toolbox in ArcGIS. ROC curve analysis is a tool to evaluate to what extent the density distribution of

the startup user locations is accurate, and AUC summarizes the overall accuracy.

3. Results and Discussion
Demographic Characteristics of Startup Users in Palembang City

Startup users in Palembang have unique demographics, which can be defined from the data collected in the field. Table 2 shows the frequency and percentage of startup users by sex, marital status, and educational attainment in 2021. It indicates significant shares of more than half of the samples for the three demographic variables. For starters, females made up 61% of the startup users, which was substantially higher than males (39%). In online marketing, females are believed to be agile, skilled in selling and promoting products, and can adapt quickly. The table also divides startup users into married and single, with single users the more dominant of the two. Up to 42.9% of the startup users were married, while the other 57.1% were never married. Based on educational attainment, the majority had completed high school or equivalent (68.1%), followed by startup users with a bachelor's degree (16.5%), an associate's degree (5.8%), middle-school education (6.9%), and primary-school education (2.7%). Based on these data, most startup users in the city are never married and have a high-school education or equivalent; both contribute to the capability of and flexibility in using technology to market online.

Table 2. Distribution of Startup Users in Palembang City Based on Sex, Marital Status, and Educational Attainment

Demographics	n (364)	% (100)
Sex		
Male	142	39
Female	222	61
Marital Status		
Married	156	42,9
Single (never married)	208	57,1
Educational attainment		
Primary school	10	2,7
Middle school or equivalent	25	6,9
High school or equivalent	248	68,1
Associate's degree	21	5,8
Bachelor/master/doctor's degree	60	16,5

Source: Primary data, 2021

Characteristics of startup users such as age and sex are generally difficult to collect (Baek et al., 2021), but this research was able to obtain data on both and other demographics like latest formal education attained, place of origin, marital status, and religion. Based on these demographic characteristics,

most startup users were female, young, with a high-school education, non-migrant, single, and Muslim. More than half of them were female. Female startup users are known to create social values in society more than their male counterparts (BPS, 2019; Singarimbun & Efendi, 2006), meaning that social values are emerging and developing more in Palembang than in other cities where males make up the majority of the startup users.

Table 3 shows the distribution of the sampled startup users by age. It explains that most of them were 20–29 years old (46.7%); the population belonging to this age group is generally more accustomed to and proficient in utilizing technology and its development, i.e., tech-based startups, to market their wares. The second-largest share was composed of those aged 30–39 years old (22.5%), followed by 10–19 years old (20.6%), 40–49 years old (5.5%), 50–59 years old (3.0%), and 60–69 years old (1.6%). The age ranges of startup users are strongly determined by the startups that a group of people has created. Startups offer new jobs and transform the way people work (Florida, 2005) and often involve modern professions (Marwick, 2013) that include creating their own work schedules (McRobbie, 2002). Those in the young age range are naturally interested in new, modern, and flexible jobs.

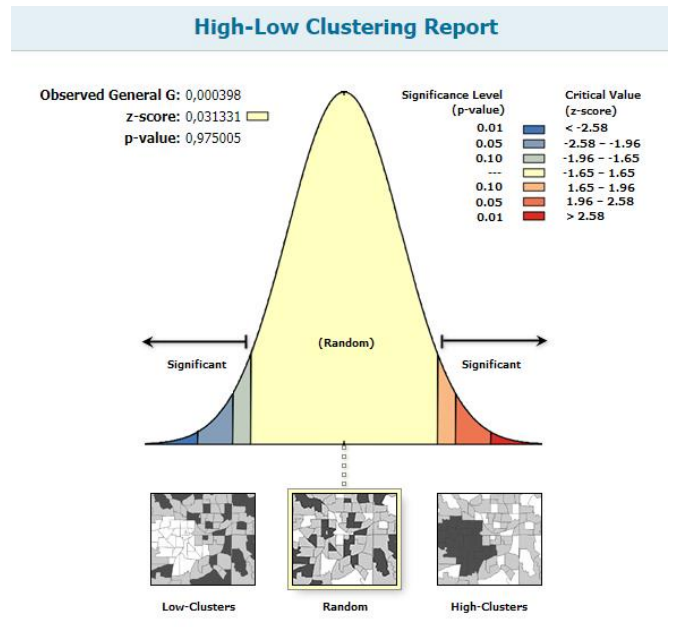Table 3. Distribution of Startup Users
in Palembang City by Age

Age groups (in years old)	n (364)	% (100)
10–19	75	20.6
20–29	170	46.7
30–39	82	22.5
40–49	20	5.5
50–59	11	3.0
60–69	6	1.6

Source: Primary data, 2021

High-Low Clustering Report

Getis-Ord General Gi* is a spatial analysis technique generally used to categorize a distribution pattern or clustering into low, high, or random. This study employed it to determine the distribution pattern of startup users' businesses in Palembang City. Fig. 1 shows the high-low clustering report derived from the analysis.

The graph in the high-low clustering report shows an observed general G of 0.000398, a z-score of 0.031331, and a p-value of 0.975055. These values or scores were < 1 >, which can be interpreted as a random pattern. Business locations of the startup users did not cluster in one area. On the contrary, startup users opened their businesses in various places throughout the city center (a dispersed pattern). It is believed that even distribution aims to attract and accommodate the needs of customers in downtown areas, and digitalization makes it easier for them to achieve this, especially because the current global conditions are strongly related to the digital world (Coviello et al., 2017; Luo, 2021). Platforms have been increasingly in demand since digitalization (Zielske & Held, 2021), allowing startup users to run their businesses more efficiently. These findings complement previous research on platform enthusiasts, as the current study focuses on users who rely on platforms/startups to run their business. However, it is noteworthy that contemporary businesses need to be resilient so as to survive and thrive in today's challenges and competitions (Baldwin & von Hippel, 2011), for instance, by providing good customer services (Iansiti & Levien, 2004).

Figure 1. High-Low Clustering Report of Startup Users

Density Distribution of Startup Users in Palembang City

Getis-Ord General Gi* showed the distribution pattern of the startup users. A subsequent spatial analysis was conducted to determine their density distribution, which is visualized in detail in Fig. 2. Based on this map, the densities of startup users in the city center were randomly scattered along the main urban roads (not in clusters). The Kernel Density Analysis results showed the lowest value at 0 and the highest at 5830.84. The map visualizes these values in red gradients: the red color with a higher brightness level indicates lower density, whereas the red color with a lower brightness level (dark red) shows higher density. This map also explains that the downtown area is geographically in the middle of Palembang City traversed by the Musi River (Putri et al., 2021; Sukmaniar, Joko Pitoyo, et al., 2020; Sukmaniar, Pitoyo, et al., 2020; Sukmaniar et al., 2021).

In addition, the map shows that the startup users' density had a distinct pattern of a random dispersion in the city center. The density of the place of business was also mapped randomly in the urban area. New types of businesses appear and thrive through the internet (Frizzo-Barker et al., 2020), and the results of this study complement previous research on the role of the internet and online platforms in enabling startup users to develop their business and compete with existing enterprises
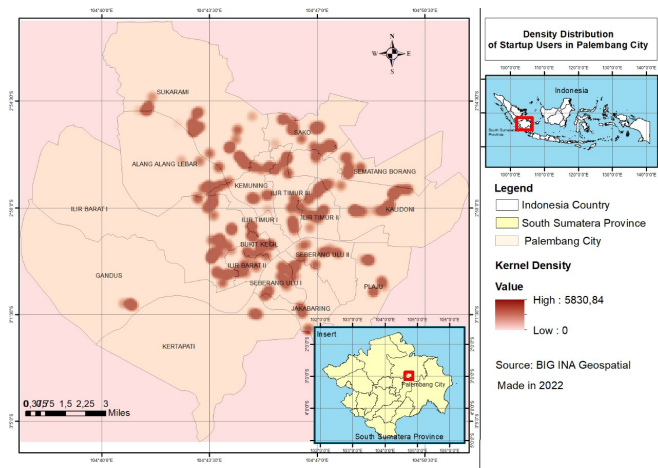
Figure 2. Density Distribution of Startup Users in Palembang City

that are run traditionally without using the platforms. With the internet and marketing platforms, startup users can advance their businesses and compete with old ones that do not use the platforms. In other words, technological innovation replaces old businesses with new ones (Adomavicius et al., 2008; Ali et al., 2020).

Spatial Data Modeling of the Startup User Locations in Palembang City

The Kernel Density Analysis results were tested using the Spatial Data Modeling (SDM) toolbox, which generated a ROC curve and an AUC value. This analysis was conducted to test the accuracy of the spatial analysis project that had been carried out. The results of the Spatial Data Modeling (SDM) test according to the ROC curve and AUC are illustrated in Fig. 3
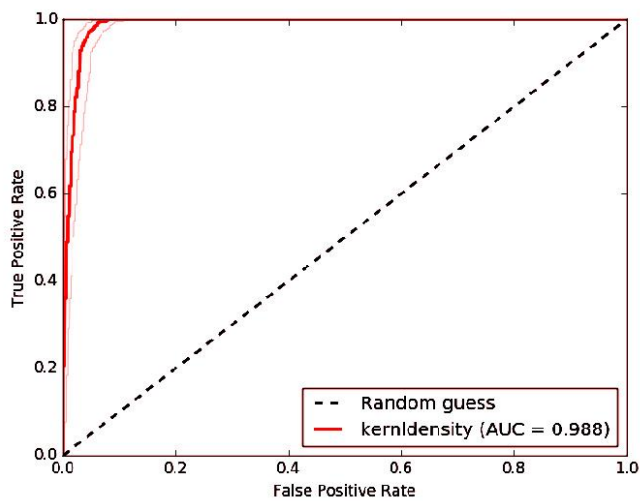

Figure 3. ROC Curve and AUC Values of the Density Distribution of Startup Users in Palembang City

Fig. 3 shows that the sensitivity and specificity values on the ROC curve were in the true positive rate (TPR) area and that the AUC was 0.988. These results indicated that the Kernel Density prediction for the spatial analysis of startup users in Palembang City has an accuracy rate of 98.8% or excellent. Classification of the level of accuracy based on AUC values is presented in Table 4.

Evaluation of accuracy using the ROC curve and AUC has proven effective in testing the density distribution analysis of the startup user locations. The test results confirmed that

Table 4. Test Quality Based on Area Under the ROC Curve (AUC)

AUC Values	Test Quality
>0,9 – 1	Excellent
>0,8 – 0,9	Very Good
>0,7 – 0,8	Good
>0,6 – 0,7	Satisfactory
0,5 – 0,6	Unsatisfactory

the density of their places of business was generally spread across the downtown area with a high level of accuracy, AUC > 0.9–1 or 98.8%. This wide distribution benefits startup users, customers, and owners. For example, startup users can easily sell their wares online, and their customers can conveniently order and quickly receive the purchased goods or services using existing startup applications, which connect them to those closest to where they live. In addition, startup owners benefit from the large number of city residents who use the applications they have created. The city center is the most suitable place as a market for startup users because it is densely populated and has, on average, reliable internet access. Most importantly, startup users are greatly helped by disruptive innovation. Disruptive innovation in this study is disruptions due to innovation like online applications that enable convenient, simple, and quick goods and services marketing. Technological innovations have given rise to an ecosystem of digital platforms (Clarysse et al., 2014; Eaton et al., 2015), which provide information facilities regardless of distance (Lusch & Nambisan, 2015). The research findings complement previous research on the utilization of digital platform ecosystem by startup users to develop and advance their businesses. Today's population needs platform innovation and diversity (Milat et al., 2013) that prioritize user-friendly interfaces for ease of use of applications. In addition, to maintain the platforms, the owners must be open to users (Eisenmann, 2006; Eisenmann et al., 2009; Sanjari Shahrezaei et al., 2018; Wang et al., 2020) because it increases their users' confidence that the startup they are currently using can develop and advance their business.

4. Conclusion

Based on the demographic data obtained in the field, startup users in Palembang City are generally female (61%), single or never married (57.1%), with a high-school education or equivalent (68.1%). According to the age group, the majority are 20 to 29 years old (46.7%). Technology such as the startup applications used to market goods and services is easy to understand and ubiquitous among the people in this demography.

The Getis-Ord General Gi* analysis yielded an observed general G value, z-score, and p-value of < 1 >, which can be interpreted as having a random pattern. These results correspond with the data obtained in the field, i.e., that startup users are randomly distributed in urban areas. Urban communities are targets or customers who support the business progress of startup users.

This study also explains that spatially, the density does not form new clusters but is spread evenly and randomly in the middle of the city. The spatial analysis results (Kernel Density in ArcGIS) visualize differences in density with color gradients: red with high brightness (light red) indicates low density, and conversely, red with low brightness (dark red) indicates high density.

Following the Kernel Density analysis was an accuracy test using Spatial Data Modeling (SDM). The results are sensitivity and specificity values on the Receiver Operating Characteristic (ROC) curve and Area Under the ROC Curve (AUC) of >0.9–1 (i.e., 0.988). The AUC value shows 98.8% accuracy (excellent). The city center is the growth zone for startup users to market their wares. Disruptive innovation in this study refers to the ease with which startup users currently have to sell their goods to many customers but with minimal marketing costs. This study also found the spatial model of startup users in Palembang City; therefore, in the future, the results can be used to identify the spatial models of startup creators or founders. This way, the research objects will also include the creators/founders. Also, the findings provide a scientific reference for other researchers to investigate the emergence and distribution of startup users and founders at the city and other urban areas using modified or varied methods.

Acknowledgment

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