Muskhelishvili Institute of Computational Mathematics of Georgian Technical University

Projects funded by the Shota Rustaveli National Science Foundation grant

№	Grant Name	Manager	Project start and end years	Total budget	Status completed/in progress	Grant code
1	Application of probabilistic methods in discrete optimization and scheduling problems	Nodari Vakhania	2018-2021	200900 Gel	Finished	DI-18-1429

Abstracts:

1. Concrete result

The project deals with the theoretical and practical aspects of determining the relationship between probability theory and combinatorial optimization. The analysis in this area revealed perspectives on the application of various probabilistic processes and their associated random elements and stochastic integrals, as well as the application of a number of known results in scheduling problems. Unification of the two named fields of mathematics in the development of methodologies for solving practically important tasks of production management and optimization, as well as the economic-social and non-local nature of these tasks, implies the need for interdisciplinary research in the context of international scientific cooperation which, to some extent, was implemented by the participants while working on the project.

The project introduces new approaches that involve the use of probabilistic estimates and random processes in the algorithmic implementation of scheduling problems (tasks). **The following results were obtained by the project participants:**

- ✓ the quantity of optimal solutions is determined, the corresponding optimal schedules are presented and the magnitude of the complete optimal completion time for specific cases in single-processor scheduling problems is determined. The probability of the occurrence that the randomly taken schedule from the possible allowable schedule is optimized is calculated;
- ✓ possibility of using certain types of probabilistic distributions in scheduling problems has been

explored, where the processing times by the processor are random variables which may lead to incorrect results. The concept of symmetrically sliced normally distributed random variables has been introduced, the application of which, by selecting the truncation level, avoids the development of irregular processes in solving these problems;

- ✓ theorems for the application of the probabilistic analogy of a set of optimal solutions for some scheduling problems have been formulated and proved;
- ✓ for multiprocessor scheduling problems, the issues related to the mathematical processing of the process of efficient distribution of tasks on identical processors have been studied, in case of different job execution times;
- ✓ a practical case from the theory of scheduling is considered when, under certain conditions, a new structural-algorithmic scheme of the process is proposed to minimize the total importance of deliveries in continuous batches and the corresponding delays, including the online scenario.

2. Recommendations

Based on the practical importance, it would be desirable to implement some of the algorithms discussed in the project in the industries of Georgia. The economic-social and non-local character of the practically important tasks of production management and optimization implies the necessity of conducting interdisciplinary research in the background of international scientific cooperation, which was realized to a certain extent by the participants while working on the project. However, interesting tasks of the mentioned direction remained beyond the project, which may be considered as the subject of future research.

To further intensify the applications of probabilistic methods in discrete optimization tasks created on the basis of the project, it would also be appropriate to expand the research group at Muskhelishvili Institute of Computational Mathematics of the Georgian Technical University with new researchers, including young researchers. The resource for this exists within the institute and, within the framework of a suitable research/innovation project, this circumstance will facilitate further research on scheduling theory problems using probabilistic and combinatorial tools. The obtained algorithms will have both theoretical and practical value for solving real life problems of Georgian industry and business.