

Participatory design of STEM initiatives with gender equity for public policies

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Abstract– Gender equality and women’s empowerment is one of the global challenges defined by the United Nations. As institutions of higher education, we are committed to advancing these goals, particularly by promoting gender equity in engineering, science and technology programs, where the gap is one of the most evident, both in terms of career paths, student representation and professionals in the workplace. In alignment with this commitment, the Organization of American States (OAS) invites organizations to generate proposals that can be presented at meetings where Latin American representatives make decisions for the benefit of our communities. This research explores the design of participatory processes with clear objectives, with logistics and facilitators from organizations committed to fostering a culture of gender equity and increasing women’s participation in STEM. The study focuses on a case study of participatory initiative design, involving stakeholders from Latin American universities through hybrid sessions (digital and face-to-face). A common design framework and a particular development by working group to include specific interests, allowed for detailed observation and the generation of recommendations for future exercises. A process approach is used, with the freedom to manage the interests and priorities of the community through working groups with common proposals. The results allow us to consider common elements such as: the passion and commitment of the participants in the subject, the difficulty of mixing the type of interaction, mixing face-to-face with digital environments, and the clear identification of common projects. These insights provide a basis for improving similar participatory approaches.

Keywords–Higher Education, Educational Innovation, Women in STEM, Gender Equality, Gender Equity.

I. INTRODUCTION

Gender equality and women’s empowerment is one of the global challenges defined by the United Nations. Sustainable Development Goal (SDG) #5 states that gender equality is not only a fundamental human right, but also states the foundation for a peaceful, prosperous, and sustainable world [1]. Women represent half of the population, but gender inequality persists everywhere even though there has been some progress over the last years. The situation in Latin America is not different, and the gender gap is even more evident in STEM (Science,

Technology, Engineering and Mathematics) fields.

Public policies are a fundamental tool to foster transformations towards achieving gender equality. Public policies most consider the social context and culture, as well as promote collaboration among different stakeholders to participate as allies advocating for gender equality and women’s empowerment. Some examples of public policies addressing the gender gap include promoting women visibility, ensuring the participation of women in leadership positions, avoiding violence and discrimination, policies addressing women health, pregnancy and maternity leave, justice, and social care, among others.

Research done on gender-equality public policies in Latin America gathers initiatives and strategies implemented in different countries. An analysis by the Economic Commission for Latin America (ECLA – CEPAL in Spanish) includes public policies implemented in Brazil, Bolivia, Chile, Colombia, Costa Rica, Mexico and Uruguay. The analyzed policies address the following topics: gender violence, access to voluntary pregnancy interruption, equal representation and gender alternation in political roles and public representation, and the definition of a specific budget to address gender equity issues [2]. A more recent study analyzes the trend for foreign policy and international cooperation policy in 12 countries in Latin America towards gender equality in the last decade from a feminist perspective. It discusses the need to implement strategies based on rights, resources, representation, reality check, research, resistance, and results. This study suggests the following recommendations for successful strategies and public policies: having a State commitment, institutional participation, considering the participation of diverse voices for inclusion and intersectionality, capacity-building and strengthening with a strategy of knowledge for change, allocating significant financial resources for equality, communication and public awareness of this social change, access to technology, international cooperation, data for statistical analysis with the information systems, and finally, a measuring process for monitoring, evaluation, and accountability [3].

There is also research work on gender-equality public policies in Latin America from the perspective of masculinity. It focuses on policies around masculinity in topics such as

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childrearing and childcare, men’s health, addressing and preventing male violence, and sexual diversity [4]. The culture and social context have an impact on the unconscious bias that hinders equality. The intersection of class, gender and policy in Latin America has also been studied. Results show that poverty has strong implications for education in Latin America, and when focusing on gender, the educational disparity is even bigger [5].

A systematic literature review on gender-equality in Latin America identified what types of gender policies exist in this region and how these policies are promoting women’s participation in STEM fields in these countries. The gender policies were grouped in eight categories: 1) affirmative action (hiring women from excluded social groups), 2) attracting women’s participation to STEM fields, 3) gender parity for political and leadership positions, 4) gender quota to ensure women’s participation, 5) identifying women’s participation in STEM areas, 6) women retention and empowerment during STEM training, 7) promoting women’s career growth, and 8) zero tolerance for violence and sexual harassment [6]. Another study also highlights the relevance of including care policies to reduce the gender gap. Paid and unpaid care work contributes significantly to gender inequalities in the distribution of employment opportunities, incomes, and access to welfare [7].

Researchers, organizations, and policymakers need access to reliable data to understand the root causes of the gender gap, promote evidence-based interventions, and enhance accountability and transparency in their efforts towards gender equality. There is limited information available on these topics, especially in Latin America. With this objective in mind, the ELLAS (Equality in Leadership for Latin America STEM) project emerged in 2022 with the cooperation of 8 universities from Bolivia, Brazil, and Peru, and 1 in the United States. ELLAS aims to generate and utilize connected open data for policies and strategies to reduce the gender gap [8]. The project includes a platform with this data and some of the challenges encountered have been the dissemination and use of this platform and limitations in the literature review of publications in English on strategies and initiatives to address gender equality in Latin America [9]. The project plans to expand to other countries in the region.

Another relevant project aiming to reduce the gender gap in STEM is W-STEM, funded by the European Union, which focuses on equity, access, and democratization of Higher Education. Their work includes proposals for attraction, retention and development of women in STEM careers, institutional policies to promote the participation of women in STEM fields, and public policies to promote women participation. As key stakeholders, they have identified the collaboration between governments and universities to define and implement public policies [10].

The Latin American Open Chair Matilda and the Women in Engineering was created with the support of three institutions: ACOFI (Colombian Association of Engineering Faculties), CONFEDI (Federal Council of Engineering Deans

of the Argentine Republic) and LACCEI (Latin American and Caribbean Consortium of Engineering Institutions). The Matilda Chair aims to give visibility and value to women in engineering, inspiring new vocations, and retaining and developing the ones that are already in the path. It has more than 200 individual members from 18 countries working towards gender equality. The Matilda Chair is organized into six committees: education, research, vocations, mentoring, communication, and professional practice. [11]

This work presents a participatory effort of defining proposals and recommendations for public policies on gender equality in Latin America, organized by LACCEI and the Organization of American States (OAS). Lessons learned are shared through the description of the processes, and an analysis of each as a case study. The Matilda Chair and the larger Latin American community were invited to participate in this effort to define relevant input to the OAS ministerial meeting.

II. METHODOLOGY

The research approach applied is qualitative [12], through a case study, composed of the following phases: 1) general description of the planning process for the design of proposals, 2) process description followed in each of the discussion tables, 3) comparative analysis of the processes, 4) conclusions with the proposal for the design of a participatory process.

The OAS, in the interest of having proposals that promote gender equity in STEM, offers the opportunity to design and present them through LACCEI and the Matilda Chair. LACCEI's Women in STEAM team designs the call that seeks to align efforts as well as being open enough to receive all the proposals that arise. The planning process consisted in the design of the call for proposals (see Figure 1), defining the themes and logistics of the process, the focus being the relevant role of the Matilda Chair in both the process and the results. It consisted of several phases: preliminary delivery, three group sessions, and final documentation. The roadmap of this process is shown in Figure 2.



Fig. 1 Call for proposals

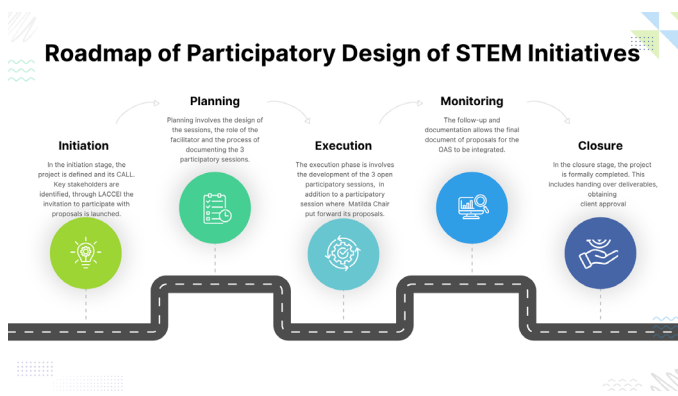


Fig. 2 Process Roadmap of Participatory Design.

The roadmap (Fig. 2) describes each phase: (1) Initiation, with the definition of the project and the CALL, (2) Planning, the participatory design sessions, (3) Execution, the development of the 3 open participatory sessions, (4) Monitoring, the follow up and documentation, and (5) Closure, the project is formally completed.

Once the logistics of the process were established, the facilitators' roles and the mechanics of the sessions were defined. The analysis of how each working group developed is part of the presentation of results. The working groups were formed according to the topics proposed in the call for proposals and the similarity with the proposals received. The topics that made up the call for proposals are shown in Figure 3.

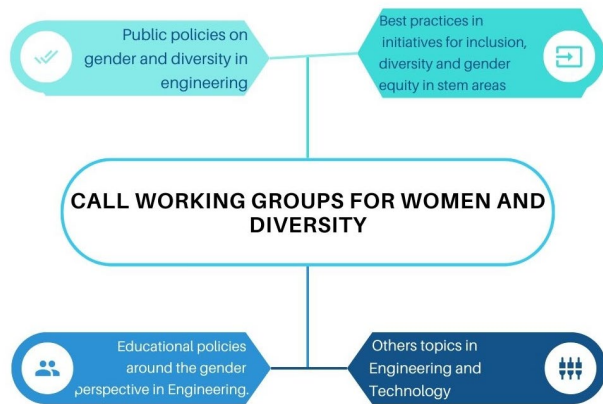


Fig. 3 Working Groups Topics

Finally, participants were asked to document their reflections from the working group sessions. The processes were then compared, and conclusions were drawn to integrate a final document.

III. RESULTS

In the results stage, the standardized design for the working group sessions is presented, followed by the development of each session.

A. Standardized design of working groups

For the first working session by tables, the logistics of the session were defined, as well as the moderators, the agenda for the session, and the documentation format. In analyzing the process, Table I identifies the elements established for each working group.

TABLE I
ELEMENTS DEFINED FOR EACH WORKING GROUP

Activity	Description
Previous Information (input)	Proposals received from those who responded to the call, by established topic.
Session logistics	Digital session, using Zoom as a platform.
Moderators	Consultation with the Matilda Chair, members of the Committees were invited to participate as facilitators.
Session's Agenda	An agenda was defined which contained: A welcome and presentation of the objectives of the session, they were distributed in rooms according to the 4 topics, to begin with a personal presentation and presentation of their proposals, group classification of the proposals identifying common topics and independent topics. Agreements for further work.
Documentation	Documentation of participant attendance, and documentation of the session, identifying common and independent proposals, with greater detail for each.
Conclusion of the session	The following dates for the roundtables are shared.

B. Work description per group

The moderators were asked to share briefly their experience in the development of the proposals in a participatory manner, to talk about their role, the process and the result, so that there was freedom in what each working group documented for the analysis of this research. The responses from each working group are presented below.

Group Work 1. The roundtable on gender and diversity public policies in engineering received three policy proposals, two from Peru, and one from Colombia. There were two moderators at this table, both from Colombia. In the first meeting, the two proposals from Peru were presented by their authors. After each presentation, the moderator made a summary of the proposal, clarified doubts, and discussed the relevance, benefits, limitations, and impact that the proposal could have. The interventions, suggestions, and improvements were registered to consolidate a second version of the proposals. Moderators made progress on the document, consolidating the proposals, and defining objectives, possible

indicators, and persons in charge of each proposal in synchronous and asynchronous manners.

During the session at the LACCEI event, Colombia's third policy proposal was presented. Its importance and the need for its implementation to promote diversity and reduce gender gaps and inequality were discussed. The progress of the consolidated proposals was reviewed, and the strategy for their final presentation was generated. After the meeting, the moderators continued working asynchronously to complete the roundtable's proposals.

The final result of the work led to the proposal of three public policies on gender and diversity in engineering: Standing Committees on Diversity and Inclusion in STEM, Pedagogical, Psychological, and Socioemotional Support for Inclusion and Gender Equality in STEM, and Affirmative Actions for Gender Equality in STEM.

Group Work 2. During the session for worktable 2, they gathered 4 proposals from LACCEI conference participants, 4 from the CAL Matilda research committee, and another 4 from the mentoring and professional practice committees from the CAL Matilda. On 2nd session, eight participants met synchronously to identify common themes for integration, although time constraints prevented full discussion of all proposals. Additionally, 2 new proposals were merged with existing ones. The subsequent asynchronous work involved contributing to a shared document, where rather than merging proposals, information was mostly added to individual initiatives. In the hybrid synchronous session during the LACCEI conference on the last session, the document was presented to other tables, advancing the consolidation of a comprehensive initiative that encompassed most previously submitted proposals. In this session, two new participants joined, completing a group of 10 participants. The working group is formed with representatives of the Research Committee of the Latin American Open Chair Matilda and Women in Engineering (CI-CAL Matilda), the Faculty of Engineering of the Technological University of Bolívar (UTB), the Universidad EAFIT, and the Universidad Mariana of Colombia, the Tecnológico de Monterrey, campus Estado de México and the Universidad Tecnológica Nacional, Faculty of Rosario, UCEL, and Universidad Nacional de Lomas de Zamora of Argentina.

The proposal entitled "Best Practices Bank for Inclusion, Diversity, and Gender Equity in Engineering" is an initiative designed to collect and systematize significant experiences within educational institutions that promote diversity, equity, and inclusion (DEI) in engineering education. The proposal covers innovative social learning and community service activities, problem-solving from a sustainable development perspective, and the creation of ventures that promote sustainability. The aim is to compile and assess the effectiveness of these practices in terms of DEI and to share them both within and outside institutions to encourage replication in different contexts.

The main goal is to establish a platform to compile best practices bank that analyzes and documents the procedures, concepts, and attitudes involved in these initiatives. The platform will facilitate the exchange of experiences through conferences, workshops, and asynchronous spaces, allowing for the measurement of the impact on sustainability and DEI. Indicators for measuring progress include the number of initiatives and participating institutions, the impact on students and communities, and the perception of practice effectiveness. Additionally, the development of sustainable competencies in students and beneficiary satisfaction will be evaluated, with the collaboration of NGOs, educational institutions, media, and communities.

Group Work 3. The participatory methodology consisted of setting specific objectives to be developed per week in the period of one month, between sessions 1 and 2 of Women in STEM & CALL OAS, through asynchronous tasks and virtual meetings with activities detailed in Table 2. The analysis, debate and co-creation of the proposals was carried out on a shared document in a drive, trying to find common issues that motivate the integration between proposals or the validation of independent proposals.

TABLE 2
PARTICIPATORY METHODOLOGY WORKTABLE 3 OF EDUCATIONAL POLICIES ON THE GENDER PERSPECTIVE IN ENGINEERING

Week	Modality	Activity
1	Asynchronous	Complete the documentation of the proposals of each participant in the established format.
2	Asynchronous	1. Analyze and identify possible proposals for integration. 2. Analyze and identify independent proposals
	Virtual meeting	Socialize progress. Define items to be worked on and product to be achieved.
3	Asynchronous	1. Integrate the proposals with common points, define the global name. Name, affiliation of the proposer. Integration of teams. 2. Develop in each proposal: Situation-problem; Proposal; Objectives; Indicators of success; Recommendations; Actors.
4	Asynchronous	Preparing the document for Worktable 3: introduction, brief methodological description, Integrated and Independent Proposals.
	Virtual meeting	Composition and revision of the final version of the Worktable Document 3.

The Integrated Proposal, entitled Comprehensive Engineering Education from a Gender Perspective and Competency-Based Approach in LATAM and the Caribbean, proposes the mainstreaming of the gender perspective in the development of social, political, and attitudinal competencies in engineering careers in Latin America and the Caribbean.

This includes the integration of the gender perspective in curricula, the training of teachers and mentors, the creation of specific evaluation mechanisms for these competencies, inclusive learning environments and collaboration with industry.

The Independent Proposals cover various topics such as dissemination, curriculum, science teaching and learning, competency-based training, institutional communication, and generation of evidence, among others, and reach Primary, Secondary and University educational levels. In a succinct characterization, the title and theme of each proposal is indicated:

1) Dissemination of engineering content at early ages to attract girls and young people to the STEAM area, proposes to implement a dissemination policy with incentives to generate engineering content aimed at schools and colleges prepared with attractive materials and adapted to the target audience.

2) Strengthening Mathematics and Science Education for Girls and Young Women: Generating Evidence and Promoting Engineering Vocations, proposes the creation of programs that finance and support research projects aimed at generating evidence on the teaching and learning of mathematics and science in girls and young women;

3) Regional Programs for the Generation of Evidence and the Integration of the Gender Perspective in the Formation of Competencies in Engineering, proposes the creation of regional integration programs that finance and support research projects to generate evidence on the integration of the gender perspective in the formation of social, political, and attitudinal competencies in engineering.

4) Promotion of Inclusive Curricula and Educational Spaces in Mathematics and Science for Girls and Young Women in Engineering, proposes the promotion of curricular prescriptions and the creation of curricular and extracurricular spaces specifically designed to reinforce the learning of mathematics and physics in girls and young women.

5) Inclusion of women engineers in the discourse of the “Latin American Engineer” documents, proposes the revision and updating of the framework documents of engineering education in Latin America to explicitly include women engineers. This includes the modification of titles, texts, and graphic material to reflect in an equitable manner the participation of women and men in engineering.

In summary, the set of integrated and independent proposals covers a broad spectrum of educational factors of possible application of educational policies with impact to harness in engineering the talent of all people, regardless of their gender.

Group Work 4. Within the topic of women and diversity, referring to table 4 (other topics in engineering and technology), the importance of carrying out an in-depth study on how underlying gender stereotypes influence the low participation of women in STEM careers was highlighted. LAC currently reaches third position in the world in the

gender parity rate according to the 2023 World Economic Forum report, although inequalities persist, especially in STEM disciplines. The proportion of women in these areas has increased, except in engineering and technology. The gap persists due to sexism, which gives rise to the construction of masculinized educational and workspaces, which discourages women according to analyzes carried out by the Technological University of Bolívar, Colombia.

Additionally, the Tecnológico de Monterrey, Mexico, together with the National Technical University of Costa Rica, the Mariana University, Colombia, and the NGO MIA, and Mujeres Investigadoras Aliadas, propose that, based on the findings resulting from the impact of the study of technology in education, could be enriched with the analysis of the biases caused in communities with limited technological resources. This type of research is necessary and could be enhanced with tools that include natural language processing to quantify the progress of the proposed tactics, including a strategy of contemporary and accessible female models in STEM. It is also important to promote training in emerging technologies and establish a mentoring network using an online bootcamp for the rapid and effective acquisition of skills in specific areas.

During the last sessions held within the LACCEI Conference, more participants interested in developing initiatives at this worktable were integrated, considering the possibility of various initiatives that can be defined and included.

Comparative Process Analysis. Identifying the similarities and differences of the processes in the 4 working groups are summarized in Table 3.

TABLE 3
COMPARATIVE ANALYSIS.

Similarities	Differences
Some work is performed outside of the sessions.	Although work is carried out outside the sessions, in some of the tables (such as worktable 1), the moderators are the ones who complement and strengthen the documentation.
In all the working groups, reflections were made related to the topics of the call with openness to receive feedback from the participants that were integrated at different times. This openness was a relevant characteristic for the success of the process and speaks of the flexibility of the moderators for a participatory process.	Difficulties arose when using hybrid sessions where participation was more complex, while in some tables a higher percentage of participants were present, in others new facilitators had to be integrated to ensure the success of the process.
In all the working groups there were proposals with related topics that could be enriched by being integrated as a single proposal.	The level of depth of the proposals is another element that varies according to the working groups.

Similarities	Differences
The proposals were of great interest to the participants themselves, which, despite being proposals for the authorities of the different LATAM countries, were also intended to be developed by them.	

As there were several working sessions (3), some people were not able to participate in some of them due to time availability. However, they kept in touch with each other during the process.

As in all participatory work, even when there are documentation guidelines, it depends on the moderator's style, so it is important that when integrating the document resulting from the call, 1 or 2 people are responsible for integrating, reviewing, and correcting it as the final version. This can be validated by the moderators of the working tables, so that it is a common agreement and that it really represents everything discussed and proposed in the report.

IV. CONCLUSIONS

Participatory processes generate enriching results, with high levels of complexity. Common objectives are the driving force, ensuring a standard basis of work, but respecting the creativity of the people who guide and participate.

The opportunity to present to international organizations and ministers of the countries of Latin America proposals for actions to continue to encourage a change in the culture of our countries on issues of equity, and particularly promoting vocations in STEM careers, is something that cannot be missed.

The collaborative efforts of several participants have highlighted key strategies to enhance gender equality in STEM participation:

- Establishing policies that support the formation of diversity committees is essential. These committees could also focus on providing pedagogical and socio-emotional support to foster the inclusion of women in STEM fields.
- By compiling participants' experiences, diversity, equity, and inclusion programs can be adapted and implemented across other institutions.
- Finally, it is crucial to introduce educational programs that promote gender equity from an early age. Additionally, securing funding for diverse initiatives, such as extracurricular activities, is vital in addressing gender disparities and reducing technological inequality.

Respecting the trust placed in LATAM international organizations such as LACCEI, in the framework of its annual Multiconference, and as the Matilda Chair whose objectives are aligned to create and strengthen this culture, efforts are made using participatory processes and digital and face-to-face media to develop proposals that continue to change the world we live in, for a better future that will grow our

generations of children and young people, and above all our countries, with more women as engineers and scientists sensitive to a world that requires a social and sustainable commitment.

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REFERENCES

- [1] V. Blazhevskaja, "United Nations: Gender equality and women's empowerment," United Nations Sustainable Development, 07-Jan-2015. [Online]. Available: <https://www.un.org/sustainabledevelopment/gender-equality/>. [Accessed: 28-Jul-2024].
- [2] A. Valdés B. and M. C. Benavente R., Políticas públicas para la igualdad de género: un aporte a la autonomía de las mujeres. Santiago de Chile, CEPAL. 2014. ISBN 978-92-1-121865-7
- [3] A. Güezmes and B. Romero Castelán, "Ten years of feminist foreign policy and feminist international development cooperation policy: an opportunity for Latin America and the Caribbean," Asuntos de Género, UN Economic Commission for Latin America (CEPAL), 2024.
- [4] F. Aguayo, "Masculinities and public policies in Latin America," Men Masc., vol. 26, no. 5, pp. 696–703, 2023.
- [5] N. P. Stromquist, "What Poverty Does to Girls' Education: The intersection of class, gender and policy in Latin America," Compare, vol. 31, no. 1, pp. 39–56, 2001.
- [6] I. R. Guzman, J. Viterbo, E. P. dos Santos Nunes, F. Suni-Lopez, E. Jimenez, A. Lara Casagrande, and C. Maciel, "Gender equality policies in STEM in Latin America - A systematic literature review," in Lecture Notes in Networks and Systems, Cham: Springer Nature Switzerland, 2024, pp. 410–419.
- [7] V. Esquivel, "The care agenda in Latin America: Women's social citizenship revisited," in The Palgrave Handbook of Gender and Citizenship, Cham: Springer International Publishing, 2024, pp. 591–615.
- [8] "ELLAS", 28-Jul-2023. [Online]. Available: <https://ellas.ufmt.br/>. [Accessed: 28-Jul-2024].
- [9] L. B. Frigo, A. Ferreira dos Santos, N. Rodriguez-Rodriguez, R. de Barros Pinto Miguel, S. A. Bim, C. Maciel, and I. R. Guzman, "Mapping women STEM initiatives in Latin American countries: Bolivia, Brazil and Peru," Lecture Notes in Networks and Systems, Cham: Springer Nature Switzerland, 2024, pp. 401–409.
- [10] F. J. García-Peñalvo, A. Bello, A. Domínguez, and R. M. Romero Chacón, "Gender Balance Actions, Policies and Strategies for STEM: Results from a World Café Conversation," Educ. Knowl. Soc. (EKS), vol. 20, p. 15, 2019.
- [11] V. Lara-Prieto, M. H. Peralta, J. A. Barrios-Martínez, A. Páez-Pino, M. M. Larrondo-Petrie, and M. I. Ruiz-Cantisani, "The impact of belonging to a women network in STEM: A Latin American sorority network," in Proceedings of the 3rd LACCEI International Multiconference on Entrepreneurship, Innovation and Regional Development (LEIRD 2023): "Igniting the Spark of Innovation: Emerging Trends, Disruptive Technologies, and Innovative Models for Business Success," 2023.
- [12] M. K. Alam, "A systematic qualitative case study: questions, data collection, NVivo analysis and saturation," Qual. Res. Organ. Manag. Int. J., vol. 16, no. 1, pp. 1–31, 2020.