

## PEDAGOGICAL FOUNDATIONS OF TEACHING APPLIED MATHEMATICS IN MANAGEMENT EDUCATION BASED ON REAL BUSINESS CASES

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**Abstract:** In today’s digital economy and global business environment, the requirements imposed on management professionals are undergoing fundamental changes. A modern manager must not only understand management theory, but also be capable of analyzing statistical data, making decisions under uncertainty, and evaluating economic processes through mathematical modeling. Therefore, improving the methodology of teaching applied mathematics and operations research in higher education has become one of the urgent issues of contemporary pedagogy.

**Keywords:** applied mathematics, operations research, pedagogical technologies, case-study, problem-based learning, mathematical modeling, statistics, probability theory, management education, business analytics

In today’s digital economy and global business environment, the requirements imposed on management professionals are undergoing fundamental changes. A modern manager must not only understand management theory, but also be capable of analyzing statistical data, making decisions under uncertainty, and evaluating economic processes through mathematical modeling. Therefore, improving the methodology of teaching applied mathematics and operations research in higher education has become one of the urgent issues of contemporary pedagogy.

In traditional teaching approaches, mathematical formulas are often presented in an abstract manner, while their connection with real economic processes is insufficiently explained. As a result, students fail to fully understand the practical significance of mathematics, which decreases their motivation toward the subject. In recent years, the experience of developed countries has demonstrated that teaching mathematics and operations research through real business cases, statistical data, and probability models is an effective pedagogical approach.

Within this approach, students work with real-world problems such as demand forecasting, inventory management, investment risk assessment, queuing theory, and logistics optimization through mathematical models. Consequently, the chain of “real situation – mathematical model – solution – managerial decision” is formed. This process teaches students how to apply theoretical knowledge in practice.

From a pedagogical perspective, case-study and problem-based learning technologies develop students’ independent thinking, teamwork skills, and decision-making competencies. Moreover, the use of digital platforms such as R, Python, SPSS, Excel, Tableau, and Power BI modernizes the educational process and promotes data-driven thinking skills.

In this regard, developing pedagogical mechanisms for teaching applied mathematics and operations research through the integration of statistics and probability theory in management education has significant scientific and methodological importance.

During the research, methods such as pedagogical observation, comparative analysis, the study of scientific and methodological literature, and the analysis of the didactic potential of case-

study and problem-based learning technologies were employed. Furthermore, the impact of mathematical modeling methods used in management education on teaching effectiveness was investigated.

### **Pedagogical Importance of Teaching Based on Real Business Cases**

Lessons organized around real business cases encourage students not merely to memorize theoretical formulas but to apply them in practical situations. For example, in the topic of sales forecasting, students analyze statistical data using regression models and develop business decisions accordingly.

For instance, the demand forecasting model can be represented through the following linear regression equation:

$$y = ax + b$$

Where:

- (y) — sales volume;
- (x) — advertising expenses;
- (a, b) — model parameters.

Using this model, students analyze the influence of advertising budgets on sales and develop optimal marketing strategies.

### **Opportunities of Problem-Based Learning Technology**

In the problem-based learning approach, students study not a ready-made formula but the process of solving a problem. This method includes the following stages:

- Identifying the problem;
- Constructing a mathematical model;
- Collecting statistical data;
- Applying probability or optimization methods;
- Interpreting the results from a business perspective.

For example, the EOQ model is used to optimize warehouse inventory:

$$EOQ = \sqrt{\frac{2DS}{H}}$$

Where:

- (D) — annual demand;
- (S) — ordering cost;
- (H) — holding cost.

This model determines the optimal order quantity. Such assignments teach students how to mathematically justify real business decisions.

### **Integration of Probability and Statistics**

Decision-making under uncertainty occupies an important place in management education. Therefore, probability theory and statistics should be taught in close integration with operations research.

For example, the expected value model is widely applied in risk assessment:

$$E(X) = \sum_{i=1}^n x_i \cdot p_i$$

This model serves as an important tool in evaluating investment projects. Students learn how to determine risk levels through probability distributions. Connecting Monte Carlo simulation, queuing theory, and stochastic modeling methods with practical projects contributes to the development of analytical thinking.

### **Digital Technologies and Analytical Platforms**

Today, mathematical modeling cannot be imagined without digital technologies. Therefore, the use of tools such as Python, R, SPSS, Excel Solver, Tableau, Power BI, and @RISK in the educational process is highly appropriate. These platforms provide opportunities for analyzing large volumes of data, creating visualizations, forecasting, optimization, and risk modeling. As a result, students acquire competencies in data analytics and business intelligence.

#### **Proposed Pedagogical Model**

The article proposes the following integrated pedagogical model:

**Real business problem – statistical data – mathematical model – software analysis – managerial decision**

This model integrates theory and practice, increases student engagement, strengthens the competency-based approach, and develops analytical and critical thinking skills.

Teaching applied mathematics in management education through the integration of real business cases, statistics, and probability theory is one of the effective directions of modern pedagogy. This approach shifts students’ focus from memorizing abstract formulas to analyzing real economic situations.

The use of case-study, problem-based learning, and mathematical modeling technologies significantly improves students’ motivation, analytical thinking, decision-making competencies, and data analysis skills.

Furthermore, integrating digital tools such as R, Python, SPSS, and other analytical platforms into education contributes to improving the quality of management education. Therefore, it is advisable to widely implement methodologies for teaching applied mathematics and operations research through integration with business analytics in higher education institutions.

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