Establishment of lines of research in the field of surveying engineering and university outreach activities

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Key words: Lines of research, university outreach, knowledge production, geotechnologies

SUMMARY

The production of knowledge cannot be carried out effectively and in a targeted manner without lines of research. In turn, the dissemination and use of knowledge and technology produced in universities cannot be carried out in society without university extension. In addition, projects can be, in part, the result of problems identified in society, which are transformed into projects whose results translate into knowledge or the production of technology that must also be at the service of society itself. However, for research to be focused and receive contributions from various areas, it must be within the scope of a line of research to deepen knowledge, even in broad areas, which should be the focus of teaching and research institutions and be cross-cutting, both for the administrative structure, mainly in teaching and research departments, and for research groups, generally centred in laboratories. This paper presents some reflections on university extension at the Faculty of Natural Sciences of Agostinho Neto University (FCNUAN), particularly in the Department of Geographical Engineering, as well as the need to implement at least one line of research. Initially, the importance of university extension and the dissemination of science is addressed, problems are identified in order to transform them into projects, and the important collaboration that must exist between the university, society and business is highlighted. An assessment is made of existing capacities and human resources, the possibilities for obtaining funding and the available journals. It addresses the possibility of taking advantage of final degree projects if they are included in lines of research, their continuity, the contribution of lines of research to the concentration of researchers, and the search for synergies for the rational use of the limited resources available. The results of the university outreach experience are presented with good examples from the Department of Geographical Engineering (Surveying Engineering) in Camacupa (Bié province), the Mabubas dam (Bengo province), as well as the activities carried out at the Cabo Ledo training ground since 2010, some existing agreements and those that may be established with public and private institutions. Finally, it is concluded that it is not possible to expect good results by separating the teaching-learning process from university extension. Furthermore, research is irrelevant if its results are not applied to solve the problems affecting populations. Therefore, lines of research must be defined in such a way as to stimulate extension activities and promote synergies.

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1. INTRODUCTION

Alongside teaching and university extension, scientific research is also one of the fundamental pillars of the teaching-learning process. This understanding has been reinforced by several authors who defend the university as an ecosystem for the production, dissemination and application of knowledge geared towards sustainable development and social innovation (Etzkowitz & Leydesdorff, 2014; OECD, 2019). To be effective and socially relevant, research must be structured around well-defined areas and lines of research that allow for the accumulation of knowledge, thematic continuity and measurable scientific impact.

Research lines are currently understood as strategic instruments of scientific and academic management, fundamental to the institutional organisation of research, the attraction of funding and the strengthening of collaborative networks (Bammer, 2017; Hicks et al., 2015). According to Bammer (2017), the clear definition of research lines and programmes favours interdisciplinary approaches and increases the social relevance of science, while Hicks et al. (2015) highlight that scientific systems guided by well-defined priorities are more efficient and have greater international visibility.

University extension, in turn, plays a central role in contemporary models of universities committed to territorial development. Authors such as Trencher et al. (2014) and Benneworth et al. (2018) argue that the so-called "engaged university" should integrate research, teaching, and extension in a systemic way, promoting the co-creation of knowledge with society and productive sectors. In this sense, problems identified in communities can and should be transformed into applied research projects, the results of which are returned to society in the form of technical, technological and scientific solutions.

In the field of surveying and geographic engineering, this integrated approach is particularly relevant. Recent studies highlight the strategic role of geotechnologies — such as global navigation satellite systems (GNSS), geographic information systems (GIS), remote sensing and Earth observation — in spatial planning, infrastructure management, environmental monitoring and spatial governance (Goodchild, 2018; Li et al., 2020; Maantay & Ziegler, 2021). The growing availability of geospatial data and the complexity of territorial problems reinforce the need for structured, interdisciplinary and application-oriented lines of research.

In this context, the Department of Geographical Engineering at the Faculty of Sciences of Agostinho Neto University has developed, over the years, various teaching, applied research

and university extension activities, with a direct impact on local communities and public institutions. However, the lack of formally established lines of research limited the consolidation of these initiatives, their continuity and their transformation into systematic scientific production.

Thus, this article aims to present the process of establishing lines of research in the field of topographic engineering, linked to university extension activities, highlighting the contemporary theoretical framework that supports this approach, the methodology adopted and the results achieved in the context of Agostinho Neto University, emphasising the integration of university extension as a strategic axis complementary to the lines of research.

2. INSTITUTIONAL CONTEXT

The Department of Geographical Engineering is part of the Faculty of Natural Sciences at Agostinho Neto University (UAN), Angola's leading public higher education institution, which receives significant government investment of around US$140.7 million. This investment is earmarked for the construction, refurbishment and equipping of the university's organisational units, including the Faculty of Natural Sciences, which is part of UAN and will benefit directly from part of this investment.

Funds have been approved for the refurbishment and modernisation of laboratories and classrooms at the Faculty of Natural Sciences, which will improve the conditions for teaching the strategic courses it offers, with an emphasis on Geographical Engineering, without losing sight of courses in Geology, Geophysics, Biology, Physics, Chemistry, Mathematics and Meteorology, Computer Science, as well as postgraduate programmes at Master's and Doctorate level, which will benefit from this investment, thereby strengthening their role in the scientific and technical training of the staff that Angola needs.

With its geographical engineering course and master's degree in geographical information systems, the Department of Geographical Engineering plays an essential role in training qualified professionals in the areas of land use planning, cartography, geodesy, topography, hydrography and support for major infrastructure projects. It will benefit from funding approved for Agostinho Neto University to equip laboratories with modern technologies, namely satellite positioning equipment (GNSS), drones for photogrammetric surveys and Geographic Information System (GIS) software, keeping pace with technological developments and the demands of the national labour market.

The Geographic Engineering course and the Master's degree in Geographic Information Systems are taught on a full-time basis, lasting five and two years respectively, and incorporating a strong theoretical and practical component. Field activities are a fundamental part of the training and take place at the Cabo Ledo Field Practice Complex in the municipality

of Quiçama, which serves as a natural laboratory for conducting topographic surveys, geodetic networks and cartographic work in real conditions.

The Department of Geographical Engineering is undergoing a process of academic and technological consolidation and aims to establish itself as a strategic hub for Angola's territorial development. However, despite the challenges related to the continuous improvement of infrastructure, the lack of formally established lines of research in the department limits the organisation, continuity and scientific impact of the research activities carried out, hindering the consolidation of an academic identity and the attraction of internal and external resources.

In this context, this work serves to support the development and structuring of lines of research, which is essential to systematically guide the efforts of teachers, researchers and students, promoting the articulation between teaching, research and extension, aligning research activities with current scientific, technological and socio-economic demands, favouring the production of relevant and sustainable knowledge, and strengthening the department's institutional visibility and contribution to scientific and technological development in the area.

3. METHODOLOGY

The methodology adopted for the creation and consolidation of the research lines of the Department of Geographical Engineering (DEG) of the Faculty of Sciences of Agostinho Neto University (FC-UAN) is based on a Scientific Strategic Planning model, designed to organically integrate the three fundamental missions of the university: teaching, research and university extension. The central objective is to avoid thematic and methodological fragmentation of research, promoting the definition of structured lines of research that support a productive, sustainable scientific ecosystem geared towards national and regional needs.

The methodology combined a top-down approach, geared towards defining strategic axes aligned with national and international priorities, with a bottom-up approach, focused on a detailed survey of the human, technical and institutional assets existing in the department. This combination ensured that the proposed lines of research are both ambitious and achievable, maximising the use of available resources.

The first phase consisted of conducting an in-depth diagnosis of the scientific and institutional potential of the DEG, structured as an asset audit, organised into three complementary areas: human resources, technological infrastructure and partnership capital. The human resources aspect focused on mapping the scientific and academic skills of the teaching staff, considering national and international academic training, areas of specialisation, professional experience, participation in scientific projects and events, as well as scientific production and the supervision of final year projects and master's dissertations. This analysis made it possible to identify the diversity of methodological approaches and schools of thought, recognising scientific plurality as an essential factor for interdisciplinarity and innovation.

The technological infrastructure aspect assessed the department's installed capacity, with emphasis on strategic equipment of high scientific and operational relevance, such as satellite positioning systems (GNSS), drones for photogrammetric surveys, Geographic Information System (GIS) software, and spaces for practical activities and applied research. Particular attention was given to the Cabo Ledo Field Practice Complex, considered a strategic asset for conducting regular scientific data collection campaigns, supporting practical teaching, developing applied research projects and university extension activities.

The partnership capital aspect analysed previous and ongoing projects, as well as cooperation initiatives with public and private institutions, both national and international, identifying thematic areas with high potential for scientific continuity, social impact and attracting external funding. University extension experiences were also considered a central element of the methodology, recognising their role in the practical application of scientific research results and in identifying real problems that could be transformed into applied research projects, strengthening the link between the university and society.

Based on the institutional diagnosis and literature review, priority thematic areas were identified, aligned with the country's structural challenges and the existing competencies of the DEG. The aim of this stage was to ensure the social relevance of the research, its practical applicability and potential impact on public policy, as well as the financial and operational viability of the proposed lines of research.

Considering the need to ensure gradual and sustainable implementation, a process of strategic grouping of thematic areas was chosen, favouring the initial creation of aggregated lines of research, which could be further developed as scientific critical mass is consolidated and available resources are strengthened. This strategic phasing aims to avoid the dispersion of resources, accelerate the production of measurable results and facilitate scientific governance.
Finally, a scientific governance model was designed based on the coordination of each line of research by a PhD professor, responsible for the thematic guidance of final year projects and master's dissertations, the coordination of projects and field campaigns, and the strategic management of scientific production, ensuring that each sub-project results in technical communications or publications in indexed scientific journals.

4. RESULTS

The application of scientific strategic planning methodology has enabled a series of structural results to be achieved for the Department of Geographical Engineering (DEG) of the Faculty of Sciences at Agostinho Neto University. The first significant result was the systematic assessment of the department's scientific, human and infrastructural capacities, which revealed the existence of diverse technical skills in the areas of geodesy, topography, cartography, geographic information systems, remote sensing and spatial planning, albeit scattered and without a formal framework in consolidated lines of research.

The mapping of the teaching staff's skills revealed significant potential for the formation of multidisciplinary research teams with academic and professional experience, capable of leading and sustaining lines of research focused on specific problems in the national context. It was also found that a considerable number of final year projects and master's theses developed in recent years have high scientific potential and practical applicability, but lacked thematic continuity and integration into a structured scientific production strategy.

With regard to scientific and technological infrastructure, the assessment confirmed that the investments made and planned for the modernisation of laboratories, the acquisition of high-precision GNSS equipment, drones for photogrammetric surveys and geographic information system software create favourable conditions for the development of applied research and university extension activities with a territorial impact. The Cabo Ledo Field Practice Complex stood out as a key strategic asset, with high potential to support systematic scientific data collection campaigns, advanced practical training, and the provision of specialised services to public and private institutions.

Figure 1 –Field practice polygon camp, permanent GNSS station and satellite image receiving antenna

In addition to institutional and infrastructural diagnosis, the results show that the department has been responsible for implementing scientific and technical projects with a high national and international impact, whose products constitute relevant scientific results that are still insufficiently systematised.

Among others, we highlight the participation in the project to extend the Angolan continental shelf beyond 200 miles, which resulted in the definition of the transformation parameters of the Camacupa system to RSA013, currently compatible with WGS84, as well as the creation and monitoring of geodetic control systems for large hydraulic infrastructures, including the

Mabubas, Cambambe and Gove dams. In addition, he has been involved in international projects such as MESA, SASSCAL and MARISMA, which have enabled the collection of significant volumes of geospatial data, the development of advanced methodologies and integration into international scientific networks.

Figure 2 - Camping in tents, dining hall and also meeting room, field activity

However, in the absence of formally established research lines, a significant part of this knowledge has not been fully converted into systematic scientific output, indexed publications, and sustained research programmes, thus reinforcing the strategic need for the creation of research lines within the department.

Another relevant outcome was the identification and systematisation of successful university extension experiences, particularly projects developed in different provinces of the country, which demonstrate the department's capacity to respond to real needs of communities and institutions. These experiences confirmed the role of university extension as a privileged source

of research problems and as an effective mechanism for knowledge transfer, highlighting the potential for integration between applied research, academic training, and social impact.

Based on the institutional diagnosis, the analysis of existing capacities, and the specialised literature, priority thematic axes were defined, enabling the proposal of an initial set of research lines conceived in an aggregated and phased manner, in order to avoid the dispersion of resources and ensure operational feasibility. This model allows for the progressive creation of scientific critical mass, the consolidation of research groups, and the systematic articulation between teaching, research, and university extension.

Accordingly, the organisation of research within the Department of Geographical Engineering is structured around three strategic axes aimed at ensuring scientific coherence, efficient use of resources, and alignment with national priorities for territorial development.

Axis I – Geodesy, Cartography and Geospatial Infrastructures integrates research lines focused on the production and maintenance of fundamental geospatial information, encompassing geodesy and satellite positioning, topographic and digital cartography, as well as the application of geographical engineering in support of the construction and management of infrastructures and public works.

Axis II – Geographic Information Systems, Remote Sensing and Spatial Analysis focuses on the integration, analysis, and interpretation of geospatial data to support territorial decision-making, urban and regional planning, and environmental monitoring.

Complementarily, Axis III – Spatial Planning, Cadastre and Sustainable Development emphasises the social application of geotechnologies, covering spatial planning, land and cadastral management, natural risk mitigation, and support for public policies oriented towards sustainability.

Figure 3 – Departure for another field activity

Finally, a scientific governance model was designed based on the coordination of each research line by a faculty member holding a PhD, with clearly defined responsibilities in the supervision of academic work, coordination of research projects, planning of field campaigns, and strategic management of scientific publications. This model strengthens organisational efficiency, thematic coherence, and the scientific visibility of the department, allowing for a phased implementation of the research lines, initially grouped into two or three priority clusters and subsequently expanded into sub-lines, without the need for profound structural changes.

The nine proposed research lines ensure comprehensive and coherent coverage of the core areas of Geographical Engineering, enabling the progressive evolution of the department's research system as scientific, infrastructural, and financial capacities are strengthened, and consolidating the role of the Agostinho Neto University as a national reference in the production and application of geospatial knowledge.

Table 1. Composition of the teaching staff

No.	Category	Quantity	Academic Degree	Country of Training
1	Professors	5	PhD	Angola, Portugal, Cuba
2	Associate	3	PhD	Russia, Brazil, Cuba
3	Auxiliary	4	MSc / PhD	Angola, Portugal
4	Assistants	8	BSc / MSc	Angola
	Total	**20**		

These research lines may be implemented in phases, beginning with two or three priority lines and subsequently expanded into sub-lines, without the need for major structural changes. The proposed model promotes the creation of critical mass, scientific continuity, integration of academic work, and the valorisation of university extension as a strategic axis of research. The nine proposed research lines allow for comprehensive and coherent coverage of the core areas of Geographical Engineering, enabling phased implementation with initial aggregation of related lines and subsequent specialisation, in accordance with the evolution of the department's scientific, infrastructural, and financial capacities.

5. CONCLUSIONS

The results obtained demonstrate that the creation and implementation of research lines within the Department of Geographical Engineering constitute an essential condition for the institutional, scientific, and social strengthening of the department. The previous absence of formally established research lines limited the continuity of scientific production, the articulation between teaching, research, and university extension, and the capacity for a structured response to national challenges in the fields of spatial planning and geotechnologies.

The adopted methodology proved to be appropriate by enabling an integrated approach that combines strategic priorities at both institutional and national levels with a realistic analysis of existing human, technological, and financial capacities. This approach ensured that the proposed research lines are simultaneously relevant, feasible, and aligned with the needs of Angola's territorial development.

It is also concluded that university extension should not be regarded as a peripheral activity, but rather as a structuring axis of research lines, functioning as a source of scientific problems, a space for validation of research results, and a privileged mechanism for knowledge transfer to society. The department's accumulated experience in extension activities confirms that the integration between applied research and territorial intervention generates concrete and measurable impacts.

The adoption of a scientific governance model based on coordinated research lines will make it possible to optimise the use of available resources, promote synergies between faculty and students, increase qualified scientific output, and enhance the capacity to attract external funding and establish national and international partnerships.

In summary, the establishment of research lines in the field of Geographical Engineering represents a strategic step towards consolidating the DEG as a reference hub for applied research, advanced training, and support for sustainable development, reinforcing the role of the university as a central agent in the production, dissemination, and application of scientific knowledge in the service of society.

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BIOGRAPHICAL NOTES

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