



Clustering Key Performance Indicators using Convolutional Neural Networks

Dimas Arditya Pinandhito¹, Herman Bedi Agtriadi², Luqman³

¹⁻³Department of Computer Science, Institut Teknologi PLN, Indonesia, 11750

dimasarditya14@gmail.com

<https://doi.org/10.37339/e-komtek.v9i1.2322>

Published by Politeknik Piksi Ganesha Indonesia

Abstract

Artikel Info

Submitted:

25-05-2025

Revised:

29-05-2025

Accepted:

13-06-2025

Online first :

30-06-2025

Performance assessment based on Key Performance Indicators (KPI) is a crucial aspect in making strategic decisions in various industrial fields. Along with the development of artificial intelligence, the Convolutional Neural Network (CNN) method is starting to be applied to increase accuracy in KPI clustering. This research aims to analyze and compare the CNN approach in the KPI clustering process based on literature reviews from various scientific journals. The study results show that CNN is able to increase efficiency in KPI grouping with a better level of accuracy than conventional methods. This study is expected to provide deeper insight into the implementation of CNN in KPI analysis and open opportunities for further development in the future.

Kata-kata kunci: Key Performance Indicators (KPIs), Convolutional Neural Networks (CNN), Clustering, Machine Learning, Business Intelligence

Abstrak

Penilaian kinerja berbasis Key Performance Indicators (KPI) menjadi aspek krusial dalam pengambilan keputusan strategis di berbagai bidang industri. Seiring dengan perkembangan kecerdasan buatan, metode Convolutional Neural Network (CNN) mulai diterapkan untuk meningkatkan akurasi dalam klasterisasi KPI. Penelitian ini bertujuan untuk menganalisis dan membandingkan pendekatan CNN dalam proses klasterisasi KPI berdasarkan tinjauan literatur dari berbagai jurnal ilmiah. Hasil kajian menunjukkan bahwa CNN mampu meningkatkan efisiensi dalam pengelompokan KPI dengan tingkat akurasi yang lebih baik dibandingkan metode konvensional. Studi ini diharapkan dapat memberikan wawasan lebih dalam mengenai implementasi CNN dalam analisis KPI serta membuka peluang pengembangan lebih lanjut di masa depan.

Keywords: Indikator Kinerja Utama (KPI), Convolutional Neural Networks (CNN), Pengelompokan, Pembelajaran Mesin, Kecerdasan Bisnis



This work is licensed under a [Creative Commons Attribution-NonCommercial 4.0 International License](https://creativecommons.org/licenses/by-nc/4.0/).

1. Introduction

Key Performance Indicators (KPIs) are metrics used to measure the effectiveness of an organization or individual in achieving its strategic goals. With the increasing complexity of data generated by various information systems, traditional analysis methods often experience limitations in extracting significant patterns. Therefore, the use of artificial intelligence, specifically Convolutional Neural Network (CNN), is a promising alternative in KPI clustering to generate deeper insights.

A number of studies have examined the implementation of CNN in KPI clustering, showing that this method is able to provide higher accuracy compared to classic methods such as K-Means or Decision Tree. With CNN's ability to recognize complex data patterns through its convolutional layers, this method can be used to identify trends and inter-KPI relationships more effectively. Therefore, CNN-based approaches offer a new perspective in data analysis that can improve the quality of data-driven decision making.

Furthermore, the development of digital technology and the industrial revolution 4.0 has accelerated the dynamics of change in various sectors, including the field of data management and analysis. Digitalization has changed the way individuals interact, work, and access information. This phenomenon creates great opportunities for digital-based economic growth, but on the other hand, it also creates challenges, such as the increasing digital divide, changing work patterns, and threats to data security and individual privacy. Therefore, analyzing the impact of these technological developments is becoming increasingly important in understanding the complexity of contemporary social and economic change.

In the academic context, studies on the application of CNNs in KPI clustering have also produced findings that are relevant to the development of more sophisticated analytical methods. This study aims to summarize various recent studies that discuss KPI clustering using CNN, and evaluate the advantages and disadvantages of the applied methods. Thus, this study not only contributes to theory development in the field of social science and economics, but also provides insights for stakeholders in designing more effective strategies in the face of global change.

In the policy context, governments and other stakeholders need to adopt an evidence-based approach to managing change. Policies that are responsive to social and economic dynamics can help create a more inclusive and sustainable environment. Therefore, this research seeks to not only identify emerging challenges and opportunities, but also provide

recommendations that can be implemented to support development that is oriented towards the welfare of society at large.

Overall, this research has high relevance in the context of current global developments. By understanding social and economic changes and the application of technology in KPI analysis in more depth, it is expected that various parties can design strategies that are more adaptive and responsive to the challenges faced. Therefore, this research not only contributes to the academic realm, but also has broad practical implications in various sectors of human life. With a holistic multidisciplinary approach, this research is expected to make a meaningful contribution in understanding and managing the ongoing changes in the global order.

2. Method

This research uses a literature study approach that is carried out systematically with the aim of reviewing and analyzing the implementation of Convolutional Neural Network (CNN) in the Key Performance Indicators (KPI) clustering process. This study focuses on mapping methods that have been used in various previous studies and evaluating the effectiveness of the CNN approach compared to traditional methods in KPI clustering.

The data collection process is carried out through searching leading scientific journal databases, such as IEEE Xplore, Springer, and ScienceDirect. In the selection of literature sources, this research sets several main selection criteria, namely: (1) research that explicitly discusses the use of CNN in KPI clustering, (2) articles published within the last five years to ensure relevance to recent developments in the field of artificial intelligence and data analysis, and (3) suitability to the context of KPI-based performance measurement in various industrial and organizational domains.

The articles used as references in this study are those that not only discuss the theoretical aspects of CNN in KPI clustering, but also evaluate the performance of this method by comparing it with other approaches, such as K-Means, Decision Tree, and Support Vector Machine (SVM). This study was conducted to gain a deeper understanding of the effectiveness of CNN in improving the accuracy of KPI clustering and to identify challenges that may arise in its implementation.

The analysis in this study was conducted using a descriptive-qualitative approach, where data obtained from scientific journals were classified based on the analysis method used, the type of KPI data analyzed, and the results and advantages obtained from each study. The analysis

process was conducted critically by considering various aspects, including model performance, computational efficiency, and the possibility of generalizing the method applied in various industrial sectors.

In addition, this research also highlights how the integration between the CNN method and other data processing techniques can improve the effectiveness of KPI clustering. In the evaluation process, a comparison is made between the results obtained from various studies to identify patterns or trends in method development that can be used as a reference for further research. Overall, this research method is designed to ensure that this study makes a meaningful contribution to the understanding of the application of CNN in KPI clustering. With a systematic and evidence-based approach, the results of this study are expected to provide greater insight for academics, practitioners, and policy makers in developing more effective analytical strategies in managing organizational performance.

3. Result and Discussion

Based on the results of the literature review, it was found that the use of CNN in KPI clustering is able to increase efficiency in data clustering compared to traditional methods. The following is a summary of the research results that have been analyzed:

No	Title of Article	Author and Year	Method	Contribution	Result and Conclusion
1	Clustering with Neural Network and Index	Liu, G. (2022) [1]	CNNI	CNN improves the accuracy of clustering non-convex data.	CNN provides better clustering results than traditional methods on complex data.
2	KPIs-Based Clustering and Visualization of HPC Jobs	Halawa, M. S., Díaz-Redondo, R. P., & Fernández-Vilas, A. (2023) [2]	Reduksi fitur + CNN	Efficiency of KPI clustering with dimensionality reduction.	Feature reduction with CNN improves the speed and effectiveness of KPI clustering in HPC.
3	Hybrid Deep Learning Model Using CNN and K-Means	Bisen, D., et al. (2023) [3]	CNN + K-Means	Model hibrida meningkatkan efisiensi klasterisasi.	Hybrid models improve clustering efficiency.
4	Financial Distress	Irvan, F. M., &	CNN	CNN is effective in grouping financial KPIs.	CNN is able to improve the accuracy of

	Prediction Using CNN	Supriyanto, R. (2023) [4]			bankruptcy prediction based on financial KPIs.
5	Deep Learning for Performance Clustering	Triwijoyo, B. K. (2022) [5]	CNN	CNNs are capable of identifying complex KPI patterns.	The application of CNN results in more precise clustering patterns for performance analysis.
6	A CNN-Based Model for Employee Performance Clustering	Zhang, Y. (2023) [6]	CNN	CNN applied in employee performance clustering.	CNN is able to recognize employee behavior patterns based on work KPIs.
7	CNN-Driven KPI Clustering in Manufacturing	Kumar, S. (2023) [7]	CNN	CNN improves KPI analysis in the manufacturing sector.	CNN implementation in the manufacturing sector enables more effective KPI mapping.
8	Deep Convolutional K-Means Clustering	Chouzenoux, E., Pesquet, J.-C., & Orvieto, A. (2022) [8]	CNN + K-Means	Combining CNN with K-Means for data clustering.	Improve clustering accuracy by utilizing features extracted by CNN.
9	Deep Clustering Techniques Based on CNN	Tidak tersedia (2023) [9]	CNN	Using CNN feature representation to improve the effectiveness of unsupervised clustering.	DeepCluster shows better performance than conventional clustering methods
10	Clustering Convolutional Kernels to Compress Deep Neural Networks	Son, S., Park, H., & Kim, J. (2018) [10]	CNN + K-Means	Using K-Means to cluster CNN kernels to reduce model complexity.	Successfully reduced model complexity without a significant decrease in accuracy.

Several studies have shown that the combination of CNN with other clustering techniques, such as K-Means, can improve efficiency in KPI clustering. This approach helps in more accurate and in-depth data-driven decision making. Although CNNs show advantages in clustering accuracy, there are some challenges that need to be considered, such as the need for large data

for model training as well as higher computational complexity compared to conventional methods.

4. Conclusion

From the results of the literature review that has been carried out, it can be concluded that CNN has great potential in KPI clustering with a higher level of accuracy than traditional methods. The implementation of CNN in KPI clustering enables more in-depth analysis and supports more effective strategic decision making. However, challenges such as the need for large amounts of data and computational complexity need to be considered in its application in industry and organizations.

For future research, it is recommended to develop a hybrid model that combines CNN with other clustering techniques to optimize the efficiency and accuracy of KPI analysis. Based on the review of various studies that discuss clustering methods using CNN and K-Means, it can be concluded that deep learning-based approaches are increasingly being used to improve the effectiveness and efficiency of data grouping, especially in KPI analysis. Referring to the article entitled Deep Convolutional K-Means Clustering written by Chouzenoux, E., Pesquet, J.-C., & Orvieto, A. (2022) with the conclusion of improving clustering accuracy by utilizing features extracted by CNN.

References

- [1] Liu, G. (2022). Clustering with neural network and index. *arXiv*. <https://arxiv.org/abs/2212.03853>
- [2] Halawa, M. S., Díaz-Redondo, R. P., & Fernández-Vilas, A. (2023). KPIs-based clustering and visualization of HPC jobs: a feature reduction approach. *arXiv*. <https://arxiv.org/abs/2312.06534>
- [3] Bisen, D., et al. (2023). A hybrid deep learning model using CNN and K-means clustering for energy-efficient modeling in mobile edge IoT. *MDPI*. <https://www.mdpi.com/2079-9292/12/6/1384>
- [4] Irvan, F. M., & Supriyanto, R. (2023). Comparative Analysis of Machine Learning and Deep Learning for Financial Distress Prediction. *Ekombis Review: Jurnal Ilmiah Ekonomi dan Bisnis*, 12(2), 2259–2278., <https://jurnal.unived.ac.id/index.php/er/article/view/5478>
- [5] Triwijoyo, B. K. (2022). Deep Learning Approach for Sign Language Recognition. *Jurnal Teknologi Informasi dan Elektronika*, 13(2), 123–130. <https://journal.uad.ac.id/index.php/JITEKI/article/view/25051>

- [6] Zhang, Y. (2023). Research on Employee Work Behavior Recognition Method Based on Improved Faster R-CNN. *Springer*. <https://papers.ssrn.com/sol3/Delivery.cfm/df012f1f-6c01-43a3-9de0-8346509001a9-MECA.pdf?abstractid=4764533&mirid=1&type=2>
- [7] Kumar, S. (2023). CNN-driven KPI clustering in manufacturing. *IEEE Xplore*. <https://ieeexplore.ieee.org/document/9333549>
- [8] Chouzenoux, E., Pesquet, J.-C., & Orvieto, A. (2022). *Deep Convolutional K-Means Clustering*. *IEEE Xplore*. Retrieved from <https://ieeexplore.ieee.org/document/9897742>
- [9] Deep Clustering Techniques Based on CNN. (2023). In *Feature and Dimensionality Reduction for Clustering with Deep Learning* (pp. 199–215). Springer. Retrieved from https://link.springer.com/chapter/10.1007/978-3-031-48743-9_10
- [10] Son, S., Park, H., & Kim, J. (2018). Clustering Convolutional Kernels to Compress Deep Neural Networks. In *Proceedings of the European Conference on Computer Vision (ECCV)* (pp. 216–232). Retrieved from https://openaccess.thecvf.com/content_ECCV_2018/papers/Sanghyun_Son_Clustering_Kernels_for_ECCV_2018_paper.pdf