Matrik: Jurnal Manajemen, Teknik Informatika, dan Rekayasa Komputer
Vol. 22, No. 1, November 2022, pp. 189∼200
ISSN: 2476-9843, accredited by Kemenristekdikti, Decree No: 200/M/KPT/2020
DOI: 10.30812/matrik.v22i1.1888

Clustering Couples of Childbearing Age to Get Family Planning Counseling using K-Means Method

Yuniar Farida[1], **Adam Fahmi Khariri**[2], **Dian Yuliati**[3], **Hani Khaulasari**[4]
UIN Sunan Ampel, Surabaya, Indonesia

Article Info

Article history:

Received April 02, 2022
Revised October 24, 2022
Accepted November 24, 2022

Keywords:

Couples of Childbearing Age
Family Planning
K-Means Clustering
Silhouette Coefficient

ABSTRACT

Couples of Childbearing Age (CCA) in the Madiun Regency have increased in the last three years. It caused the population in Madiun to overgrow with the newborn, which implies the economic, social, and environmental aspects. This study aims to cluster villages in Madiun with CCA case studies instead of birth control participants who will give birth and want children to determine the priority of getting Family Planning (in Indonesia, namely Keluarga Berencana/KB) counseling. K-Means clustering is used in this study because it has a linear space of complexity that can be executed quickly and easily. The result of this study is four (4) CCA clusters. CCA cluster 1 is a very high level of giving birth and wanting children, consisting of 7 villages. CCA cluster 2 is a high level of giving birth and wanting children with 119 villages. CCA cluster 3 is a medium level of giving birth and wanting children in 50 villages, and CCA cluster 4 is a low level of giving birth and wanting children, including 34 villages. So, cluster 1, which includes seven villages, is the most prioritized to get Family Planning counseling because it is the CCA cluster with the most birthing rate and wants children. This research obtained a silhouette coefficient of 0.42, which belongs to the medium level.

Corresponding Author:

Yuniar Farida,
Department of Science and Technology,
UIN Sunan Ampel,Surabaya, Indonesia
Email: yuniar_farida@uinsby.ac.id

How to Cite: Y. Farida, A. Khariri, D. Yuliati, and H. Khaulasari, Clustering Couples of Childbearing Age to Get Family Planning Counseling Using K-Means Method, MATRIK : Jurnal Manajemen, Teknik Informatika dan Rekayasa Komputer, vol. 22, no. 1, pp. 191-202, Nov. 2022.

1. INTRODUCTION

Attention to fertility and family planning has always been associated with population problems [1]. The presumption to reduce fertility is often cited as the main element for balancing the economy and social welfare [2]. According to the United Nations, the 7.8 billion global population by 2020 will increase by 10.9 billion people by 2100. In Indonesia, Couples of Childbearing Age (CCA) in 2020 amounted to 31.5 million people [3]. In comparison, the population continues to increase every ten years based on the population census conducted by the government through the Central Statistics Agency, which amounted to 271.35 million people according to administrative data in 2020. In Indonesia, the most populous population is the island of Java. East Java Province is the second-most populous province on the island of Java [4]. In the past decade, the population of East Java has increased by 3.19 million people, followed by an increase in the number of CCA in East Java from 2019, which amounted to 6.34 million people to 6.43 million people [5] and became the fifth most populous province in 2020 [6]. While on Madiun Regency, CCA growth in 2017 was 136,154 people and then increased in 2019 to as many as 138,855 people, and then the population growth increased in 2018 from 681,394 people and rose again in 2019 to 749,066 people [7].

Increasing CCA occurs due to early marriage in Indonesia during the COVID-19 pandemic [8]. In addition, the increase in CCA also occurs due to lack of knowledge and parental income, as happened in Air Rami District, Mukomuko Regency, Bengkulu Province, to CCA under 21 years old [9]. In addition, there is another factor, namely fear of adverse health consequences obtained from the birth control program [10]. If the problem is not considered, the population density in Indonesia [11], especially in the Madiun Regency, continues to increase yearly. Therefore, the government can educate about birth control programs and the use of contraceptives and can provide them quickly. The use of modern contraception is crucial because it can reduce TFR [11]. Indonesia National Family Planning Coordination Board, known as BKKBN, has experimented with various approaches to fertility control, such as extensive campaigns to educate couples about birth control. Family Planning (FP) is an effort to anticipate the number of children and regulate the period of birth through contraceptives and infertility treatment [12]. Contraceptive use can reduce birth rates, improve maternal health, and lower mortality in both mother and child [13]. The success of birth control programs by the Indonesia Government is evidenced by the increase in Contraceptive Prevalence Rate (CPR) in married women from 8% in the early 1970s to 60% in 2002 and experienced a slow rise in contraceptive use rate of 63% in 2017 [14]. Obtain education on using contraceptives through the programs. There is a need for communication strategies about birth control education that must be carried out by field extensions from the local government [15]. One crucial communication is interpersonal methods such as counseling guidance, group meetings, meet-ups, etc., to patients who are spouses of CCA [16].

Couples of childbearing age (CCA) in Madiun Regency who don't follow birth control has three categories that potentially increase the number of residents, namely Pregnant (P), Want Children Immediately (WCI), and Want Children to Delay (WCD) [17]. The indicator is found in every village in Madiun Regency, which indicates that the government, as the organizer of the FP program, can find out the villages that first carried out the extension of the FP program. For data visualization, clustering can better understand each group [18]. Clustering is one of the well-known methods and techniques of data mining that can help map and divide data into objects into several clusters [19] and is also a critical variation of machine learning and regression and prediction [20]. One of the popular methods is K-Means clustering, which is simple and easy to implement. In addition, K-Means also has a linear space of complexity that can be executed quickly [21].

Some previous studies on families using K-Means clustering have been carried out, Moura et al. [22] measured the effectiveness of the birth control program in Rio De Janeiro. K-Means clustering is used to help determine the interaction characteristics of the sensitivity of mothers who have entered childbearing age. On other birth control programs, Wahidin et al. [23] used K-Means clustering to map provinces in Indonesia with unmet healthcare needs. It resulted in 74% of provinces being included in Indonesia's low unmet needs for health services. Furthermore, Ahmer [24] implemented K-Means clustering to classify provinces in Indonesia according to the population level, education level, human development index, and distribution. Which produces as many as five groups centered with cluster 1 in South Sumatra, cluster 2 centered in Lampung, cluster 3 centered in DKI Jakarta, cluster 4 centered in Central Java, and cluster 5 centered in West Kalimantan. Im and Jung [25] used K-Means clustering as a method of family management who have children with chronic atopic disease. Generating 4 clusters with each cluster shows the level of complexity of each parent in self-management of the illness suffered by their child. K-means clustering has also been used in several previous studies, such as social assistance recipients in 257 poor people in Mataram, West Sumbawa, and produced 2 clusters where cluster 1 contains 196 social assistance recipients on target [26]. Cluster 2 has 61 residents who received social assistance that is not on target [27]. Then in another study, K-Means clustering was used to map the quality of education in Indonesia [27]. Ali [28] used K-Means clustering to classify 534 patient data at Anwar Medika Hospital in Sidoarjo Regency and produced 4 clusters where cluster 1 consisted of 79 female patients, cluster 2 with 214 males, cluster 3 with 89 female patients, and cluster 4 with 214 female patients. It produced 0.06 seconds of identification completion time.

In the case of grouping regions by Couples of Childbearing Age (CCA), it is still infrequent for studies to cluster related to this. So this study aims to cluster CCA in each village in Madiun Regency based on indicators of giving birth and wanting children, using K-Means clustering. Through this research, the local government can determine which villages must be prioritized for birth control counseling from each produced cluster to achieve the total fertility rate target of 2.1% by 2023 [7]. To achieve this goal, the next section (section 2) will explain the data processing procedure using the K-Means Clustering method and how to measure the accuracy or quality of the clustering. Section 3 presents the results of clustering couples of childbearing age along with the recommendations given to the cluster results. Finally, in section 4, the conclusions of this study are presented.

2. RESEARCH METHOD

2.1. Flowchart

This research was conducted to show the cluster Couple of childbearing (CCA) of each village in Madiun Regency. The result from this research was processed with an optimized K-Means clustering method using KKZ algorithm optimization. Figure 1 shows the research stages.

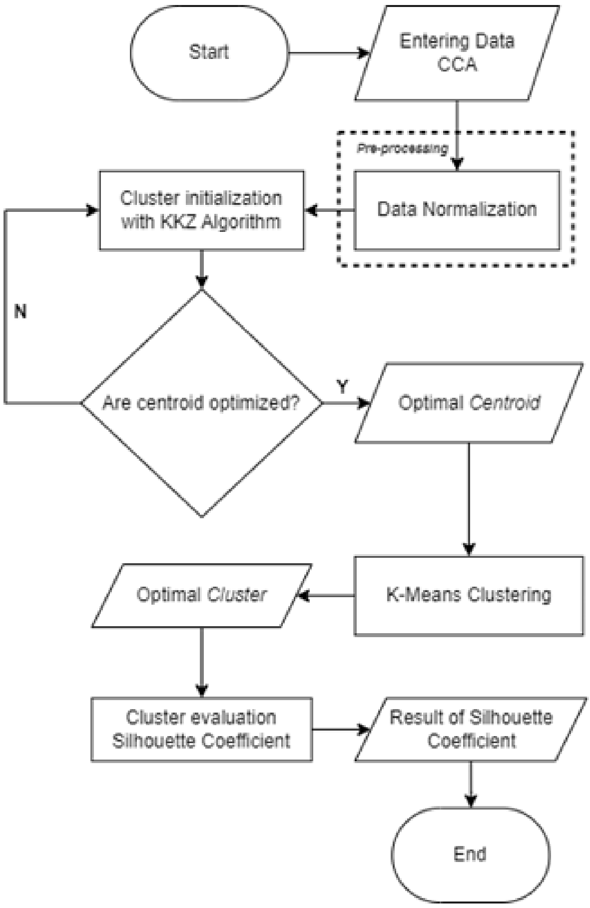

Figure 1. Research stages of the research using K-Means Clustering with the KKZ Algorithm

Figure 1 shows the flow of the research stage from the beginning to the end. The first stage is to enter CCA data for normalization. The normalization process uses min-max normalization to lighten and minimize the data. Cluster initialization is carried out using the KKZ algorithm, and if it is optimal, the following process is clustering using the K-Means method to get the optimal cluster. Finally, evaluation is carried out using the silhouette coefficient.

2.2. Data

The data in this study was obtained through the BPS Madiun Regency. The data is from Couples of Childbearing Age (CCA) who are not Family Planning (FP) participants with four indicators. Still, one indicator cannot be used, namely Not Wanting Children Anymore (NWCA), because CCA does not want to add children and does not have the potential to cause a population increase. Finally, the data was selected into three parts, including Pregnant (P), Want Immediate Children (WCI), and Want Children to Delay (WCD), according to the village with 206 villages in the period 2020-2021, as shown in Table 1.

Table 1. Data of CCA in Each Village

No	Village	A Couple of Childbearing (CCA) Not A Member of Family Planning (FP)		
		Pregnant (P)	Want Immediate Children (WCI)	Want Children to Delay (WCD)
1	Ketandan	16	142	31
2	Tileng	6	45	13
3	Mendak	5	31	10
4	Segulung	10	135	39
5	Padas	5	40	15
6	Ngranget	11	60	20
7	Joho	12	84	23
8	Kepet	16	48	19
9	Dagangan	14	135	31
10	Jetis	9	68	19
...	...	...	...	...
...	...	...	...	...
...	...	...	...	...
204	Tiron	8	135	21
205	Gunungsari	8	64	27
206	Bagi	17	189	32

2.3. Min-Max Normalization

This method can change attributes or outputs from one range of values to a new range [29]. Min-max normalization performs transformations in the range (0,1) using equations (1)

$$M' = \frac{M - min_N}{max_N - min_N} \tag{1}$$

Based on the equation obtained, minN and maxN is the minimum and maximum value of variable N. For the original and average values based on attributes, N is indicated by M, respectively. And it is known that each maximum and minimum value is found at the 1st and 0th values [30].

2.4. KKZ Algorithm

The KatsavounidisKuoZhang (KKZ) algorithm identifies a case to initialize optimal centroids in K-means clustering [31]. This algorithm can select the closest model of the centroid (within Euclidean distance) based on the most relative length distance of the previously established model [32].

It starts by selecting the x point from one of the data edges as the first core. Next, use the point furthest from x and select the second core. Then the distance from the point to the nearest point of the two core points is calculated. And then set the farthest point from the nearest core as the third core. The process is repeated to choose the farthest point from the nearest core until core K is found. The risk of this method is that if every noise in the data is obtained at the outermost point, it will cause initialization difficulties because the outer point will be preferred by the algorithm that produces a precise point. After all, it is near the cluster's center [33].

2.5. K-Means

The K-means algorithm is a simple algorithm that uses distance as a category for K in a dataset by calculating the average distance to get a centroid value. At the value of X containing n for the multidimensional point category K to be divided, the euclidean distance is selected as the similarity index for the clustering target [35].

$$c = \Sigma_{j=1}^{j} \Sigma_{i=1}^{n} \parallel (v_i - w_j) \parallel^2 \tag{2}$$

Where j represents the number of clusters, n represents the number of objects, w_j represents the jth center, and v_i illustrate the ith point. The K-means algorithm produces the cluster's central point that changes randomly and unstably. Still, it is also the focus of the K-means algorithm resulting in optimal clustering [35].

2.6. Silhouette Coefficient

The silhouette coefficient is used to evaluate cluster quality based on the average size of the distance between one point and another point in the same cluster (cohesion) and the average distance between different clusters (separation) [34].

The point silhouette value is indicated in equation (3) obtained by the degree of proximity of the distance point on each cluster.

$$d(i) = \frac{x(i) - h(i)}{maxh(i)x(i)} \tag{3}$$

In Silhouette d(i), some values vary, as stated in equation (4). Still, if the value (i) is 0, then h(i) is the average distance between cluster points, and x(i), which is the minimum value between clusters, has approximately the same value.

$$-1 \leq d(i) \leq 1 \tag{4}$$

The d(i) value can range between -1 and 1.

$$SC = max_k d(k) \tag{5}$$

Silhouette Coefficient (S.C.), as shown in equation (5) with the maximum value instead of all values k and d(k), is the whole of the average silhouette value.

3. RESULT AND ANALYSIS

3.1. Min-Max Normalization

The first process is normalized to minimize the data range because the data obtained has many large data ranges. The result of normalization is used to get the smallest range of data between 0 to 1, shown in Table 2.

Table 2. CCA Dataset After Normalization

No.	P	WCI	WCD
1	0.072727	0.133829	0.126316
2	0.054545	0.081784	0.094737
3	0.145455	0.468401	0.4
4	0.054545	0.115242	0.147368
5	0.163636	0.189591	0.2
6	0.181818	0.27881	0.231579
7	0.254545	0.144981	0.189474
8	0.218182	0.468401	0.315789
9	0.127273	0.219331	0.189474
10	0.090909	0.133829	0.115789
…	…	…	…
…	…	…	…
…	…	…	…
206	0.272727	0.669145	0.326316

Normalization of data with min-max algorithms is used in equation (1) with a minimum value of 1 and a maximum value of 278 to obtain the normalization dataset.

3.2. KKZ Algorithm

Furthermore, the initialization of the centroid cluster is carried out using the KKZ algorithm, wherein this process is selected using four centroid clusters obtained by dividing from many clusters. Here are the results of the KKZ algorithm, which is an optimization of centroids by dividing 4 clusters from data that has been normalized before. Table 3 gives the initialization results of the min-max result and is used to obtain the optimal K-means results.

Table 3. KKZ Algorithm Results

No.	P	WCI	WCD
1	1	0.513011	0.757895
2	0.054545	0.115242	0.147368
3	0.854545	0.513011	0.926316
4	0.836364	0.63197	0.905263

3.3. K-Means Clustering

Based on the results of the KKZ algorithm in Table 3, K-means clustering can be divided into four selected clusters as follows and displayed in Figure 1 and Table 3.

Figure 2. K-Means Clustering Results

Figure 2 shows CCA clusters as a result K-Means clustering, and the member of each cluster are shown in Table 4 below:

Table 4. K-Means Clustering Results With K = 4

Klaster	K-Means With KKZ Algorithm (Village)
1 (Very High level)	Sugihwaras, Tulung, Kare, Randualas, Cermo, Morang, Tawangrejo.
2 (High level)	Tileng, Mendak, Padas, Ngranget, Joho, Kepet, Jetis, Prambon, Banjarejo, Mruwak, Sukosari, Garon, Balerejo, Kebonagung, Gading, Jerukgulung, Sumberbening, Bulakrejo, Tapelan, Babadan Lor, Warurejo, Kedungjati, Glonggong, Banaran, Pacinan, Simo, Banaran.1, Klorogan, Slambur, Geger, Sareng, Sumberejo, Uteran, Pagotan, Jogodayuh, Samberejo, Putat, Sangen, Kertosari, Kertobanyon, Kaibon, Kranggan, Bukur, Kwangsen, Ngetrep, Bedoho, Bibrik, Blabakan, Wonorejo, Sidodadi, Kuncen, Klecorejo, Krajan, Pandeyan, Ngampel, Bajulan, Ngepeh, Bongsopotro, Sambirejo.1, Jatirejo, Banyukambang, Wonoasri, Bancong, Klitik, Buduran, Kanung, Sidomulyo.1, Rejosari, Bakur, Pucangrejo, Krokeh, Lebakayu, Golan, Cabean, Sawahan, Pule, Kajang, Klumpit, Kepel, Bolo, Kuwiran, Lembah, Suluk, Blimbing, Ketawang, Pilangrejo, Karangrejo, Brumbun, Nglambangan, Sobrah, Purworejo.1, Wonoayu, Kedungmaron, Sumbergandu, Muneng, Ngale, Krebet, Kedungbanteng, Ngengor, Bulu, Dawuhan, Sukorejo.1, Singgahan, Sidorejo.2, Palur, Mojorejo, Bacem, Dempelan, Betek, Sendangrejo, Sirapan, Dimong, Tulungrejo, Sumberejo.1, Tanjungrejo.1, Banjarsari, Nglames, Gunungsari.
3 (Medium level)	Sogo, Kedungrejo, Kuwu, Purworejo, Jatisari, Nglandung, Sambirejo, Metesih, Jiwan, Sukolilo, Kincang Wetan, Grobogan, Wayut, Klagenserut, Teguhan, Kebonagung.1, Darmorejo, Kaligunting, Bangunsari, Sukorejo, Sidorejo, Bandungan, Pajaran, Klumutan, Sumbersari, Bener, Sumberbendo, Klangon, Ngadirejo, Plumpungrejo, Bodag, Kedungrejo.1, Duren, Pilangkenceng, Pulerejo, Luworo, Gandul, Kenongorejo, Batok, Dureman, Winong, Tambakmas, Tanjungrejo, Pucanganom, Krandegan, Kebonsari, Rejosari.1, Balerejo.1, Kedondong.
4 (Low level)	Ketandan, Segulung, Dagangan, Banjarsari Wetan, Banjarsari Kulon, Sewulan, Kaliabu, Mejayan, Sidomulyo, Purwosari, Mlilir, Kradinan, Bader, Candimulyo, Glonggong.1, Dolopo, Doho, Bangunsari.1, Sidorejo.1, Munggut, Mojopurno, Kresek, Wungu, Mojorayung, Bantengan, Tempursari, Nglanduk, Gemarang, Sebayi, Ngampu, Tiron, Bagi

Figure 2 and Table 4 show that CCA cluster 1 is a very high level of giving birth and wanting children, consisting of 7 villages. CCA cluster 2 is a high level of giving birth and wanting children with 119 villages. CCA cluster 3 is a medium level of giving birth and wanting children with 50 villages, and CCA cluster 4 is a low level of giving birth and wanting children, including 34 villages. So, the prioritized cluster to get Family Planning (FP) education is cluster 1.

3.4. Silhouette Coefficient

After obtaining clustering results, a kindness test is carried out using the silhouette coefficient method to determine the quality of clustering results. The results of the cluster kindness test, as shown in Table 5.

Table 5. Results of Silhouette Coefficient

Cluster	Silhouette Coefficient
Cluster 1	0.52
Cluster 2	0.49
Cluster 3	0.34
Cluster 4	0.27
Average	0.42

Based on Table 5, K-Means clustering gets a silhouette coefficient value of 0.42 and belongs to the medium category because it avoids 0 and is close to 1. And for visualization of the table is presented in Figure 2 as follows.

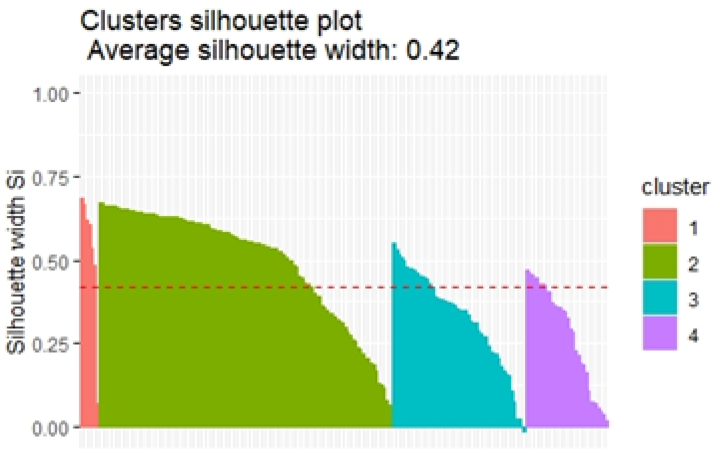

Figure 3. Silhouette Coefficient of K-Means Clustering Plot With KKZ Algorithm

Table 5 and Figure 3 show that K-Means clustering gets a silhouette coefficient characterized in the medium category. Since it is a medium category, the comparison from other research resulted in the following table.

Table 6. Results of Silhouette Coefficient Comparison

Dataset	Clustering	Cluster	Average Silhouette Coefficient
Couples of Childbearing Age	K-Means with KKZ Algorithm	4	0.42
Home Industry	Improved K-Means	3	0.36
Air Pollution	K-Means	4	0.28

Table 6 shows the comparison between optimized K-Means with the KKZ algorithm and regular K-Means. It shows that the ideal cluster of K-Means with optimization in Madiun City with 4 clusters and 0.42 average silhouette coefficient value perform better than the improved K-Means without optimization for Home Industry dataset with 3 cluster and average silhouette coefficient of 0.36 in Bangka Belitung Province [35], and traditional K-Means for Air Pollution with 4 clusters and 0.28 average silhouette coefficient value in Makassar City [36].

4. CONCLUSION

This study used K-Means clustering to group the CCA non-FP participants in Madiun Regency to get FP counseling. Obtained the results that cluster 1 is a village with CCA that has a very high rate of birth and wants children, followed by cluster 2 with a high level, cluster 3 with a medium level, and cluster 4 with the lowest level. The clustering results show the prioritized cluster to get FP education is cluster 1 because it is a CCA cluster with the highest childbirth rate and wants children in Madiun Regency. The result of the silhouette coefficient level of 0.42 belongs to the medium level. Because this study produced the accuracy of the silhouette coefficient with the KKZ algorithm at a medium level, more research can be conducted on CCA experiencing pregnancy and the desire to have children using cluster optimizing initialization algorithms such as Genetic Algorithm and Particle Swarm Optimization and other types of clustering such as hierarchical, density-based (DBSCAN), and others that can produce silhouette coefficients closer to the value of 1.

5. ACKNOWLEDGEMENTS

The Acknowledgments section is optional. Research sources can be included in this section.

6. DECLARATIONS

AUTHOR CONTIBUTION
YuniarFarida: Conceptualization, Methodology, Writing Review & Editing, Supervision. Adam Fahmi Khariri: Original Draft, Investigation, Data. Dian yuliati: Validation and Interpretation. Hani Khaulasari: Validation and Editing.

FUNDING STATEMENT
This research received no specific grant from any funding agency.

COMPETING INTEREST
The authors declare no conflict of interest.

REFERENCES

[1] A. V. Cicourel, "Fertility, Family Planning and the Social Organization of Family Life: Some Methodological Issues," *Journal of Social Issues*, vol. 23, no. 4, pp. 57–81, oct 1967.

[2] J. W. Molyneaux and P. J. Gertler, "The Impact of Targeted Family Planning Programs in Indonesia," *Population and Development Review*, vol. 26, pp. 61–85, apr 2000.

[3] I. Y. Padlilah, Rahmi, Elfanda Sholihah, "Dampak Virus Covid 19 Terhadap Pemakaian Kontrasepsi di Kalimantan Utara," *Jurnal Kebidanan Indonesia*, vol. 13, no. 1, pp. 77 – 85, 2022.

[4] E. I. Goma, A. T. Sandy, and M. Zakaria, "Analisis Distribusi dan Interpretasi Data Penduduk Usia Produktif Indonesia Tahun 2020," *Jurnal Georafflesia: Artikel Ilmiah Pendidikan Geografi*, vol. 6, no. 1, pp. 20–27, jul 2021.

[5] D. R. Wulandari and D. A. Laksono, "Hubungan Paritas dan Karakteristik Individu terhadap Pemakaian Alat Kontrasepsi diantara Wanita Usia Subur di Provinsi Jawa Timur Tahun 2017," *Buletin Penelitian Sistem Kesehatan*, vol. 24, no. 1, pp. 20–30, 2021.

[6] Y. Farida, M. Farmita, N. Ulinnuha, and D. Yuliati, "Forecasting Population of Madiun Regency Using ARIMA Method," *CAUCHY: Jurnal Matematika Murni dan Aplikasi*, vol. 7, no. 3, pp. 420–431, 2022.

[7] S. Zubaedah, "Blue Control Mari KB sebagai instrument untuk meningkatkan kepesertaan KB MKJP di Kabupaten Madiun," *Jurnal Pemerintahan, Pembangunan dan Inovasi Daerah*, vol. 3, no. 1, pp. 1–8, 2021.

[8] M. D. Rahiem, "COVID-19 and the surge of child marriages: A phenomenon in Nusa Tenggara Barat, Indonesia," *Child Abuse & Neglect*, vol. 118, no. October, pp. 1–13, aug 2021.

[9] E. Riany, “Faktor-Faktor yang Berpengaruh Terhadap Pernikahan Usia Dini,” *Journal Of Telenursing*, vol. 2, no. 2, pp. 158–167, 2020.

[10] K. Machiyama, J. B. Casterline, J. N. Mumah, F. A. Huda, F. Obare, G. Odwe, C. W. Kabiru, S. Yeasmin, and J. Cleland, “Reasons for unmet need for family planning, with attention to the measurement of fertility preferences: protocol for a multi-site cohort study,” *Reproductive Health*, vol. 14, no. 1, pp. 14 – 23, dec 2017.

[11] F. Götmark and M. Andersson, “Human fertility in relation to education, economy, religion, contraception, and family planning programs,” *BMC Public Health*, vol. 20, no. 1, pp. 1–17, dec 2020.

[12] Institute of Medicine (U.S.). Committee on a Comprehensive Review of the HHS Office of Family Planning Title X Program., A. S. Butler, E. W. Clayton, Institute of Medicine (U.S.). Committee on a Comprehensive Review of the HHS Office of Family Planning Title X Program., Institute of Medicine (U.S.). Board on Health Sciences Policy., and Y. National Research Council (U.S.). Board on Children, *A review of the HHS Family Planning Program : mission, management, and measurement of results*. National Academies Press, 2009.

[13] C. D. and S. T.P., “The economic consequences of reproductive health and family planning,” *The Lancet*, vol. 379, no. 9837, pp. 165–171, 2012.

[14] B. Utomo, P. K. Sucahya, N. A. Romadlona, A. S. Robertson, R. I. Aryanty, and R. J. Magnani, “The impact of family planning on maternal mortality in Indonesia: what future contribution can be expected?” *Population Health Metrics*, vol. 19, no. 1, pp. 1–13, dec 2021.

[15] D. Dailami, W. N. Atikah, and S. Rahmayanti, “Strategi Komunikasi Penyuluh Lapangan dalam Memasyarakatkan Penggunaan Kontrasepsi bagi Pasangan Usia Subur (PUS) di Asahan,” *Jurnal Pendidikan Tambusai*, vol. 5, no. 2, pp. 5316–5322, 2021.

[16] M. Mazharul Islam and A. H. M. Saidul Hasan, “Mass Media Exposure and its Impact on Family Planning in Bangladesh,” *Journal of Biosocial Science*, vol. 32, no. 4, pp. 513–526, oct 2000.

[17] W. Astuti and Sudarmiani, “Pemberdayaan Ekonomi Keluarga Melalui Usaha Peningkatan Pendapatan Keluarga Sejahtera (UPPKS) (Studi Kasus di Desa Sukorejo Kecamatan Saradan Kabupaten Madiun),” *EQUILIBRIUM : Jurnal Ilmiah Ekonomi dan Pembelajarannya*, vol. 7, no. 2, pp. 116–124, jul 2019.

[18] P. Nerurkar, A. Shirke, M. Chandane, and S. Bhirud, “Empirical Analysis of Data Clustering Algorithms,” in *Procedia Computer Science*. Elsevier B.V., 2018, pp. 770–779.

[19] A. Rajabi, M. Eskandari, M. J. Ghadi, L. Li, J. Zhang, and P. Siano, “A comparative study of clustering techniques for electrical load pattern segmentation,” *Renewable and Sustainable Energy Reviews*, vol. 120, no. January, mar 2020.

[20] A. Saxena, M. Prasad, A. Gupta, N. Bharill, O. P. Patel, A. Tiwari, M. J. Er, W. Ding, and C.-T. Lin, “A review of clustering techniques and developments,” *Neurocomputing*, vol. 267, no. December, pp. 664–681, dec 2017.

[21] N. Nidheesh, K. A. Abdul Nazeer, and P. M. Ameer, “An enhanced deterministic K-Means clustering algorithm for cancer subtype prediction from gene expression data,” *Computers in Biology and Medicine*, vol. 91, pp. 213–221, 2017.

[22] A. C. L. Ribeiro-Accioly, M. L. Seidl-De-Moura, D. M. L. F. Mendes, and J. Mesman, “Maternal sensitivity in mother-infant interactions in Rio de Janeiro Brazil,” *Attachment & Human Development*, pp. 1–8, mar 2018.

[23] W. Wahidin, M. Mugihartadi, T. H. B. Aviani, H. Pratiwi, Y. I. Wijaya, A. Andie, A. P. Windarto, and A. Waluyo, “Application of data mining techniques using the K-Means Method on Unmet Need of Health Services by Province in Indonesia,” *Journal of Physics: Conference Series*, vol. 1783, no. 1, pp. 1–7, feb 2021.

[24] A. S. Ahmar, D. Napitupulu, R. Rahim, R. Hidayat, Y. Sonatha, and M. Azmi, “Using K-Means Clustering to Cluster Provinces in Indonesia,” *Journal of Physics: Conference Series*, vol. 1028, no. 1, pp. 1–6, jun 2018.

[25] Y. Im and S. Jung, “Family functioning according to clusters of family management styles in Korean families of children with chronic atopic disease: A cross-sectional study,” *International Journal of Nursing Studies*, vol. 109, no. Sep, p. 103674, sep 2020.

[26] L. Ganda, R. Putra, and A. Anggrawan, “Pengelompokan Penerima Bantuan Sosial Masyarakat dengan Metode Grouping of Recipients of Community Social Assistance with the K-Means Method,” *Matrik: Jurnal Manajemen, Teknik Informatika, dan Rekayasa Komputer*, vol. 21, no. 1, pp. 205–214, 2021.

[27] G. S. Nugraha and H. Hairani, “Aplikasi Pemetaan Kualitas Pendidikan di Indonesia Menggunakan Metode K-Means,” *MATRIK: Jurnal Manajemen, Teknik Informatika dan Rekayasa Komputer*, vol. 17, no. 2, pp. 13–23, 2018.

[28] A. Ali, “Klasterisasi Data Rekam Medis Pasien Menggunakan Metode K-Means Clustering di Rumah Sakit Anwar Medika Balong Bendo Sidoarjo,” *MATRIK : Jurnal Manajemen, Teknik Informatika dan Rekayasa Komputer*, vol. 19, no. 1, pp. 186–195, 2019.

[29] A. Adeyemo, H. Wimmer, and L. M. Powell, “Effects of normalization techniques on logistic regression in data science,” in *2018 Proceedings of the Conference on Information Systems Applied Research*, 2018, pp. 1–9.

[30] S. Jain, S. Shukla, and R. Wadhvani, “Dynamic selection of normalization techniques using data complexity measures,” *Expert Systems with Applications*, vol. 106, pp. 252–262, 2018.

[31] S. B. Seo, Y. O. Kim, Y. Kim, and H. I. Eum, “Selecting climate change scenarios for regional hydrologic impact studies based on climate extremes indices,” *Climate Dynamics*, vol. 52, no. 3-4, pp. 1595–1611, 2019.

[32] A. C. Ross and R. G. Najjar, “Evaluation of methods for selecting climate models to simulate future hydrological change,” *Climatic Change*, vol. 157, no. 3-4, pp. 407–428, dec 2019.

[33] S. J. Redmond and C. Heneghan, “A method for initialising the clustering algorithm using kd-trees,” *Pattern Recognition Letters*, vol. 28, no. 8, pp. 965–973, 2007.

[34] H. B. Tambunan, D. H. Barus, J. Hartono, A. S. Alam, D. A. Nugraha, and H. H. H. Usman, “Electrical Peak Load Clustering Analysis Using K-Means Algorithm and Silhouette Coefficient,” in *2020 International Conference on Technology and Policy in Energy and Electric Power (ICT-PEP)*. IEEE, sep 2020, pp. 258–262.

[35] H. Santoso and H. Magdalena, “Improved K-Means Algorithm on Home Industry Data Clustering in the Province of Bangka Belitung,” in *2020 International Conference on Smart Technology and Applications (ICoSTA)*. IEEE, feb 2020, pp. 1–6.

[36] S. Annas, R. H. Safei, and Z. Rais, “Using k-Means and Self Organizing Maps in Clustering Air Pollution Distribution in Makassar City , Indonesia,” *Jambura Journal of Mathematics*, vol. 4, no. 1, pp. 167–176, 2022.