Quantitative methods for executive public managers

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\textbf{Abstract.} Digitalization is becoming a priority in the development of the public governance system, and the question arises about the effectiveness and efficiency of management with the introduction of quantitative methods. This article presents a meta-analysis of relevant studies of quantitative methods that are used in the global practice of public administration. The purpose of the study: to determine a set of quantitative methods that will be necessary and sufficient in the decision-making arsenal of a public executive. A selection of two dozen articles was obtained during systematized research and grouped according to the criteria of compliance with a certain quantitative method and compared with the general potential of quantitative methods in relation to public administration. As a result, a classification of quantitative methods is proposed divided into three global classes of mathematical tools, namely, empirical, logical, and special methods. Methods from the classification are correlated with their potential areas of application in public administration. The authors concluded that it is necessary to increase the research, differentiate effective quantitative methods and introduce the necessary special training of managers for the rational application of quantitative methods in the public sphere.

\textbf{Keywords:} public governance, quantitative methods, smart government

\section{Introduction}

In accordance with the primary goal of the national project "Digital Transformation," 95\% of all public socially significant services should be accessible online by 2030 \cite{1}. Achieving this goal logically involves preparing and making decisions in a digital environment and with the use of digital technology. This objective requires a high level of formalization and poses the question of the necessity to comprehend the application of quantitative methods in public administration in a new phase of technological progress. The volume of decisions made at the national level is significant and important, and the matter

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of the efficiency and effectiveness of management with the implementation of quantitative methods cannot help but arise. The literature review identified case studies and technological solutions that have been implemented at the local level of some government agencies and institutions.

This research is based on a systematic analysis of twenty case studies published in public administration journals between 2012 and 2022. It was found that research on quantitative methods was dominated by the study of application-specific narrow-focused problems. The following problems and applied methods were described in the articles reviewed:

- credit rating method for contract risk management [2];
- a machine learning algorithm for planning and developing predictive maintenance strategies for critical infrastructure facilities [3];
- simulation modeling for two-loop learning in management teams to improve decision making [4];
- predictive analytics of the impact of genetics and psychological traits of job applicants in the recruitment policies of public institutions [5];
- empirical Bayesian evaluation to analyze the COVID-19 spread among citizens [6];
- implementation of big data analytics for large government agencies, e.g., border security [7];
- e-project maturity modelling to assess progress in digital management of municipal e-projects and their further adaptation [8];
- a multipoint scale that is used in organizational and functional settings to evaluate management practices within an organization [9];
- empirical method of processing data from the academic and practice literature applied to public decision making in policy development [10];
- predictive analytics based on omni-channel data collection and processing contributes to smart decision making in public management [11];
- universal quality management combined with citizen and employee feedback to improve health care [12, 13];
- a comprehensive systems performance management system based on regular monitoring of the dynamic environment [14];
- sensor technology and algorithmic systems to introduce certain indicators, and conceptualize the environment as an object that can be optimized and rationalized [15];
- a data analysis method for measuring industry risks associated with COVID-19 [16];
- a land management system that uses digitalized land records [17];
- predictive analytics and autonomous agents to improve the efficiency of public service delivery [18];
- an accounting model and inventory method for estimating the carbon budget [19];
- algorithmic domain regulation for risk management and behavior change through continuous computational knowledge generation through systematic data collection [20];
- e-government as a means to combat the COVID-19 epidemic and stimulate economic recovery [21];

The meta-analysis of the above findings demonstrates the necessity of addressing the issue of systematization and prioritization of the use of quantitative methods in the toolkit of the New Age manager. This evident consideration leads us to the question: which set of quantitative methods will be necessary and sufficient in the executive manager's toolkit?
What competencies are imperative for the manager, to not calculate results manually using formulas, but to assign tasks to dedicated experts and ensure a relevant and valid outcome that will accurately reflect reality?

In the following section we will present a summary of quantitative methods and their possible application in the field of strategic and public administration, then we will consider the relevance of quantitative methods, and in the final section, we will formulate conclusions from our analysis for the theory of public administration and highlight the most prospective options for the application of the mathematical instrument to the decision-making process.

2 Materials and Methods

The article is based on the systematization of studies published in major international academic citation databases (Administrative Science Quarterly, Journal of Public Administration Research and Theory, Public Administration Review) in journals on public administration in the period from 2012 to 2022.

The search was conducted using the following keywords: "public administration," "quantitative method," and "decision making. The result was a selection of twenty articles, which were grouped according to the criteria of relevance to a particular quantitative method. We compared the vision of methods that came into the focus of the study with the general potential of quantitative methods as applied to public administration. The study used the method of historical and comparative analysis, grouping and classification according to criteria.

3 Results

Certainly, quantitative methods represent the essence of the science of mathematics, but not all of its sections can be applied to the objectives of the public sector. Further in Table 1, quantitative methods will be classified conventionally into three global classes of mathematical tools, namely empirical, logical, and special methods. Empirical research aims directly at an object. It masters the object by means of such tools as description, comparison, measurement, observation, experiment, analysis, and induction [22]. The idea of a mathematical approach to logic was proposed by D. Boole in his Mathematical Analysis of Logic [23], where he combined formal logic and computational tools. In the column "Special Methods" all remaining relevant methods from higher mathematics were allocated.

<table>
<thead>
<tr>
<th>Type</th>
<th>Aggregated sections</th>
<th>Scope of application in public administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empirical methods</td>
<td>Observation</td>
<td>monitoring the dynamic environment</td>
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<td></td>
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<td>human resource management decisions</td>
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<td>monitoring the impact of government actions</td>
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<td>Experiment</td>
<td>deployment of complex hardware and software systems</td>
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<td>Logical methods</td>
<td>Fuzzy Logic</td>
<td>forecasting of complex systems</td>
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<td>Combinatorial Logic</td>
<td>modelling of complex systems behavior</td>
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<td>Theory of sets</td>
<td>management of socio-economic processes</td>
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<td>Algebraic Logic</td>
<td>regulatory support</td>
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<td>Special methods</td>
<td>Algebra</td>
<td>rigorous economic calculations</td>
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<td></td>
<td>Discrete Mathematics (Graph Theory)</td>
<td>credit rating techniques</td>
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<td>Probability Theory and Mathematical Statistics</td>
<td>scales for assessing management practices</td>
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<td>Modeling</td>
<td>contractual risks in public administration</td>
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<td>estimation of carbon budgets</td>
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The evidence indicates that state authorities in several countries are adopting quantitative methods, including smart technologies, especially in the area of predictive analytics and strategy development to support decision-making. The adoption of quantitative methods can have an unforeseen impact when public administrators with computational algorithms in their toolbox lack the proper technical background. The synergy of the manager and the contemporary tool is important to ensure the high efficiency and quality of public service delivery. Visualization of the dynamics of the discourse is presented in the following histograms.

![Fig. 1. Selection of articles on the topic of quantitative methods in public administration for the period 2012-2022.](image-url)
According to the time dynamics in Figure 1, the topic of application of quantitative methods in public administration is becoming relevant and scientific interest is increasing.

![Diagram showing distribution of selected articles]

**Fig. 2.** Distribution of the selected articles according to the proposed classification

Figure 2 shows the distribution of the reviewed articles according to the previously proposed classification of quantitative methods. As it follows from the histogram, at the present moment more emphasis is placed on empirical and special methods, namely observation and modelling of systems.

### 4 Discussion

The necessity of applying quantitative methods in public administration, seemingly, cannot have any controversial answers: at this present moment it is the most logical direction of development.

Decision-making is a process that requires compulsory human engagement, reasoning. For elementary decisions, a manager's standard competencies are quite sufficient. However, as uncertainty increases and the number of variables, factors, and long-term perspective rise, decision making tends to become more complex, judgments become rather abstract. In such cases, quantitative methods and the corresponding competences of the manager are required to help them to model a more accurate system and make the right decision.

In this regard, objectification of algorithms, methods and data becomes a key issue. In the case of algorithms and machine learning, human interpretation of the world around us is extremely important. There is a certain risk that an algorithm will accept the subjective worldview of a manager or engineer, or the limitations of the data itself, unless there is a safeguarding mechanism for correction or self-correction. Without mechanisms for objectivity, even artificial intelligence technology will not automatically make everything smart. Governance that is based on reflection and considers the needs of each individual will guarantee the greatest degree of objectivity. The technology for public administration is the means to achieve the main goal, the Platonic well-being of the citizens [24].

### 5 Conclusion
This research paper presented a meta-analysis of relevant studies of quantitative methods that are applied in the world practice of public administration. Further, a general classification of mathematical tools was proposed, as well as their potential areas of application in the public sector. Conducting a study of a given selection of articles, the increasing relevance of the topic under study and the interest of the scientific community in it was proved. The results allow us to conclude that not all sections of quantitative methods and not to the full extent have been scientifically developed. Accordingly, it means that it is necessary to increase research and to introduce the required special training of managers for effective and rational application of quantitative methods in the public sector. The authors question the objective validity of these methods, showing that social values and beliefs must be considered in this regard.

References


