

Adapting Psychosocial Scales to Measure Career Exit Factors in Colombian Women Engineers

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Abstract: *Background:* Despite ongoing efforts to promote gender equality, women remain underrepresented in STEM fields such as engineering. This underrepresentation is evident not only in early career choices but also among professional women engineers who face significant barriers in their work environments, leading to higher rates of leaving the profession. While this issue has been extensively studied in various regions worldwide, there is a notable gap in research on the experiences and career exit intentions of women engineers in Latin America. Furthermore, a lack of Spanish-language scales with strong validity evidence measuring key psychosocial factors associated with the decision to leave engineering hinders progress in understanding and addressing these challenges. *Purpose:* This study aimed to develop and implement a robust protocol for adapting and translating five scales that measure engineering identity, career commitment, career satisfaction, observed hostility toward women in the workplace, and the likelihood of leaving the engineering profession. The research sought to answer the question: *How do respondents perceive these adapted scales' clarity, relevance, and representation in capturing the intended constructs?* *Methods:* The protocol was guided by recommendations of the International Test Commission and the American Educational Research Association. A forward translation design was selected, focusing on achieving functional equivalence between cultures. The protocol involved multiple stages, including expert translation, cultural adaptation, and reconciliation processes. Additionally, an expert panel reviewed the scales, and a qualitative phase using cognitive interviews with a sample of Colombian women engineers provided further validity evidence and refinement. *Results:* The study contributes both theoretically and practically. From a theoretical standpoint, it presents a comprehensive, evidence-based protocol for scale adaptation, offering a model that can be replicated in other contexts. Practically, the adapted scales provide essential tools for researchers and practitioners working with Spanish-speaking populations, addressing a significant gap in the literature. By enabling more inclusive and accurate research on women engineers' experiences in Latin America, these tools can inform policies and interventions aimed at reducing career exits and promoting gender equity in engineering.

Keywords: Psychosocial Scale Adaptation, Forward Translation Design, Women Engineers in Latin America, Gender Equity in Engineering, Engineering Identity

1. Introduction

The underrepresentation of women in engineering remains a significant global concern. Although women earn approximately 20% of engineering degrees worldwide (Bossart and Bharti, 2017; EngineeringUK, 2018; Bello, 2020), their presence in the workforce is even more limited. In the United States, for example, women occupy only 16% of engineering roles (Department of Labor, 2022). A significant, though difficult to quantify, contributor to this disparity is the high rate at which women exit the engineering profession; in the U.S., 50% of women with engineering degrees are no longer working in engineering or science-related fields (NCSES, 2022).

Despite the urgency of this issue, research on the reasons women leave engineering remains limited, and predominantly emerges from the U.S. (Singh *et al.*, 2013; Ross and Godwin, 2016). In Latin America, and particularly in Colombia, studies examining women engineers' workplace experiences and career trajectories are sparse (Cano-Morales and Major, 2024). To address this gap, we undertook a project focused on understanding the factors influencing Colombian women engineers' intentions to leave the profession. However, we encountered an initial barrier: the absence of validated Spanish-language instruments tailored to the professional engineering context that assess key workplace factors affecting women engineers. This study sought to overcome this challenge by developing a translation and adaptation protocol and applying it to translate and adapt five English-language scales measuring key factors in women engineers' experiences into Spanish.

2. Literature Review

2.1 Factors Influencing Women Engineers' Persistence

A key factor in understanding women engineers' persistence is engineering identity, defined as one's perception of being the kind of person who can perform engineering tasks (Godwin *et al.*, 2016). For example, Ross and Godwin (2016) observed that Black women redefined the stereotypical image of an engineer, aligning it with their personal values and professional aspirations, which bolstered their persistence. Similarly, Plett *et al.* (2011) found that a strong engineering identity helped women sustain their careers despite workplace challenges. These findings align with Hatmaker's (2013) study, which revealed that gendered experiences, such as being valued more for their gender than their skills, often triggered identity negotiations.

Women engineers' persistence is also heavily impacted by the support and barriers they encounter in their professional environment (Fouad *et al.*, 2017; Fernando, Cohen and Duberley, 2018). A particularly significant barrier is working in environments where overt harassment and mistreatment toward women occur and are tolerated (Miner-Rubino and Cortina, 2007). The literature on women engineers' experiences in Latin America indicates that hostile environments remain prevalent and normalised in certain engineering sectors (Cano-Morales and Major, 2024). Such environments have been shown to undermine women's engineering identity (Hatmaker, 2013), which subsequently affects their persistence in the field (Plett *et al.*, 2011).

Environmental factors, along with individuals' perception of their ability to perform within a profession, influence their attitudes toward their career (Lent and Brown, 2008; Singh *et al.*, 2013). Specifically, low career satisfaction and career commitment has been significantly linked to intentions to leave the profession (Rhodes and Doering, 1983; Singh *et al.*, 2013).

While engineering identity, hostility toward women in the workplace, career satisfaction, and career commitment, are known to significantly influence women engineers' career decision, no Spanish-language scales were identified to measure these constructs. Furthermore, we found no instruments to assess women engineers' intentions to leave the profession.

2.2 Instrument Translation

Instrument adaptation extends beyond literal translation; it involves ensuring that the scale reliably measures the intended construct in the target population's linguistic and cultural context (International Test Commission–ITC, 2017). Adapting an instrument to a new language requires attention to linguistic, cultural, idiomatic and contextual factors (Hambleton, 2004).

A widely used method for instrument adaptation has been backward translation (Hambleton, 2004), in which an instrument is translated into the target language and then back into the original language for comparison. While this method is popular in cases where principal investigators are not fluent in the target language, it is no longer recommended as the sole method for cross-cultural instrument adaptation (Borsa, Damásio and Bandeira, 2012). Relying solely on linguistic equivalence often overlooks critical cultural and contextual dimensions. Words that are linguistically equivalent may still result in different response patterns if these other dimensions are not accounted for (Peña, 2007). Backward translation frequently produces target language versions that facilitate back translation but may be awkward or unclear for the intended population (ITC, 2017).

More recent approaches favour forward translation, which prioritises functional equivalence—ensuring that the translated scale is contextually relevant and appropriate for the target population—over literal accuracy (ITC, 2017). Forward translation involves at least two translators independently adapting the scale into the target language, followed by a reconciliation process to merge the translations. An expert panel then evaluates the equivalence of the original and adapted versions, considering cultural, linguistic, and idiomatic aspects (Hambleton, 2004). Although forward translation addresses many of the limitations of backward translation, it introduces the potential for subjective inference by translators and experts. To mitigate these biases, reconciliation processes are incorporated at each stage.

The quality of translators and experts involved in the adaptation process is critical. Research recommends that translators should be proficient in both languages, ideally native speakers of the target language, and knowledgeable about both cultures (Borsa, Damásio and Bandeira, 2012). Furthermore, they should have expertise in the subject of the test and understand general principles of test construction (ITC, 2017).

The literature also emphasises the importance of evaluating the adapted instrument with the target population through pilot testing to assess face validity (ITC, 2017). During the pilot study, statistical analyses are not required; instead, the focus is on participants' understanding of the items and the overall structure of the instrument (Borsa, Damásio and Bandeira, 2012).

2.3 Purpose of the Study

This study aims to address the absence of Spanish-language psychosocial scales that measure career exit factors among Colombian women engineers. To this end, we developed and implemented a translation and adaptation protocol to adapt five scales: engineering identity, career satisfaction, career commitment, observed hostility toward women in the workplace, and engineering turnover intentions. These scales were tailored for use in a Spanish-speaking professional engineering context. The study seeks to answer the following research question: *How do respondents to the adapted scales of engineering identity, career satisfaction, career commitment, observed hostility toward women in the workplace, and engineering turnover intentions perceive the clarity, relevance, and representation of the intended constructs?*

3. Methods

3.1 Adaptation Protocol

We developed the adaptation protocol presented in Figure 1, following the guidelines from the American Educational Research Association (AERA, 2014), the International Test Commission (ITC, 2017), and literature on scale adaptation (Hambleton, 2004; Peña, 2007; Borsa, Damásio and Bandeira, 2012).

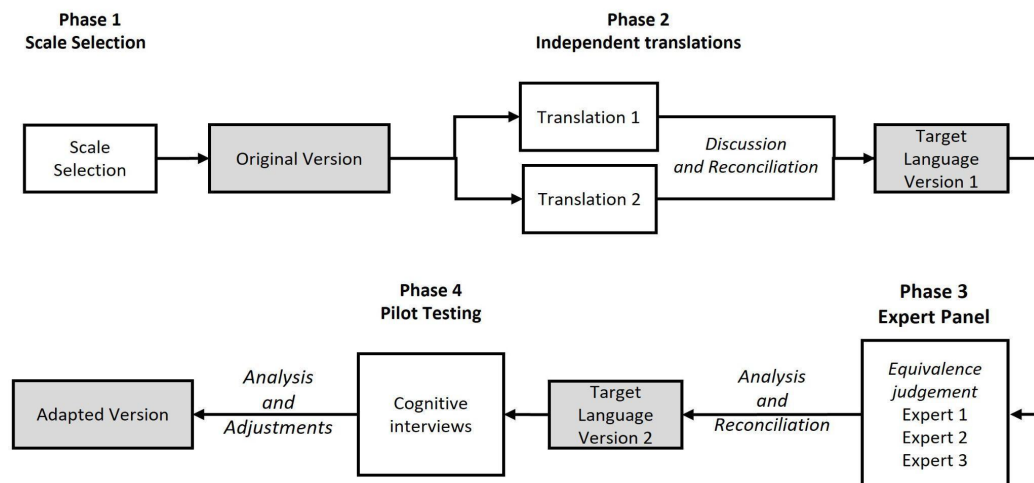


Figure 1: Adaptation protocol.

The protocol begins with scale selection, where researchers should establish criteria such as strong psychometric properties in the original language, alignment with the research objectives, and a preference for shorter scales to reduce participant burden (ITC, 2017).

In the second phase, two translators independently translate the scale into the target language. Translators should be native speakers of the target language, fluent in the source language, familiar with both cultures, and knowledgeable in the subject matter and principles of test construction (AERA, 2014; ITC, 2017). Following translation, a reconciliation process addresses any differences to ensure both linguistic accuracy and cultural relevance.

The third phase involves expert panel review. A panel of bilingual experts, with relevant expertise in both the subject and the involved cultures, assesses the scale's equivalence to the original version using a structured revision form that considers cultural differences, grammar, phrasing, meaning, and clarity (Hambleton and Zenisky, 2010). Researchers analyse and reconcile feedback from the expert panel to produce a second translated version.

In the final phase, pilot testing is conducted with a small sample from the target population using cognitive interviews (CIs). We considered CIs because they are among the most effective qualitative methods for revealing how participants understand and respond to scale items (Meadows, 2021). CIs enable researchers to assess whether participants interpret items as intended, addressing potential misunderstandings or ambiguities (Padilla, García and Gómez, 2007). Following the Tourangeau model, an individual answering a question typically progresses through four stages: (a) understanding the meaning, (b) mentally retrieving relevant information, (c) decision-making, and (d) selecting a response (Meadows, 2021). CIs aim to examine each stage of the response process through methods such as “think aloud” responses, item-by-item probing during responses, and follow-up questions once all items are completed to clarify interpretations and confirm clarity and relevance. Data obtained from CIs is then analysed through a text summary or thematic analysis to identify patterns, misunderstandings, and cultural nuances (Meadows, 2021), which informs final adjustments to the adapted scale.

We applied the developed protocol to adapt five scales measuring engineering identity, career satisfaction, career commitment, observed hostility toward women in the workplace, and engineering turnover intentions. In the first phase, we selected scales that met the criteria of having strong psychometric properties, alignment with our research objectives, and brevity (20 items or fewer). The selected scales are detailed in the following section.

In the second phase, two native Spanish-speaking Ph.D. students in Engineering Education, fluent in English and knowledgeable about both U.S. and Colombian engineering contexts, independently translated each scale. The expert panel in the third phase consisted of three native Spanish-speaking researchers fluent in English, with one holding a Ph.D. in psychology and two in Engineering Education. For the expert panel judgement, we adapted the form from Hambleton and Zenisky (2010) to assess equivalence. The form included construct definitions for each scale, and ten questions related to meaning, grammar, writing quality and cultural appropriateness for each item. The adapted form is included in the supplementary material (<https://zenodo.org/records/14031756>).

For the final phase, we conducted CIs with nine Colombian women engineers. Details of data collection and analysis for each phase are described in subsequent sections.

3.2 Instruments

The scales selected for adaptation were based on key factors influencing women engineers' workplace experiences.

For Engineering Identity, we adapted the 13-item instrument by Godwin (Godwin, 2016), which assesses Interest, Performance/Competence, and Recognition, with Cronbach's α values exceeding .77 across dimensions. Originally developed for students, scale items were revised for a professional context. Sample items include “My supervisor(s) see me as an engineer,” “I am interested in learning more about engineering,” and “I have the engineering skills necessary to work within my field.” For Career Satisfaction, we used the five-item Career Satisfaction Scale by Greenhaus, Parasuraman and Wormley (1990), which assesses satisfaction with career outcomes such as success, income, professional advancement, and skill development. This scale demonstrated high reliability with a Cronbach's α of .88. A sample item is “[I am satisfied with] the success I have achieved in my career.” For Career Commitment, we adapted the shortened version of Meyer, Allen and Smith (1993) Occupational Commitment Scale specifically to engineering. This multidimensional scale, measuring affective, continuance, and normative commitment, has shown strong reliability, with Cronbach's α values above .7. A sample item is “I am proud to be an engineer.” For Observed Hostility Toward Women in the Workplace Scale, we selected the six-item instrument developed by Miner-Rubino and Cortina (2007), which evaluates the perception of hostility in terms of observed incivility and sexual harassment toward women at work. This scale demonstrated high reliability (Cronbach's α = .82). A sample item is “[how frequently have you observed someone in your organisation] treat in a disrespectful or discourteous manner a female employee?” Finally, for Engineering Turnover Intentions, we combined items from Singh et al. (2018) and Wayne, Shore and Liden (1997) to create a three-item scale. While the combined scale has not been previously validated, Singh et al.'s (2018) scale reported a Cronbach's α of .86, and Wayne, Shore and Liden's (1997) item had a factor loading of .7. A sample item is “I often think about quitting engineering”.

The observed hostility toward women scales instructs participants to rate the frequency with which they have observed specific behaviours in their organisation, while the other four scales ask participants to rate their agreement or disagreement with item statements. All five scales are available in the supplementary material.

3.3 Participants and Data Collection Procedures

We conducted a pilot study using convenience sampling, recruiting participants via LinkedIn based on availability and willingness to participate. Eligible participants were Colombian women with bachelor's degrees in engineering, currently working in engineering or related fields within Colombia.

A total of 35 women were invited through LinkedIn, representing diversity across university backgrounds, engineering disciplines, regions, organisational types, and professional experience levels. Of these, 15 women expressed interest, and nine ultimately provided informed consent and participated in the CI. Participants received a \$25 USD compensation for their time. Rowan University's Institutional Review Board approved all data collection protocols.

Individual think-aloud CIs were conducted with the nine women engineers from diverse engineering backgrounds and geographical regions across Colombia, including degrees in disciplines such as Agricultural, Electronics, Electric, Informatics, Environmental, Electromechanics, Civil, and Industrial Engineering. One participant worked in education, while the others were employed in industry, with professional experience ranging from 1.5 years to more than 10 years. During each CI, participants were encouraged to verbalise their thoughts while completing an online survey with the adapted scales. Additional probing questions were posed to clarify participants' understanding of items, especially those identified as challenging during the translation and expert panel review phases (Padilla, García and Gómez, 2007). Items that caused confusion, discomfort, or hesitation in responses were further explored through probing questions (Presser *et al.*, 2004).

3.4 Data Analysis Procedures

Data analysis involved both quantitative and qualitative methods, tailored to each phase of the adaptation protocol. In the Independent Translations phase, a comparative analysis examined similarities and differences between translations provided by the two experts, leading to the development of a preliminary version of the instruments.

In the Expert Panel phase, we used the Item Content Validity Index (I-CVI; Polit, Beck and Owen, 2007) to assess expert agreement on the validity of the adapted items. Experts independently rated each item's equivalent meaning, difficulty, clarity, grammar, writing quality, level of abstraction, and cultural appropriateness by responding to ten questions. Ratings included agreement, disagreement, uncertainty, or non-applicability. An agreement response was coded as 1, and all other responses as 0. An agreement score was then calculated for each question as the proportion of experts who agreed, and the I-CVI was computed as the average of these agreement scores across the ten questions. I-CVI values greater than .83 were considered adequate (Polit, Beck and Owen, 2007).

In the pilot phase, we conducted a qualitative analysis using a text summary strategy to assess participant interaction with each item (Meadows, 2021). The text summary approach involved identifying and describing dominant themes, recurring issues, and conclusions drawn from CIs. The insights obtained allowed us to refine item phrasing to improve clarity and cultural relevance.

4. Results

We organised our results conceptually according to the protocol phases: (a) Independent Translations, (b) Expert Panel, and (c) Pilot Study.

In the Independent Translations phase, we qualitatively analysed the translations for each scale. The translations were largely similar, with only minor discrepancies noted among the experts. After discussion and reconciliation, a preliminary Spanish version was created.

In the Expert Panel phase, we calculated item-CVI (I-CVI) for each item of each of the five scales to establish the content validity. For the Engineering Identity scale, all items, except one, met the criteria for an adequate item-CVI (I-CVIs $\geq .83$; $M = .94$). The item "I can overcome setbacks in engineering / *Puedo superar contratiempos*

técnicos de ingeniería" had an I-CVI of .66. In the Career Satisfaction scale, all items were above the cutoff for adequate item-CVI (I-CVIs $\geq$.96; $M = .96$). Similarly, for the Career Commitment scale, all items had I-CVI values above the cutoff (I-CVIs $\geq$.83; $M = .93$). In the Observed Hostility Toward Women in the Workplace scale, all items exceeded the cutoff (I-CVIs $\geq$.96; $M = .96$), as did the items in the Engineering Turnover Intentions scale (I-CVIs $\geq$.96; $M = .96$). Details on the agreement scores and I-CVIs are included in the supplementary material.

Cognitive Interviews (CIs) were analysed using text summary. Key findings for each scale are summarised below, emphasising items that presented interpretive challenges. Adjustments were made to these items in the final version.

In the Engineering Identity Scale, generally, items were well understood. However, some participants found the word "setbacks" (*contratiempos*) in "I can overcome setbacks in engineering" ambiguous. One participant interpreted the phrase as an activity not completed on time, while another associated the phrase with academic challenges rather than challenges in the practice of engineering. Further investigation revealed that the remaining participants' interpretations aligned with the intended meaning, so no changes were made to this item. Additionally, items framed in a general way prompted clarification questions from some participants. For example, one participant associated "I can understand new engineering concepts" with complex technological trends like Artificial Intelligence, which she thought she could not understand. Another participant, after reading the item "I can discuss engineering concepts with others", stated she could not discuss any engineering concept outside of those from her field. Additionally, a third participant for the item "I have the engineering skills necessary to work in my field" was unsure if "field" referred to her major or the field where she was currently working. These insights highlighted the need to specify items more clearly.

In the Career Satisfaction scale, participants responded without significant hesitation. One item, "I am satisfied with the success I have achieved in my career / *Estoy satisfecha con el éxito que he alcanzado en mi carrera*," raised a question for one participant regarding whether "career" referred to their academic major or professional path. In this case, the problem was in the translation of the word "career." In Spanish "career" is used for both major and professional trajectory. This meaning suggested that clarifying "career" by adding "professional" or "career path" may avoid confusion. One participant expressed some discomfort with the word "goals" as she did not have goals for each outcome, though other participants had no issue with it. Thus, the word "goals" was left as included in the original scale. Additionally, some participants found similarities between items "I am satisfied with the progress I have made toward meeting my overall career goals" and "I am satisfied with the progress I have made toward meeting my goals for advancement." This similarity may stem from the Spanish translation of "advancement", which could be clarified by translating it to a term more closely associated with "promotion". Finally, one participant expressed doubts when evaluating career success, because she only had one and a half years of experience, which showed that years of experience should be considered as a control variable within this scale.

In the Career Commitment Scale, participants encountered some challenges with the Continuing Commitment construct. Most of the participants showed discomfort with answering or expressed not knowing what to answer. The follow-up questions to understand the discomfort and doubts, showed that it was not a translation problem but that the items required a high cognitive load, so no modifications were made to these items.

In the Turnover Intentions scale, while participants generally understood the items, the phrase "I think" in "I think I will be working in engineering five years from now" raised a minor issue for one participant, as the instruction "To what extent do you agree or disagree with: I think I will work..." felt awkward. Adjusting the wording may improve clarity. Additionally, one participant indicated that while she did not intend to leave engineering, she would consider opportunities outside the field if they arose. This suggests that adding an item about openness to alternative career options could provide further insights.

Finally, in the Observed Hostility Towards Women Scale, no response issues were identified. However, one participant misread "female employee/*empleada*" as "employee/*empleado*", altering the item's meaning. Changing the font to distinguish an "a" from a "o" could prevent this error. Another participant mentioned rating hostility low due to a predominantly female workplace, suggesting that controlling for coworker gender may benefit this scale.

The final adapted scales are included in the supplementary material.

5. Discussion

Women remain consistently underrepresented in engineering (Bossart and Bharti, 2017; Bello, 2020), leaving the field at disproportionately high rates (NCSES, 2022). This attrition is partly due to barriers in engineering work environments (Miner-Rubino and Cortina, 2007; Hatmaker, 2013; Plett et al., 2011; Singh et al., 2013). In Latin America, research on the experiences of women engineers is scarce (Cano-Morales and Major, 2024), and there is a shortage of Spanish-language instruments that enable a quantitative examination of these experiences. Addressing this gap, this study developed a protocol to adapt five scales, originally in English, that assess relevant factors affecting women engineers' experiences, enabling future research within Spanish-speaking contexts.

This study employed a forward translation approach, incorporating reconciliation processes at each stage to reduce inter-expert subjective bias, a common limitation of forward translation (Hambleton, 2004). The multi-step protocol achieved robust content validity, as evidenced by high I-CVI values, aligning with existing literature that highlights the importance of addressing functional and cultural equivalence beyond mere linguistic translation (Peña, 2007; Borsa, Damásio and Bandeira, 2012).

Cognitive interviews (CIs) conducted during the pilot phase with a sample of Colombian women engineers provided valuable insights into item behaviour and the overall scale function. CIs identified recurrent issues with interpretation and item difficulty, enabling refinements to improve clarity and cultural relevance (Meadows, 2021). Specifically, in the engineering identity scale, terms such as "setbacks" and items with broad language (e.g., "engineering concepts") occasionally led to varied interpretations among participants, reflecting the literature's emphasis on the need for pilot testing to evaluate participants' understanding and ensure cultural and idiomatic appropriateness (Borsa, Damásio and Bandeira, 2012; ITC, 2017).

For the career satisfaction scale, ambiguity surrounding the term "career" arose, as it can signify either one's academic discipline or professional trajectory in Spanish. This finding highlights the importance of culturally nuanced language to avoid misinterpretations. Additionally, participant years of experience may function as a control variable when assessing career success, impacting scale accuracy.

The career commitment scale posed challenges in its continuance commitment dimension, presenting a high cognitive load for some participants who struggled with responses. This cognitive load may stem from the overlap of continuance commitment with other constructs. De Aguiar Rodrigues et al. (2022) suggest that continuance commitment may align more closely with organisational entrenchment, while Blau and Holladay (2006) recommend treating continuance commitment as two distinct dimensions: accumulated costs and limited alternatives.

In the turnover intentions scale, findings indicated that an additional item on openness to alternative career paths could enhance the scale's capture of nuanced career intentions. The Observed Hostility Toward Women scale was well understood, though the gender composition of the workplace emerged as a potential control variable to manage response variability.

This study has several limitations. First, the cognitive load issues associated with the continuance commitment dimension were not fully explored; future research should delve deeper into these challenges. Second, the transferability of the adapted scales to other populations is uncertain. Direct application to other Latin American groups may require additional revisions. Finally, while this study focused on protocol development and implementation, further research should validate the psychometric properties of the adapted scales by gathering validity evidence from a larger sample.

6. Conclusion

This study demonstrates a replicable, multi-step approach for translating and adapting scales across cultural contexts, confirming the value of forward translation combined with systematic reconciliation processes, as recommended in cross-cultural adaptation guidelines (ITC, 2017; Hambleton, 2004). By carefully addressing cultural, idiomatic, and contextual nuances, the adaptation protocol achieved robust content validity, as evidenced by high I-CVI values. Furthermore, the results support the necessity of pilot studies to evaluate the clarity, relevance, and structure of adapted instruments, as highlighted in the literature (Hambleton, 2004). The minimal adjustments required during the pilot phase suggest that the protocol's emphasis on expert selection

and reconciliation processes was effective. Translators and panel members were native Spanish speakers fluent in English, knowledgeable of both cultures, and experienced in scale construction, further aligning with best practices outlined in the literature (Borsa, Damásio and Bandeira, 2012).

The theoretical contribution of this research lies in the development and implementation of a structured adaptation protocol that ensures robust results. This protocol not only achieved functional and cultural precision but also serves as a replicable model for future cross-cultural instrument adaptations, advancing the methodology of scale development.

Practically, these findings provide organisations and educational institutions with tools to improve the professional experiences and retention of women engineers. The adapted scales—focused on engineering identity, career satisfaction, career commitment, workplace hostility, and turnover intentions—offer tools to quantitatively examine factors influencing women engineers' career trajectories. These scales can be applied in both organisational and educational settings to identify barriers and supports, enabling the development of targeted retention strategies and workplace policies.

Future research should consider incorporating control variables, such as workplace gender composition and years of experience, to improve the interpretative power of responses in assessing hostility toward women and career satisfaction.

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