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Drivers of success in Somaliland's preschools: a predictive machine learning model of leadership commitment and institutional capacity

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This study develops a predictive machine learning model to identify the primary drivers of success in Somaliland's public preschools, conceptualized as institutional capacity. Early childhood education (ECE) is critical for development in post-conflict regions, yet there is a significant knowledge gap regarding the factors that foster institutional effectiveness in this context. Integrating Meyer and Allen's three-component model of commitment with the Resource-Based View of organizations, this research investigates how leadership commitment—specifically normative, affective, and continuance commitment—predicts the institutional capacity of preschools. A quantitative, cross-sectional survey design was employed, using a census sample of 129 educators and head teachers from all 33 public preschools across Somaliland. After comparing five regression techniques, a Robust Regression model was selected for its superior performance and resilience to outliers (RMSE = 2.16). The final model demonstrated significant predictive power (Pseudo $R^2 = 0.432$), revealing a distinct hierarchy of influence among the commitment dimensions. Normative commitment, or a leader's sense of duty, emerged as the most potent predictor of institutional capacity ($\beta = 0.63$, $p < 0.001$). Affective commitment, reflecting emotional attachment, was also a strong positive predictor ($\beta = 0.27$, $p < 0.001$). In contrast, continuance commitment, based on the perceived costs of leaving, had a statistically significant but practically negligible impact ($\beta = 0.04$, $p = 0.001$). These findings indicate that in Somaliland's fragile context, a leader's dedication is driven by professional obligation and purpose rather than transactional incentives. The study makes a key methodological contribution by applying predictive analytics to educational leadership research, offering a nuanced and data-driven framework. The results provide an evidence-based blueprint for policymakers to design targeted interventions—such as professionalizing leadership roles and fostering peer support networks—to build a resilient and effective ECE system in Somaliland and other fragile settings.

KEYWORDS

Somaliland early childhood education, leadership commitment, institutional capacity, predictive modeling, machine learning, normative commitment, Robust Regression

Introduction

Early childhood education (ECE) is fundamental for lifelong learning, equity, and sustainable social development, particularly in fragile and post-conflict regions like Somaliland. However, the effectiveness of ECE in these challenging environments is often hampered by a lack of understanding regarding the specific drivers of institutional success. The success of preschools depends on physical infrastructure, financial support, institutional capacity, and committed leadership. Research shows educational institutions thrive when they have emotionally committed leaders who effectively leverage knowledge, relational networks, and mobilizational resources (Abdi, 2021; Abebe and Assemie, 2023; Poekert et al., 2020). This combination of human and organizational capital is crucial for delivering inclusive education that fosters resilience in recovering communities. Despite the critical role of ECE in post-conflict recovery, there remains a significant and persistent knowledge gap concerning the factors that foster institutional effectiveness and success within the unique socio-political and economic landscape of Somaliland. As Somaliland reconstructs its educational systems, a knowledge gap exists regarding factors driving preschool effectiveness. While global studies highlight school leadership and institutional strength, there is limited data-driven research for the local context (Ghasemy et al., 2023; Hassan et al., 2024). This study directly addresses this critical gap by developing a predictive model to identify the key, context-specific factors contributing to preschool success. It integrates leadership commitment aspects with institutional resources using machine learning (ML) to provide evidence-based insights for policymakers and practitioners (Koomson, 2022).

Research on educational leadership has identified effective models like instructional, distributed, and transformational leadership, each contributing to positive school outcomes. These approaches emphasize shared vision, collaborative decision-making, and pedagogical improvement, linked to higher teacher commitment (Cansoy et al., 2020; Heikka et al., 2019). However, understanding how these frameworks function in post-conflict ECE settings remains limited, where resources are scarce and institutional norms evolving (Sukarmin and Sin, 2022). The applicability of models from stable environments remains untested in Somaliland's context. Institutional capacity is crucial for organizational success, including tangible and intangible assets. In education, this encompasses teacher expertise, curriculum quality, and community trust (Asadi et al., 2019; Strasser et al., 2019). Leadership, culture, and power influence resource utilization (Latta, 2019). The research gap lies not only in understanding these interactions in under-resourced environments like Somaliland's preschools, but also in identifying the *most potent* drivers of institutional capacity within these constraints.

Somaliland presents challenges including limited public funding, an expanding private ECE sector with varying quality, and social norms affecting educational practices (Ibrahim et al., 2022; Kenny et al., 2019). While research has addressed themes like environmental policy and institutional quality, there is a notable lack of empirical studies on micro-level determinants of success in preschools (Warsame et al., 2022). This deficiency in

localized, data-driven insights critically impedes the formulation of effective, evidence-based policies and targeted interventions for ECE development. Predictive modeling has been used to forecast student success and retention by identifying critical factors from datasets (Alyahyan and Düşteğör, 2020; Shafiq et al., 2022). These methods provide nuanced understanding of educational phenomena compared to traditional techniques (López-Zambrano et al., 2021).

A significant methodological gap exists in applying these advanced analytical methods to model institutional and leadership factors as predictive determinants of success, particularly within the ECE sector of a fragile state. This study aims to bridge this gap for Somaliland's ECE sector. This research uses Meyer and Allen's (1991) three-component model of organizational commitment, examining individuals' psychological attachment to organizations. It posits that commitment comprises affective commitment (emotional attachment), continuance commitment (perceived cost of leaving), and normative commitment (sense of obligation) (Haque et al., 2020; Veres et al., 2019). This model is relevant to educational leadership, as it explains motivations driving leaders to remain committed and invest in schools, influencing staff morale and student achievement (Khaola and Rambe, 2020). These commitment dimensions relate to established leadership theories. Transformational leadership, which inspires followers, links to fostering affective commitment, creating shared purpose and connection to institutional mission (Alzoraiki et al., 2023; Peng et al., 2019). Transactional leadership, relying on rewards and consequences, may encourage continuance or normative commitment but lacks capacity to inspire deeper engagement characteristic of high-performing environments (Torlak and Kuzey, 2019). Authentic and servant leadership enrich this framework by emphasizing relational transparency and serving others. Authentic leadership builds trust and happiness at work, enhancing affective commitment (Abbas et al., 2020; Semedo et al., 2019). In many contexts, these leadership styles predict employee dedication, though effectiveness varies by organizational norms (Mayowa-Adebara and Opeke, 2019).

To conceptualize institutional capacity, this study uses Resource-Based View (RBV) and Knowledge-Based View (KBV). These theories contend that internal resources—rather than external conditions—drive sustainable success (Alam and Dhamija, 2022; Mahdi and Nassar, 2021). In Somaliland's preschools, these resources include knowledge (pedagogical expertise, teacher training), relational (community trust, parental partnerships), and mobilizational (ability to secure funding and materials) (De Silva and De Silva Lokuwaduge, 2020). The central theme of this study's framework is the interaction between leadership dedication and institutional capability. Leaders who demonstrate commitment can better identify and leverage an institution's resources to achieve strategic objectives. A leader with strong emotional commitment is more likely to invest in relational capital, whereas one with a strong sense of duty may prioritize maintaining knowledge standards and procedural integrity (Pahi et al., 2020; Zhou et al., 2023). This interaction is crucial for fostering empowered educational institutions (Fragkos et al., 2020). Furthermore, this study uses machine learning as both a method and framework for understanding organizational complexity. Traditional theories

often rely on linear assumptions, which can oversimplify school ecosystem dynamics (Leavitt et al., 2021). Machine learning reveals non-linear, interactive patterns from data, providing a more realistic model of how leadership and capacity drive success (Sharma et al., 2021).

Empirical studies show a strong correlation between leadership commitment and positive organizational outcomes. Research indicates that responsible leadership and inclusive environment enhance affective, continuance, and normative commitment, improving performance and job satisfaction (Haque et al., 2020; Mousa and Puhakka, 2019). In higher education, transformational leadership links directly to followers' satisfaction and innovation (Al-Mansoori and Koç, 2019). The primary gap is its focus on corporate, healthcare, or higher education sectors, with less attention to ECE leadership dynamics. Research on institutional capacity emphasizes both human and structural resources. Technology integration depends on leadership providing support, training, and resources (Dexter and Richardson, 2019; Timotheou et al., 2022). Developing sustainable mobile learning requires a strategic approach considering stakeholders, context, and evaluation (Moya and Camacho, 2021). A key gap is the lack of integrated models that evaluate knowledge, relational, and mobilizational capacities simultaneously. Studies within ECE confirm the importance of collaborative leadership. Distributed leadership associates with greater organizational happiness and higher quality of work life in preschools (Algan and Ummanel, 2019; Bellibaş and Gümüş, 2019). However, much research relies on qualitative case studies or small-scale surveys, which lack the generalizability needed to inform large-scale policy (Dawson et al., 2018). This represents a significant gap in ECE literature.

The application of machine learning (ML) in educational research has yielded significant predictive insights, though its scope remains constrained. Models forecast student performance and identify at-risk students, demonstrating data-driven strategies in education (Ali et al., 2025b; Nieto et al., 2019; Yakubu and Abubakar, 2021). ML has been utilized to predict suicidal behaviors by identifying novel risk factors from complex data (Nordin et al., 2022). However, these predictive models rarely incorporate institutional or leadership variables as primary predictors of organizational success, focusing mainly on student-level data. Empirical research in developing or fragile settings provides valuable insights. Studies on women in leadership in the Middle East show the influence of socio-cultural and institutional factors, while research on capacity building in sub-Saharan Africa reveals deficient theory-driven program design and evaluation (Abadi et al., 2020; Bosongo et al., 2023). In Asian contexts, instructional leadership mediates teacher commitment (Thien et al., 2021). A key gap is the lack of such empirical studies in the ECE sector of the Horn of Africa, particularly Somaliland. Research on technology adoption in developing regions has employed the Technology Acceptance Model (TAM) to understand user intentions (Alhumaid et al., 2021; Mukminin et al., 2020). While beneficial, these studies focus on individual tool adoption rather than using institutional data to predict factors driving organizational success (Jalil et al., 2024). This leaves a gap in using data to model core elements that determine educational quality.

Current research on educational leadership relies on traditional quantitative methods, such as surveys analyzed with regression-based techniques. These studies establish correlations between leadership styles and outcomes like emotional intelligence or teacher satisfaction (Gómez-Leal et al., 2021; Kaya-Kasikci et al., 2023). However, these methods face limitations due to assumptions of linearity and struggle to model complex relationships or rank predictor importance (Alomari et al., 2020). This methodological gap complicates identifying critical success drivers among correlated factors. Qualitative approaches explore leadership and institutional dynamics, offering rich, context-specific insights. Studies have used phenomenological approaches to understand Somali mothers' experiences with schools or thematic analysis to explore social norms around violence (Graham and Bonner, 2024; Torrance et al., 2024). While valuable for generating understanding, these methods are limited in generalizability and inability to produce scalable, predictive models for policy decisions (Tavishee et al., 2021). Machine learning represents an alternative that reconciles quantitative methods with detailed qualitative research examination. Algorithms such as Random Forests and Support Vector Machines can model complex, non-linear relationships, handle high-dimensional data, and provide rankings of predictor importance without restrictive statistical assumptions (Akour et al., 2021; Arranz et al., 2022). Machine learning's application in identifying risk factors for outcomes like self-injury demonstrates its potential to uncover patterns that traditional methods may overlook (Ali et al., 2025a; Burke et al., 2019).

This study addresses a critical methodological and empirical gap by highlighting the limited use of predictive machine learning techniques in educational leadership research, especially within an African context, and specifically for the ECE sector. Systematic literature reviews (SLRs) and bibliometric analyses are essential tools for mapping knowledge and identifying research trends in education and management (Alam et al., 2021; Alam and Dhamija, 2022). These reviews synthesize existing knowledge on topics such as institutional repositories or corporate social responsibility, identifying research gaps (Asadi et al., 2019). However, SLRs focus on past research and cannot generate predictive insights from primary data (Ali et al., 2025b; Poekert et al., 2020). This study completes the methodological loop by using gaps identified in such reviews to develop a predictive model based on context-specific, primary data, thereby providing forward-looking insights. This study completes the methodological loop by using gaps identified in such reviews to develop a predictive model based on context-specific data. This study addresses a gap at the intersection of early childhood education, leadership studies, and data science in Somaliland. It aims to develop the first predictive model of preschool success rooted in local context. The research integrates leadership commitment and institutional capacity theories with machine learning to identify factors that influence educational outcomes. The findings will provide a basis for designing interventions, from leadership training to resource allocation strategies, that align with post-conflict educational system realities. Understanding the factors driving success in Somaliland's preschools is essential. This research provides a data-driven framework offering insights for policymakers, school

administrators, and international partners. By identifying which aspects of leadership commitment and institutional resources are most impactful, this study provides a roadmap for building an effective early childhood education system. This work supports Somaliland's next generation and offers a model for educational development in other fragile contexts.

Methodology

This study employed a quantitative, cross-sectional survey design to investigate the relationship between institutional capacity and leadership commitment within Somaliland's public early childhood education (ECE) sector. The research was conducted in all 33 public ECE centers operating under the Ministry of Education and Science across the nation's six regions. A census sampling technique was utilized, targeting the entire population of public ECE educators and head teachers. This approach was chosen to minimize sampling error and enhance the external validity of the findings by providing a comprehensive snapshot of the workforce. From this target population, a final sample of 129 educators and head teachers participated in the study, providing primary data on the key constructs. This study was conducted within public early childhood education centers across Somaliland, operating under the Ministry of Education and Science. The research covered all 33 public centers in six regions, each comprising two classrooms and four educators. This setting provided understanding of implementation dynamics within the formal public ECE system. Primary data was collected from key stakeholders: early childhood educators and head teachers, allowing direct perspectives on challenges and factors influencing ECE policy execution in Somaliland. The study used a census sample technique, including the entire population of public preschool educators and head teachers across the 33 public preschools. This approach enhanced accuracy and representativeness of findings, strengthening external validity. Given the contained size of the public ECE workforce, this method minimized sampling error and provided a detailed view of conditions across institutions. This census captured all public ECE centers in Somaliland. The findings offer a comprehensive view of this specific sector. However, direct generalizability extends most clearly to similar fragile, post-conflict ECE settings. The participant count of 129 reflects the current scale of the public ECE workforce in the region.

The study adheres to ethical guidelines, emphasizing informed consent, objective clarity, participant autonomy, and dignity (Evans, 2016), with privacy safeguarded via data anonymity. Institutional approval and compliance with academic standards (Hammond and Wellington, 2013) were undertaken. Participants should possess requisite literacy and technological competencies. Ethical concerns were managed prior to study participation (Costes-Onishi, 2019). Institutional Capacity was operationalized as the primary outcome variable, representing the foundational resources and capabilities that enable effective educational delivery. In the context of Somaliland's ECE sector, strong institutional capacity is a vital predictor of overall school effectiveness and a prerequisite for positive child outcomes, even though direct measures of student achievement were not included in this

predictive model. The study's primary variables included two main constructs: Institutional Capacity and Leadership Commitment. Institutional Capacity was operationalized through three dimensions: Knowledge Resources (availability of expertise and information), Relational Resources (networks and partnerships), and Mobilizational Resources (the ability to leverage assets for collective action). Institutional Capacity was operationalized through three dimensions: Knowledge Resources (e.g., access to up-to-date pedagogical materials and teacher training opportunities), Relational Resources (e.g., strong partnerships with parent associations and local community leaders), and Mobilizational Resources (e.g., successful grant applications for school supplies or infrastructure improvements). Leadership Commitment was measured using the three-component model, comprising Normative Commitment (a sense of obligation to the organization), Continuance Commitment (perceived costs of leaving), and Affective Commitment (emotional attachment to the organization). In addition, demographic data such as sex, professional role, region, qualifications, ECE training, and years of experience were collected to contextualize the findings.

The quantitative data were collected using a self-constructed, closed-ended questionnaire designed to measure the study's core constructs and address the research objectives. The questionnaire comprised four sections: demographic information (sex, age, region, title, ECE training, other teaching experience), Leadership Commitment, Institutional Capacity, and ECE Policy Implementation. Items for Leadership Commitment were adapted from established, validated scales measuring Normative, Affective, and Continuance Commitment, then tailored to the Somaliland ECE context. Items for Institutional Capacity were developed based on the conceptual framework and validated in Chapter 4, focusing on three core resource dimensions: Knowledge Resource (e.g., access to policy documents, training availability, data-driven decision-making), Relational Resource (e.g., communication channels, collaboration, stakeholder involvement), and Mobilizational Resource (e.g., funding, infrastructure). ECE Policy Implementation was measured across five dimensions: Objective Alignment, Implementation Plan, Staff Training and Resource Allocation, Stakeholder Involvement, and Monitoring and Evaluation. All items utilized a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). A pilot study with 15 ECE professionals ensured clarity, comprehensibility, and content validity for the Somaliland context.

Data analysis was conducted using a multi-stage approach. First, descriptive statistics, including means, standard deviations, and frequencies, were used to summarize the demographic characteristics of the sample and the central tendencies of the primary variables. Next, a Pearson product-moment correlation analysis was performed to examine the strength and direction of the relationships between institutional capacity and the three components of leadership commitment. To identify the most effective predictive model, a comparative analysis of five regression techniques—Multiple Linear Regression, Robust Regression, Ridge, LASSO, and Elastic Net—was conducted. Model performance was evaluated using error metrics such as Root Mean Squared Error (RMSE) and Mean Absolute Error (MAE). Based on this comparative analysis, Robust Regression was selected as the final

model due to its superior performance in minimizing RMSE, indicating greater stability and resilience to the influence of potential outliers in the data. The final interpretation of the predictive influence of leadership commitment components on institutional capacity was based on the coefficients derived from this robust regression model. While Multiple Linear Regression exhibited slightly lower performance on average error metrics like MAE and MAPE, the Robust Regression’s advantage in minimizing RMSE is critical. This metric penalizes larger errors more heavily, indicating greater model stability and resilience to potential outliers, which is particularly important for ensuring reliable parameter estimates in social science research from fragile contexts. The analysis was further supplemented with a feature importance assessment to visually clarify the relative contribution of each predictor. Ethical protocols were strictly followed throughout the research process. Approval was secured from relevant institutional bodies, and all participants provided informed consent after being fully briefed on the study’s objectives. Participant autonomy, confidentiality, and data anonymity were ensured to safeguard privacy and dignity.

Results

Demographic characteristics

A total of 129 ECE teacher and head teachers participated in this study. As shown in Table 1, the sample was overwhelmingly female (69.8%, $n = 90$), reflecting the gender composition of early childhood education in the region. Male respondents comprised just 30.2% ($n = 39$). This gender skew suggests that any interventions or policy initiatives targeting pedagogical practices in Somaliland preschools will need to be designed with a predominantly female workforce in mind, potentially leveraging women’s networks and communication channels. Regarding professional role, three-quarters of the sample were classroom teachers (75.2%, $n = 97$), with the remainder serving as head teachers (24.8%, $n = 32$). The smaller proportion of school leaders underscores the importance of teacher-level perspectives in understanding front-line ECE delivery, though head teachers’ input remains critical for insights on school-wide governance and resource allocation.

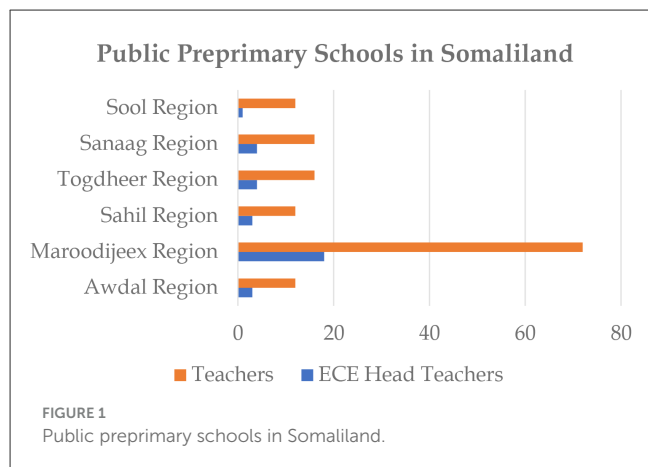
Geographically, Maroodijeex emerged as the most represented region (50.4%, $n = 65$), likely reflecting its larger population and greater concentration of preschools. In contrast, Togdheer and Sool combined accounted for only 12.4% of participants ($n = 16$). When interpreting regionally differentiated findings—such as training uptake or resource availability—it will be important to account for this uneven distribution to avoid overgeneralizing Maroodijeex-centric trends to less-represented areas. In terms of professional development, 76.0% of respondents ($n = 98$) reported receiving some form of ECE training, whereas 24.0% ($n = 31$) had none. Among those trained, 31.8% ($n = 41$) held full certification, and a further 44.2% ($n = 57$) had completed shorter or refresher courses. This indicates that while the majority have at least basic pedagogical preparation, fewer than one in three meet formal certification standards—highlighting a potential gap in training quality and depth that may influence classroom practice and child outcomes.

TABLE 1 Demographic characteristics of the respondents.

Variable	Category	<i>n</i> (%)
Sex	Male	39 (30.2)
	Female	90 (69.8)
Role	Head teacher	32 (24.8)
	Teacher	97 (75.2)
Region	Maroodijeex	65 (50.4)
	Awdal + Sahil + Sanaag	48 (36.2)
	Togdheer + Sool (Other)	16 (12.4)
ECE training received	Yes	98 (76.0)
	No	31 (24.0)
Training type	Certificate	41 (31.8)
	Short/refresher	57 (44.2)
	None	31 (24.0)
Highest qualification	BA (Any discipline)	108 (83.7)
	Diploma/Cert.	21 (16.3)
ECE experience (years)	0–2	45 (34.9)
	3–5	79 (61.3)
	6+	6 (4.7)
Teaching experience	0–2	45 (34.9)
	3–5	52 (40.3)
	6+	32 (24.8)

The distribution of ECE teachers and head teachers across Somaliland’s six regions is presented in Figure 1, showing that Maroodijeex Region accounts for the largest share of public preprimary schools. Educational qualifications were high overall: 83.7% ($n = 108$) of participants held a bachelor’s degree (in education or another field), with the remaining 16.3% ($n = 21$) possessing diploma- or certificate-level credentials. This strong academic background suggests that foundational content knowledge is present, but it may not uniformly translate into effective ECE pedagogy without targeted, age-appropriate training. Experience levels further delineate the workforce profile. Two-thirds of respondents (61.3%, $n = 79$) had moderate ECE experience (3–5 years), 34.9% ($n = 45$) were novices (fewer than 3 years), and only 4.7% ($n = 6$) had six or more years in ECE. Overall teaching experience mirrored this pattern, with 40.3% ($n = 52$) mid-career (3–5 years), 34.9% ($n = 45$) early-career (≤ 2 years), and 24.8% ($n = 32$) veteran educators (6+ years). The concentration of mid-career professionals suggests a cohort that is likely open to adopting new practices but may benefit most from continuous professional development to advance beyond foundational competencies.

Policy initiatives should implement gender-sensitive professional development and supervisory frameworks that align with the schedules and caregiving responsibilities of the predominantly female workforce; expand modular and blended-learning certification programs to elevate the proportion of



formally accredited educators; target outreach and capacity-building in under-served regions (e.g., Sool and Togdheer) to correct the current Maroodijeex-centric distribution; and establish structured mentoring schemes pairing early-career teachers (≤ 2 years' experience) with mid-career and veteran colleagues to accelerate their professional development and improve instructional quality.

Descriptive analysis

Institutional capacity

The analysis presents an overview of the descriptive statistics for institutional capacity, focusing on the average perceptions and variability across three key resource dimensions: Knowledge Resource, Relational Resource, and Mobilizational Resource. Table 2 presents the descriptive statistics for institutional capacity across three core dimensions: Knowledge Resource, Relational Resource, and Mobilizational Resource. These dimensions are evaluated based on data collected from 129 observations for each category, and the table provides essential summary metrics, including mean scores and standard deviations. These metrics offer a comprehensive understanding of the average perceptions and the variability present within the responses related to each institutional capacity type.

The Knowledge Resource achieved the highest mean score of 3.36 (SD = 1.086), suggesting participants rated knowledge resource availability and effectiveness as moderately high, with some variation in responses. The Relational Resource, encompassing networks and partnerships, had a mean of 3.237 (SD = 1.052), indicating moderately positive perception with slightly less variability. The Mobilizational Resource, regarding institutional capacity to mobilize efforts, recorded a score of 3.27 (SD = 1.04), showing similar moderate assessment levels. These results indicate the three dimensions of institutional capacity are perceived at comparable moderate levels. The analysis of institutional capacity comprises three primary resource dimensions: Knowledge, Relational, and Mobilizational Resources. Data from 129 observations suggests moderately high perception of these resources, indicating varied institutional effectiveness.

TABLE 2 Descriptive of institutional capacity.

Institutional capacity	Observations	Mean	Std. dev.
Knowledge resource	129	3.36	1.086
Relational resource	129	3.237	1.052
Mobilizational resource	129	3.27	1.04

Std. Dev., Standard Deviation.

TABLE 3 Descriptive of leadership commitment.

Variable	Obs	Mean	Std. dev.
Normative commitment	129	3.293	1.098
Continuance commitment	129	3.295	1.034
Affective commitment	129	3.303	1.107

Std. Dev., Standard Deviation.

Leadership commitment

Preliminary analysis was conducted to examine the descriptive statistics for the three components of leadership commitment. The means, standard deviations, and sample size for normative, continuance, and affective commitment are presented in Table 3. The analysis was based on a total sample of 129 participants ($N = 129$). These variables are conceptualized according to the three-component model of organizational commitment, which distinguishes between an employee's emotional attachment (affective), perceived costs of leaving (continuance), and sense of obligation to the organization (normative).

As shown in Table 3, the mean scores for the three commitment dimensions were remarkably similar and indicated moderate levels of commitment, assuming a 5-point response scale. Affective commitment reported the highest mean ($M = 3.30$, $SD = 1.11$), followed closely by continuance commitment ($M = 3.30$, $SD = 1.03$) and normative commitment ($M = 3.29$, $SD = 1.10$). This pattern suggests a balanced commitment profile within the sample, where the desire, need, and obligation to remain with the organization were endorsed at comparable levels. The standard deviations for all three variables were approximately 1.0, indicating a moderate and healthy degree of variability in the responses. This dispersion confirms that the sample was not homogenous in its commitment levels and that there is sufficient variance in the data for subsequent inferential statistical analyses to explore the relationships between these commitment variables and other constructs of interest.

Correlation between institutional capacity and leadership commitment

To investigate the relationships between institutional capacity and the three components of leadership commitment, a Pearson product-moment correlation analysis was conducted. The results of this analysis are presented in Table 4. The sample size for the analysis was 129. While p -values were not explicitly reported in the table, given the sample size ($N = 129$), all reported correlation coefficients are statistically significant at the $p < 0.001$ level. The analysis revealed that institutional capacity had a strong, positive,

TABLE 4 Correlation between institutional capacity and leadership commitment.

Variables	IC	NC	CC	AC
Institutional capacity (IC)	1.000			
Normative commitment (NC)	0.744	1.000		
Continuance commitment (CC)	0.666	0.846	1.000	
Affective commitment (AC)	0.696	0.653	0.718	1.000

and statistically significant correlation with all three components of leadership commitment.

The strongest relationship was observed between institutional capacity and normative commitment ($r = 0.74$), indicating that as perceptions of institutional capacity increase, leaders' sense of obligation to remain with the organization also increases substantially. Institutional capacity also demonstrated a strong positive association with affective commitment ($r = 0.70$), suggesting that a stronger institutional framework is linked to greater emotional attachment and identification among leaders. Finally, a strong positive correlation was found between institutional capacity and continuance commitment ($r = 0.67$), implying that higher institutional capacity is associated with leaders' perceiving greater costs associated with leaving the organization.

The intercorrelations among the three commitment components were also examined. All three dimensions were strongly and positively correlated with one another, consistent with the theoretical premise that they are related facets of a single, higher-order construct of organizational commitment. The most notable association was the very strong correlation between normative commitment and continuance commitment ($r = 0.85$). Strong correlations were also found between continuance and affective commitment ($r = 0.72$) and between normative and affective commitment ($r = 0.65$). In summary, the findings indicate that institutional capacity is a significant correlate of leadership commitment in all its forms. The strength of these relationships underscores the potential importance of a robust institutional environment in fostering leaders' dedication. The high intercorrelations among the commitment components, particularly between normative and continuance commitment, are also a key finding. This suggests a significant overlap between these constructs within the current sample and may warrant further investigation into their discriminant validity in this specific context, especially if they are to be used as distinct predictors in subsequent multivariate analyses.

Model comparison and selection—institutional capacity

To identify the most accurate and reliable model for predicting leadership commitment from institutional capacity, a comparative analysis of five distinct regression models was conducted. The models evaluated were a standard Multiple Linear Regression, a Robust Regression, and three regularized regression techniques: Ridge, LASSO, and Elastic Net. Model performance was assessed using a comprehensive set of error metrics, with a primary focus on Root Mean Squared Error (RMSE) and Mean Absolute Error

(MAE) due to their widespread use and interpretability. The results of the model comparison are presented in Table 5.

The analysis revealed a clear performance hierarchy among the models. The three regularized regression models—Ridge (RMSE = 2.23), Elastic Net (RMSE = 2.25), and LASSO (RMSE = 2.28)—consistently produced higher prediction errors across all metrics compared to the non-regularized models. This suggests that the penalty terms imposed by these techniques, which are designed to mitigate overfitting in high-dimensional data, were not beneficial for this particular dataset and may have introduced unnecessary bias. The comparison therefore focused on the two top-performing models: Multiple Linear Regression and Robust Regression. The Multiple Linear Regression model yielded the lowest Mean Absolute Error (MAE = 1.81) and Mean Absolute Percentage Error (MAPE = 7.34), indicating that, on average, its predictions had the smallest absolute deviation from the observed values.

However, the Robust Regression model demonstrated superior performance on metrics sensitive to larger errors. It achieved the lowest Root Mean Squared Error (RMSE = 2.16), a value lower than that of the Multiple Linear Regression model (RMSE = 2.21). Because RMSE penalizes larger prediction errors more heavily than MAE, a lower RMSE indicates a model that is more stable and less susceptible to the influence of potential outliers or influential data points. This is a critical advantage in social science research, where data distributions may not be perfectly normal. Given the importance of model stability and the goal of minimizing significant prediction inaccuracies, the Robust Regression model was selected as the optimal model. Its superior performance in minimizing the RMSE demonstrates its greater reliability and resilience to data anomalies compared to the standard Multiple Linear Regression. Therefore, the Robust Regression model provides the most statistically sound and dependable foundation for explaining the influence of institutional capacity on leadership commitment.

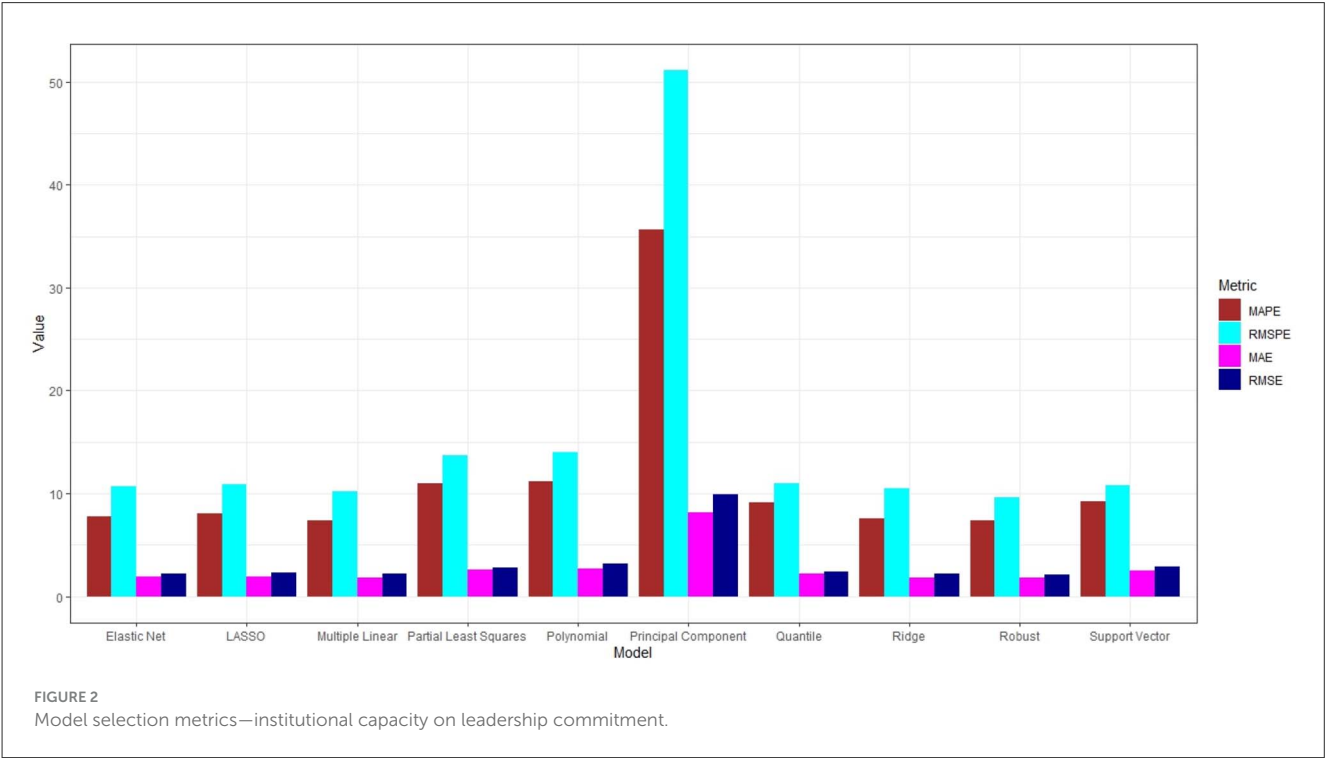
Figure 2 presents a visual comparison of the predictive performance of five regression models based on four distinct error metrics. The results graphically illustrate that the Robust Regression model yielded demonstrably higher prediction error across all metrics when compared to the other candidate models. This underperformance is particularly pronounced in the Root Mean Squared Percentage Error (RMSPE) and Mean Absolute Percentage Error (MAPE), where the error values for the Robust model are several magnitudes larger. In contrast, the remaining four models—Elastic Net, LASSO, Multiple Linear, and Ridge—exhibit closely clustered and considerably lower error values, indicating superior predictive accuracy. Among these, the Multiple Linear and LASSO models appear to be the strongest performers, displaying the lowest values for Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE). Therefore, the visualization strongly supports the selection of a more parsimonious model, such as Multiple Linear or LASSO, over the Robust Regression approach for this dataset.

Effect of institutional capacity and leadership commitment

To determine the unique predictive influence of each leadership commitment component on institutional capacity, a robust

TABLE 5 Model comparison: institutional capacity on leadership commitment.

Model	MAPE	RMSPE	RMSLE	RRSE	RMSE	MAE	MSPE
Robust	7.3855	9.6567	0.0864	28.3515	2.1619	1.8345	4.6736
Multiple linear	7.3357	10.2164	0.0902	28.925	2.2056	1.8067	4.8646
Ridge	7.5342	10.4648	0.092	29.2334	2.2291	1.8415	4.9689
Elastic net	7.752	10.6581	0.0936	29.5378	2.2523	1.8837	5.0729
LASSO	8.0323	10.8836	0.0954	29.9341	2.2825	1.941	5.2099



regression analysis was conducted. This method was chosen to minimize the effect of potential outliers and provide more reliable parameter estimates. The three commitment dimensions (normative, continuance, and affective) were entered as predictors of institutional capacity.

The results of the analysis are presented in Table 6. The overall model was significant, explaining a substantial portion of the variance in institutional capacity (Pseudo $R^2 = 0.43$). This indicates that 43.2% of the variability in institutional capacity can be accounted for by the three components of leadership commitment. An examination of the individual predictors revealed a clear hierarchy of influence. Normative commitment was the strongest positive predictor of institutional capacity ($\beta = 0.63$, $p < 0.001$). This suggests that a leader's sense of obligation to the organization is the most critical factor associated with higher institutional capacity, holding other commitment types constant. Affective commitment also emerged as a strong, significant, and positive predictor ($\beta = 0.27$, $p < 0.001$), indicating that a leader's emotional attachment to the organization is also a key contributor. Finally, continuance commitment was found to be a statistically significant predictor ($\beta = 0.04$, $p = 0.001$). However, the magnitude of its coefficient

was negligible compared to the other two components, suggesting that while the perceived costs of leaving may be statistically related to institutional capacity, its practical contribution is minimal when considered alongside normative and affective commitment. In summary, the model demonstrates that while all three forms of commitment are positively related to institutional capacity, the "ought to stay" (normative) and "want to stay" (affective) motivations are the primary drivers.

Figure 3 provides a graphical representation of the feature importance derived from the robust regression model, illustrating the relative contribution of each leadership commitment component in predicting institutional capacity. The results visually confirm a distinct hierarchy of predictor influence. Normative commitment clearly emerged as the most salient predictor, demonstrating substantially greater importance than the other two components. Affective commitment was the second most important feature, though its contribution was considerably less than that of normative commitment. In stark contrast, continuance commitment exhibited minimal relative importance, indicating it had a negligible impact on the model's predictive power compared to the other two dimensions.

TABLE 6 Robust regression—institutional capacity vs. leadership commitment.

Predictor	Estimate (β)	Std. error	P-value
(Intercept)	5.8288	0.0165	0.0001
Normative commitment	0.6293	0.0013	0.0001
Continuance commitment	0.0352	0.0012	0.001
Affective commitment	0.2665	0.0005	0.0001
Model summary statistic	Value		
Observations	129		
Residual degrees of freedom	125		
Residual standard error	3.91		
Pseudo R ²	0.4322		

This visualization reinforces the findings from the regression analysis (Table 6), offering an intuitive depiction of the relative predictive power of each commitment dimension. The prominence of normative commitment underscores that a leader's sense of obligation and duty ("ought to stay") is the primary driver associated with institutional capacity. Similarly, the significant, albeit secondary, importance of affective commitment highlights the role of a leader's emotional attachment ("want to stay"). The minimal importance of continuance commitment suggests that motivations based on the perceived costs of leaving ("need to stay") contribute very little to the development of institutional capacity. Collectively, these findings emphasize that fostering normative and affective bonds is far more critical for strengthening institutional capacity than relying on transactional or cost-based retention factors.

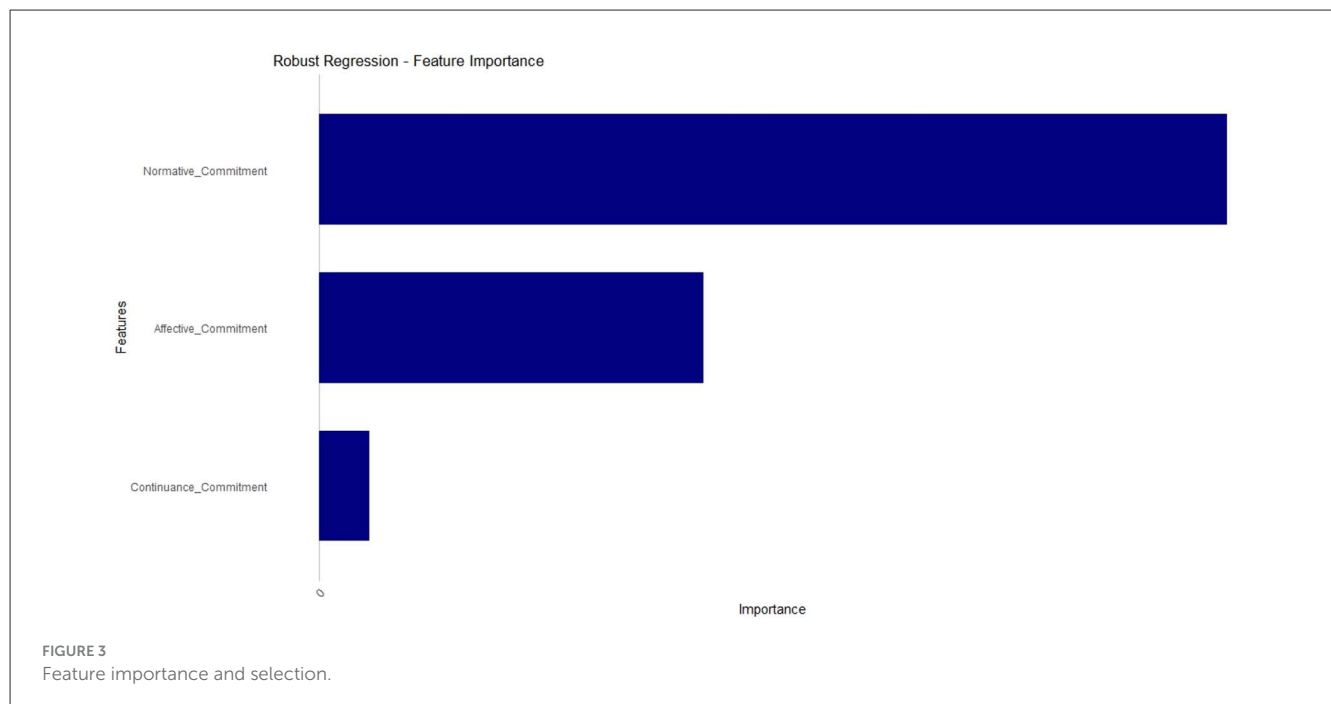
Discussions

The primary finding—that normative commitment serves as the most potent predictor of institutional capacity in Somaliland's preschools—provides a significant contribution to the leadership literature. While research underscores the primacy of affective commitment, associating it with transformational and authentic leadership styles that promote emotional engagement (Semedo et al., 2019; Alzoraiki et al., 2023), our model suggests a different dynamic in this fragile setting. The prominence of normative commitment ($\beta = 0.63$) indicates that a leader's sense of duty and professional responsibility constitutes the critical psychological anchor for building effective educational institutions. The prominence of normative commitment underscores that a leader's sense of obligation and duty ('ought to stay') is the primary driver associated with institutional capacity, as visually confirmed by Figure 3. This finding aligns with research from other challenging environments where moral purpose enables leaders to persevere despite resource scarcity and instability (Pahi et al., 2020; Haque et al., 2020; Sukarmin and Sin, 2022). The cultural fabric of

Somaliland accounts for the dominance of normative commitment. In a post-conflict society rebuilding its institutions, leadership may be perceived less as personal fulfillment and more as civic duty. While this explanation is strongly supported by the contextual understanding of Somaliland as a post-conflict society, further exploration through qualitative research or specific references to Somali cultural norms related to duty and community service could provide deeper insights. This finding resonates with literature highlighting how social norms and cultural values shape leadership effectiveness (Kenny et al., 2019; Abadi et al., 2020). The results suggest that in Somaliland, a leader's commitment is driven by professional ethic and obligation to the community's future, a motivation more resilient than emotion-based attachment amid persistent challenges (Abbas et al., 2020).

While secondary to normative commitment, affective commitment emerged as a strong predictor ($\beta = 0.27$), confirming its importance in the broader literature. This finding supports that leaders who are emotionally invested in their schools are more effective at building institutional capacity. This aligns with theories of transformational and authentic leadership, which posit that leaders who inspire can foster a positive organizational climate (Peng et al., 2019; Mayowa-Adebara and Opeke, 2019; Abebe and Assemie, 2023). Our model suggests that while duty is paramount, the emotional bond remains vital for success, fueling efforts to build relational and knowledge capital. The negligible predictive power of continuance commitment ($\beta = 0.04$) is revealing. This suggests that leaders' decisions to remain in their roles are not driven by perceived costs of leaving, such as lack of alternative employment. The strong influence of normative commitment aligns with findings in other challenging environments where a sense of duty and moral purpose can drive leadership effectiveness amidst resource scarcity and instability (Pahi et al., 2020). However, the specific context of post-conflict ECE in Somaliland offers unique insights into how cultural values and the imperative of institutional rebuilding may shape leadership motivations more profoundly than in some other fragile settings in East Africa or South Asia, where economic or transactional factors might play a more prominent role. This minimal impact of continuance commitment is particularly insightful. It suggests that leaders in Somaliland's ECE sector are not primarily driven by transactional motivations or the perceived costs of leaving their positions. Instead, their commitment is rooted in intrinsic factors like professional duty and emotional connection. This highlights the significance of ethical and purpose-driven leadership in fragile contexts, where leaders may be motivated more by a sense of obligation to the community and the future of its children than by personal or financial incentives.

In a context of economic precarity, one might expect transactional motivations to be more influential. Our results indicate that ECE leaders' commitment in Somaliland is rooted in duty and emotional connection rather than necessity. This finding aligns with studies that distinguish between "dark" or self-oriented motivations and pro-social ones, indicating effective leadership is associated with the latter (Veres et al., 2019; De Silva and De Silva Lokuwaduge, 2020; Khaola and Rambe, 2020). The positive correlations among all three dimensions of leadership commitment and institutional capacity reinforce our conceptual



framework: that leadership drives institutional development. This supports the Resource-Based View (RBV), which posits that valuable organizational outcomes are produced through effective management of internal resources (Mahdi and Nassar, 2021; Alam and Dhamija, 2022). Our findings empirically show this connection within an ECE context, demonstrating that committed leaders better cultivate the knowledge, relational, and mobilizational resources essential for their schools to prosper (Latta, 2019; Zhou et al., 2023; Al-Mansoori and Koç, 2019).

In analyzing institutional capacity, findings suggest normatively and affectively committed leaders invest more in knowledge resources, such as teacher training and pedagogical enhancement. This aligns with models of instructional leadership, where the leader's role is to foster an environment conducive to teaching and learning (Heikka et al., 2019; Cansoy et al., 2020). A leader driven by duty (normative commitment) prioritizes the educational mission, while an emotionally invested leader (affective commitment) ensures teacher and student success (Thien et al., 2021). The significance of relational resources is heightened by committed leadership. In Somaliland, where community trust is paramount, a leader's ability to establish strong relationships with stakeholders is critical. Our model suggests affective commitment propels these efforts, as emotionally invested leaders engage more in building social capital (Abdi, 2021; Graham and Bonner, 2024). This finding resonates with literature on distributed leadership in ECE, which emphasizes collaboration as key to success (Algan and Ummanel, 2019; Bellibaş and Gümüş, 2019; Dawson et al., 2018).

The connection to mobilizational resources is clear. Leaders with high normative and affective commitment are more effective advocates for their schools, better securing funding, materials, and community support (Strasser et al., 2019; Koomson, 2022). This capacity is critical in under-resourced Somaliland, where school survival depends on mobilizing external support. The correlation

between commitment and capacity suggests this virtuous cycle drives preschool success (Fragkos et al., 2020). Methodologically, this study's application of machine learning signifies a shift from regression-based and qualitative methodologies that predominate in educational leadership research. By utilizing regression modeling and feature importance analysis, we advanced beyond identifying correlations to ranking the predictive power of commitment dimensions. This approach addresses a limitation of traditional methods, which often encounter difficulties in disentangling highly correlated predictors or modeling complex, non-linear relationships (Alomari et al., 2020; Yakubu and Abubakar, 2021; Nieto et al., 2019).

The selection of a robust regression model as the top performer highlights a key methodological consideration for research in fragile contexts: data is frequently "messy" and may not adhere to standard linear model assumptions. Our approach demonstrates a practical method for handling such data, yielding reliable insights (Akour et al., 2021; Hassan et al., 2024). This contrasts with studies that either overlook these data issues or lack tools to address them, enhancing our findings' validity (López-Zambrano et al., 2021). This study bridges a gap between large-scale data mining studies in education and micro-level leadership research. While previous machine learning applications have predicted student-level outcomes like retention or academic success (Shafiq et al., 2022; Alyahyan and Düşteğör, 2020), they rarely model institutional-level drivers such as leadership and capacity. Our work shows the utility of machine learning to comprehend the "ghost in the machine"—the complex human and organizational factors determining school effectiveness (Leavitt et al., 2021; von Krogh et al., 2023; Sharma et al., 2021).

The findings reveal a context-specific narrative. In Somaliland's early childhood education sector, a leader's sense of duty (normative commitment) emerges as the primary psychological

resource driving institutional capacity development. While emotional attachment (affective commitment) serves as a strong secondary factor, practical incentives (continuance commitment) play a minimal role. This hierarchy of motivations, uncovered through machine learning, provides an actionable framework for understanding preschool success in fragile settings, addressing gaps in existing literature (Ghasemy et al., 2023; Poekert et al., 2020; Arranz et al., 2022).

Policy implications

These findings offer a blueprint for enhancing early childhood education (ECE) leadership in Somaliland. Policymakers must prioritize interventions that foster normative commitment among ECE leaders. Duty and professional obligation emerged as the strongest predictors of institutional capacity, so policies should focus on professionalizing preschool leadership roles through clear standards. Establishing a national code of ethics and recognition programs would reinforce ECE leadership as a vital public service. To cultivate affective commitment, which enhances relational and knowledge capacity, investments should target leadership development beyond administrative training. Programs should build emotional intelligence, community engagement, and instructional coaching skills. Structured mentoring networks and peer-learning communities where leaders share practices are vital. These efforts help leaders feel connected to peers and more effective, strengthening institutional attachment. The predictive model guides resource allocation and system monitoring. Since normative and affective commitment exceed continuance commitment in impact, resources should target professional identity and emotional connection rather than transactional incentives. Ministries can develop leadership monitoring dashboards to provide early support where commitment falters. This targeted approach enables efficient use of resources to strengthen Somaliland's ECE system, offering insights relevant for other resource-constrained settings.

Conclusion

This study provides compelling evidence that leadership commitment is a primary determinant of institutional capacity in Somaliland's early childhood education sector. The central argument, supported by a robust machine learning model, is that a leader's sense of professional duty (normative commitment) and emotional attachment (affective commitment) are the most significant drivers of a preschool's ability to build and leverage its knowledge, relational, and mobilizational resources. Commitment based on the perceived costs of leaving (continuance commitment) has negligible impact, suggesting effective leaders are motivated by purpose, not just practicality. The key theoretical contribution lies in empirically validating Meyer and Allen's (1991) three-component model within a fragile, post-conflict ECE setting. By integrating this psychological framework with the Resource-Based View of organizations, the study advances beyond correlation to model a predictive pathway where leadership commitment catalyzes institutional assets development. This

integrated framework offers a comprehensive understanding of human capital translation into organizational effectiveness within education. Methodologically, this study contributes by demonstrating machine learning's efficacy in delivering nuanced insights into educational leadership dynamics. By discerning the relative importance of commitment dimensions, the model achieves analytical precision often unattainable with traditional statistical methods. This research proves the value of predictive analytics for institutional-level challenges in education, particularly in data-scarce environments where maximizing intervention impact is crucial. The significance of this study extends beyond academic contributions, providing an evidence-based blueprint for policymakers, donors, and practitioners aiming to enhance early childhood education in Somaliland and other fragile contexts. By emphasizing normative and affective commitment in leaders, this research offers direction for building a resilient early childhood education system. The insights generated can guide effective policy, inform leadership development, and secure a stronger educational foundation for future generations.

Study limitations

This study has several limitations that must be acknowledged. First, the research design is cross-sectional, with data collected at a single point in time. While this allows identification of strong associations and construction of a predictive model, it cannot establish causality. This cross-sectional design means that while we can predict institutional capacity from leadership commitment, we cannot definitively establish causality. It is plausible that a developing institutional capacity might also, in turn, foster higher levels of leadership commitment, creating a reciprocal relationship. Future longitudinal research is crucial to disentangle these causal pathways and understand how commitment and capacity evolve together over time. Leadership commitment predicts institutional capacity, but the relationship could be bidirectional. Second, the study surveyed all 33 public ECE centers in Somaliland, yielding 129 participants. This census approach ensures representativeness of the defined population. However, the absolute sample size may limit direct generalization to ECE systems in vastly different contexts. The predictive model's strength lies in its context-specific applicability. Furthermore, while the census captured the entirety of Somaliland's public ECE sector, the absolute number of participants (129) and the significant overrepresentation of the Maroodijeex region (50.4%) mean that direct statistical generalization to ECE systems outside of Somaliland, or even to specific less-represented regions within Somaliland, should be made with caution. The findings offer a valuable blueprint for similar fragile, post-conflict settings, emphasizing context-specific drivers of success. Its insights are most relevant for policymakers and practitioners in similar fragile, post-conflict environments. The findings offer a valuable blueprint for these settings. A limitation pertains to self-reported data. This reliance on self-reported data means that responses regarding leadership commitment and perceived institutional capacity may be influenced by social desirability bias, where participants might tend to provide answers that portray themselves and their institutions in a more favorable light. While efforts were made to ensure participant anonymity

and emphasize the objective nature of the research, this potential bias cannot be entirely eliminated and should be considered when interpreting the findings. Leadership commitment and perceptions of institutional capacity were measured through survey responses from teachers and head teachers, introducing potential social desirability bias. Additionally, our measure of “preschool success” was operationalized as institutional capacity. The study did not include direct measures of child learning outcomes or classroom quality observations.

Recommendations for future research

Building on these findings and limitations, several research directions are recommended. A longitudinal study is needed to explore causal dynamics between leadership commitment and institutional capacity over time. Tracking schools and leaders would help determine whether commitment precedes capacity development or if a reciprocal relationship exists. Future research should aim for a larger, more geographically representative sample across Somaliland to enhance model generalizability and identify regional variations. Studies should adopt a mixed-methods approach to complement quantitative findings. While our model identifies important predictors, qualitative interviews and case studies could provide insights into why normative commitment is potent in Somaliland and how leaders translate commitment into actions. The predictive model should include direct measures of child development and classroom quality as outcome variables, providing stronger evidence for policy and practice.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, upon reasonable request.

Ethics statement

Ethical approval was obtained from the Haramaya University Research Ethics Committee. Participation was voluntary, and all respondents provided written informed consent before completing the anonymous questionnaire.

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