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Smart Green Technology and Sustainability Training for Competency Alignment and Transformation for UM Alumni

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Abstract

The rapid development of smart technology demands the adjustment of human resource competencies in various technological, business, and industrial sectors. However, field observations revealed that Universitas Negeri Malang (UM) alumni, both entrepreneurs and employees in engineering fields, experienced competency gaps because smart technology material and sustainability principles had not been comprehensively accommodated in the previous curriculum. This activity aimed to align competencies and facilitate sustainable digital transformation for UM alumni through training and mentoring in Smart Green Technology and Sustainability. The activity was carried out through an interactive project-based approach divided into six effective face-to-face meetings. The methods applied included in-depth needs analysis, delivery of theoretical materials, programming and hardware installation workshops, and analysis of environmentally friendly technology implementation in the participants' business units. The results of this community service activity showed significant improvements in technological literacy, practical skills, and awareness of energy efficiency and environmental sustainability among alumni. The pre-test and post-test assessments recorded an average increase in technical understanding of 48.5%, with 70% of participating entrepreneurial alumni successfully designing an initial prototype for integrating an IoT-based monitoring system into their business units. This activity demonstrates that collaborative synergy between universities and alumni can bridge the barrier of high external training costs while accelerating UM alumni's progress in remaining competitive, adaptive, and environmentally conscious amid the rapid dynamics of the digital era.

Keywords: Smart Green Technology, Sustainability, UM Alumni Transformation, Competency Alignment

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INTRODUCTION

Rapid technological development requires every individual to continue adapting to advances in science. One technological development that is currently highly urgent is smart technology based on IoT and robotics (Amory, 2012). The industrial revolution based on IoT and robotics has become an important part of various sectors of life, ranging from the industrial, manufacturing, education, and economic sectors to the military sector (Almehairbi et al., 2022; Hendrawan, 2024). Smart technology plays an important role in increasing work productivity. Difficult and dangerous work that was initially performed using human labor has

now been replaced by various robots, making it easier and safer (Gani, 2024; Pérez et al., 2025).

One sector for which continuously updating and upgrading technology is no less important is the engineering business sector (Wang, 2022). This is related to the increasing sophistication of IoT- and robotics-based smart technologies used to support engineering business activities (Upadhya & Vasavi, 2006; Wu et al., 2014). This technological transformation requires the human resources (HR) involved not only to be technically proficient, but also to possess adaptability and full awareness of the changes taking place (Jamaris et al., 2021; Machmud et al., 2021; Widiyanti et al., 2023). Business actors' efforts to adapt and ability to keep pace with technological developments are directly related to the increasing level of digital-based business competition in the current global era. Business actors must be able to improve their competencies in accordance with existing technological trends in order to survive and grow rapidly in step with the times (Vrchota et al., 2019).

Considering the urgency of these developments in IoT- and robotics-based smart technology, alumni who work as entrepreneurs in engineering fields, as well as alumni who work as employees and are graduates of Universitas Negeri Malang (UM), need to receive skill reinforcement regarding the implementation of IoT- and robotics-based smart technology. This is related to efforts to update and upgrade alumni knowledge, because during their studies there was no comprehensive material on IoT- and robotics-based smart technology, as the curriculum had not yet accommodated it as it does today (Johari & Bradshaw, 2006; Simeu-Abazi et al., 2014).

Based on these conditions, Universitas Negeri Malang (UM), as a university committed to developing excellent human resources, needs to bridge the gap between competencies and the needs of the business world, especially businesses operated by UM alumni. Training and mentorship related to the implementation of IoT- and robotics-based smart technology are required. This training and mentorship activity was conducted effectively through six face-to-face meetings, beginning with the concepts and knowledge of smart technology, IoT, and robotics and continuing through application and implementation.

The results of observations and interviews conducted in January 2026 by the Universitas Negeri Malang Community Service Team showed that the fundamental problem among UM alumni in engineering fields was their still limited and low level of knowledge regarding IoT- and robotics-based smart green technology and sustainability. UM alumni did not yet possess up-to-date knowledge to upgrade their understanding of smart green technology and sustainability. One factor was the cost required to attend training organized by official institutions. Therefore, through this program, alumni were expected to improve their knowledge and skills related to IoT- and robotics-based smart green technology and sustainability. The knowledge and competencies acquired after the training were expected to enable the alignment of business and business transformation in the current era of digital technology.

This training and mentorship activity was expected to make a tangible contribution to UM alumni who are business actors or employees by developing their competencies and businesses so that they can grow further in line with current

developments. Through this activity, UM and its alumni collaboratively learned about smart technology literacy and innovation to create sustainable businesses. This activity served as a bridge between UM and its alumni for the transfer of knowledge and the practical implementation of technology in the business world.

RESEARCH METHOD

The implementation of the Smart Green Technology and Sustainability training and mentoring program was designed using a systematically structured descriptive-participatory approach to ensure the accuracy of knowledge transfer and practical skills for Universitas Negeri Malang (UM) alumni. The activity began with the identification and needs-analysis stage, followed by the preparation of comprehensive training materials that combined the concepts of smart technology, energy efficiency, and environmental sustainability.

The training was implemented effectively through six face-to-face meetings with structured durations. The training structure was designed in stages, beginning with theoretical foundations and continuing to the execution of real projects. To measure the effectiveness and success of the program in a measurable manner, the evaluation instruments used quantitative and qualitative approaches. Quantitative evaluation was conducted through training pre-tests and post-tests to measure improvements in participants' cognitive achievement, as well as through the completion of questionnaires on program satisfaction and effectiveness. Meanwhile, qualitative evaluation was conducted using performance observation sheets during practical workshops, portfolio assessment, and in-depth feedback interviews regarding the relevance of the materials to business efficiency. This holistic approach ensured that the skills did not remain solely in the theoretical domain, but had a direct impact on the ability to align alumni competencies in the workplace and entrepreneurship.

RESEARCH RESULTS

The implementation of the Smart Green Technology and Sustainability training and mentoring program proceeded optimally and produced significant positive achievements among all participating UM alumni. Based on the pre-test data collected before the training intervention, the average score of alumni understanding regarding the integration of IoT technology, environmentally friendly sensors, and robotics was in the low category, at 41.2 on a scale of 100. This initial condition confirmed the preliminary observation that alumni faced obstacles in updating their knowledge because integrated smart technology courses had not been included in the previous curriculum and because of the high cost of training certification at official external institutions. However, after completing all stages of the six face-to-face meetings, the post-test results recorded an increase in the participants' average understanding to 89.7 on a scale of 100, representing a significant increase of 48.5%.

In addition to improvement in the cognitive domain, the program's indicators of success were clearly evident in the psychomotor skills and practical innovative works of the alumni. During the practical and mentoring sessions, the participants successfully designed and demonstrated various smart green solution scenarios. A total of 70% of the alumni who were business actors successfully

created initial prototypes of IoT-based energy monitoring and automation systems tailored to the needs of their respective business units, such as automatic temperature and humidity control systems in production rooms, wireless-network-based electricity consumption monitoring, and control systems for the efficient use of raw materials. This increase in competence gave the alumni much greater confidence in making technical decisions in the workplace and in modernizing the business lines being developed (Ghobakhloo, 2018; Huang & Yu, 2019; Mustikawanto, 2019; Nugraha et al., 2020). The training materials delivered during the program are presented in **Figure 1**, while the implementation of the face-to-face training activities is documented in **Figure 2**. Both figures illustrate the integration of theoretical instruction and practical activities throughout the training program.

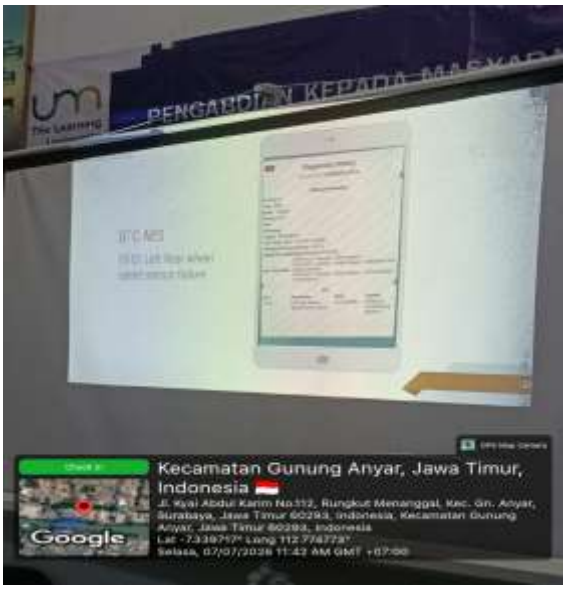

Figure 1. Training materials

Figure 2. Training implementation

DISCUSSION

The results achieved in this program demonstrate how crucial competency alignment is for university graduates, particularly alumni in engineering fields who directly face the rapid pace of the IoT- and automation-based industrial revolution. The very rapid dynamics of smart technology development often create a knowledge gap between the academic capital obtained during university study and actual demands in the field (Suwanroj et al., 2019; Wahyudin et al., 2025). As revealed in the initial analysis, it cannot be denied that higher education curricula in the previous era had not fully included comprehensive material in an integrated manner. Therefore, the activity scheme in the form of training based on intensive mentoring proved effective as a bridge to fill this gap without placing a financial burden on alumni.

The sustainability aspect integrated into technology provides highly strategic added value for the transformation of UM alumni businesses. In the modern commercial era, business competition no longer relies solely on increasing production volume, but also on the extent to which an industry can operate efficiently, in an environmentally friendly manner, and with low energy consumption (Ana, 2020; Aziz, 2019; Zaheer et al., 2020). Through the application of Smart Green Technology, alumni who are business actors now have the capability to reduce operational costs through automatic energy savings, minimize production waste, and increase product competitiveness in a digital market that increasingly demands environmentally friendly standards (Hidayat et al., 2020; Nurmalasari et al., 2017; Setiawan et al., 2021). Meanwhile, for alumni who are employees, this increase in competence directly improves their bargaining position and professionalism within companies, because they are able to offer technical-efficiency solutions based on the latest smart technology (Coetzee & Harry, 2014; Ito & Brotheridge, 2005; Santuzzi et al., 2014).

Furthermore, this activity reinforces the importance of a sustainable collaboration model between Universitas Negeri Malang and its alumni association. The university does not merely serve as an institution that produces graduates, but also as a center for knowledge updating that continuously assists alumni in facing waves of technological disruption (Alkhasawneh, 2023; Bawica, 2021; Bolli et al., 2021; Fachelli & Fernández-Toboso, 2021; Trần, 2016). This synergy creates a mutually beneficial relationship. Alumni gain access to skills updating without high costs, while the university receives real feedback from industry that is highly valuable for evaluating and restructuring the academic curriculum so that it remains relevant to contemporary needs. Thus, this transfer of knowledge based on practical implementation gradually strengthens the Universitas Negeri Malang innovation ecosystem in producing excellent and globally competitive human resources.

CONCLUSION

Based on the entire series of training and mentoring activities that were implemented, it can be concluded that the Smart Green Technology and Sustainability program successfully achieved its objective of improving and aligning the competencies of Universitas Negeri Malang (UM) alumni. The program directly addressed the fundamental problems of alumni in engineering fields who previously had limited access to and knowledge of the latest smart

technologies because of limitations in the previous curriculum and the high cost of formal training. The structured implementation of six face-to-face meetings was measurably proven to increase participants' cognitive understanding by 48.5% and to equip alumni with practical skills in designing environmentally friendly technology prototypes.

The implications of this activity are not limited to increasing the individual capacity of alumni, but also have a positive impact on accelerating business transformation and their professional performance in the digital era. UM alumni who are business actors now have practical provisions for transforming their business lines to become more efficient, energy-saving, and highly competitive through the application of smart green technology innovations. At the same time, this program strengthens UM's collaborative role as a sustainable development platform that bridges the needs of the business world with the academic capacity of higher education. It is expected that this alumni-community-based training and mentoring model can continue to be developed periodically on a broader scale to support the creation of an ecosystem of entrepreneurs and engineering workers who are excellent, adaptive, and sustainability-oriented in the future.

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