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CAPACITY BUILDING OF POST GRADUATE ALUMNI: CONCRETE IMPLICATIONS OF PARTICIPATORY ACTION RESEARCH METHODS

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Abstrak

Alumni memiliki peran strategis dalam penguatan jejaring akademik dan diseminasi riset. Namun, keterbatasan penguasaan analisis data lanjutan menjadi hambatan utama publikasi internasional. Program pengabdian kepada masyarakat ini bertujuan meningkatkan kapasitas analisis data alumni melalui pendidikan nonformal berkelanjutan dengan mengintegrasikan *Participatory Action Research* (PAR), model evaluasi Kirkpatrick, dan pelatihan berbasis perangkat lunak R. Program melibatkan 38 alumni sekolah pascasarjana dan dievaluasi pada empat level Kirkpatrick. Hasil menunjukkan 68,42% peserta memiliki tingkat keterlibatan tinggi, dan 81,58% menilai materi sangat relevan dengan kebutuhan profesional. Analisis PLS-SEM menunjukkan bahwa pembelajaran berpengaruh signifikan terhadap perubahan perilaku (R^2 = 0,217), dan perilaku berkontribusi kuat terhadap hasil (R^2 = 0,399), ditandai dengan meningkatnya frekuensi penggunaan R, penerapan analisis lanjutan, dan kolaborasi riset. Program ini berkontribusi nyata dalam menyediakan model penguatan kapasitas alumni yang terstruktur, terukur, dan berkelanjutan, serta dapat direplikasi oleh perguruan tinggi lain untuk meningkatkan kualitas publikasi dan produktivitas riset berbasis data.

***Kata kunci**:* Alumni; Peningkatan Kapasitas; Pendidikan Berkelanjutan; *Participatory Action Research.*

Abstract

Alumni play a strategic role in strengthening academic networks and research dissemination. However, limited mastery of advanced data analysis remains a major barrier to publication in reputable international journals. This community service program aimed to enhance alumni data analysis capacity through a non-formal continuing education model integrating Participatory Action Research (PAR), Kirkpatrick's evaluation framework, and hands-on training using R software. The program involved 38 graduate school alumni and was evaluated using the four Kirkpatrick levels. Results show that 68.42% of participants demonstrated high engagement (reaction), while 81.58% perceived strong relevance between training materials and their professional needs. Quantitative evaluation using PLS-SEM indicates that learning significantly influenced behavioral change (R^2 = 0.217), and behavior had a strong effect on results (R^2 = 0.399), reflected in increased frequency of R usage, application of advanced analytical techniques, and research collaboration. This program makes a real contribution in providing a structured, measurable, and sustainable model for strengthening alumni capacity, and can be replicated by other universities to improve the quality of publications and the productivity of data-based research.

Keywords: Alumni; Capacity Building; Continuing Education; Participatory Action Research.

INTRODUCTION

Higher education plays a central role in developing high-quality human resources (HR) and its quality is often reflected in graduates' readiness to contribute to society and the professional world. This role is closely aligned with Sustainable Development Goals (SDGs) 4, which emphasize inclusive and equitable quality education to ensure equal access and the production of superior human resources (Filho et al., 2019; Safitri et al., 2022). One of the strategic contributions of higher education institutions in achieving this goal is through Community Service, as part of the Higher Education Tridharma alongside education and research.

Alumni represent a critical output of higher education institutions and function not only as indicators of institutional quality but also as agents who shape institutional reputation and networks at national and international levels (Abidin, 2021; Cheng et al., 2022). Competent alumni, particularly those with strong academic and professional capacities, contribute to innovation, technological development, and problem-solving within society (Cahyaningrum et al., 2022; Mok & Jiang, 2020). Pedro et al. (2018) highlighted that alumni competence (both academic and non-academic) plays a decisive role in strengthening institutional image and sustainability. Consequently, continuous capacity development programs for alumni are essential, especially in response to rapid changes in research and technology.

One critical competency increasingly demanded in the academic and research environment is data analysis. Advances in research methodology and digital technology require alumni, particularly those working as lecturers and researchers, to continuously update their data analysis skills to produce high-quality, publishable research. The quality of higher education is frequently associated with the quantity and quality of publications in reputable international journals Bond et al. (2019). However, mastering advanced research methodology (especially data analysis) remains a significant challenge for many alumni. Reputable international journals impose stringent methodological standards, particularly regarding the validity and appropriateness of data analysis techniques (Kwiek, 2021). Alumni who lack familiarity with contemporary analytical approaches often experience difficulties meeting these standards, resulting in high manuscript rejection rates Knight (2022).

Several community service and training initiatives aimed at improving alumni capacity have been implemented by higher education institutions, primarily focusing on technical skill enhancement (Mok & Jiang, 2020). While these initiatives have demonstrated positive outcomes, many have not explicitly integrated data literacy development with sustainable professional networking and long-term capacity building. Brandi et al. (2023) emphasized that the digital era demands more

complex competencies, including advanced data processing and analytical skills, yet rapid technological developments often outpace alumni access to relevant training. This condition indicates a gap between the increasing demand for advanced data analysis competencies and the availability of structured, sustainable training programs that simultaneously strengthen alumni networks and research collaboration.

In the Indonesian context, improving alumni data analysis skills is also directly related to national research productivity. Although Indonesia has experienced growth in scientific publications, challenges remain in enhancing research quality and methodological rigor (Merga & Mason, 2021; Niemczyk & Rónay, 2023). Strong data analysis skills not only improve research quality but also increase opportunities for publication in reputable international journals, thereby enhancing national academic reputation (Kwiek, 2021). Non-formal education and community service-based training have been recognized as effective mechanisms for sustainable human resource development, particularly in technical and methodological competencies Safitri et al. (2022).

This community service program responds to these gaps by providing structured data analysis training for university alumni, with a specific focus on the use of R software. R is one of the most widely used data analysis tools across disciplines and is particularly relevant in the era of big data due to its flexibility, efficiency, and capacity to handle large and complex datasets (Halwani et al., 2022; Johnson et al., 2020). Training based on R not only enhances technical proficiency but also supports deeper conceptual understanding of statistical reasoning, thereby bridging the gap between theory and practice.

This community service program aims to enhance alumni competencies in quantitative data analysis through structured training and mentoring using R software, while simultaneously strengthening collaborative academic networks among alumni and partner institutions. By integrating capacity building with network strengthening, this program is expected to contribute to sustainable alumni development, improve research quality and publication outcomes, and support the broader mission of higher education institutions in advancing education and research quality at national and global levels.

METHODS

Community Service Programs Design and Approach

The community service program adopts a community service with an evaluative research design, aimed at increasing the capacity of Graduate School alumni of Yogyakarta State University (UNY) in research data analysis. The program employs a Participatory Action Research (PAR) approach due to its collaborative, reflective, and solution-oriented nature, which is highly relevant for capacity-building and empowerment activities (Robingatun et al., 2024). Through PAR,

alumni are not positioned merely as training recipients but as active participants involved in identifying problems, implementing actions, and reflecting on outcomes to ensure sustainable impact.

The PAR framework used in this program is adapted from Chevalier and Buckles (2019), consisting of iterative and cyclical stages of problem identification, action planning, action implementation, and reflection (evaluation). Each cycle produces learning-based improvements that inform subsequent actions, with the ultimate goal of strengthening alumni competence in advanced research data analysis to support scientific publication. The PAR Design for Alumni Capacity Building is presented in Figure 1.

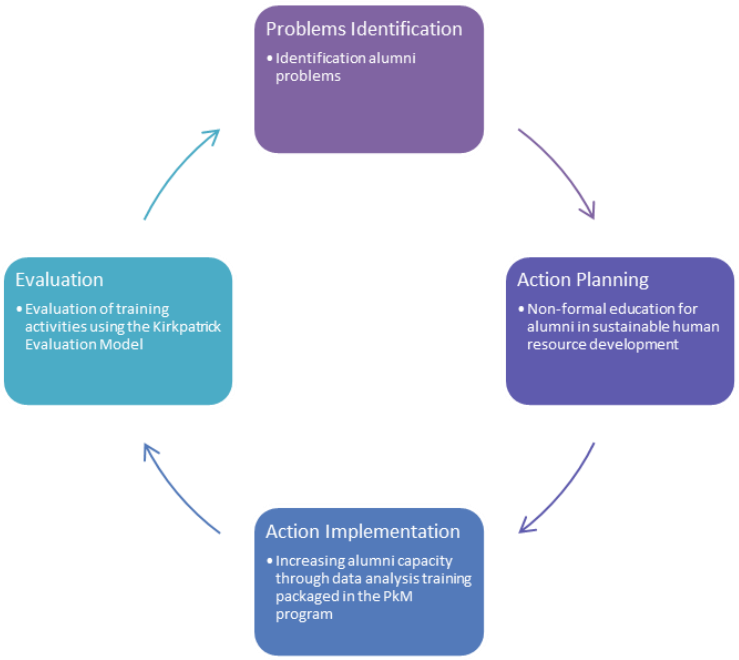

Figure 1. PAR Design for Alumni Capacity Building

Problems Identification

The initial stage focused on identifying challenges faced by alumni related to research productivity and data analysis competencies. Institutional data indicated that UNY's scientific publication output in reputable international journals and proceedings had not met expected targets. Between 2018 and 2022, publication achievements declined, with only 440 articles published in 2022 out of a target of 2,050 (approximately 21%). One contributing factor identified was the limited mastery of advanced research methodology and data analysis techniques among alumni. These findings justified the need for a structured community service intervention emphasizing data analysis capacity development.

Action Planning

Based on the identified problems, an action plan was formulated to provide non-formal education through structured data analysis training as part of the community service program. The training design was aligned with alumni needs and

facilitated by experts in advanced quantitative data analysis. A total of 38 alumni were selected through a needs assessment and screening process to ensure relevance and optimal program impact. The action plan emphasized practical applicability, expert facilitation, and alignment with alumni research contexts.

Action Implementation

The action stage was implemented through an offline intensive training session lasting eight hours, conducted at UNY. The training involved resource persons, facilitators, participant companions, and administrative support. Training materials focused on advanced quantitative data analysis methods required for contemporary research, including: 1) path analysis, 2) confirmatory factor analysis (CFA), and 3) structural equation modeling (SEM). A hands-on learning approach was applied, enabling participants to directly analyze their own research data using the introduced methods, thereby strengthening both conceptual understanding and technical skills.

Evaluation Design and Instruments

Program evaluation employed the Kirkpatrick Model, selected for its comprehensive and structured framework in assessing training effectiveness (Kirkpatrick & Kirkpatrick, 2016). The model evaluates impact across four levels: Reaction, Learning, Behavior, and Results. Evaluation instruments were designed to measure changes in knowledge, skills, attitudes, and practical application related to data analysis competencies.

Reaction was measured using a participant satisfaction questionnaire with a four-point Likert scale (1 = very low to 4 = high), covering relevance of material, clarity of delivery, and perceived usefulness. Learning outcomes were assessed through self-assessment questionnaires related to data analysis concepts and procedures. Behavior was evaluated using follow-up self-assessment questionnaires and facilitator observations to identify changes in participants' application of data analysis skills in their research activities. Results focused on perceived improvements in research quality, confidence in conducting data analysis, and readiness to prepare manuscripts for reputable journals. Details of the evaluation indicators and measurement instruments are presented in Table 1.

Table 1. Evaluation Indicators and Measurement Instruments

Evaluation Level	Indicator	Instrument	Scale
Reaction	Satisfaction with training content, delivery, and relevance	Questionnaire	Likert 1–4
Learning	Conceptual understanding and technical data analysis skills	Self-assessment	Likert 1–4
Behavior	Application of data analysis skills in research activities	Observation	Likert 1–4
Results	Perceived improvement in research quality and publication readiness	Questionnaire	Likert 1–4

Instrument validity was ensured through expert judgment involving two specialists in educational evaluation and research methodology. Reliability testing using Cronbach's alpha showed acceptable internal consistency ($\alpha > 0.70$) for all questionnaire-based instruments.

Data Analysis Strategy

Data analysis was conducted using descriptive and evaluative quantitative techniques. Descriptive statistics were used to summarize participant profiles and changes in competency levels across evaluation stages. To examine the relationships among evaluation dimensions (Reaction, Learning, Behavior, and Results), Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed. The use of PLS-SEM was intended solely for evaluating the impact of the community service intervention, not as an experimental or causal research design. This approach was selected due to its suitability for small sample sizes and its effectiveness in modeling complex relationships within program evaluation contexts.

The integration of PAR and the Kirkpatrick evaluation framework ensures not only immediate skill enhancement but also sustainable capacity development. Through reflective cycles and continuous feedback, the program encourages alumni collaboration, responsiveness to evolving research needs, and long-term utilization of data analysis competencies in academic and professional settings.

RESULTS AND DISCUSSION

Result

Prior to the implementation of the data analysis training, the Community Service Programs team conducted participant recruitment and a systematic needs analysis to ensure alignment between program objectives and alumni requirements. Recruitment was facilitated through coordination with the Board of Directors of the UNY Postgraduate School Alumni Association and disseminated via social media platforms such as Instagram, WhatsApp, and Facebook. Prospective participants who registered were required to complete a pre-activity needs assessment form, which served to map participants' academic backgrounds, professional roles, and expectations regarding data analysis competencies. This preliminary stage was essential in tailoring the training design to the heterogeneous characteristics of alumni originating from diverse institutions and disciplines. A total of 38 alumni were selected to participate after the recruitment and needs analysis process. Detailed demographic characteristics are presented in Table 2.

Table 2. Demographics of Data Analysis Training Participants

Criteria		Frequency (f)	Percentage (%)
Gender	Man	13	34.21%
	Woman	25	65.79%
Education Level	S1	2	5.26%
	S2	26	68.42%
	S3	10	26.32%

Criteria		Frequency (f)	Percentage (%)
Occupation	Analyst	5	13.16%
	Lecturer	24	63.16%
	Teacher	1	2.63%
	Researcher	5	13.16%
	Educational staff	3	7.89%
Years of Experience	1-10	21	55.26%
	11-20	13	34.21%
	21-30	4	10.53%

In summary, the participants were predominantly female (65.79%), with the majority holding a master's degree (68.42%) and working as lecturers (63.16%). Participants originated from various regions across Indonesia. Rather than serving as a focal point, these demographic characteristics provide contextual information indicating that the training reached alumni who are strategically positioned to apply data analysis skills in academic and professional environments. Judging from the level education education and type of occupation of the training participants, it shows that the majority of participants have a master's degree (68.42%) and work as lecturers (63.16%). Furthermore, when viewed from the length of service of training participants, 55.26% have a work period of 1-10 years, 34.21% with a work period of 11-20 years, and 10.53% with a work period of 21-30 years.

The findings demonstrate that the Participatory Action Research (PAR) approach adopted in this Community Service Programs program was effective in fostering participant engagement and responsiveness. The program was implemented through four stages: problem identification, action planning, action implementation, and evaluation. As shown in Figure 2a, the facilitator played an active role in guiding participants through data analysis concepts within a participatory action research framework.

Figure 2a. Facilitator Explaining Data Analysis Concepts within the PAR Framework

Figure 2b. Individual Mentoring Process during Data Analysis Training

During the implementation phase, participants demonstrated a high level of enthusiasm toward the training activities, as shown in Figure 3, where 68.42% of participants reported being enthusiastic about the data analysis training. This level of engagement reflects the collaborative nature of PAR, which positions participants

as active contributors rather than passive recipients of knowledge. This participatory orientation enhanced ownership of the learning process and strengthened motivation. Figure 2b illustrates the individualized mentoring approach adopted to accommodate differences in participants' analytical skills and learning pace.

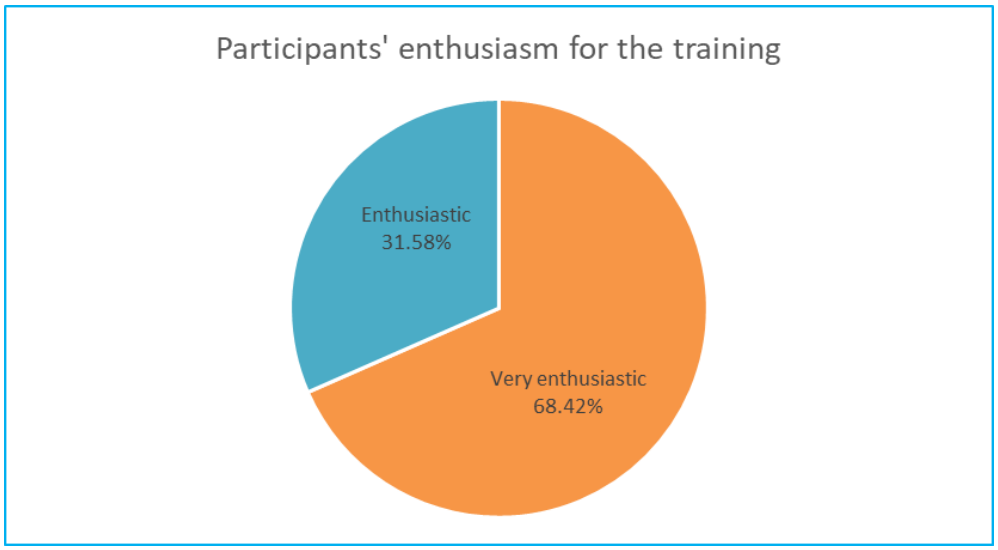

Figure 3. Participants' Enthusiasm in Following the Training

Participants' responsiveness was further reflected in their assessment of the relevance of training materials, as illustrated in Figure 4. The results show that 81.58% of participants perceived the materials as highly aligned with their professional needs, while only a small proportion rated them as moderately appropriate. The relevance of training materials was reinforced through collaborative, hands-on data analysis activities supported by multiple facilitators, as illustrated in Figure 5a.

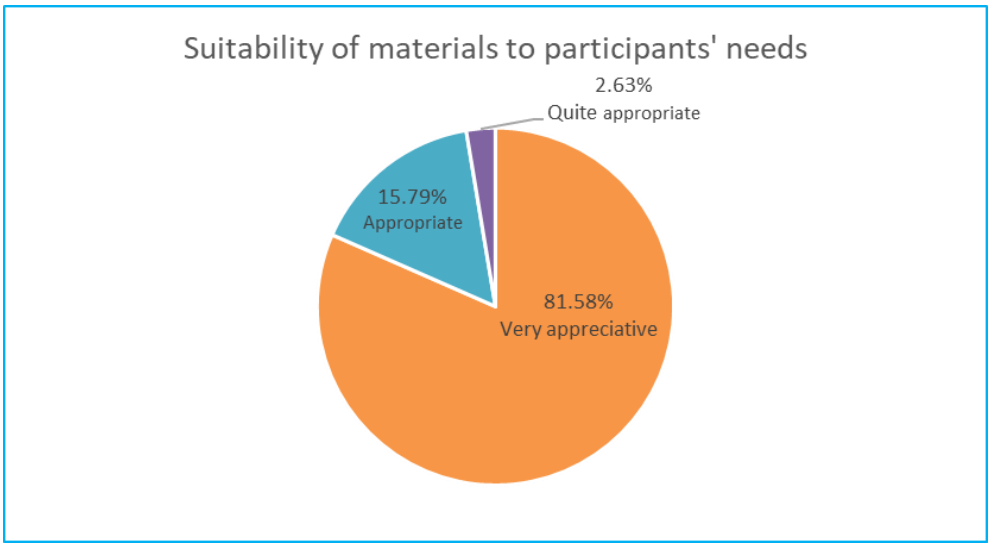

Figure 4. Suitability of Material to Training Participants' Needs

Figure 5a. Collaborative Hands-on Data Analysis Practice Assisted by Multiple Facilitators

Figure 5b. Team of Expert Facilitators Supporting the Data Analysis Training Program

The evaluation phase employed the four-level Kirkpatrick Model as presented in Figure 6. The findings reveal a coherent progression of training impact. The effectiveness of the training was also supported by the involvement of facilitators with strong academic and practical expertise, as presented in Figure 5b.

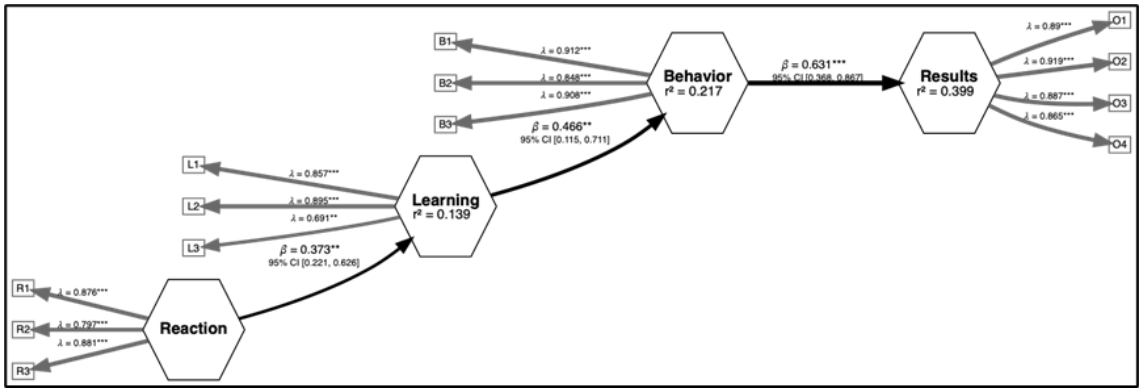

Figure 6. Training Evaluation using the Kirkpatrick Model

At the reaction level, participants' initial responses significantly influenced learning outcomes (R^2 = 0.139), Figure 4 shows that the evaluation was conducted in a structured manner on four levels: reaction, learning, behavior, and results. The results show that reaction has a significant positive effect on learning with an R-Square value of 0.139. It shows that the initial response of participants (reaction) to the training is able to explain 13.9% of the variance with a positive score on the training material (R1 = 0.876), facilitator competence (R2 = 0.797), and training relevance (R3 = 0.881). This shows that the initial response of training participants to the training held is valuable and interesting. Thus, the participants feel the need to follow the next stage.

In the final stage, an evaluation of the impact of the training (result) was carried out. The results showed positive scores for the efficiency of using the R program as a data analysis tool (O1 = 0.890), the effectiveness of using the R program (O2 = 919), the impact of using the R program on the quality of data analysis results (O3 = 887), and the impact of increasing research productivity (O4

= 865). The findings of this study also underscore the importance of learning transfer, which is the ability of participants to apply the knowledge and skills they have acquired to real-world practice. With the increased frequency of using the R program as a tool for complex data analysis and collaboration in research, it is clear that training not only affects technical skills but also encourages increased collaboration that is essential in academic research. Overall, these results suggest that training can enhance learning, change behavior, and ultimately lead to better outcomes for participants.

Despite these positive outcomes, several limitations should be acknowledged. First, the relatively short duration of the training constrained the depth of material that could be covered, particularly for participants with minimal prior experience in programming-based statistical analysis. Second, the heterogeneity of participants' backgrounds posed challenges in balancing material difficulty, as differences in disciplinary focus and prior analytical skills affected learning pace.

Additionally, participants from regions with limited access to stable internet connectivity faced constraints in fully engaging with online components of the training. These limitations suggest that while the program was effective, its impact could be further enhanced through extended training duration, differentiated learning tracks, and blended delivery models.

The findings of this study have important implications for the design of future community service programs, particularly in defining success indicators based on the perceived benefits experienced by assisted partners. In this program, success was reflected not only in participants' satisfaction and learning outcomes but also in their ability to apply data analysis skills in real academic and professional contexts, such as increased research productivity, more efficient use of analytical tools, and enhanced collaboration after the training.

First, needs-based and participatory approaches such as PAR should be prioritized, as they enable community service programs to directly address the actual challenges faced by partners. The high level of participant engagement and perceived relevance of the training materials indicates that programs designed through systematic needs analysis are more likely to generate meaningful and sustainable benefits for participants.

Second, training programs aimed at enhancing data literacy should integrate follow-up mentoring, advanced modules, or communities of practice to ensure that the benefits of training extend beyond short-term knowledge acquisition. Such post-training support mechanisms are crucial for strengthening learning transfer and sustaining the practical benefits perceived by partners over time.

Furthermore, future Community Service Programs initiatives should consider regional disparities in access and infrastructure by adopting flexible delivery modes, including blended or hybrid learning models. This approach can

enhance inclusivity and ensure that the benefits of capacity-building programs are equitably experienced by partners from diverse regions. Finally, strengthening post-training academic collaboration networks may amplify the long-term impact of community service programs, particularly by fostering continued knowledge exchange, joint research activities, and cross-institutional partnerships that are directly valued by participants.

Discussion

The relatively high participation of women aligns with previous studies highlighting women's strong engagement in capacity-building and professional development programs (Chuang, 2019; Elliott, 2021; Ray et al., 2018). Regional diversity, while uneven, also enriched learning dynamics by allowing participants to share varied institutional challenges and research contexts (Gupta et al., 2019; Stahl & Maznevski, 2021). Lecturers and academics play an important role in the dissemination of knowledge and skills development, especially related to data analysis in higher education environments (Adhikari & Shrestha, 2023; Djikhy & Moustaghfir, 2019). Studies by Deroncele-Acosta et al. (2023) and Matos et al. (2023) revealed that lecturers with master's and doctoral educational backgrounds need to continue to improve their research and data analysis skills in order to remain relevant in scientific publications.

Participation from training attendees in analyst and researcher professions is lower compared to other professions. It reflects the cross-sector need for data analysis skills which shows an increase in demand for data skills in various professions, especially in the academic and research fields (Brandi et al., 2023; Poláková et al., 2023). Regional differences reflect different access and interest in technology-based training, especially in data analysis training. According to Purnastuti and Izzaty (2016) and Triyono and Mateeke Moses (2019) regions with better educational infrastructure. This is reinforced by the finding that the majority of training participants come from DKI Jakarta, DI Yogyakarta, and Central Java. These three regions tend to have greater access to skills development programs. Meanwhile, lower participation from regions such as North Sumatra or West Kalimantan could be due to limited access or resources.

Training for skills development tends to be more effective for individuals with moderate work experience, as they already have a sufficient knowledge base but remain open to new learning (Smith & Gillespie, 2023). Furthermore, Hassett (2022) stated that someone with more than 20 years of work experience may be less enthusiastic about taking new training, as they feel established in their role, although such training is still important for updating knowledge. Active participation is a critical determinant of training effectiveness. Prior studies confirm that high engagement during training is associated with stronger knowledge retention and greater application of skills in professional contexts Biwer et al. (2020) and Lombardi et al. (2021). In this program, participant enthusiasm suggests

that the training successfully addressed a previously unmet need for practical and relevant data analysis competencies. The level of enthusiasm of the participants in this training indicates that the training successfully responded to their needs, as emphasized by Poth (2018) who stated that the relevance of training materials to participants' needs is a major factor in increasing participation and learning outcomes.

Principles of adult learning and andragogy, which emphasize that learning is most effective when content is directly linked to real-world problems faced by participants (Hiemstra & Brockett, 2012; Merriam, 2013). The high level of perceived relevance indicates that the needs-based design approach adopted in this program was successful in enhancing motivation, participation, and learning outcomes (Alamri et al., 2020). Participants' responsiveness in receiving relevant materials also has an impact on the long-term outcomes of training, particularly in improving productivity and collaboration in the workplace. As found by Fauth and González-Martínez (2021) and Schoeb et al. (2021) training programs designed with participants' specific needs in mind can be more effective in changing real-world behaviors and practices. Therefore, the finding that the majority of participants felt that the training materials were relevant to their needs reinforces the importance of a needs-based approach in training design.

Kirkpatrick & Kirkpatrick, (2016), which states that effective training has a significant impact on improving individual performance and productivity. Evaluation of training results is essential to assess how well the skills acquired during training are applied in real work contexts. Other studies have shown that increased efficiency and effectiveness of R program use after training is directly related to increased productivity, especially in the context of technology (Dwivedi et al., 2023; Mannuru et al., 2023). Training that targets mastery of specific technologies or tools has a long-term impact on work quality and innovation (Blume et al., 2010; Hughes et al., 2020). In academic and research contexts, effective use of data analysis software can improve analysis efficiency and speed up the research process, which ultimately has a positive impact on the quality of research results and productivity.

Indicating positive perceptions of training materials, facilitator competence, and relevance contributed to effective learning (Halliwell et al., 2023; Kirkpatrick & Kirkpatrick, 2016b). Furthermore, the relevance between the materials and participants' needs also strengthens the view that personalization of training improves knowledge transfer and application in the workplace (Guerra-López & Toker, 2012; McDavid et al., 2018). At the learning level, improvements in participants' understanding and analytical ability significantly influenced behavioral change (R^2 = 0.217). This confirms that the training enhanced participants' data analysis competencies, consistent with prior research

emphasizing the role of well-designed training in strengthening professional skills (Darling-Hammond et al., 2020; Noe et al., 2020; Rahmawati, 2024).

The strongest effect was observed at the behavior-to-results level (R^2 = 0.399), indicating that behavioral changes translated into tangible outcomes. These outcomes included improved research collaboration and productivity, underscoring the importance of learning transfer in professional training contexts (Nafukho et al., 2023; Shukla et al., 2023).

CONCLUSIONS AND SUGGESTIONS

Alumni capacity building through data analysis training represents a strategic form of continuing education that not only enhances individual competencies but also generates sustainable engagement between alumni and the university. The main contribution of this community service program lies in its successful integration of needs-based training, participatory learning, and the use of open-source statistical tools to strengthen alumni data literacy and professional capacity in real work contexts. The findings demonstrate that the program contributed to measurable improvements in alumni capacity, including increased analytical skills, greater confidence in using data for academic and professional decision-making, and enhanced research collaboration across institutions. At the institutional level, this program reinforces the university's role as a lifelong learning hub that supports alumni productivity and academic networking beyond graduation.

Evaluation results indicate that participants reported a high level of satisfaction with the training implementation, confirming the relevance and effectiveness of the program design. Nevertheless, participants expressed the need for advanced and continuous follow-up activities. This suggests that the program's contribution extends beyond short-term skill acquisition, serving as a foundation for long-term alumni development, sustained research productivity, and strengthened academic partnerships. Overall, this community service initiative provides a replicable model for alumni-oriented capacity-building programs that emphasizes data literacy, participatory approaches, and sustainable impact within higher education ecosystems.

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