Capacity Building Project in Higher Education: Leveraging Big Data and Engineering Tools to Transform Food Science Education in Indonesia

Monika Polanska*, Yoga Pratama**, Setya Budi Abduh**, Ahmad Ni'matullah Al-Baarri**, Jan F.M. Van Impe*

* BioTeC+, Chemical & Biochemical Process Technology & Control,
KU Leuven, Belgium (e-mail: jan.vanimpe@kuleuven.be)
**Department of Food Technology, Diponegoro University, Indonesia

1. INTRODUCTION

The recently launched Erasmus+ project "Enhancing Higher Education Capacity for Sustainable Data Driven Food Systems in INDonesia" – FIND4S ("*FIND force*") addresses EU overarching priorities including Green Deal and Digital Transformation to be applied within an Indonesian landscape.

Indonesia has poor performance in sustainable agriculture. A Barilla Foundation and Economist Impact report has ranked Indonesia 71 out of 78 countries assessed (The Economist Newspaper Limited, 2024). The low sustainability score in food production is largely influenced by the increasing deforestation due to massive plantation agriculture. For instance, oil palm plantations have been the biggest driver of Indonesian deforestation (Austin *et al*., 2019). At the same time, it is a nationwide dilemma because palm oil, on one side, is an important export commodity and contributes to the country's economy. Other significant problems undermining the sustainability of the food system also arise from overfishing, inadequate water management and high food loss/waste in the supply chain (Nurhasan *et al*., 2021).

FIND4S approaches the sustainability problem in the Indonesian food system by providing suitable knowledge and skills. The courses in sustainable food systems have yet to become an integral part of Indonesian Higher Education Institutions (HEI) curricula. Likewise, Indonesian graduates need to be better equipped in data science/big data processing. Data mining and big data processing prove useful in closing the gap due to isolated studies. To illustrate, the sustainability of rice production at a national level can be simulated/extrapolated using machine learning from many region-specific studies. The result can then be used to formulate strategies for country-level sustainable rice production. Whilst Indonesia is diverse, and its suitable food system might be area-specific, similarities can be found in some respects. Similarities and dissimilarities in the archipelago need to be comprehensively understood to enable appropriate actions to deal with the issues in the food system. Hence, skills in data science are essential.

2. OBJECTIVES AND METHODOLOGY

2.1 Objectives

The main FIND4S objective is to increase the capacity of seven HEIs in Java by strengthening their institutional and administrative facilities. Sharing best practices of a consortium of four European universities, producing context-specific knowledge, and delivering and disseminating outcomes will enhance curricula relevance for the local labor market and impact society at large. The capacity, knowledge and skills developed at the regionally targeted HEIs will eventually be transferred throughout the country.

This capacity-building initiative aims to transform food systems education BSc/MSc in Indonesia by integrating cutting-edge technologies such as big data, quantitative modeling, and engineering tools into the core of the educational framework. By designing new curricula and upgrading existing programs, this project seeks to equip students and academic staff with the skills needed to harness these technologies, fostering a deeper understanding of food systems and their sustainable transformation.

2.2 Consortium composition

The required expertise is readily available at the level of a long lasting cooperation among four European partners KU Leuven (Belgium), UCD University College Dublin (Ireland), UCP Universidade Católica Portuguesa (Portugal), and Anhalt University of Applied Sciences (Germany). These European partners already jointly offer a European Master of Science in Sustainable Food Systems Engineering, Technology and Business (FOOD4S "*food force*"). FOOD4S adopts a transversal and multidisciplinary approach to a broad range of topics related to the 4S pillars Science (Food Science & Engineering Technology), Sustainability (Sustainable Food Product & Food Process Design), Safety (Food Safety & Quality), and Simulation (Computational Food Science & Technology) (www.food4s.eu). Seven Indonesian universities participate in FIND4S. Diponegoro University, a top ten university in Indonesia, will be the central hub of Indonesian HEIs forming a local cluster (Fig.1). Diponegoro offers both BSc and MSc, the other members offer BSc.
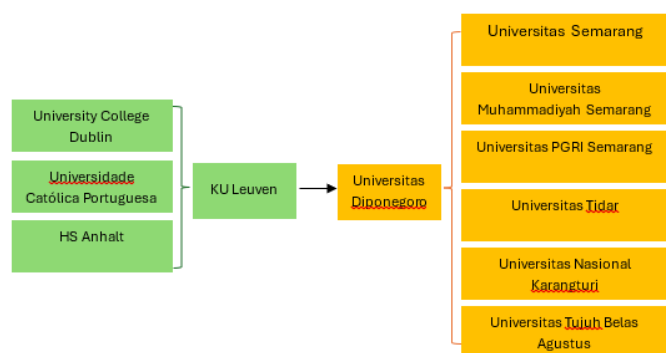
Fig. 1. FIND4S Consortium composition.

2.3 Methods and expected results

Higher Education plays a critical role in supporting the Green Deal by fostering knowledge, skills, and values that drive sustainability. The modernization of competitive and innovative curricula will promote the creation of green jobs and support the transition to sustainable food systems, with a focus on minimizing environmental impact. The project addresses significant environmental challenges, such as food safety and quality, water management, biodiversity loss, and the sustainable use of natural resources, while strengthening agri-food value chains at both national and regional levels.

The integration of risk assessment, predictive modeling, and computational optimization with sustainability principles in food production and processing is a core element of the new BSc/MSc curricula. These courses will encompass energy and food chain concepts, including Life Cycle Assessment, within a cohesive framework. By expanding the theoretical, research and policy discussions around sustainable agriculture and food production, the program aims to deepen understanding of ecological and food system dynamics. It will also explore strategies for regenerating natural systems through the use of big data and predictive tools for the food industry. These modeling tools will enable stakeholders, including industry players, to assess the impact of climate change on food safety and manage emerging threats.

At the heart of the project is the utilization of big data analytics, which will empower both educators and students to collect, analyze, and interpret vast amounts of data relevant to food science. By implementing quantitative modeling techniques, students will learn to predict and optimize processes in food production, distribution, and consumption, helping them solve complex problems faced by the food industry in real-time. Engineering tools will be incorporated into lab work and research activities, enabling the design and testing of innovative solutions to food system challenges.

The project also emphasizes the training of academic staff in these advanced technologies, ensuring they can effectively integrate them into their teaching methodologies. This will be further supported by establishing a dedicated research center and upgrading laboratory facilities to include the latest technological tools for data analysis and engineering simulations. Such infrastructure will allow students and

researchers to engage in hands-on learning, preparing them to apply these skills in real-world scenarios.

In collaboration with the aforementioned European HEIs, the initiative will foster an exchange of expertise, allowing Indonesian institutions to benefit from best practices in data-driven research and food system innovation. By building this international network, the project will ensure that Indonesian higher education stays at the forefront of global developments in food science.

A central component of the initiative is the development of a comprehensive MSc program at the central hub Diponegoro that embeds big data, quantitative modeling, and engineering tools throughout its curriculum. This advanced program will meet the growing demand for professionals equipped with modern technological and analytical skills, addressing critical issues in food security, sustainability, and innovation. Graduates will not only be able to analyze complex data sets but will also contribute to the design and implementation of sustainable food systems that are socially, economically, and environmentally responsible.

The strategic application of big data, computational methods and engineering tools will engage a broad range of stakeholders including industry partners, to ensure the program aligns with current and future market needs. These partnerships will enable the practical application of academic research, translating classroom knowledge into real-world solutions that promote a greener, more sustainable economy.

3. CONCLUSIONS

This capacity building project will serve as a transformative force in Indonesian higher education, equipping students and faculty with the tools needed to drive meaningful change. By integrating big data, quantitative modeling, and engineering tools, the initiative will support Indonesia's transition to sustainable food systems, fostering innovation and resilience in the country's food economy.

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