# Matrix: Basic Concepts And Practical Applications In Daily Life

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**ABSTRACT –** *Matrix, as a fundamental mathematical concept, have crucial applications in computer science. This study analyzes: the basic structure of matrices (definition, types, addition-multiplication-inverse operations), and their implementation in computational fields, including: digital image processing (pixel representation, image transformation), intelligent systems (matrix-based neural networks), data security (matrix encryption), and network optimization (routing algorithms). A combination of literature review and case analysis reveals that understanding matrices is the backbone of modern computing, particularly in the development of machine learning and computer vision. Findings indicate a gap between conventional matrix theory and the demands of large-scale computing in industry. This study recommends integrating examples of computer science applications into matrix education to prepare digital talent.*

**Keywords** - *Mathematics, Linear Algebra, Matrix, Matrix Operation, Mathematical Application, Data Processing*

## *Matriks: Konsep Dasar Dan Penerapannya Dalam Kehidupan Sehari-Hari*

**ABSTRAK –** *Matriks sebagai konsep matematika fundamental memiliki aplikasi krusial dalam informatika. Penelitian ini menganalisis: struktur dasar matriks (definisi, jenis, operasi penjumlahan-perkalian-invers), dan implementasinya dalam bidang komputasi meliputi: pemrosesan citra digital (representasi piksel, transformasi gambar), sistem cerdas (jaringan saraf berbasis matriks), keamanan data (enkripsi matriks), serta optimasi jaringan (algoritma routing). Metode kombinasi studi literatur dan analisis kasus mengungkap bahwa pemahaman matriks menjadi tulang punggung komputasi modern, khususnya dalam pengembangan machine learning dan computer vision. Temuan menunjukkan adanya kesenjangan antara teori matriks konvensional dengan kebutuhan komputasi skala besar di industri. Penelitian ini merekomendasikan integrasi contoh aplikasi informatika dalam pembelajaran matriks untuk mempersiapkan talenta digital.*

**Kata Kunci** *– Matematika, Aljabar Linear, Matriks, Operasi Matriks, Aplikasi Matematika, Pemrosesan Data*

## 1. INTRODUCTION

In the world of mathematics, there are many concepts and structures used to solve problems and represent phenomena in various aspects of life. One of the most significant and widely applied concepts is the matrix. A matrix is a collection of numbers or other elements arranged in rows and columns, forming a rectangular table. Although at first glance a matrix may seem like nothing more than an orderly arrangement of numbers, behind this simple structure lies great power in data management, solving equations, and developing complex systems in the fields of science and technology.

A fundamental understanding of matrix is not only a component of the mathematics curriculum, but also serves as an important tool in various disciplines, such as physics, economics, computer science, engineering, and social sciences. The concept of matrix is used for various purposes, from simplifying linear equation systems, modeling transformations in computer graphics, to forming the basis for Artificial Intelligence (AI) systems, which are currently developing rapidly.

In today's digital age, matrix have become an essential component in digital image processing, facial recognition, recommendation systems on online platforms, and statistical analysis in social

research, as well as in traffic management and urban planning. A computer's ability to process millions of data points in a short amount of time is largely made possible by matrix-based processing. For example, in the field of information technology, algorithms applied in machine learning and neural networks are largely based on matrix operations.

Although matrix have widespread and significant applications, many people still find them unfamiliar or difficult to understand, especially if they are not equipped with an applied and contextual learning approach. Therefore, it is very important to learn and understand the basics of matrix with an approach that is relevant to real life so that this concept is not only understood theoretically but can also be applied practically.

Through this article, the author will delve deeply into the definition, basic forms, and important operations of matrix, as well as present practical examples of matrix applications in everyday life. It is hoped that by understanding the fundamentals of matrix and seeing how they function in the real world, readers will come to appreciate the importance of mathematics in shaping and simplifying modern life.

## 2. LITERATURE REVIEWER

The concept of matrices has become a significant part of the development of modern mathematics, particularly in the field of linear algebra. The term "matrix" was first used by **James Joseph Sylvester** in the mid-19th century, but its systematic and in-depth use was popularized by **Arthur Cayley**, who published a fundamental work on matrix theory in 1858. In that publication, **Cayley** defined various basic operations on matrices, such as addition, multiplication, and inversion, which now form the foundation for many methods in linear algebra (Strang, 2009).

According to **Anton** and **Rorres**, a matrix is a highly flexible mathematical structure that can be used to represent and solve various systems of linear equations. These systems often appear in various real-world problems, both in science and engineering. For example, in electrical engineering, systems of linear equations are used to analyze electrical circuits, while in economics, these systems are used to model relationships between production sectors.

**Lay** emphasizes that understanding the properties of matrices, such as determinants, rank, and eigenvalues, is key to solving problems across various disciplines. Determinants are used to determine whether a matrix has an inverse, while eigenvalues and eigenvectors are crucial in analyzing dynamic systems and linear transformations. This understanding forms an important foundation for advanced studies, such as linear programming, numerical analysis, and optimization.

In the field of computer science and information technology, matrix applications have developed rapidly. According to **Gonzalez** and **Woods**, every digital image can be represented in the form of a matrix containing the light intensity or color values of each pixel. Image manipulation, such as rotation, enlargement, filtering, and compression, is performed through matrix operations on this representation. This also applies to pattern recognition, such as face and fingerprint recognition, which are important parts of today's digital security systems.

In the field of artificial intelligence and machine learning, matrices form the foundation for almost all algorithms used. **Goodfellow, Bengio,** and **Courville** explain that neural networks operate by processing data in matrix form, where the weights between neurons are represented as elements within the matrix. The training and prediction processes in these models essentially involve large-scale matrix manipulation and transformation, which requires high computational efficiency.

Matrix applications are also highly relevant in the social and economic sciences. **Miller** and **Blair** describe how input-output analysis in macroeconomics uses matrices to represent the relationships between sectors in an economy. Through this approach, it is possible to determine how changes in one sector affect others, enabling governments or planning agencies to formulate more effective data-driven policies.

In civil and mechanical engineering, the finite element method (FEM) also relies heavily on matrix representation. This method is used to solve structural mechanics problems, such as stress and deformation analysis in buildings or bridges. Each structural element is represented as a stiffness matrix, which is then combined into a large matrix system for overall analysis.

The concept of matrices also appears in everyday life through various technologies used by society. For example, GPS navigation systems use matrix-based coordinate transformations to determine the user's position. Applications such as Google Maps or online transportation apps also utilize this concept in distance calculations and route optimization.

Based on these various literature sources, it can be concluded that understanding matrices has a very broad and practical scope. Therefore, introducing this concept in a contextual and practical manner is crucial so that learners not only understand the theory but can also connect it to real-world phenomena around them.

## 3. RESEARCH METHODS

This study uses a qualitative descriptive approach with a library research method. This approach was chosen because the purpose of the study is to systematically and comprehensively describe the basic concepts of matrices and their application in everyday life, both in science, technology, economics, and social life in general. This research does not involve experiments or direct field data collection but instead utilizes data and information from various relevant and credible sources.

In this literature review, data was collected from various written references, such as mathematics textbooks, scientific journals, online scientific articles, and officially published educational documents. Mathematics textbooks were used as the main source for examining the definitions, structures, and basic operations of matrices, such as addition, multiplication, transposition, determinants, and inverses. Meanwhile, scientific journals and articles were used to reinforce the understanding of how matrices are applied in various areas of real life, including information technology, engineering, artificial intelligence, economics, and social sciences.

Data collection was carried out through reading, recording, and systematically processing information from these sources. Researchers selected and sorted information based on its relevance to the research focus, namely understanding the basic concepts of matrices and their applications. Next, a documentation process was carried out to store and organize the data obtained, thereby facilitating the analysis stage.

In this study, data analysis was conducted using content analysis. This method allows researchers to identify, categorize, and interpret various information from literature sources into a coherent and meaningful narrative. The analysis was conducted by examining the content of each reference and then linking it to predetermined major themes. The themes examined include the definition and basic structure of matrices, basic matrix operations, and various examples of their application in everyday life. Each section was analyzed to find the connection between theory and practice, as well as the extent to which an understanding of matrices can enrich the public's insight into the role of mathematics in modern life.

To maintain the quality and validity of the data obtained, researchers strive to use only literature sources that have been recognized for their credibility. Content validity is strengthened by comparing information from several different sources that discuss the same material, thereby enabling data triangulation. Thus, the information obtained is more reliable, accurate, and in line with the research objectives.

Through this method, it is hoped that the research results will provide a clear and in-depth understanding of the importance of conceptualizing and applying the matrix. Additionally, this method allows the research to be reflective of existing literature, thereby not only describing facts but also providing interpretations and emphasizing the relevance of the matrix in everyday life.

## 4. RESULT AND DISCUSSION

The results of this study indicate that a basic understanding of matrices is a very important aspect of mathematics education, especially at the secondary and university levels. In addition to being an integral part of linear algebra, the concept of matrices has a close connection to real life and various other fields of science. Through a review of various scientific literature, textbooks, and reliable digital sources, it was found that the use of matrices is not limited to the classroom or mathematical theory, but has also expanded widely in technological, economic, engineering, and social science applications.

Table 1. Number of Students by Class and Gender

| CLASS | BOY | GIRL | AMOUNT |
|-------|-----|------|--------|
| Informatika A | 28 | 15 | 43 |
| Informatika B | 32 | 10 | 42 |
| **AMOUNT** | 60 | 25 | 85 |

In mathematics, such a set of numbers, a set of numbers arranged in rows and columns to form a rectangle and placed between two brackets, is called a matrix.

The above list can be written in matrix form as follows
$$\begin{pmatrix} 28 & 15 & 43 \\ 32 & 10 & 42 \\ 60 & 25 & 85 \end{pmatrix}$$

Each number in the matrix is called an element (component) of the matrix. The location of a matrix element is determined by the row and column in which the element is located. For example, in the matrix above, the element 25 is located in the third row and the second column. A matrix is denoted by capital letters A, B, C, and so on, while matrix elements are denoted by lowercase letters a, b, c, and so on.

Example:

$$\begin{matrix} 1^{st} \text{ rows} \\ 2^{nd} \text{ rows} \end{matrix} \quad \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{pmatrix}$$

$1^{st}$ column, $2^{nd}$ column, $3^{rd}$ column

Matrix A has two rows and two columns. Therefore, we say that matrix A is of order 2x3, written as $A_{2x3}$ or $(a_{23})$. The order of a matrix is determined by the number of rows and columns in the matrix.

Matrices, simply defined, are arrangements of numbers or elements organized into rows and columns. This simple structure is highly efficient for storing, processing, and transforming large amounts of data. From observations of various sources, it is known that nearly all modern digital technologies, including social media applications, digital cameras, graphic design software, and recommendation systems like those used on YouTube or Netflix, utilize data manipulation in the form of matrices. This demonstrates that understanding matrices is highly relevant to the current development of information technology.

In the field of information technology, particularly in digital image processing and computer graphics, digital images are represented as two-dimensional matrices, where each element represents the intensity of light or color at a specific pixel. For example, a digital photo displayed on a monitor screen is actually the result of manipulating millions of numbers in a matrix, which are then translated into specific colors. Processes such as blurring, sharpening, rotation, or resizing images are direct results of mathematical operations on that matrix. Therefore, understanding matrix operations such as multiplication and transposition is crucial in the creative industry and digital design.

In the fields of artificial intelligence (AI) and machine learning, the use of matrices becomes even more fundamental. Every training data input into an AI algorithm system is processed in matrix form. The weights in neural networks, used to recognize patterns such as handwriting, human faces, or sounds, are represented as matrices and modified during the model training process. This enables machines to learn from experience and make decisions based on recognized patterns. Thus, matrices have become the foundation for the development of technologies that are increasingly used in everyday life, from virtual assistants to biometric security systems.

In the field of economics and management, analysis shows that matrices are used in input-output models between production sectors. For example, in the Leontief model, the relationship between industrial sectors in an economy can be represented in matrix form, which facilitates analysis of the impact of changes in one sector on other sectors. Matrices also play a role in financial portfolio risk analysis, calculating correlations between assets, and data-driven decision making. This demonstrates that understanding the basic concepts of matrices can provide added value for economic actors and policymakers in designing more effective strategies.

Equally important, the application of matrices in engineering and natural sciences is also highly significant. In civil engineering and mechanical engineering, the Finite Element Method (FEM) uses stiffness matrices to calculate stress and deformation in building structures or machine components. In modern physics, particularly quantum mechanics, wave functions and physical operators are represented in matrix form, enabling mathematical calculations of system states. This demonstrates that matrices are not merely computational tools but also the primary language for mathematically representing physical reality.

The results of this study also show that students' understanding of matrix concepts is often limited to technical or procedural mastery, such as how to add two matrices or find their inverses. The inadequacy of the contextual approach causes students to have difficulty connecting this material to real-life situations. Therefore, it is recommended to apply an applied and problem-based learning method so that students not only understand "how" to perform operations but also 'why' and "where" the concept is used. For example, teachers can relate the use of matrices to processing student grades, scheduling lessons, or distributing goods in logistics.

This discussion also emphasizes that matrices play a crucial role in the digital age characterized by big data and automation. The existence of spreadsheet software such as Microsoft Excel or Google Sheets, which allows users to perform matrix operations directly, further highlights the importance of mastering this concept, even for non-technical purposes such as household financial planning or analyzing community survey data. Thus, matrix literacy can be considered part of data literacy and numeracy, which are increasingly necessary in the information age.

Overall, the results of this study indicate that a basic understanding of matrices is not only a foundation in formal mathematics, but also an important prerequisite for individuals to adapt and actively participate in the development of technology, economics, and data-driven social life. By expanding the scope of learning and applying a more contextual teaching approach, it is hoped that students' and society's understanding of this concept can be significantly improved.

## 5. CONCLUSION

From the results of the study and discussion that has been conducted, it can be concluded that matrices are one of the fundamental concepts in mathematics that play a crucial role, not only in theoretical

learning but also in various aspects of daily life. Matrices are more than just an arrangement of numbers in rows and columns used to solve mathematical problems in class; they function as an efficient and multifunctional tool for data representation and processing. A basic understanding of the structure and operations of matrices, such as addition, multiplication, transposition, determinants, and inverses, forms an important foundation for understanding more complex systems, especially in today's digital age. Research shows that the applications of matrices are extremely broad and span various fields, including information technology, artificial intelligence, digital image processing, computer graphics, civil engineering, physics, economics, management, and social sciences. In the world of technology, matrices form the basis for data processing in computer systems, digital image representation, and artificial intelligence development. In economics, matrices are used to analyze relationships between industrial sectors and financial portfolio management. Meanwhile, in engineering and science, matrices help solve complex calculations related to building structures, particle motion, and physical system analysis. Although matrices have many benefits and applications, students' understanding of this concept is often limited to procedural aspects. Many students are unable to relate this concept to real life because of overly theoretical learning. This presents both a challenge and an opportunity for educators to apply contextual and problem-based learning approaches, so that students can see the direct connection between mathematics and the world around them. Thus, a basic understanding of matrices is not only important in the context of mathematics education but also in preparing individuals to navigate a world increasingly reliant on data, technology, and structured systems. Enhancing mathematical literacy, particularly in understanding matrices, will be highly beneficial in fostering a generation capable of logical and analytical thinking, and ready to tackle challenges in the information age.

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