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D. B. ZADNIPROVSKYI
Postgraduate Student at the Department of Electronic Computers
Kharkiv National University of Radio Electronics
ORCID: 0009-0004-6637-6315

V. I. SITNIKOV
Assistant at the Department of Electronic Computers
Kharkiv National University of Radio Electronics
ORCID: 0009-0005-3087-6104

OVERVIEW OF DATA ANALYSIS METHODS IN THE CONTEXT OF PROJECT MANAGEMENT ACTIVITIES

The subject of this study is the data analysis methods that can be applied in the context of project management information systems to enhance the efficiency of managerial decision-making, optimize the utilization of available resources, forecast risks, and improve project outcomes. The aim of this work is to systematize and review the key data analysis methods that can be utilized in the development of project management information systems, as well as to identify their practical applications for addressing critical tasks in project management. This study addresses the following tasks: 1) Identifying the key areas of ap-plied data analysis within project management information systems; 2) Describing data analysis methods, their purposes, and examples of their application in the context of project management; 3) Classifying data analysis methods applicable to project management information systems by types of analysis (descriptive, diagnostic, predictive, prescriptive). The following meth-ods are applied: systems analysis, classification, as well as methods of descriptive, diagnostic, predictive, and prescriptive data analysis. Achieved results: the primary types and methods of data analysis applicable to project management have been sys-tematized; the tables that contain methods description for each type of analysis, their purposes, and examples of application in project management have been developed; have been identified key advantages of applying data analysis to address project management challenges such as risk forecasting, resource optimization, and improving team efficiency; practical examples of using data analysis methods for managerial decision-making have been described. Conclusions. Data analysis is a critical tool for enhancing the efficiency of project management. The use of techniques and methods of descriptive, diagnostic, predictive, and prescriptive analysis within project management information systems ena-bles managers to obtain valuable insights for informed decision-making, improve resource utilization, forecast risks, and en-hance project outcomes. The systematization of data analysis methods applicable to project management promotes their more effective application and integration into information systems, thereby improving project planning, resource utilization, risk mitigation, and ultimately increasing the quality of project execution.

Key words: *data analysis, project management, descriptive analysis, diagnostic analysis, predictive analysis, prescriptive analysis, analysis methods.*

Д. Б. ЗАДНІПРОВСЬКИЙ
аспірант кафедри електронних обчислювальних машин
Харківський національний університет радіоелектроніки
ORCID: 0009-0002-7400-2925

В. І. СІТНІКОВ
асистент кафедри електронних обчислювальних машин
Харківський національний університет радіоелектроніки
ORCID: 0009-0005-3087-6104

ДОСЛІДЖЕННЯ МЕТОДІВ АНАЛІЗУ ДАНИХ У КОНТЕКСТІ ДІЯЛЬНОСТІ З УПРАВЛІННЯ ПРОЄКТАМИ

Предметом дослідження *в статті є методи аналізу даних, які можуть застосовуватись в контексті інформаційних систем з управлінні проєктами з метою підвищення ефективності прийняття управлінських рішень, використання наявних ресурсів, прогнозування ризиків та покращення результатів проєктів.* ***Мета роботи*** *– систематизувати та провести огляд основних методів аналізу даних, які можуть бути використані при побудові інформаційних систем з управління проєктами, а також визначити їх практичне застосування для вирішення ключових завдань проєктного менеджменту. У статті розв'язуються такі* ***завдання****: 1) визначення ключових напрямів прикладного застосування аналізу даних в інформаційних системах з управління проєктами; 2) опис методів аналізу даних, їх призначення та приклади застосування в контексті проєктного менеджменту; 3) класифікація методів аналізу даних, які можуть застосовуватись в інформаційних системах з управління проєкта-*

ми, за типами аналізу даних (описовий, діагностичний, прогнозний, приписний); Застосовуються такі ***методи****: системний аналіз, класифікація, а також методи описового, діагностичного, прогнозного та приписного аналізу даних.* ***Досягнуті результати:*** *систематизовано основні типи та методи аналізу даних, які можуть використовуватись в управлінні проєктами; розроблено таблиці з описом методів кожного типу аналізу, їх призначенням та прикладами застосування в проєктному менеджменті; виявлено ключові переваги застосування аналізу даних для вирішення проблем управління проєктами, таких як прогнозування ризиків, оптимізація ресурсів та підвищення ефективності роботи команди; описано практичні приклади використання методів аналізу даних для прийняття управлінських рішень.* ***Висновки.*** *Аналіз даних є ключовим інструментом для підвищення ефективності управління проєктами. Використання технік та методів описового, діагностичного, прогнозного та приписного аналізу в інформаційних системах з управління проєктами дозволяє менеджерам отримувати цінну інформацію для прийняття обґрунтованих рішень, підвищувати ефективність використання ресурсів, прогнозувати ризики та покращувати результати проєктів. Систематизація методів аналізу даних, які можуть використовуватись в управлінні проєктами, сприяє їх більш ефективному застосуванню та інтеграції в інформаційні системи з метою підвищення ефективності планування та використання проєктних ресурсів, зниження ризиків та, як наслідок, підвищення якості виконання проєктів.*

Ключові слова: *аналіз даних, управління проєктами, описовий аналіз, діагностичний аналіз, прогнозний аналіз, приписний аналіз, методи аналізу.*

Introduction

In modern conditions, project management is characterized by increasing complexity, driven by the growing volume of data that must be analyzed to make informed managerial decisions. Projects frequently encounter numerous challenges, including budget overruns, delays in task execution, reduced team efficiency, and various risks that are often difficult to predict. The data generated during project implementation contains potentially valuable information, such as insights into risks, performance, schedules, budgets, costs, timelines, client feedback, and other aspects of operations.

However, without proper analysis, this data remains merely an unstructured collection of numerical and textual values that cannot be effectively utilized to support managerial decisions. The application of data analysis methods in project management enables the identification of hidden patterns, the prediction of future outcomes, the classification of projects based on specific characteristics (e.g., risk levels or efficiency), and the formulation of recommendations for process optimization. Thus, data analysis becomes a key tool for extracting valuable information necessary for making rational and well-founded decisions [8].

The absence of adequate data analysis forces managers to rely on intuition or limited information, significantly increasing the likelihood of erroneous decisions and, consequently, reducing the effectiveness of project management.

One of the primary challenges in data analysis within the field of project management is that the data is often insufficiently structured and complete or excessively large for manual analysis. Additionally, many projects face a lack of standardized approaches to data collection, processing, and integration, creating further barriers to effective managerial decision-making. Under such conditions, managers often lack access to timely, reliable, and relevant information, which negatively impacts the quality of project management.

Another significant challenge is the complexity of selecting appropriate data analysis methods. Since each project has unique objectives, methods that are effective for one project may be unsuitable for another. For instance, predictive analysis methods may be useful for estimating project completion timelines or resource planning but are likely to be less effective for generating recommendations or classifying tasks.

Moreover, there is a general consensus among data users regarding the importance of access to large volumes of information. However, several issues arise concerning its effective utilization. These issues can be classified into three key areas:

– Simplification: ensuring easy access to data and convenient data management.
– Unification: integrating analytical tools into the environments where users operate.
– Automation and self-service: developing mechanisms that allow users to obtain necessary reports in real time without the need for manual requests and processing [14].

According to a study by the International Data Corporation (IDC, 2021), global spending on big data and business analytics (BDA) solutions reached $215.7 billion in 2021, representing a 10.1 % increase compared to 2020. In 2022, this figure rose to $271.83 billion, and it is projected to grow to $655.53 billion by 2029 [3, 7].

The main part of the article

Problem statement and analysis types. Effective data management in project management requires clearly defined processes for collecting relevant information and ensuring its high quality. Data collection is a resource-intensive process, and data that is not actively used for decision-making leads to inefficient use of organizational resources. Identifying key information necessary for informed managerial decision-making allows for optimizing the data collection process by focusing only on metrics of strategic importance.

Organizations should carefully determine which metrics, analytical indicators, and reports are most significant for supporting management processes. Based on this, mechanisms for data collection should be developed or improved to ensure data relevance, accuracy, and accessibility. High-quality project portfolio data contributes to portfolio optimization, enabling more effective decisions regarding resource allocation, project prioritization, and risk management [14].

Project management is often accompanied by a range of challenges that impact the effectiveness of project implementation. Key challenges include:

– Uncertainty and Risks: projects frequently operate under conditions of uncertainty, which can negatively affect timelines, budgets, or the quality of outcomes.

– Limited Resources: time, financial, and human resources are constrained, requiring optimal allocation and utilization.

– Dynamic Environments: changes in market conditions, technologies, or client requirements can significantly influence project execution.

– Large Volumes of Data: the growing volume of data creates difficulties in processing and analysis without modern analytical methods.

– Lack of Data Integration: data is often stored in disparate systems, complicating comprehensive analysis.

The application of data analysis in project management helps address these challenges by improving forecast accuracy, risk classification, and the formulation of recommendations for informed managerial decision-making.

From the aforementioned challenges arise the primary directions for the practical application of data analysis in project management activities, for which various types, methods, and techniques of data analysis are utilized.

The key directions for the practical application of data analysis in project management activities include the following:

– Forecasting: enables the prediction of future project outcomes, such as completion timelines, costs, or the likelihood of risks, delays, or budget overruns. For example, historical data analysis can identify project types prone to delays and uncover the causes of such delays [12].

– Classification: facilitates the categorization of projects or client groups based on factors such as risk level, complexity, or priority. This allows managers to identify projects requiring special attention and select optimal management approaches [6].

– Recommendations: based on data analysis, recommendations can be formulated to optimize processes, improve resource allocation, or select the best execution strategies. For instance, analysis can help identify tasks with the highest risk of delay and propose methods to minimize them [11].

From the perspective of data analysis types that can be applied in project management, based on their functional purpose and the tasks they address, the following are distinguished:

– Descriptive Analysis: focuses on identifying key trends and patterns in the data, enabling the assessment of the current state of the project.

– Diagnostic Analysis: aims to uncover cause-and-effect relationships that explain the observed outcomes.

– Predictive Analysis: utilizes historical data to forecast future results, such as completion timelines or the likelihood of risks.

– Prescriptive Analysis: provides recommendations for optimal actions to achieve desired outcomes, leveraging optimization models and decision-making algorithms.

Table 1 presents a summary of the main types of data analysis, each of which is designed to address specific tasks, answer particular questions, achieve defined goals, and encompass corresponding functions.

Table 1

Main types of data analysis

Type of Analysis	Question	Objective	Example of Application
Descriptive	What happened?	Establish indicators of the current state using historical business analysis data	Development/visualization of dashboards with metrics/KPIs. Comparative performance analysis. Insights/segmentation. Fact-based evaluations.
Diagnostic	Why did it happen?	Identify the causes of problems or deviations in data or processes	Analysis of cause-and-effect relationships. Detection of anomalies. Assessment of variable impacts
Predictive	What will happen?	Predict outcomes, tendencies, customer behavior, preferences, or entity characteristics	Development of “What-if” marketing scenarios and forecasting. Predictive classification of risks, behaviors, or outcomes
Prescriptive	What should we do?	Use analytical methods to demonstrate the consequences or impacts of decision options	Automation of decision-making processes. Formulation of recommendations to improve various aspects of project management. Simulation of the impact of changes on the project. Risk management

Descriptive Analysis. Descriptive analysis is aimed at answering key questions such as “What hap-pened?”, “How often?”, and “Where?”. This level of analysis serves as the foundation for data-driven deci-sion-making, as it relies on factual data and forms the basis for developing key performance indicators (KPIs) and dashboards. Descriptive analysis involves trans-forming raw data into a format that facilitates under-standing, interpretation, reorganization, structuring, and manipulation to create summarized information that can be used for managerial decision-making [17].

This type of analysis utilizes large datasets gener-ated from historical records or observations. These da-tasets may originate from various sources, be heteroge-neous, or exist in different formats. Through specific procedures, key characteristics are identified, enabling the discovery of potentially interesting patterns. De-scriptive analysis helps uncover hidden relationships in the data, issues related to data storage, and the formu-lation of new questions requiring further investigation. The primary goal of this analysis is to simplify the complexity of data understanding and provide a more representative presentation. This is often achieved through numerical or graphical summarization, such as charts, tables, or diagrams, which allow organizations to extract valuable insights from existing data more easily [7].

For interpreting raw information within the frame-work of descriptive data analysis, the following ques-tions can be used:

– How frequently does each value (or set of values) of the relevant variable occur? For example, what is the count and percentage?
– What value best represents the «typical assessment»? For instance, how similar are the data points?
– How widely is the data distributed?
– Are there values that occur more frequently than others?
– What are the largest and smallest values?
– Are there any specific trends observed in the data?

While answers to these questions indicate that a certain event has occurred or a problem exists, they do not explain the reasons behind it. To uncover the causes of phenomena, deeper analysis is required.

Descriptive analysis focuses on detailed measure-ment of the characteristics of the studied population. During the analysis, the population is defined, all its elements are evaluated, and summary metrics such as mean values or standard deviations are calculated based on the obtained data [14].

In project management activities, the descriptive analysis methods are used to assess the current state of a project, identify key trends and patterns in the data, and form a general understanding of critical perfor-mance indicators. This provides managers with baseline information about task execution, resource utilization, timelines, and costs, serving as the foundation for fur-ther analysis and managerial decision-making.

Table 2 presents the main methods used in de-scriptive data analysis, their purpose and examples of application in the context of project management ac-tivities.

Diagnostic Analysis. Diagnostic analysis builds upon the results of descriptive analysis and focuses on answering the question, “Why did the event occur?” This type of analysis provides a deeper understanding of the causes behind patterns identified in the data. The primary goal of diagnostic analysis is to explain the reasons for anomalies and deviations by formulating and testing various hypotheses [18].

A critical aspect of conducting diagnostic analysis is the collection of detailed data. In some cases, addi-tional sources of information must be incorporated to create a complete picture, after which the conclusions are validated against the initial database.

Diagnostic analysis may involve the use of various approaches and methods, such as regression analysis, cluster analysis, time series analysis, and others [7].

In project management activities, diagnostic anal-ysis methods are used to identify cause-and-effect rela-tionships that explain observed results and analyze de-viations from planned metrics. This enables managers to gain a deeper understanding of the root causes of problems, assess the impact of various factors on pro-ject outcomes, and develop effective strategies to ad-dress these issues.

Table 3 presents the main methods employed in diagnostic analysis, their purposes, and examples of application in the context of project management ac-tivities.

Predictive Analysis. Predictive analysis is one of the most advanced types of data analysis, aimed at answering the key question: “What will happen?” It leverages the results of descriptive and diagnostic anal-ysis to identify patterns and predict “what is likely to occur” with a certain level of confidence. The accuracy and reliability of predictive analysis results largely de-pend on the quality and completeness of the input data.

With sufficient data, organizations can forecast outcomes, including those related to project risks, task performance, the impact of various factors on project execution, or the overall project portfolio.

Predictive analysis is often defined as forecasting at a more granular level, such as generating predictive scores (probabilities) for each individual element within an organization. This distinguishes it from simple fore-casting of future values. For example, predictive analyt-ics is described as “a technology that learns from expe-rience (data) to predict future behavior in order to make more effective decisions”.

In information systems, predictive analytics holds key and increasingly growing value in anticipating and preventing potential problems, enabling near-zero fail-ure rates. Furthermore, predictive analysis is increasing-ly integrated into

Table 2

Descriptive analysis techniques that could be applied to project management activities

Technique	Description	Purpose	Example of Application
Frequency distribution	Organizing and summarizing data by counting the frequency of each value or category in a dataset	Identifying the frequency of values or categories in a dataset	Tracking the frequency of completed tasks with different characteristics, project stages, or outcomes. Monitoring the occurrence of problems or risks throughout the project lifecycle
Measures of central tendency	Summarizing data by determining the central value (mean, median, mode)	Highlighting the "typical" value in a dataset	Calculating the average project completion time or task duration. Identifying the most common duration or cost of projects or specific functionalities within a project
Measures of dispersion	Quantifying the spread or variability of data (range, variance, standard deviation)	Understanding consistency or variability in a dataset	Measuring the standard deviation of task completion times to assess consistency. Analyzing variability in costs, timelines, or resource allocation. Identifying projects with significant deviations from planned metrics
Percentiles and quartiles	Summarizing data and providing information about its distribution	Representing the relative position of data points in a dataset	Evaluating project performance relative to benchmark metrics (e.g., 75th percentile of budgets). Identifying projects in the upper or lower quartile for costs or duration
Cross-tabulation	Exploring relationships between two or more categorical variables	Identifying patterns or correlations between variables	Analyzing relationships between project types and success rates. Examining correlations between team size and project completion time
Visualization techniques	Using graphical representations to summarize and present data	Facilitating data interpretation and identifying trends or patterns	Creating dashboards to visualize project progress, resource allocation, budget utilization, and risk status. Using Gantt charts to track timelines and dependencies
Data aggregation	Combining data from multiple sources or groups to create summary statistics	Providing an overall view of a dataset	Summarizing costs, resources, or hours spent across multiple projects or departments. Aggregating risk data to identify common issues in a project portfolio
Trend analysis	Identifying and describing patterns or trends in data	Understanding changes or developments in a dataset	Monitoring trends in project performance metrics over time (e.g., cost overruns, delays). Identifying seasonal patterns in project demand or resource utilization
Anomaly detection	Identifying data points that significantly deviate from the rest of the dataset	Detecting anomalies or errors in data	Identifying projects with unusually high costs, delays, or resource usage. Detecting anomalies in task completion times or budget utilization
Data summarization	Reducing large datasets to summary statistics or key metrics	Providing a concise overview of a dataset	Creating executive reports on project performance metrics for stakeholders. Reducing large datasets to key indicators for decision-making
Categorical analysis	Analyzing data divided into categories or groups	Understanding the distribution and frequency of categorical variables	Analyzing the distribution of project types in a portfolio (e.g., IT, construction, marketing). Categorizing risks or issues by severity or frequency

Table 3

Diagnostic analysis techniques that could be applied to project management activities

Method	Description	Purpose	Example of Application
Regression analysis	Examines relationships between variables to determine how changes in one variable affect another	Evaluates the impact of changes in one variable (independent) on another variable (dependent) to identify factors with the greatest influence on outcomes, aiding in problem diagnosis	Determining whether increasing team size reduces project delays
Correlation analysis	Measures the strength and direction of relationships between two or more variables	Identifies positive, negative, or no correlation between variables	Identifying relationships between project variables, such as team size and project duration. Analyzing the correlation between resource allocation and project success rates
Cluster analysis	Groups data points into clusters based on their similarity	Identifies hidden structures and patterns in data that can be used to diagnose problems or understand the causes of certain phenomena	Grouping projects by risk levl, complexity, or performance
Time series analysis	Analyzes data collected or recorded over time to identify trends, patterns, or seasonal effects	Analyzes the impact of external factors on trends, detects anomalies or deviations from expected trends, and evaluates the influence of events or changes over time	Analyzing seasonal fluctuations in project costs to determine the causes of peak expenses during specific periods
Sensitivity analysis	Measures how changes in one variable affect the outcome of a model or system	Evaluates the impact of changes in variables, such as budget, on project success. Identifies critical variables with the greatest influence on project outcomes	Analyzing how fluctuations in resource availability or team skill levels affect project completion time

prescriptive analytics to optimize deci-sion-making processes. Transformed data can also be used to improve the product lifecycle within a closed-loop system [14].

In project management, predictive analysis meth-ods are used to forecast future project outcomes, such as completion timelines, costs, the likelihood of risks, or team performance. This allows managers to evaluate potential scenarios, make informed decisions, and de-velop strategies to minimize risks and achieve project goals.

Table 4 presents the main methods employed in predictive analysis, their purposes, and examples of application in the context of project management ac-tivities.

Table 4

Predictive analysis techniques that could be applied to project management activities

Method	Description	Purpose	Example of Application
Bayesian network	A model that uses probabilistic dependencies between variables for prediction and causal analysis	Estimating event probabilities based on incomplete data and modeling complex systems	Risk management, outcome prediction
Pattern recognition	A method that analyzes data to identify patterns or trends	Detecting trends, classifying data, and forecasting based on patterns	Identifying customer behavior patterns to predict future needs
Random forest	An ensemble method that uses multiple decision trees for classification or regression	Improving prediction accuracy by combining the results of multiple decision trees	Predicting project success based on historical data about budgets and timelines
Conditional inference tree	A decision tree method that considers the statistical significance of variables	Identifying key factors influencing outcomes and forecasting based on conditional dependencies	Decision-making, risk analysis
Support vector machine (SVM)	A classification and regression algorithm that finds the optimal hyperplane to separate data	Classifying data and forecasting based on multidimensional variables	Performance analysis, predicting project success based on a set of parameters
Ensemble learning	A method that combines multiple models to improve prediction accuracy	Enhancing prediction accuracy and stability by aggregating results from different models	Outcome prediction, risk assessment
Artificial neural network (ANN)	A model that mimics the human brain to analyze complex dependencies in data	Predicting complex nonlinear relationships between variables	Forecasting project costs based on historical data and external factors
Decision tree	A method that uses a hierarchical structure to make decisions based on conditions	Identifying key factors and predicting outcomes	Decision-making, risk analysis
Heuristic clustering	A method that uses clustering to identify groups of data with similar characteristics	Detecting patterns in data and forecasting based on clusters	Predicting team performance based on clustering members by skill level
k-nearest neighbors (k-NN)	An algorithm that classifies data based on similarity to nearest neighbors	Classifying and forecasting based on data similarity	Predicting outcomes, performance analysis. Forecasting project success based on similarity to other projects with similar parameters

Prescriptive Analysis. Prescriptive analysis focuses on addressing the complex question: "What actions should be taken?" This type of analysis involves detailed and extensive research to determine the optimal path from a set of possible options.

In the context of project portfolio management, prescriptive analysis provides significant advantages by enabling organizations to select the portfolio with the highest value and the group of projects with the greatest likelihood of successful implementation. This approach enhances resource management efficiency and minimizes risks [14].

Prescriptive analysis not only predicts what will happen and when it will occur but also explains why it might happen. Furthermore, it offers decision-making options aimed at leveraging future opportunities or mitigating potential risks while demonstrating the consequences of each possible course of action [9].

A key feature of prescriptive analysis is its ability to continuously integrate new data, allowing for re-forecasting and adjustment of recommendations. This ensures automatic improvement in forecast accuracy and the generation of more effective decision options.

This approach uses hybrid data, which includes both structured information (numerical values, categories) and unstructured data (videos, images, sounds, textual data). Additionally, prescriptive analysis incorporates business rules to predict future events and develop recommendations on how best to capitalize on forecasted opportunities without compromising other organizational priorities [14].

In project management, prescriptive analysis methods are used to determine the optimal actions for achieving desired outcomes while considering resource constraints, risks, and strategic priorities. This type of analysis enables managers to formulate recommendations for resource allocation, task planning, risk management, and selecting the best decision options to ensure successful project implementation.

Table 5 presents the main methods employed in prescriptive analysis, their purposes, and examples of application in the context of project management activities.

Conclusions

Data analysis has become a critical area of focus for both researchers and practitioners in the field of project management. With the increasing volume of data available to organizations, there is a growing body of research aimed at developing data analysis methods that provide valuable insights for managerial decision-making. This article outlines the key potential applications of data analysis in project management activities and provides an overview and systematization

Table 5

Prescriptive analysis techniques that could be applied to project management activities

Method	Description	Purpose	Example of Application
Reinforcement learning	A machine learning method that uses a reward system to optimize agent actions in an environment	Predicting optimal actions in complex dynamic systems	Optimizing resource allocation in a project to minimize costs and timelines
Mixed integer programming	An optimization method that works with both integer and continuous variables	Solving optimization problems with constraints involving integer variables	Optimizing schedules and budgets
Linear programming	An optimization method that works with linear functions and constraints	Solving optimization problems where all dependencies are linear	Optimizing resource utilization in a project to achieve maximum results
Binary quadratic programming	An optimization method that works with binary variables and quadratic functions	Solving optimization problems where variables have only two possible values	Selecting the optimal set of tasks to execute within a limited budget
Nonlinear programming	An optimization method that works with nonlinear functions and constraints	Solving optimization problems with nonlinear relationships between variables	Advanced project planning. Optimizing project costs considering complex dependencies between variables
Binary linear integer programming	An optimization method that works with binary and integer variables in linear functions	Solving optimization problems where variables have only two possible values	Selecting the optimal set of functionalities/tasks for funding within a limited budget
Stochastic optimization	An optimization method that accounts for uncertainty in data	Solving optimization problems under uncertainty	Optimizing resource allocation considering the probability of project delays
Conditional stochastic optimization	An extension of stochastic optimization that incorporates additional conditions	Solving optimization problems under uncertainty with additional constraints	Optimizing project planning considering risk probabilities and funding conditions
Fuzzy linear optimization	An optimization method that accounts for fuzziness in data and constraints	Solving optimization problems under uncertain data conditions	Allocating resources under uncertainty
Robust and adaptive optimization	An optimization method that accounts for changing conditions and adapts to them	Solving optimization problems under variable data and constraints	Optimizing project planning considering changes in resource availability
Dynamic programming	An optimization method that breaks a problem into subproblems for simplification	Solving optimization problems with recursive structures	Multi-stage project planning
Random forest-based simulation	A simulation method that uses random forests to predict outcomes	Predicting outcomes based on simulations using ensemble models	Risk assessment and forecasting project success probabilities based on historical data
Risk assessment	A method that evaluates the probability and impact of risks	Identifying and assessing risks for decision-making	Simulating the impact of resource shortages on project delays based on risk assessments
Stochastic simulation	A simulation method that accounts for probabilistic dependencies between variables	Predicting outcomes in systems with uncertainty	Simulating project completion timelines considering the probability of delays
What-If scenarios	A method that evaluates outcomes under different conditions	Assessing the impact of changes on system outcomes	Analyzing the impact of budget increases on project completion timelines
Association rules	A method that identifies patterns between variables in large datasets	Detecting hidden relationships between variables	Identifying dependencies between project types and risk levels
Decision rules	A method that uses a set of rules for decision-making	Automating decision-making processes based on defined criteria	Selecting the optimal set of tasks to execute within a limited budget
Criteria-based rules	A method that uses criteria for evaluation and decision-making	Evaluating options based on defined criteria	Allocating resources. Selecting projects for funding based on profitability.
Fuzzy rules	A method that uses fuzzy logic rules for decision-making	Making decisions under uncertain data conditions	Selecting the most efficient project execution plan with fuzzy resource constraints
Comparison rules	A method that compares options with benchmark metrics	Evaluating options based on comparison with benchmark data	Performance evaluation. Selecting projects for funding based on comparison with successful analogs
Desirability function	A method that evaluates options based on a desirability function	Evaluating options to select the optimal decision	Selecting the most efficient project execution plan based on desired outcomes
Graph-based recommendations	A method that uses graphs to analyze relationships between data	Identifying optimal options based on graph structures	Optimizing workflows
Optimal path search	A method for finding the best path or sequence of actions to solve a problem in complex systems	Optimizing decision-making processes in complex systems	Selecting the optimal task execution route in a project to minimize costs or reduce dependencies and downtime

of the main types of data analysis that can be utilized in this context, as each type of analysis has its specific functional purpose, addresses particular challenges, and employs corresponding methods and techniques.

The descriptive analysis techniques presented in the article, such as frequency distribution, measures of central tendency, trend analysis, and others, enable the assessment of the current state of a project, the identification of key patterns, and the formation of a general understanding of critical performance indicators.

Diagnostic analysis methods, such as regression analysis, cluster analysis, time series analysis, and sensitivity analysis, are aimed at identifying cause-and-effect relationships among various historical project performance metrics and explaining the observed outcomes.

Predictive analysis methods utilize historical data to forecast future outcomes, such as project completion timelines, costs, or the likelihood of risk occurrences. Key predictive analysis methods include artificial neural networks, decision trees, support vector machines, ensemble learning, and the k-nearest neighbors algorithm.

Prescriptive analysis methods represent the most advanced type of analysis, as they not only predict future events but also recommend optimal actions to achieve desired outcomes. Key prescriptive analysis methods include linear and nonlinear programming, stochastic optimization, "what-if" scenarios, random forest-based simulations, and dynamic programming. This type of analysis addresses a critical gap in project management by providing managers with actionable recommendations for future steps. Planning and monitoring are the most essential components of project management activities, as the ultimate success of each project depends on them. When a manager possesses the knowledge and skills to apply prescriptive analysis methods, it significantly increases the likelihood of achieving project goals within the defined timelines, ensuring that the «iron triangle» of project management – time, cost, and quality – remains intact.

The developed tables, detailing the methods for each type of analysis, their purposes, and examples of application in the context of project management, serve as practical tools that enable the selection of relevant methods to address specific challenges encountered during the practical activities of project management.

The application of data analysis methods in project management offers numerous advantages. Specifically, it enhances the accuracy of forecasts, which is critically important for resource planning, scheduling, and budgeting. Additionally, data analysis facilitates the early detection of risks, enabling the development of effective strategies for their mitigation. Analytical methods also help optimize resource allocation, ensuring their efficient use, and contribute to improving team productivity by identifying weaknesses in processes and suggesting ways to address them.

Planning and monitoring are key components of project management activities, significantly influencing the success of project implementation and the effectiveness of managerial decision-making. Providing managers with the necessary analytical tools and equipping them with the ability to apply data analysis methods in management processes greatly increases the likelihood of achieving project objectives within the defined timelines and budgets. Such approaches support adherence to the principles of the "iron triangle" of project management, which emphasizes a balance between time, cost, and quality, ensuring the successful execution of projects in dynamic environments.

Thus, data analysis is an integral component of modern project management. Information systems that incorporate combinations of the described methods and techniques are becoming increasingly powerful tools, enabling managers to make informed decisions, enhance project management efficiency, and achieve strategic goals.

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