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Research Article

Determining Appropriate Number of Labors in Yellow Noodle SMEs Using K-Means Clustering Method: Meeting Demand While Minimizing Company Costs

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Abstract.

Yellow noodle SMEs face the challenge of aligning their workforce with the fluctuating customer demand. Addressing this issue involves scaling up production staffing during peak yellow noodle demand. This study aimed to determine when and how much production labor should be added. Workforce expansion occurred through contractual arrangements during demand surges. This study used the K-Means clustering method to determine demand clusters. Each cluster underwent detailed analysis to calculate the precise number of required production workers. The study used the noodle sales in 2021–2022. Results showed that yellow noodle SMEs had eight permanent workers. Demand clusters were categorized into three classes. High-demand periods were observed in May and December, while moderate demand occurred in January, February, March, April, June, July, and August. September, October, and November constituted the low-demand cluster. Based on these findings, the study recommended adding one worker during high-demand and moderate-demand periods to maintain operational efficiency. Remarkably, no workforce additions were advised during the low-demand phase to optimize resource allocation and cost-effectiveness. In summary, this research addresses labor management challenges for yellow noodle SMEs. Leveraging data-driven approaches and cluster analysis offers SMEs a strategic framework to enhance workforce planning thereby improving operational efficiency and cost-effectiveness.

Keywords: yellow noodle SMEs, workforce demand clustering, operational efficiency

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1. Introduction

This study took place in yellow noodle SMEs (small-medium enterprises). This business could produce an average of 3800 pcs of yellow noodles monthly. In one year, there were times when this business experienced demand above the average production, so the business had to force employees to work extra hours. Until then, the business had eight permanent production employees. This number was always constant throughout the year. The business never hired additional employees, even during the high-demand months. This was undoubtedly a problem from the health side of workers because workers experienced fatigue.

From these problems, the business needed an effective way to determine the number of workers. Determining the number of workers was identifying and determining the number of employees or workers needed to carry out specific tasks in a company. This was essential to the company's human resource (HR) planning. The accuracy of the number of workers was critical because they could do the work according to the needs and be done according to the target. Furthermore, it could meet consumer demand for many products. At the same time, excess labour could also be bad for the company because there would be more expenses while there were unemployed or not optimal workers. The optimal number of workers would positively impact the continuity of a company, reduce the workload between workers, and provide customer satisfaction with orders that would be processed quickly [1].

This study used the K-means clustering method to determine the optimal number of workers at yellow noodle SMEs. K-Means clustering was a method for categorizing or grouping objects according to the same attribute into several groups. It defined a cluster by its mass, representing the cluster's mean [2]. In this study, k-means clustering was used to classify production months. Then each group was analyzed to determine the optimal number of workers it had. If the required workforce exceeded the existing workforce, the company was advised to hire contract workers. From this research, it could be seen when and how much the number of workers was added.

K-means clustering was a standard method for grouping objects. K-Means clustering could be used to group building materials into several categories: very in demand, in demand, and less in demand [3]. K-means was also used to classify data on student scores [4,5], Indonesia COVID-19 risk province clustering [6], hotspot fire area [7], group unemployment data [8,9], group of jobs [10], group goods that were in demand [11–13], group data of Umrah pilgrims [14], group of corn planting area [15], and group businesses

within a district [16]. K-means have also been used to map teacher workforce needs [17]. However, the research conducted by [17] did not describe how many workers were needed.

In this study, we used k-means to classify production months. We then used this information to compile the required number of workers. From the discussion above, the objectives of this study were (1) to determine the grouping of production months based on sales using K-means clustering and (2) to determine the need for the number of workers at yellow noodle SMEs based on the results of production month groupings.

2. Methodology

2.1. Location and time of research

This research was conducted at yellow noodle SMEs which is located at Pekanbaru. This study was held from April to July 2023.

2.2. Data collection

The data needed in this research was information on the company's condition. The following data needed was noodle sales data from 2021-2022.

2.3. Research process stages

This study used the k-means clustering method to determine the period cluster. Before using the k-means algorithm, it applied WCSS (Within-Cluster Sum of Squares) and average silhouette width (ASW) to determine the number of clusters from the data. The whole research process stages were described in Figure 1.

2.3.1. K-means clustering

The K-Means method was used to group data into several groups. Data in one group had the same and different characteristics from data from other groups. This method sought to minimize variations between data in a cluster and maximize data variations in other clusters [18,19]. Equation 1 mentioned the mathematical equations of K-Means method [2,20].

$$E = \sum_{i=1}^{k} \sum_{p \in C_i} dist(p, c_i)^2$$

E = the sum of the squared error for all objects in the data

p = point or object

c = centroid

dist(p,c) = Euclidean distance

k = the number of cluster

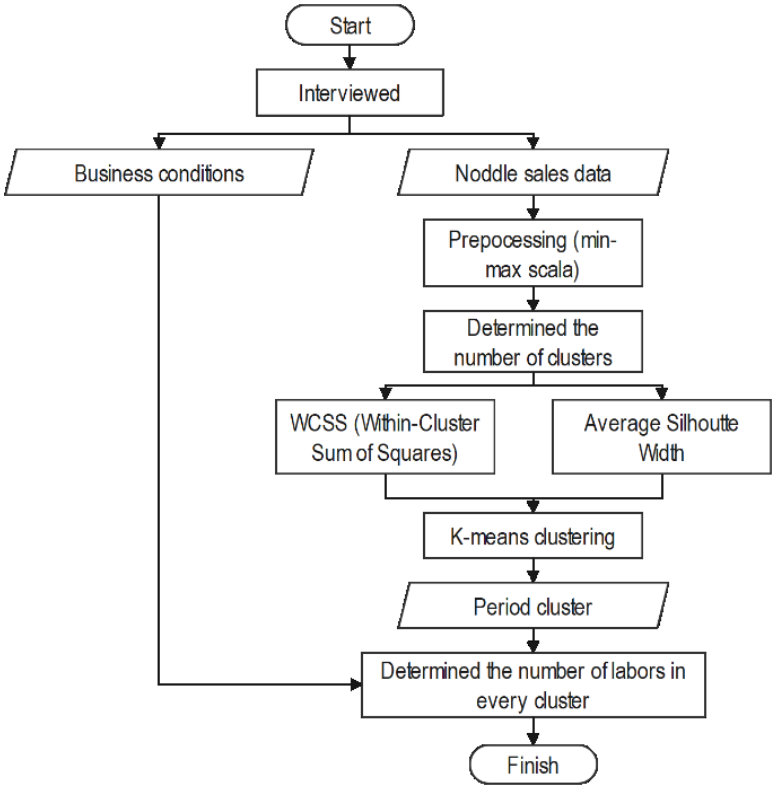

Figure 1: Research process stages.

3. Results and discussions

3.1. The noodle sales data

We got the noodle sales data from interview with the business. Before using KMeans clustering, we have to preprocessing the data with min-max scala preprocessing data. Table 1 showed the noodle sales data and prerpocessing for 2021 and 2022.

3.2. Calculated the number of clusters

This study used the WCSS and the ASW method to determine the number of clusters. The results of each method were shown in Figure 2 and Figure 3. After analyzed the result in Figure 2 and 3, we determined the number of clusters was three. We chose three because the ASW results showed the highest value, and the WCSS value had decreased. We did not choose a value of four because, according to the results of the ASW, cluster values four and six had the same the ASW value.

3.3. Calculated the number of clusters

We run k-means clustering using Rstudio with R languange. Table 2 was the cluster result for every periode. Figure 4 described the detail of Table 2.

Table 1: Noodle sales data and preprocessing for 2021-2022.

Period	Noodles Sales 2021	Preprocessing of Noodles Sales 2021	Noodles Sales 2022	Preprocessing of Noodles Sales 2022
January	3900	0.4242159	3900	0.5380276
February	3700	-0.2121079	3800	0.0000000
March	3800	0.1060540	3700	-0.5380276
April	4200	1.3787016	3800	0.0000000
Mei	3800	0.1060540	4100	1.6140828
June	4000	0.7423778	3700	-0.5380276
July	3700	-0.2121079	3800	-1.0760552
August	3700	-0.2121079	3700	-0.5380276
September	3400	-1.1665936	3600	-1.0760552
October	3200	-1.8029174	3700	-0.5380276
November	3500	-0.8484317	3600	-1.0760552
December	4300	1.6968635	4200	2.1521103

We changed the name of cluster to cluster 1 = moderate demand, cluster 2 = low demand, and cluster 3 = high demand. So, the Figure 5 showed the cluster with the specific name. From Figure 5 we know, October, September, and November were the low demand period. The moderate demand period was January, February, March, April, June, July, and August. The high demand period was June and December.

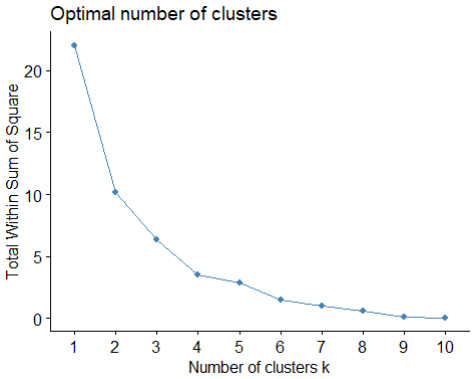

Figure 2: The WCSS chart.

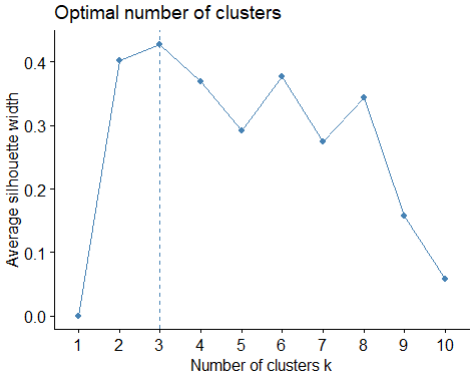

Figure 3: The ASW chart.

TABLE 2: Noodle sales data for 2021-2022 and its cluster.

Period	Noodles Sales 2021	Noodles Sales 2022	Cluster
January	3900	3900	1
February	3700	3800	1
March	3800	3700	1
April	4200	3800	1
Mei	3800	4100	3
June	4000	3700	1
July	3700	3800	1
August	3700	3700	1
September	3400	3600	2
October	3200	3700	2
November	3500	3600	2
December	4300	4200	3

Figure 4: The clustering results.

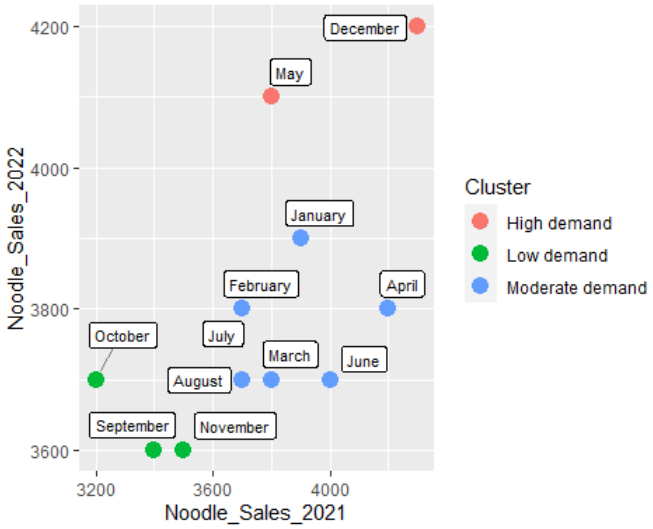

Figure 5: The clustering results with the specific name.

3.4. Determined the number of labors in yellow noodle SMEs

The business's permanent workforce was eight people. Hypothetically, the maximum number of noodles that could be produced in a month was 3800 pcs, like the interview result with the business. So, the maximum workload for each worker was to produce 475 packs of yellow noddles per month. This raised a problem when entering a very hot sales month cluster that was selling well to meet customer demand. The existing workforce needed to be increased and needed to be outsourced.

Outsourcing is delegating activities and daily management of a business process to outsiders (outsourcing service provider companies) [18]. Outsourcing was done based

TABLE 3: The addition of the number of workers each period.

Period	Cluster	Permanent Employees	Outsourcing	Total Employees
January	Moderate demand	8	1	9
February	Moderate demand	8	1	9
March	Moderate demand	8	1	9
April	Moderate demand	8	1	9
Mei	Moderate demand	8	1	9
June	High demand	8	1	9
July	Moderate demand	8	1	9
August	Moderate demand	8	1	9
September	Low demand	8	0	8
October	Low demand	8	0	8
November	Low demand	8	0	8
December	High demand	8	1	9

on fulfilling customer demands that increased over time. The characteristics of each cluster could be seen through the average monthly demand in the specified cluster. The average demand in the high-demand cluster was 4100 pcs, the average demand in the moderate-demand cluster was 3814.29 orders, and the low-demand cluster had an average request of 3500 orders.

The decision to add workers was based on the workload of each worker of 475 packs of noodles per month. Business owners could outsource based on clustering results if there were an increase in noodle demand. The high-demand and moderate-demand period added one worker, while the moderate- low-demand period cluster did not add external workers. Table 3 showed the total employees should the business has for every period. The addition of one worker could increase the capacity of 475 packs of yellow noodles per month.

4. Conclusion

Determining the number of workers at yellow noodle SMEs was done using k-means clustering. The results of k-means clustering were that there were three noodle sales

clusters in the business, namely the high-demand period (May and December), the moderate-demand period (January, February, March, April, June, July, and August), and the low-demand period (September, October, and November). The business had eight permanent employees. Each worker produced a maximum of 475 pcs of noodles per month. So, from the cluster results, the business could add the workers from the outsourcing as many as one person in the moderate-demand and high-demand period..

References

[1] Kusuma TY, Firdaus MF. Penentuan Jumlah Tenaga Kerja Optimal Untuk Peningkatan Produktifitas Kerja (Studi Kasus: UD.Rekayasa Wangdi W). Integrated Lab Journal. 2019;7:26–36.

[2] Han J, Pei J, Tong H. Data Mining: Concepts and Techniques. 4th ed. Morgan Kaufmann; 2022.

[3] Harahap B. Penerapan Algoritma K-Means Untuk Menentukan Bahan Bangunan Laris (Studi Kasus Pada UD. Toko Bangunan YD Indarung). READY STAR - 2 2019;2:394–403.

[4] Hutagalung J, Syahputra YH, Tanjung ZP. Pemetaan Siswa Kelas Unggulan Menggunakan Algoritma K-Means Clustering. Hal AH Nasution. 2022;9(1):606–20.

[5] Yudhistira A, Andika R. Pengelompokan Data Nilai Siswa Menggunakan Metode K-Means Clustering [JAITI]. Journal of Artificial Intelligence and Technology Information. 2023;1(1):20–8.

[6] Abdullah D, Susilo S, Ahmar AS, Rusli R, Hidayat R. The application of K-means clustering for province clustering in Indonesia of the risk of the COVID-19 pandemic based on COVID-19 data. Qual Quant. 2022;56(3):1283–91.

[7] Khairani NA, Sutoyo E. Application of k-means clustering algorithm for determination of fire-prone areas utilizing hotspots in West Kalimantan Province. International Journal of Advances in Data and Information Systems. 2020;1(1):9–16.

[8] Harits D, Andriyas Puji A, Andivas M, Dermawan D, Thoriq EA, Raya JP, et al. Analisis Klaster Tingkat Pengangguran di Provinsi Kalimantan Timur Menggunakan Algoritma K-Means. Jurnal Surya Teknika. 2022;9(2):456–60.

[9] Sarbaini SW, Muttakin F. Cluster Analysis Menggunakan Algoritma Fuzzy K-Means Untuk Tingkat Pengangguran di Provinsi Riau [JTMIT]. Jurnal Teknologi Dan Manajemen Industri Terapan. 2022;1(2):78–84.

[10] Shamrat FM, Tasnim Z, Mahmud I, Jahan N, Nobel NI. Application Of K-Means Clustering Algorithm To Determine The Density Of Demand Of Different Kinds Of Jobs. International Journal of Scientific & Technology Research. 2020;9:2.

[11] Astuti N, Utamajaya JN, Pratama A. Penerapan Data Mining Pada Penjualan Produk Digital Konter Leppangeng Cell Menggunakan Metode K-Means Clustering [Jurnal Riset Komputer]. JURIKOM. 2022;9(3):754.

[12] Sallaby AF, Alinse RT, Sari VN, Ramadani T. Pengelompokan Barang Menggunakan Metode K-Means Clustering Berdasarkan Hasil PenjualanDi Toko Widya Bengkulu. Jurnal Media Infotama. 2022;18(1):99–104.

[13] Triyandana G, Putri LA, Umaidah Y. Penerapan Data Mining Pengelompokan Menu Makanan dan Minuman Berdasarkan Tingkat Penjualan Menggunakan Metode K-Means [JAIC]. Journal of Applied Informatics and Computing. 2022;6(1):40–6.

[14] Hidayat T. Klasifikasi Data Jamaah Umroh Menggunakan Metode K-Means Clustering. Jurnal Sistim Informasi Dan Teknologi; 2022. pp. 19–24.

[15] Aldino AA, Darwis D, Prastowo AT, Sujana C. Implementation of K-Means Algorithm for Clustering Corn Planting Feasibility Area in South Lampung Regency. J Phys Conf Ser, vol. 1751, IOP Publishing Ltd; 2021.

[16] Kurniadewi H, Hakim RA, Jajuli M, Jaman JH. Pemetaan UMKM dalam Upaya Pengentasan Kemiskinan dan Penyerapan Tenaga Kerja Menggunakan Algoritma K-Means [JAIC]. Journal of Applied Informatics and Computing. 2022;6(2):113–9.

[17] Rasyid R, Salim Y, Ramdaniah R. Sistem Informasi Pemetaan Kebutuhan Tenaga Kerja Guru berbasis Web menggunakan Metode K-Means. Buletin Sistem Informasi Dan Teknologi Islam. BUSITI; 2023. p. 4.

[18] Melani I, Priyatna B, Nurapriani F, Hilabi SS. Implementasi Metode K-Means Clustering Pada Penilaian Kinerja Karyawan PT Kopetri Citra Abadi. Jurnal Informasi Interaktif. 2023;8:24–30.

[19] Septiana V, Rahman AN. Penerapan Metode K-Means Clustering Untuk Mengelompokan Jenis Industri di Kota Tangerang Selatan. Math Vis. 2022;04(2):100–5.

[20] Mohammed J. Zaki, Wagner Meira Jr. Data Mining and Machine Learning: Fundamental Concepts and Algorithms. 2nd ed. Cambridge University Press; 2020.