A Case Study from Lithuania on Applying AI in Food Systems

Advancing Food System Maturity: A Case Study on AI-Driven Sustainability, Health, and Smart Solutions in Lithuania

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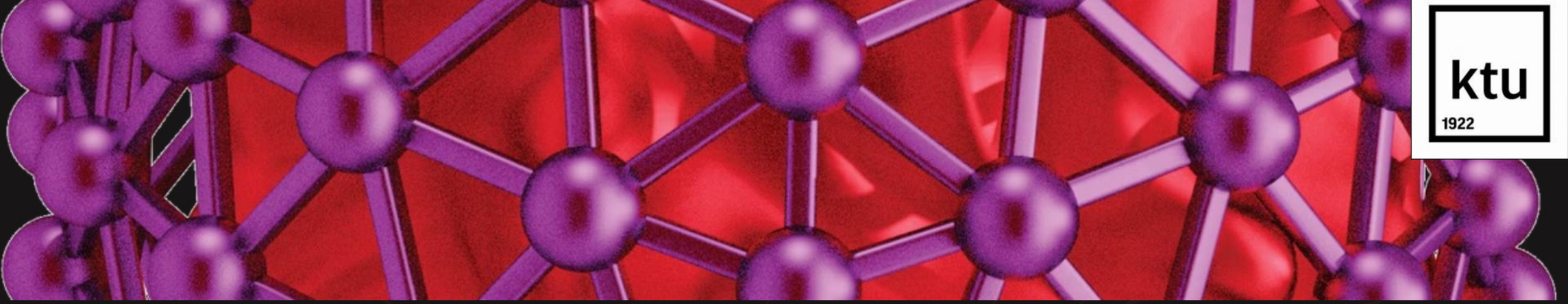
Lithuania Overview

- Population
  2.8 million
- GDP
  46.3 billion EUR
- Capital City
  Vilnius
- KTU Location
  Kaunas



Kaunas and KTU Statistics

50K

Students

The Kaunas region boasts a robust educational landscape, with over 50,000 students enrolled in various institutions.

51%

University Graduates

A remarkable 51% of Kaunas' population holds a university diploma, demonstrating a high level of education attainment.

90%

Technology Employment

The technology sector in Kaunas is highly competitive, with an impressive 90% employment rate for graduates in the field.

Kaunas University of Technology Overview

Established in 1922

Kaunas University of Technology (KTU) is one of the oldest and largest technological universities in Lithuania, boasting a rich history and tradition.

Baltic Region Leader

KTU is a prominent technological university in the Baltic region, recognized for its excellence in research, teaching, and innovation.

Multidisciplinary Approach

KTU offers a wide range of study programs across all fields of science, covering engineering, technology, business, and the humanities.

Research and Development

KTU is actively involved in research and development (R&D) activities, contributing significantly to the advancement of knowledge and innovation.

European Consortium of Innovative Universities (ECIU)

KTU Achievements in Horizon programs

1

Horizon 2020

Top-ranked university in Lithuania

2

Horizon Europe

Second-ranked university in Lithuania

KTU structure and campuses

Faculties	9
Research Institutes	8
Integrated Centers of Research, Studies, and Business	2
Campuses	4
KTU Gymnasium	1
Schools Named After KTU	2

Centre of Smart Cities and Infrastructure

M-LAB

Co-creation and Challenge-based Learning Area

KTU Artificial Intelligence Centre

Multifunctional Center and Library

Project "Digital governance and AI maturity within Lithuanian food systems: quantitative Descriptive Research Model"

Interdisciplinary Collaboration

KTU's research activities encompassed diverse fields, fostering interdisciplinary collaboration between experts in food science, technology, and artificial intelligence.

Data-Driven Insights

Utilizing advanced data analytics and AI techniques, researchers delved into complex food systems dynamics to uncover valuable insights.

Impactful Outcomes

KTU's research aimed at generating impactful findings that contribute to the development of sustainable, healthy and innovative food systems.

Methodology

Methodoloy objectives

- Analyze the global and national current state of digitalization in food systems
- Identify key factors influencing digital adoption
- Develop a framework for assessing digital maturity
- Provide actionable recommendations for improvement

Methodology approach

- Literature review
- Quantitative survey
- Stakeholder interviews
- Data analysis and interpretation

Global context and strategic importance

The global food system is undergoing a significant transformation driven by digitalization and artificial intelligence (AI), impacting production, distribution, and consumption.

Integrating digital solutions is crucial for Lithuania to achieve the UN Sustainable Development Goals (SDGs), particularly SDG 2: Zero Hunger and SDG 12: Responsible Consumption and Production.

Lithuania's 2021–2030 National Progress Plan emphasizes the importance of digitalization and technological innovation, recognizing their role in achieving national goals.

Literature review highlights

Precision Farming

AI, IoT, and robotics enhance resource efficiency in farming by optimizing irrigation, fertilization, and pest control.

Blockchain in Food Systems

Blockchain improves transparency and traceability in food supply chains, enabling consumers to track the origin and journey of their food.

Automation and Robotics

Automation and robotics in food processing reduce costs, increase safety, and improve efficiency.

Quantitative Descriptive Research Model

1. Stakeholder focus
2. Data collection tools
3. Evaluation dimensions and criteria

Stakeholder focus

The research model was specifically developed to assess stakeholders across the entire food system, encompassing primary production, processing, distribution, retail, catering, consumption, and waste management.

Questionnaire details by Stakeholder

Primary Food Production

- Resourcing and planning
- Planting and cultivation
- Harvesting
- Post-harvest treatment
- Packaging and distribution
- Sales and marketing
- Financial management
- Social aspects
- Environmental aspects

Food Processors

- Ingredient sourcing and quality control
- Production processes and technology
- Packaging and labeling
- Product development and innovation
- Waste management and recycling
- Supply chain management
- Marketing and sales strategies
- Financial performance and profitability
- Social and environmental responsibility

Food Distributors

- Transportation and logistics
- Inventory management
- Cold chain management
- Customer service and order fulfillment
- Sustainability practices
- Technology adoption and innovation
- Financial performance and profitability
- Social and environmental responsibility

Retailers

- Product assortment and merchandising
- Pricing and promotions
- Store layout and design
- Customer service and experience
- Waste management and recycling
- Technology adoption and innovation
- Financial performance and profitability
- Social and environmental responsibility

Data collection tools

Online platform

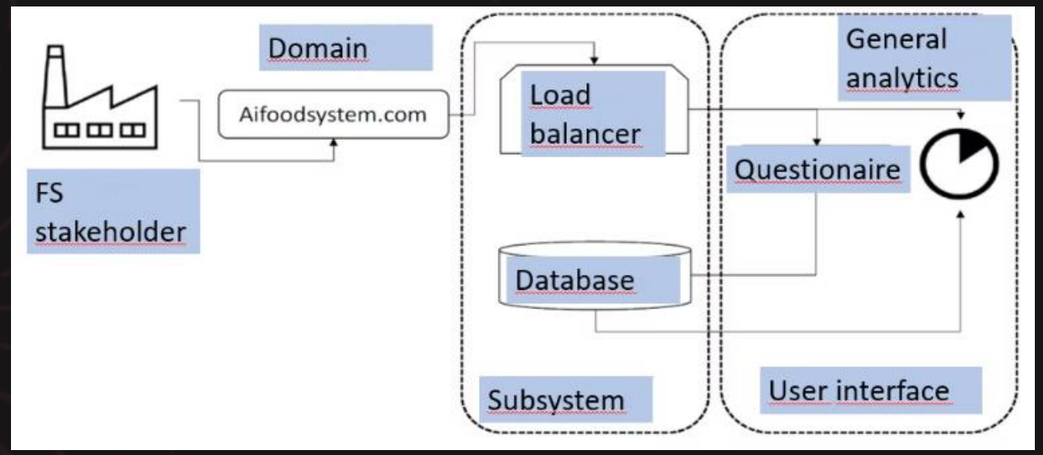
Questionnaire

Online platform architecture of aifoodsystem.com

The aifoodsystem.com online platform enables intuitive survey conduction and secure data collection.

Built with scalability, reliability, and maintainability in mind,

It employs a three-tier architecture: the presentation layer (user interface), the business logic layer (data processing and validation), and the data access layer (database communication)



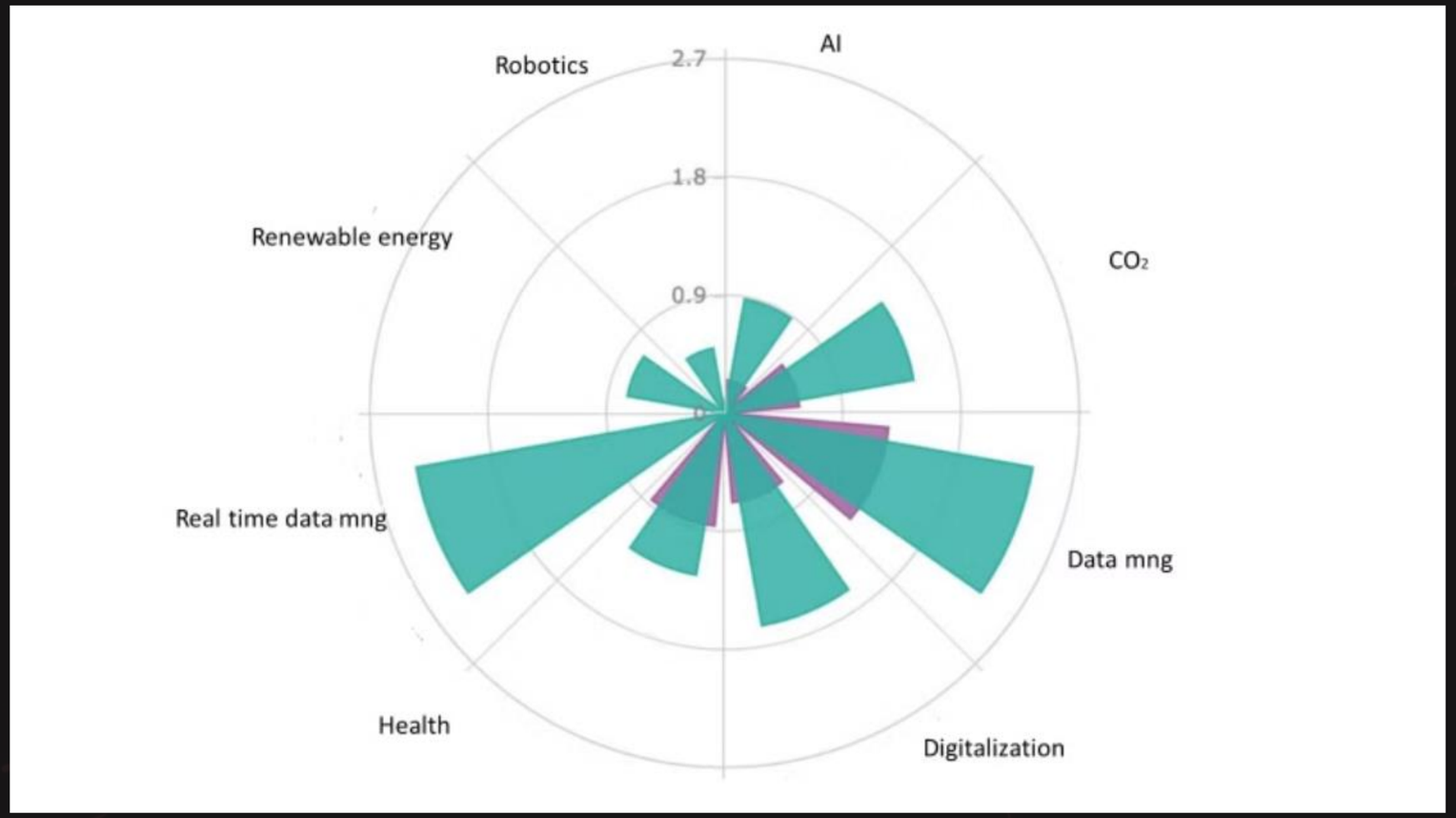
Questionnaire development

Three dimensions

- Economic
- Social
- Environmental

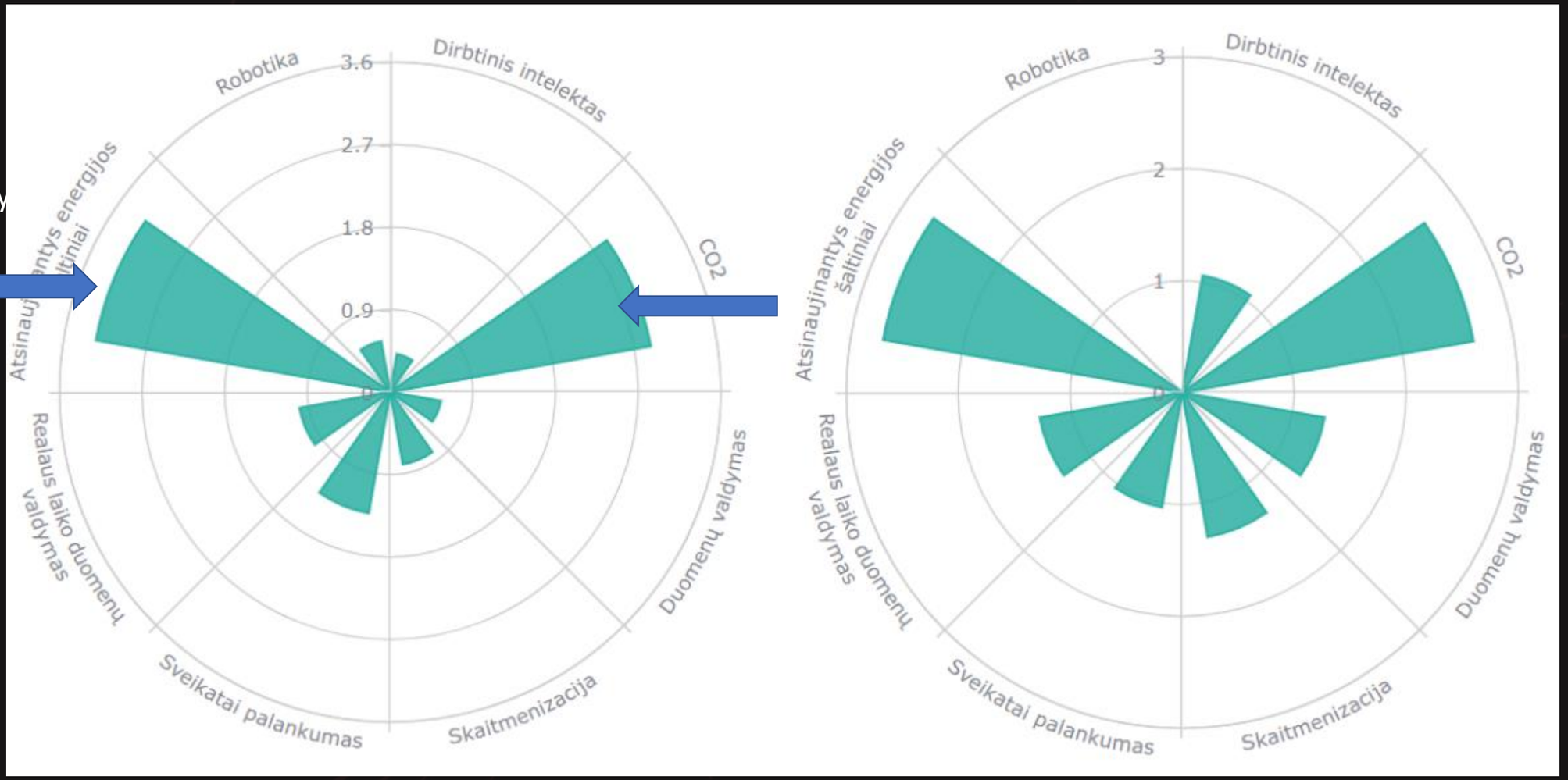
Eight criteria

1. Implementation of Digitalisation
2. Implementation of AI Technologies
3. Data Management
4. Real-Time Data Management
5. Implementation of Health-Friendly Technologies
6. CO2 Reduction/Balancing Efforts
7. Implementation of Renewable Energy Sources
8. Use of Robotics



Questionnaire results

Renewable Energy Sources



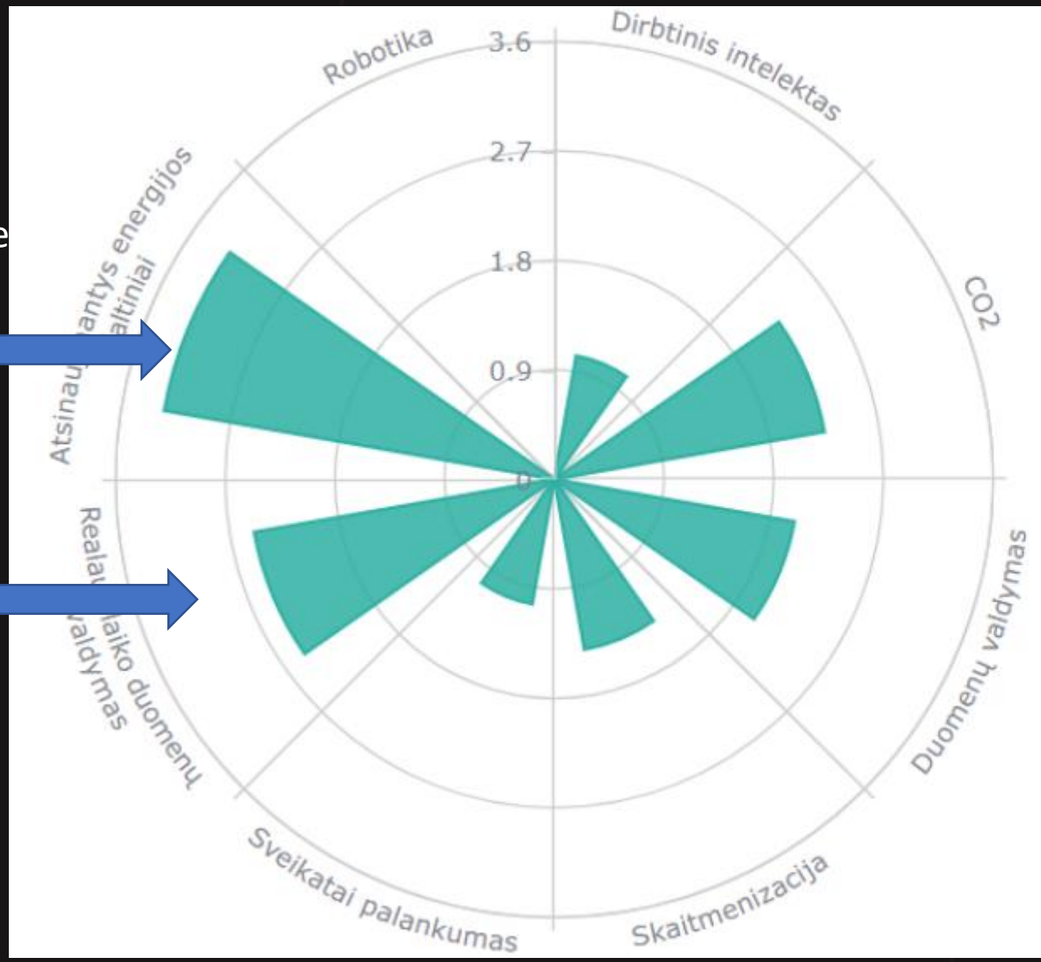
Food producers

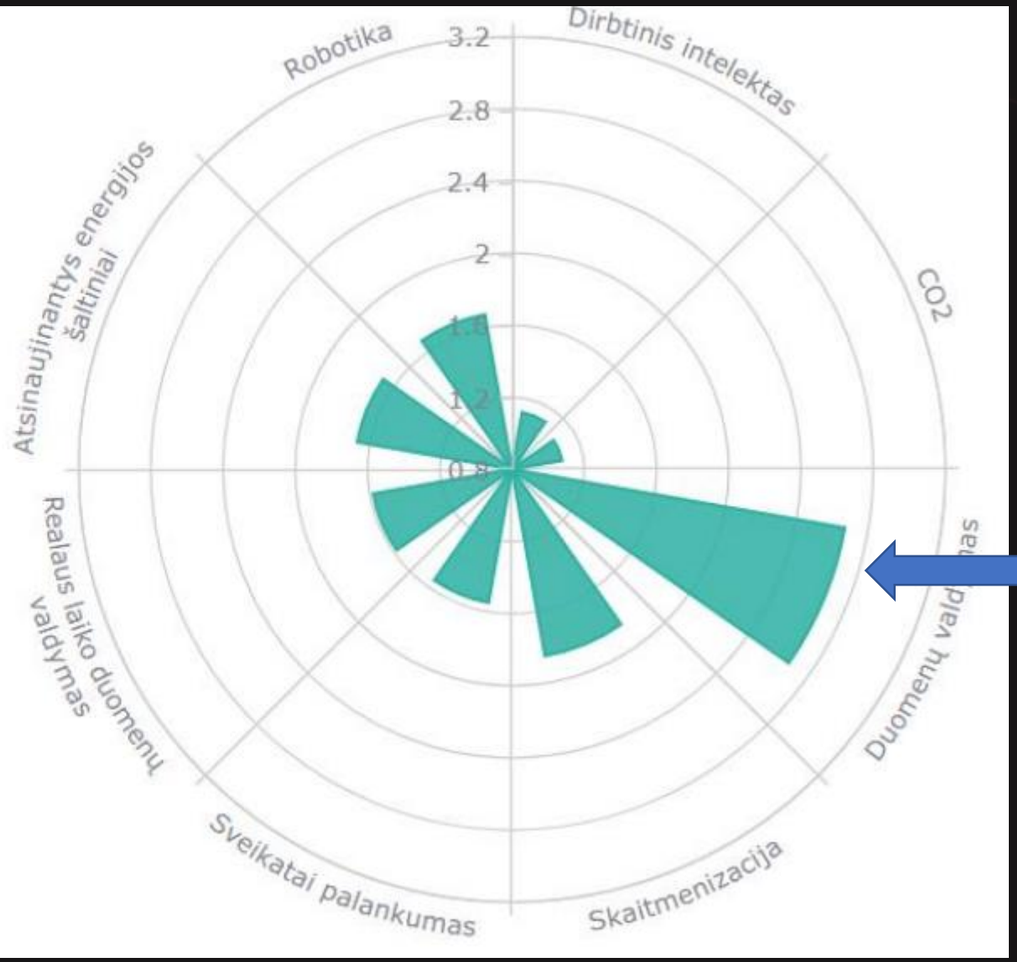
Food processors

Investment and knowledge in sustainability, healthiness, and digitalization within FS

Renewable Ene
Sources

Real data mng



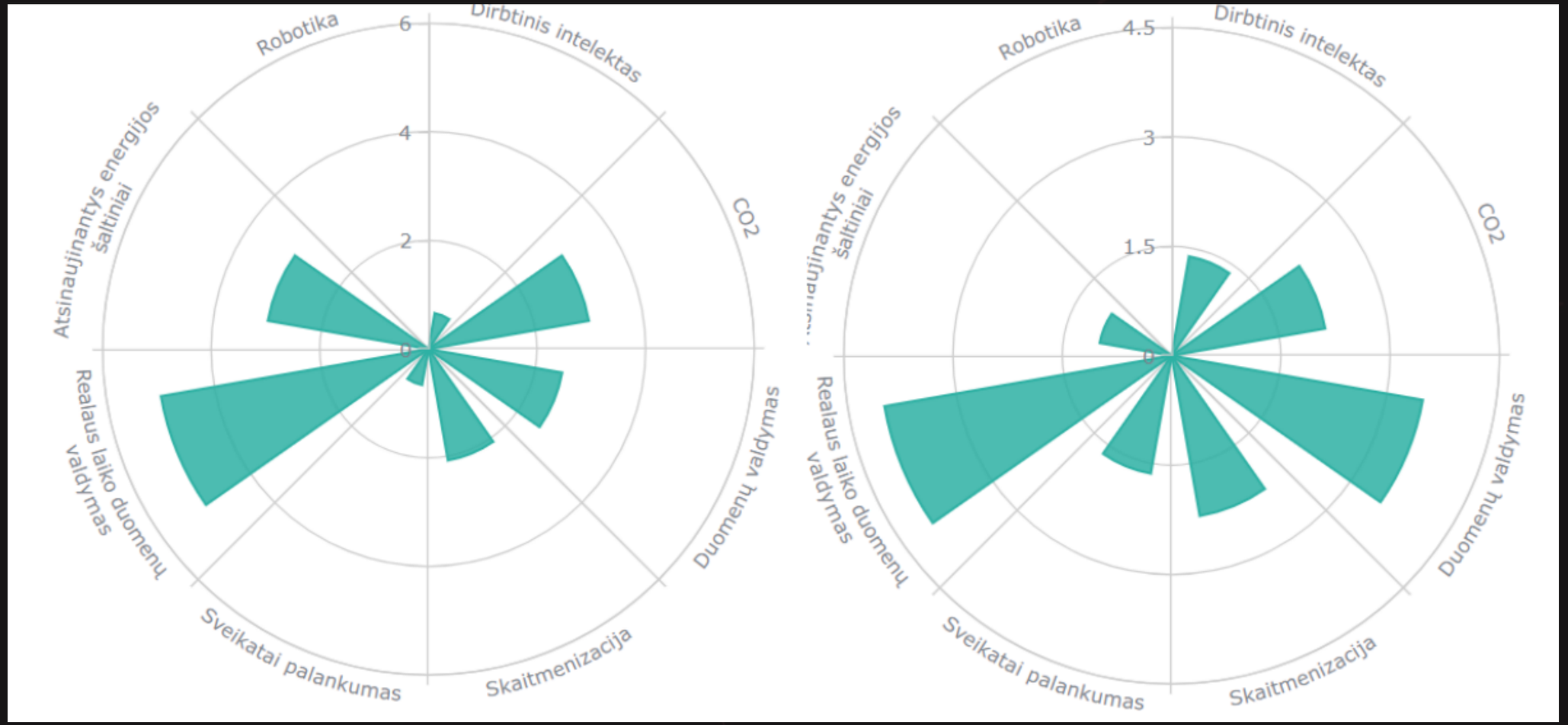


Data mng

Food retailers

Consumers

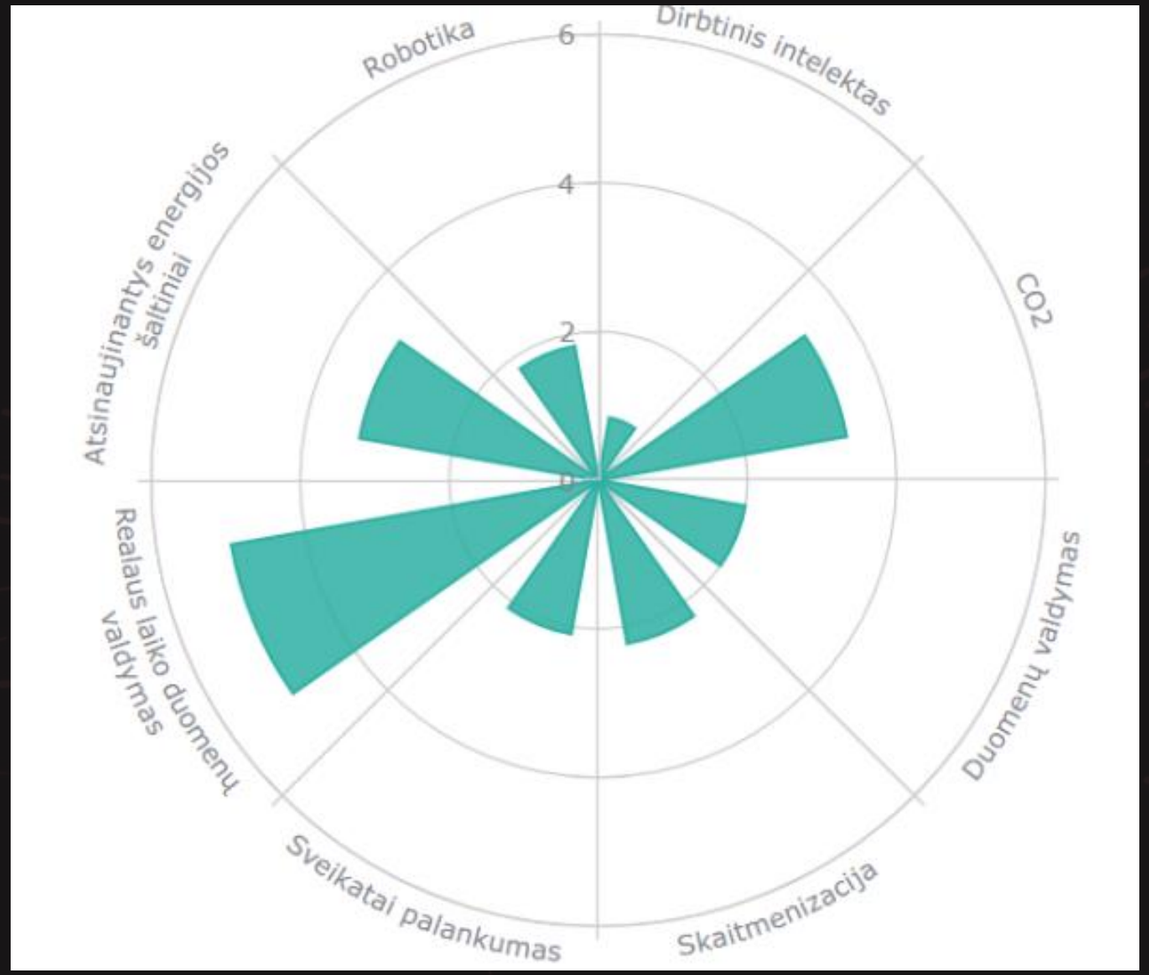
Investment and knowledge in sustainability, healthiness, and digitalization within FS



Food waste recycle service

Public catering service

Investment and knowledge within sustainability, healthiness, and digitalization in FS



Food Distribution Stakeholder

Investment and knowledge within sustainability, healthiness, and digitalization in FS

Likert scale for Maturity levels

MEPI Calculation method

1 Weighted Average Method

The overall national AI-FS progress index (MEPI) is calculated using a weighted average method. The index represents the level of maturity of the Lithuanian food system in terms of eight key criteria.

2 Formula

MEPI = Σ(wk * avgk) / nk = DM, where n ∈ {DM, DIGI, DI, SV, C_O2_, AT, RE, R}

3 Criteria

The eight criteria include: Data Management (DM), Digitalisation (DIGI), Artificial Intelligence (AI), Health Technologies (HIT), CO2 Reduction/Balancing (C_O2_), Agricultural Technologies (AT), Real-Time Data Management (RE), and Robotics (R).

MEPI Index _LT

The collected survey data enabled the calculation of the MEPI index, which empirically evaluates the progress of Lithuania's food systems.

During the period from September 1, 2023, to November 9, 2023, the overall MEPI index reached only 1.74 points (with a maximum possible score of 5),

indicating a low level of progress in Lithuania's food system

Impact of DG/AI on Food Systems

Environmental Dimension

The research findings reveal that Lithuanian food system stakeholders are investing in innovative renewable energy technologies, indicating a positive shift towards sustainable practices and accelerating environmental changes.

Data Management and Integration

Despite the advancements in renewable energy, the integration of digital and AI technologies in data management remains at a low level of maturity in Lithuania.

Lithuanian FS Progress Index

The Lithuanian Food System Progress Index, which measures the maturity of DG/AI integration, scores 1.74 on a five-point scale, highlighting the need for further advancements in this area.

Recommendations for Improvement

Increase Investment

Prioritize increased funding for research and development in digital and AI technologies within all segments of the food system, including production, processing, distribution, and consumption.

Strengthen Data Infrastructure

Develop robust data infrastructure that enables real-time monitoring of food systems, facilitating informed decision-making and proactive interventions.

Foster Collaboration

Promote collaborative efforts between government agencies, research institutions, and industry stakeholders to facilitate knowledge sharing, technology transfer, and effective implementation of digital solutions.

Promote Sustainable Practices

Leverage digital innovation to promote environmentally friendly practices in food production, reduce food waste, and optimize resource utilization.

Thank you!

Acknowledgments

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- Dr. Loreta Bašinskienė
- Dr. Andrius Grybauskas