



Development of Roadmap for Research and Community Service in D4 Electrical Engineering, Universitas Negeri Surabaya

Aditya Chandra Hermawan¹ Reza Rahmadian¹ Widi Aribowo¹
Mahendra Widyartono¹ dan Ayusta Lukita Wardani¹

¹ Universitas Negeri Surabaya, Surabaya, Indonesia
rezarahmadian@unesa.ac.id

Abstract. The development of a research and community service roadmap aims to outline the various research studies and community service activities in accordance with the expertise of faculty members and scientific knowledge. This roadmap serves as a reference for executing, assessing, and advancing research and community service initiatives, taking into account the capabilities of lecturers and also students as part of the research. The selected research method for this study is the technology roadmap methodology or TMR. Several areas were analysed such as, the alignment of the research topic and community engagement with the university's vision and mission and the academic needs that align with the industry/job market. The purpose of this roadmap is to provide a concise and comprehensive direction for the lecturer to plan and implement selected focus for their Research, yielding improved and measurable outcomes. The carefully crafted roadmap is intended to facilitate coordination and alignment among various related activities during implementation.

Keywords: Technology Roadmap Methodology, Electrical Engineering, Community Service.

1 Introduction

The incredibly swift technological advancements, particularly in the Information Technology domain, have propelled Indonesia's industries into the era of Industry 4.0 and towards the era of Society 5.0. The focal points of this Industrial Revolution include elements like the Big Data, Artificial Intelligence, Internet of Things (IoT), and Cloud Computing. These characteristics bring about significant transformations in the realms of work and industries. With the advent of digitization in the industrial realm, the working landscape is bound to undergo significant transformations. A noticeable change is the obsolescence of skills that were once indispensable in the industrial sphere, primarily due to the replacement of human roles with machines or their outright elimination from the industrial sector. Alongside this, new job positions will emerge, requiring specialized skills. In fact, entirely novel job roles that currently do not exist might also come into existence [1].

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This major change presents one of the obstacle for Vocational Faculties, which are dedicated to preparing their graduates to compete in an ever-evolving job market. There's even the possibility that what vocational students are learning today may no longer be relevant by the time they complete their university studies [2]. Therefore, students are not only expected to be competent in their skills but also capable of transforming the knowledge acquired in their academic studies into the knowledge required in new job positions.

In response to this challenge, Kementrian Riset Teknologi dan Pendidikan Tinggi (Kemenristek Dikti) encourages universities to be relevant to Rencana Riset Induk Nasional (RIRN) to enhance the standart of their graduates through the improvement of research standart that is both qualitative and quantifiable, and outputs that are beneficial for the overall societal well-being. Universitas Negeri Surabaya, as a part of Kementrian Riset Teknologi dan Pendidikan Tinggi, has developed a clear and targeted research roadmap outlined in Rencana Induk Penelitian (RIP). Within this plan, one of the university's visions is to become a world-class research university while also fostering an entrepreneurial spirit.

To support the vision of Universitas Negeri Surabaya, specifically within the Faculty of Vocational Studies, and particularly the Electrical Engineering program, efforts are being made to craft a focused and measurable research and Community Service or Pengabdian Kepada Masyarakat (PKM) roadmap. The topics within this roadmap are aligned with the current technological advancements or state of the art, all to contribute to the graduate profile of D4 Electrical Engineering students. The vocational direction aims to produce graduates who are job-ready [3].

2 Literature Review

The government's attempts to promote technology and science and enhance the economic impact of research have involved the issuance of various regulations and policies. However, an assesment of the Government report on Research, Development, and Application of Science and Technology, as well as Kebijakan Nasional Strategis Iptek, and Agenda Riset Nasional (ARN) indicates that these policies haven't entirely served as guiding frameworks. As a solution, a more organized and legally robust sector-specific master plan, in the form of Rencana Riset Induk Nasional (RIRN), has been deemed necessary. The RIRN, spanning from 2017 to 2045, is designed to establish coordinated research planning in alignment with national development strategies [4]. It is not only aligning research topics with long-term developmental objectives but also caters to the demands of the business sphere and society as a whole. Therefore, to address this concern, Rencana Riset Induk Nasional (RIRN) spanning from 2017 to 2045 was formulated, taking into account the strategic blueprints for various sectors, such as Rencana Induk Pembangunan Industri Nasional 2015–2035 (RIPIN), Kebijakan Energi Nasional (KEN), and Rencana Induk Ekonomi Kreatif Nasional (RIEKN). This approach is founded on research rooted in science and technology, aiming to drive technology-based manufacturing within the industry and foster the creation of innovative products in the realm of the creative economy. The progression of human civilization,

notably throughout the last six millennia as documented in historical records, has underscored that a pivotal factor in enhancing societal well-being lies in the capacity to amplify the production of collective goods and services [5].

Conversely, the enhancement of aggregate production capacity hinges on the extent of augmenting production factors and refining efficiency. Technology stands as a key requirement for this augmentation and enhancement. As a result, the capacity to uplift human welfare significantly rests on the caliber of technological advancement and the adeptness in its management. This advancement is primarily steered by the pace at which scientific knowledge accumulates. In turn, the speed of this accumulation is considerably influenced by socio-cultural elements, specifically the value system, determination, and virtuous ethical principles. The initial stage of this scientific accumulation is manifested through research endeavors.

The purpose of conducting research is to uncover new ideas or discoveries. The novelty of the research findings can be established through verification from the surroundings, particularly in the form of Intellectual Property Rights (IPR), mainly for scientific publications and registered copyrights or event patents. Claims of novelty must be acknowledged and globally recognized. Thus, since the era of advance technology, publication in international indexed journals has become a primary indicator. Conversely, novelty that holds practical and tangible significance is substantiated by patent certificates, technical feasibility reports, and registered copyrights, both domestically and internationally. Consequently, Indonesian position and contribution for research can be gauged through globally indexed scientific publications and registered patents.

The core objective of the research is to discover innovation or new invention. The originality of the research outcomes is proven through outputs that have received validation from the community, particularly in terms of Intellectual Property Rights (IPR), including scientific publications and patents/PVT/registered copyrights. Claims of innovation must gain international recognition and acknowledgement. Hence, since in this modern era of science and technology, publishing in internationally recognized journals has emerged as a key benchmark. Conversely, innovation that can be practically and tangibly applied, both in physical and non-physical aspects, is demonstrated through patent certificates and registered copyrights, both domestically and internationally. Therefore, the status and the contribution of Indonesian research can be assessed based on globally acknowledged scientific publications and registered patents. In addition, the output of the national research can be measured in the globally recognized publications and the count of registered patents and also available across numerous international indexing systems.

From Fig 1, it can be observed that publications in Indonesia from 2013 to 2022 experienced a significant increase in 2016, but underwent a highly significant decrease from 2019 to 2021. This is concerning as it indicates a sharp decline, and Indonesia's publication output remains below that of Malaysia. Given this trend, it wouldn't be surprising if Singapore surpasses Indonesia in publication count in the upcoming years.

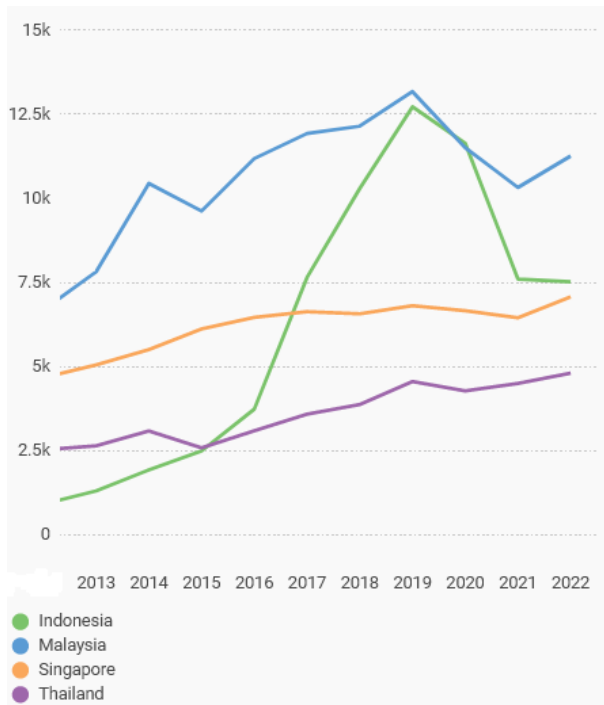


Fig. 1. International Publication of several countries in ASEAN.

As for SCOPUS publications at the institutional or university level, according to the graph from simlitabmas, the University of Indonesia still holds the top position in terms of publication count with 4,119 publications, followed by Gadjah Mada University with 3,061 publications, and then Bandung Institute of Technology with 2,143 publications [5]. On the other hand, Universitas Negeri Surabaya is currently below Universitas Negeri Malang, with only 492 SCOPUS publications as shown in figure 2. This serves as a consideration for Universitas Negeri Surabaya to promptly increase its publication count. This effort is important not only to support UNESA's mission of becoming a world-class research university, but also to contribute to the growth of globally indexed publications in Indonesia.

In the context of Law Number 11 of 2019 regarding Sistem Nasional Ilmu Pengetahuan dan Teknologi or the National System of Science and Technology, the focus has been placed on universities being responsible for managing science and technology by means of education and fulfilling their duty of cultivating skilled individuals for the practical application of science and technology. Universities bear the duty of enhancing the prowess related to the three fundamental functions of higher education [6]. Moreover, universities assume a critical role in fortifying the stature both in science and also technology as essential investment resources for short, medium, and long-term national advancement.

One of the primary objectives of the National System of Science and Technology is to enhance the country's self-reliance and competitive edge. This implies that

universities should receive support from research and development institutions, industries, and skilled professionals to contribute to bolstering not only in the economy area, but also contribute in advancing community well-being. It's imperative to provide greater encouragement and resources to universities, enabling them to generate more inventions and innovations that lead to the application of appropriate technology, value addition, and increased utilization of domestic components to reduce reliance on imported goods. Unesa, as Lembaga Pendidikan Tenaga Kependidikan (LPTK), holds the vision of being "Superior in Education, Strong in Science." This vision underscores the resolute determination of all members of Unesa to establish it as a higher education institution excelling in academic quality, authority, and academic integrity. This aspiration extends to the national and international educational landscape, with the aim of becoming a benchmark in educational development.

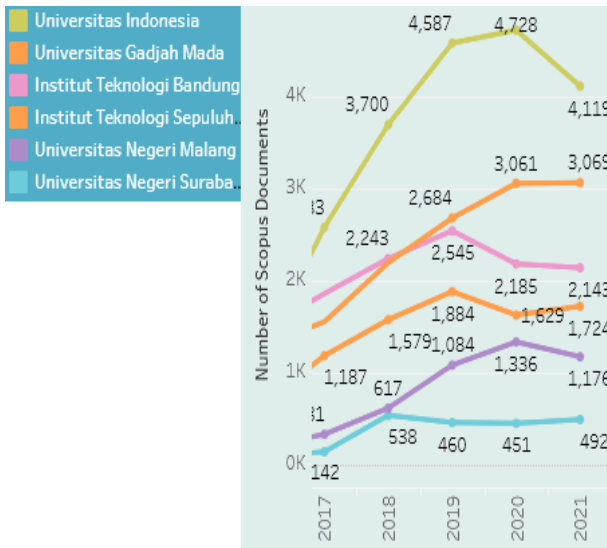


Fig. 2. SCOPUS Publication of several universities in Indonesia.

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To align the research and Community Service (PKM) themes in the D4 Electrical Engineering program, establishing a foundational clarification for theme selection is crucial. This ensures that the chosen themes consistently support the teaching quality within the program. Outcome-Based Education (OBE) has been adopted as a curriculum approach not only to enhance teaching quality but also to prepare the program for International Accreditation. OBE's approach to curriculum development is rooted in the competencies that students acquire after finishing the education in university. Hence, these final competencies become the reference points for curriculum design, assessment strategies, and learning models [7]. Collaborative efforts are essential for implementing OBE, from instructors, guardians, students, and representatives from the industries to ensure successful execution [8].

3 Method

In this study, a technique known as the technology roadmapping methodology (TRM) was employed. TRM is a flexible approach encompassing technology foresight, strategic planning, and innovation management. It is employed by the knowledge triangle, comprising industry, government, and academia, and is applicable in diverse contexts, with various structures and approaches [9].

The first step in the TRM method is to conduct library research, or literature review. This method employs ways of obtaining information through available resources, such as SIMLPPM, libraries, printed documents, or certificates from institutions, combined with direct interviews with sources. Data can be sourced from the LP2M Unesa institution's database, statistical data documents, or research reports previously conducted by faculty members of the D4 Electrical Engineering homepage. Among the documents taken are: National Research Master Plan documents, Unesa's Research Agenda (Resntra), Unesa's Research Master Plan, and other relevant documents. In addition, the secondary data analysis research, the researcher gathers information sources from these identified data sources. The second step is to conduct literature review of government policies for research, such Rencana Riset Induk Nasional (RIRN) from the Ministry of Research, Technology, and Higher Education (Kemristek Dikti), Rencana Induk Pembangunan Industri Nasional 2015–2035 (RIPIN), Kebijakan Energi Nasional (KEN), and Rencana Induk Ekonomi Kreatif Nasional (RIEKN). The third step is to conducting a forum group discussion by inviting experts from the industrial

sector to identify issues related to electricity that are currently under discussion and the technologies required in both the industrial and societal contexts.

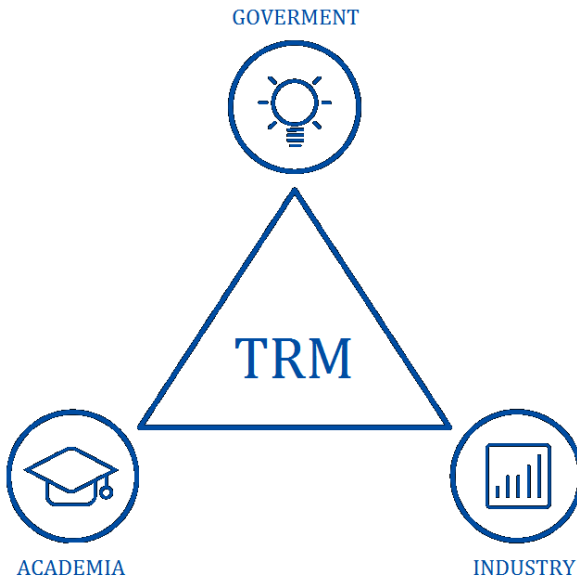


Fig. 3. Technology road-mapping methodology.

4 Results and Discussion

From the data collected from SIMLPPM and LP2M Universitas Negeri Surabaya, the research and Community Service (PKM) focus conducted by the lecturers of the D4 Electrical Engineering program can be mapped that the main focus of research and PKM lies in renewable energy, followed by control systems, and electricity system. With this data, an internal Forum Group Discussion (FGD) is organized to determine the themes to be carried forward in the research and PKM development plan of the program. During the FGD, the agreed-upon themes and their implementation are discussed, keeping in mind the research focuses of the lecturers that have been undertaken previously.

The roadmap should align with the domestic issues, particularly those outlined by the Ministry of Research and Technology (Ristek Dikti) in the National Research Priorities (PRN) 2020-2024. There are nine focuses outlined in the PRN 2020-2024: 1) Food, 2) Energy, 3) Health, 4) Transportation, 5) Engineering, 6) Defense and Security, 7) Maritime, 8) Socio-Humanities, 9) Multidisciplinary and Cross-Sectoral [10]. Based on the above focuses, the D4 Electrical Engineering program can find relevance in two sub-focuses, namely, the Energy field focus, which specifically mentions New and Renewable Energy-Based Electrical Technology, and the Multidisciplinary and Cross-Sectoral focus, which includes topics related to the Environment and Climate Change, directly related to the utilization of Green Energy technology.

The outcome of the suggestions provided by experts from Perusahaan Listrik Negara (PLN) leads to the adoption of research themes that are presently of significant importance to local power plants system. Since this study program's vision aims to produce adept and competitive experts in electrical engineering both in technical skills and in information technology, it's imperative that the research themes and Community Service (PKM) concerns of the study program are aligned with the requirements of local industries. Below are the research and PKM themes advised by the experts.

Due to the recent occurrences of natural disasters, students are expected to possess knowledge about mitigating power plant damage resulting from natural calamities. This encompasses the understanding and skills related to power distribution and hazard warning systems for power plants. Consequently, the desired expertise involves proficiency in digitizing existing systems within the national power company (PLN). One of the systems currently utilized and under development is the Supervisory Control and Data Acquisition (SCADA) system. This system can be employed to both monitor and regulate power distribution from the central PLN, also serving as a provisional security mechanism in case of damage to power plants affected by natural disasters.

Several considerations also taken into account in determining the themes and focuses for the formulated roadmap. These considerations are derived from factors such as (1)

National Research Priorities (PRN) 2020-2024, especially the point regarding the Energy field focus and the Multi-Disciplinary and Cross-Sectoral focus, which includes Environmental and Climate Change issues directly related to Green Energy technology; (2) Increasing the number of publications in both National and International scientific journals; (3) Beneficial impact on society; (4) Feasibility within the available time frame; (5) Potential for patenting; (6) Alignment with the curriculum; (7) Application of state-of-the-art and appropriate technologies.

Guided by these points, along with the research and PKM data from the D4 Electrical Engineering lecturers, the next step is to engage in discussions by inviting experts from the industrial sector to understand the current issues in the field of electricity and the technologies needed in both industry and society. Based on several internal and external FGDs, the following themes and focuses for research and PKM in the D4 Electrical Engineering program is Implementation of Green Technology in Electrical Engineering, with several themes as show in the Table 1.

Referring to the overarching research theme and the aforementioned research focuses, a Research and Community Service (PKM) Roadmap is crafted for the D4 Electrical Engineering program, spanning from 2022 to 2035 as illustrated in Figure 3a and 3b. The Research and Development (RnD) phase and technological engineering phase align with the National Research Priorities (PRN) and Unesa's Strategic Plan (2020-2024). This is followed by prototype product development in 2025, with products poised for market readiness between 2030 and 2035.

Table 1. Table captions should be placed above the tables.

Theme	Point of Interests
Renewable Energy	Solar Powered Generator for Small Housing Solar Powered Generator for Small Village Water Powered Generator for Small Village
Natural Disasters	Emergency Solar Generator Disaster Mitigation for Power Plants Disaster Mitigation based on Digital for Power Plants
Teknologi Tepat Guna	Solar Powered Lighting for small village Small Scaled solar powered plants for emergency Solar Powered Generator for Agriculture
Control in Power Systems	SCADA for electrical power Smart system for electrical motor control and monitoring Electrical system based IoT

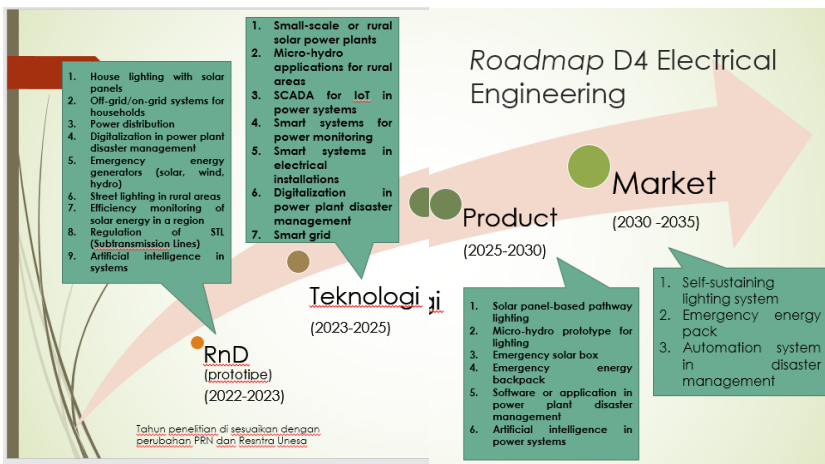


Fig. 4. Roadmap for Research and Community Service.

5 Conclusion

In the effort to enhance the quality and quantity of research and community engagement in the D4 Electrical Engineering program, a guideline is essential to align and focus the themes and scopes of research and community projects conducted earlier. This alignment process can be effectively and efficiently achieved through thorough and systematic preparation, which in this case is executed by formulating a research and community engagement roadmap for the D4 Electrical Engineering program. With the presence of this roadmap, research and community projects within the program should refer to and follow it as a guide. If the guidelines within the roadmap are diligently implemented and followed, it is expected that the D4 Electrical Engineering program can yield purposeful research, prototype development research, ultimately culminating in

the creation of market-ready tools or patents. The framework of policies in this research and community engagement roadmap will be meaningful if the agreed-upon outcomes genuinely transform into action plans, rather than being mere guiding principles to follow at one's discretion

References

1. The Economist, Intelligence Unit, *Driving the Skills Agenda: Preparing Students for the Future*. The Economist Report, London (2015)
2. World Economic Forum, *The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution*. World Economic Forum, Switzerland (2016)
3. King, Kenneth & Robert Palmer. *Planning for Technical and Vocational Skills Development*. Unesco International Institute for Educational Planning, Paris (2010)
4. Peraturan Presiden (PERPRES), Peraturan Presiden (PERPRES) Rencana Induk Riset Nasional Tahun 2017–2045. Indonesia (2018)
5. Gouvea R., Kapelianis D., M.-J. . Montoya R, and Vora G., “The creative economy, innovation and entrepreneurship: an empirical examination,” *Creative Industries Journal*, vol. 14, no. 1, pp. 23–62, Apr (2021)
6. T. dan P. T. Kementerian Riset, Peraturan Menteri Kementerian Riset, Teknologi, Dan Pendidikan Tinggi Republik Indonesia tentang Prioritas Riset Nasional Tahun 2020–2024. (2018)
7. Harden R. M., “Ten questions to ask when planning a course or curriculum,” *Med Educ.*, vol. 20, no. 4, pp. 356–365, Jul. (1986)
8. Eldeeb R. and Shatakumari N., “Outcome Based Education (OBE) - Trend Review,” *IOSR Journal of Research & Method in Education (IOSR-JRME)*, vol. 1, no. 2, pp. 9–11, Mar. (2013)
9. Kostoff, R.N.; Schaller, R.R. Science and technology roadmaps. *IEEE Trans. Eng. Manag.*, 48, 132–143.(2001)
10. Kementrian Riset, Teknologi dan Pendidikan Tinggi Prioritas Riset Nasional. Available at: <https://baketrans.dephub.go.id/file/138> (Accessed: August 9, 2023), (2019)

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