# A Multi-Agent System for Facility Location Problems

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# Introduction - FLP

Facility Location Problem is a critical aspect of **operational management**.

It involves minimizing costs, improving customer satisfaction, and increasing profitability.

Inefficient facility locations can result in excess costs throughout the facility's lifetime.

Facility location significantly impacts revenue, costs, and customer service.

Optimal facility location decisions are crucial for expanding market share and minimizing cost factors.

Initially this study focus on Discreet Competitive Facility Location Problem (DCFLP).

This should be overlooked in a Single objective and Multi-Objective manner.

# Different Models of FLP

## FLP FOR ENTERING THE FIRM

While a new business implementation, facility location would be a major factor that needs to be considered. Those firms may need to compete for the market share with other firms that are already in the market for establishment.

## FLP FOR FIRM EXPANSION

With the growth of a business, the expansion can be in the form of opening new branches.

# Customer Behavior Model

## BINARY / PARTIAL BINARY MODEL

In the binary model, the customer patronizes into the most attractive facility of all. (Eg;: Nearest Facility)

In the partial binary model, customer choice rules the buying power of a single demand point is satisfied by all firms. Still, the customers patronize one facility per firm – the most attractive one. (a nearest leader and a nearest follower)

## PROPORTIONAL MODEL

customers patronize all the facilities in proportion to facility attraction. This attractiveness can depend on different factors.

# Multi-Agent System

Multiple autonomous agents work together to accomplish a shared objective in a system known as MAS.

Each Agent has unique information, skills, and capacity for making decisions. Agents (**independent decision-makers**) cooperate and negotiate to achieve common goals which can jointly solve complicated issues, agents coordinate their behaviors, interact, and exchange information.

With the help of MAS, problem-solving is made **flexible** and **dispersed**, allowing for parallel processing, scalability, and flexibility.

The computational hurdle posed by complex facility location formulations causes limited research in this area. A multi-agent system would be one of the optimum solutions for the above situation. **SH Owen and MS Daskin, 2011 (ScienceDirect)**

# Goals & Objectives

The primary objective of this research is to design and implement a Multi-Agent System solution for the Facility Location Problem.

Specific objectives include:

- Develop a comprehensive understanding of the Facility Location Problem and its variants.
- Design and implement a Multi-Agent System architecture suitable for solving Facility Location Problems.
- Create intelligent agents capable of optimizing facility locations based on real-time and dynamic data.
- Evaluate the proposed system's performance, efficiency, and scalability.
- Compare the proposed MAS solution with traditional optimization methods to assess its advantages.

# Research Methods and Tools

Literature review

Case studies and application

Data Collection: (Dep. Stat., Public Data, Survey etc...)

Data model and algorithm design

System development (Python, Framework)

Multi-agent system (MAS)

- Agent modeling
- Agent development
- Agent training

Combined method

- ACO and MAS are combined by incorporating the ACO algorithm into a MAS framework.
- Algorithm design (ant colony optimization algorithm and multi-agent system combined method)

**Iterative refinement:** continuous updating of agents' training and decision-making ability adjustments to improve solution quality

# PhD Study Plan – Course Modules

| Course module | Date of Examination |
|---|---|
| Research Methods in Informatics and Informatics Engineering | 2024 Quarter II |
| Fundamental Methods of Informatics and Informatics Engineering Science | 2025 Quarter I |
| Parallel and Distributed Computing | 2025 Quarter IV |
| Optimization Methods and Their Applications | 2025 Quarter I |

Participation in capacity-building activities or international summer/winter schools for PhD students. **2025 quarter III.**

# Activities and Publication Plan

**ATTENDING CONFERENCES, SEMINARS, OTHER MOBILITY ACTIVITIES OF DOCTORAL STUDIES (MOBILITY PROGRAM OF ERASMUS, MOBILITY MEANS AT THE DEPARTMENTS, ETC.)**

| | Planned activities | Date |
|---|---|---|
| 1. | Participation in an international or national scientific conference. | 2024 y. IV quarter |
| 2. | Participation in an international scientific conference. | 2026 y. I quarter |
| 3. | Participation in an international scientific conference. | 2027 y. III quarter |
| 4. | Participation in a PhD students' training school and/or internship at a foreign institution | 2026 y. III quarter |

**PLANNED PUBLICATIONS OF SCIENTIFIC RESEARCH**

| | Tentative theme of scientific publication, intended scientific journals | Date |
|---|---|---|
| 1. | Publication on overview of research on the dissertation topic in a peer-reviewed scientific journal or conference proceedings. | 2026 y. II quarter |
| 2. | Publication on results of theoretical investigation in scientific journal with Impact Factor in Clarivate Analytics Web of Science database. | 2026 y. I quarter |
| 3. | Publication on results of empirical investigation in scientific journal with Impact Factor in Clarivate Analytics Web of Science database. | 2027 y. I quarter |

# Stage of scientific research (Overview)

1. **Review** and **analysis** of scientific research related to the theme of the doctoral thesis (in Lithuania and abroad) - **2023 quarter IV to 2024 quarter III**
2. **Prosecution** of scientific research- **2024 quarter IV to 2026 quarter IV**
3. Preparation of separate parts of the doctoral thesis (study methodology, got facts, defended propositions, inferences, etc.) - **2027 quarter I to 2027 quarter II**
4. Preparation of doctoral thesis and debating at the department - **2027 quarter III**
5. Defending of doctoral thesis - **2027 quarter IV**

# Thank you