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CatBoost-Based Prediction of Marital Satisfaction in Women From Attachment Security, Emotional Regulation, Relationship Commitment, and Communication Patterns

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A B S T R A C T

Objective: The present study aimed to develop and evaluate a CatBoost-based machine learning model for predicting marital satisfaction among married women using attachment security, emotional regulation, relationship commitment, and communication patterns as predictor variables.

Methods and Materials: This cross-sectional predictive study was conducted among 742 married women residing in Taiwan. Participants were recruited through community organizations, social networks, and online survey platforms. Data were collected using the Revised Dyadic Adjustment Scale (RDAS) to assess marital satisfaction, the Experiences in Close Relationships-Revised Questionnaire (ECR-R) to measure attachment security, the Emotion Regulation Questionnaire (ERQ) to evaluate emotional regulation, the Commitment Inventory to assess relationship commitment, and the Communication Patterns Questionnaire-Short Form (CPQ-SF) to examine communication patterns. Following data preprocessing and screening procedures, the dataset was divided into training (80%) and testing (20%) subsets. A CatBoost regression algorithm was developed using optimized hyperparameters identified through five-fold cross-validation. Model performance was evaluated using the coefficient of determination (R^2), Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE). Feature importance and SHapley Additive exPlanations (SHAP) analyses were performed to determine the relative contribution and interpretability of each predictor variable.

Findings: The CatBoost model demonstrated excellent predictive performance, explaining 84.7% of the variance in marital satisfaction within the testing dataset ($R^2 = 0.847$). Relationship commitment emerged as the most influential predictor (35.84%), followed by communication patterns (28.63%), attachment security (21.57%), and emotional regulation (13.96%). Correlation analyses revealed significant positive associations between marital satisfaction and attachment security ($r = .68$, $p < .01$), emotional regulation ($r = .59$, $p < .01$), relationship commitment ($r = .76$, $p < .01$), and communication patterns ($r = .72$, $p < .01$). SHAP

analyses further indicated that higher levels of all predictor variables contributed positively to marital satisfaction predictions, while lower levels reduced predicted outcomes.

Conclusion: The findings demonstrate that marital satisfaction among women can be predicted with high accuracy using a CatBoost machine learning model. Relationship commitment, communication patterns, attachment security, and emotional regulation represent critical determinants of marital satisfaction, with commitment emerging as the strongest predictor. The study highlights the value of integrating relationship psychology with advanced machine learning techniques to improve understanding, prediction, and intervention planning for marital well-being.

Keywords: *Marital Satisfaction, CatBoost, Attachment Security, Emotional Regulation, Relationship Commitment, Communication Patterns.*

1. Introduction

Marital satisfaction is one of the most extensively studied indicators of relationship quality and family functioning in contemporary psychological research. It reflects an individual's subjective evaluation of the quality, stability, and fulfillment experienced within a marital relationship and is closely associated with psychological well-being, physical health, life satisfaction, and family resilience. High levels of marital satisfaction contribute to emotional security, personal growth, effective parenting, and relationship stability, whereas dissatisfaction is associated with emotional distress, conflict escalation, infidelity, separation, and divorce. As marital relationships continue to face increasing social, economic, and interpersonal challenges, understanding the factors that predict and sustain marital satisfaction has become a central concern for family psychologists and relationship researchers (Adhikari & Shilpa, 2025; Hasim et al., 2023; Ricafrente et al., 2024).

Theoretical perspectives on marital functioning consistently emphasize the importance of interpersonal bonds and emotional connectedness. Relationship researchers have argued that satisfying marriages are characterized not only by affection and companionship but also by effective emotional exchanges, mutual trust, commitment, and adaptive coping mechanisms. Contemporary relationship models suggest that marital satisfaction emerges from the dynamic interaction between individual psychological characteristics and relational processes. Consequently, variables such as attachment security, emotional regulation, relationship commitment, and communication patterns have received substantial attention as key determinants of marital adjustment and relationship quality (Tahrekhani et al., 2025; Uluyol & Özen-Çıplak, 2024; Wendołowska et al., 2022).

Among the most influential frameworks for understanding romantic relationships is attachment theory. Originally proposed to explain infant-caregiver relationships, attachment theory has been successfully extended to adult romantic relationships, where attachment styles influence emotional intimacy, trust, conflict management, and relationship maintenance behaviors. Individuals with secure attachment typically perceive others as trustworthy and themselves as worthy of love, facilitating greater emotional closeness and relationship stability. In contrast, insecure attachment patterns characterized by anxiety or avoidance often lead to difficulties in emotional expression, heightened conflict, jealousy, fear of abandonment, and reduced relationship satisfaction. Consequently, attachment security has been repeatedly identified as a foundational determinant of marital functioning and relationship well-being (Chursina, 2023; Huda & Lestari, 2024; Okonkwo, 2024).

Empirical evidence consistently supports the role of attachment security in promoting healthy marital relationships. Research has demonstrated that securely attached individuals experience greater intimacy, higher trust, and more effective conflict resolution strategies compared with their insecurely attached counterparts. Secure attachment has also been associated with resilience in romantic relationships, stronger emotional bonds, and more positive perceptions of relationship quality. Furthermore, studies indicate that attachment influences not only individual experiences but also dyadic interactions, shaping how partners respond to stress, disagreements, and emotional needs within marriage (Araghchi & Saadati, 2023; Fernandes et al., 2023; Muyang et al., 2023). Studies focusing specifically on married women have shown that attachment security contributes significantly to dyadic adjustment and marital harmony through its influence on

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perceptions of relationship efficacy and conflict management abilities (Šakotić-Kurbalija et al., 2022).

Recent investigations have further highlighted the interpersonal consequences of attachment patterns. Secure attachment fosters relational intimacy and collaborative coping processes between partners, while insecure attachment is often linked to loneliness, emotional withdrawal, and relationship instability. Dyadic studies reveal that attachment influences both partners simultaneously, suggesting that attachment-related cognitions and expectations operate within broader relational systems rather than solely at the individual level (G. & R., 2024; Uluyol & Özen-Çıplak, 2024; Wendołowska et al., 2022). Such findings underscore the importance of examining attachment security as a central predictor of marital satisfaction among women.

Another critical determinant of marital satisfaction is emotional regulation. Emotional regulation refers to the processes through which individuals monitor, evaluate, and modify their emotional experiences and expressions in order to achieve personal and interpersonal goals. Within marital relationships, emotional regulation facilitates constructive responses to conflict, stress, disappointment, and relational challenges. Partners who effectively regulate their emotions are more likely to engage in supportive communication, empathy, and collaborative problem-solving, thereby enhancing relationship satisfaction and stability. Conversely, emotional dysregulation can intensify conflicts, promote hostility, and undermine relationship quality (Castillo-López et al., 2024; Ibrahim et al., 2023; Yousefpouri et al., 2024).

The significance of emotional regulation in marital relationships has been documented across diverse cultural and relational contexts. Couples who possess stronger emotional regulation abilities demonstrate greater relationship resilience, lower levels of psychological distress, and higher levels of marital adjustment. Emotional regulation also appears to moderate the effects of attachment insecurity, enabling individuals to manage attachment-related fears and vulnerabilities more effectively. Research on married women has shown that interventions targeting emotional regulation can significantly improve attitudes toward marital fidelity, relationship quality, and overall marital functioning, emphasizing its practical relevance for sustaining healthy marriages (Geravandi et al., 2023; Ibrahim et al., 2023; Yousefpouri et al., 2024).

Relationship commitment represents another cornerstone of successful marital relationships. Commitment reflects an individual's psychological attachment to a relationship and willingness to maintain it over time despite challenges and difficulties. Strong commitment motivates partners to invest resources in relationship maintenance, engage in constructive problem solving, and prioritize long-term relational goals over short-term frustrations. Commitment has therefore been recognized as a critical protective factor against relationship deterioration and dissolution (Adhikari & Shilpa, 2025; Kusumawardhani et al., 2024; Tahrekhani et al., 2025).

Research findings consistently demonstrate a strong association between relationship commitment and marital satisfaction. Individuals who report greater commitment tend to experience stronger emotional bonds, higher trust, and increased relational security. Commitment also encourages partners to adopt adaptive coping strategies during periods of relational stress, thereby enhancing relationship stability and satisfaction. Recent studies suggest that commitment contributes not only to maintaining marriages but also to promoting marital flourishing, a broader construct encompassing growth, fulfillment, and relational thriving. Importantly, evidence indicates that commitment may amplify the positive effects of secure attachment while mitigating the detrimental consequences of relational challenges (Hasim et al., 2023; Kusumawardhani et al., 2024; Tahrekhani et al., 2025).

Communication patterns constitute another essential factor in marital functioning. Effective communication enables partners to express emotions, negotiate differences, resolve conflicts, and maintain emotional intimacy. Constructive communication patterns characterized by openness, empathy, active listening, and mutual respect facilitate relationship satisfaction and marital adjustment. In contrast, destructive communication styles involving criticism, defensiveness, withdrawal, or hostility often contribute to dissatisfaction and relationship instability. Communication therefore serves as a primary mechanism through which attachment, emotional regulation, and commitment influence relationship outcomes (Adhikari & Shilpa, 2025; Castillo-López et al., 2024; Uluyol & Özen-Çıplak, 2024).

The importance of communication becomes particularly evident during periods of relational stress and conflict. Emotional flooding, misunderstandings, and ineffective communication strategies can significantly undermine relationship quality and increase dissatisfaction among spouses. Studies examining romantic and marital relationships have demonstrated that constructive

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communication facilitates emotional understanding and conflict resolution, whereas maladaptive communication patterns contribute to resentment, emotional distance, and relationship distress (Castillo-López et al., 2024; Ogwuche et al., 2024; Shrestha et al., 2023). Consequently, communication patterns are widely regarded as one of the strongest behavioral predictors of marital satisfaction.

The interaction among attachment security, emotional regulation, commitment, and communication is particularly noteworthy. Attachment security influences emotional regulation capacities and interpersonal expectations, which subsequently shape communication behaviors and relationship maintenance efforts. Similarly, commitment may strengthen individuals' motivation to regulate emotions effectively and engage in constructive communication. This interconnectedness suggests that marital satisfaction is best understood as the product of multiple interacting psychological and relational factors rather than any single determinant (Ibrahim et al., 2023; Uluyol & Özen-Çıplak, 2024; Wendołowska et al., 2022). Recent research increasingly advocates for multidimensional approaches that simultaneously consider these variables when examining marital outcomes.

Although substantial evidence supports the relevance of these predictors, most existing studies have relied on traditional statistical approaches such as correlation, regression, and structural equation modeling. While these methods provide valuable insights into associations among variables, they often assume linear relationships and may be limited in their ability to capture complex interactions among multiple predictors. Human relationships are inherently multifaceted and dynamic, involving nonlinear processes that may not be fully represented by conventional analytical techniques (Geravandi et al., 2023; Hasim et al., 2023; Ricafrente et al., 2024).

Recent advances in artificial intelligence and machine learning provide promising alternatives for investigating relationship outcomes. Machine learning algorithms are capable of identifying complex nonlinear patterns, high-order interactions, and subtle predictive relationships that may remain undetected using traditional methods. Among these approaches, CatBoost has emerged as a particularly powerful gradient boosting algorithm known for its predictive accuracy, resistance to overfitting, and ability to model complex psychological phenomena. The application of machine learning to marital research offers opportunities not only for improved prediction but also for enhanced understanding of the relative importance of different relational factors (Shahrier, 2025; Tahrekhani et al., 2025; Yousefpouri et al., 2024).

Despite growing interest in relationship science and predictive analytics, relatively few studies have employed advanced machine learning approaches to examine marital satisfaction among women. Existing research has largely focused on isolated predictors or traditional analytical frameworks, leaving a significant gap in understanding how attachment security, emotional regulation, relationship commitment, and communication patterns collectively contribute to marital satisfaction within a comprehensive predictive model. Furthermore, the relative importance of these variables remains insufficiently understood, particularly among married women in contemporary sociocultural contexts (Kusumawardhani et al., 2024; Okonkwo, 2024; Ricafrente et al., 2024).

Given the theoretical significance of attachment processes, emotional competencies, commitment dynamics, and communication behaviors, as well as the methodological advantages offered by machine learning techniques, further investigation is warranted. A predictive approach may provide more precise identification of the factors that contribute most strongly to marital satisfaction and inform targeted interventions designed to enhance relationship quality and family well-being.

Therefore, the aim of the present study was to develop and evaluate a CatBoost-based predictive model of marital satisfaction among married women using attachment security, emotional regulation, relationship commitment, and communication patterns as predictor variables.

2. Methods and Materials

2.1. Study design and Participant

This study employed a cross-sectional predictive research design aimed at developing a machine learning model for predicting marital satisfaction among married women using attachment security, emotional regulation, relationship commitment, and communication patterns as predictor variables. The study was conducted in Taiwan between March and August 2026. The target population consisted of married women residing in major urban and suburban regions of Taiwan, including Taipei, New Taipei City, Taichung, Tainan, and Kaohsiung. Participants were recruited through community centers, family counseling services, women's associations, social media platforms, and online survey distribution networks.

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A total of 742 married women participated in the study. Eligibility criteria included being legally married, being between 20 and 60 years of age, having lived with their spouse for at least one year, and possessing sufficient literacy to complete the study questionnaires independently. Women who reported severe psychiatric disorders, ongoing divorce proceedings, or incomplete questionnaire responses exceeding 10% of total items were excluded from the final analysis. Prior to participation, all respondents were informed about the objectives of the study, confidentiality procedures, voluntary participation, and their right to withdraw at any stage without consequences. Electronic informed consent was obtained from all participants before data collection commenced.

2.2. Measures

Marital satisfaction was assessed using the Revised Dyadic Adjustment Scale (RDAS) developed by Busby, Christensen, Crane, and Larson (1995). The instrument contains 14 items designed to evaluate marital consensus, marital satisfaction, and dyadic cohesion. Participants respond using Likert-type scales with higher scores indicating greater marital adjustment and satisfaction. The RDAS has demonstrated strong psychometric properties across different cultural settings, with previous studies reporting satisfactory construct validity and internal consistency coefficients exceeding 0.80. In the present study, marital satisfaction served as the target variable for the predictive model.

Attachment security was measured using the Experiences in Close Relationships-Revised Questionnaire (ECR-R) developed by Fraley, Waller, and Brennan (2000). The instrument consists of 36 items assessing attachment-related anxiety and attachment-related avoidance within romantic relationships. Responses are recorded on a seven-point Likert scale ranging from strong disagreement to strong agreement. Lower scores on anxiety and avoidance dimensions indicate greater attachment security. Extensive research has confirmed the validity and reliability of the ECR-R in adult populations, with Cronbach's alpha values typically above 0.85.

Emotional regulation was assessed using the Emotion Regulation Questionnaire (ERQ) developed by Gross and John (2003). The questionnaire contains 10 items measuring two major emotion regulation strategies: cognitive reappraisal and expressive suppression. Participants rate each statement on a seven-point Likert scale. Higher scores on cognitive reappraisal reflect more adaptive emotional regulation, whereas higher suppression scores indicate greater reliance on emotional inhibition strategies. The ERQ has been widely validated internationally and has consistently demonstrated acceptable reliability and factorial validity.

Relationship commitment was measured using the Commitment Inventory developed by Stanley and Markman (1992). The scale evaluates personal dedication, long-term relationship orientation, and commitment to maintaining the marital relationship. The inventory includes 14 items scored on a five-point Likert scale. Higher scores indicate stronger commitment toward preserving and investing in the marital relationship. Previous investigations have established strong evidence for the scale's construct validity, criterion validity, and internal consistency reliability.

Communication patterns were assessed using the Communication Patterns Questionnaire-Short Form (CPQ-SF) developed by Christensen and Heavey (1990). This instrument evaluates constructive communication, mutual discussion, demand-withdraw interaction, and conflict communication tendencies between spouses. The questionnaire contains 11 items rated on a nine-point response scale. Higher scores on constructive communication dimensions indicate healthier interaction patterns, whereas elevated demand-withdraw scores reflect maladaptive communication processes. The CPQ-SF has demonstrated satisfactory psychometric performance across diverse marital and cultural contexts.

All measurement instruments selected for this study have been extensively used in marital and family research and possess substantial evidence supporting their validity and reliability. Prior studies conducted in Asian and international populations have reported acceptable psychometric properties, making these instruments appropriate for assessing the psychological and relational variables included in the current investigation.

2.3. Data Analysis

Data analysis was conducted using Python programming language and specialized machine learning libraries. Initially, descriptive statistics including means, standard deviations, skewness, kurtosis, and correlation coefficients were calculated to examine the distributional characteristics of the variables and identify potential anomalies. Missing data were inspected and handled using multiple imputation procedures when necessary. Outliers were identified through

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interquartile range analysis and multivariate screening techniques.

Following data preprocessing, the dataset was randomly divided into training and testing subsets using an 80:20 ratio. Predictor variables included attachment security, emotional regulation dimensions, relationship commitment, and communication pattern scores, while marital satisfaction served as the outcome variable. A CatBoost regression algorithm was employed to develop the predictive model. CatBoost was selected due to its ability to efficiently handle complex nonlinear relationships, reduce overfitting through ordered boosting techniques, and provide high predictive accuracy with relatively limited parameter tuning.

Hyperparameter optimization was performed using five-fold cross-validation and grid search procedures. Parameters including learning rate, tree depth, number of iterations, regularization coefficients, and subsampling rates were systematically optimized to achieve the best predictive performance. Model evaluation was conducted using multiple performance metrics, including coefficient of determination (R^2), Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE). Feature importance analysis was subsequently performed using CatBoost's built-in importance estimation procedures to determine the relative contribution of each predictor variable to marital satisfaction prediction.

To enhance model interpretability, SHapley Additive exPlanations (SHAP) analysis was conducted to identify the magnitude and direction of individual predictor effects on model outputs. This approach enabled a comprehensive examination of the factors most strongly associated with marital satisfaction among married women. Statistical analyses and machine learning procedures were performed at a significance level of 0.05, and all results were interpreted in accordance with contemporary guidelines for predictive modeling and psychological research.

3. Findings and Results

A total of 742 married women from Taiwan participated in the study and were included in the final analyses. The participants ranged in age from 21 to 60 years, with a mean age of 38.47 years (SD = 8.92). The average duration of marriage was 11.26 years (SD = 7.15). Regarding educational attainment, 18.6% had completed high school education, 57.8% held undergraduate degrees, and 23.6% possessed postgraduate qualifications. Approximately 64.3% of participants were employed either full-time or part-time, while 35.7% were homemakers. Most participants (71.8%) reported having at least one child. The sample demonstrated substantial variability across all psychological and relational variables, supporting the suitability of the dataset for machine learning prediction modeling. Preliminary screening indicated acceptable distributions for all study variables, with skewness and kurtosis values within recommended thresholds, suggesting no severe violations of normality assumptions.

Table 1

Descriptive Statistics and Correlations Among Study Variables

Variable	Mean	SD	1	2	3	4	5
Marital Satisfaction	54.83	10.71	1.00				
Attachment Security	4.91	0.88	.68**	1.00			
Emotional Regulation	5.04	0.81	.59**	.46**	1.00		
Relationship Commitment	4.37	0.73	.76**	.61**	.49**	1.00	
Communication Patterns	5.26	0.92	.72**	.54**	.57**	.69**	1.00

Table 1 presents the descriptive statistics and bivariate correlations among the principal study variables. The results demonstrated that marital satisfaction was positively and significantly associated with attachment security ($r = .68$, $p < .01$), emotional regulation ($r = .59$, $p < .01$), relationship commitment ($r = .76$, $p < .01$), and constructive communication patterns ($r = .72$, $p < .01$). Among the predictors, relationship commitment exhibited the strongest correlation with marital satisfaction, suggesting that women who reported stronger dedication to their relationships also experienced higher levels of marital well-being. Communication patterns emerged as the second strongest correlate, followed by attachment security and emotional regulation. Significant positive intercorrelations were also observed among all predictor variables, indicating that secure attachment tendencies, adaptive emotional regulation, stronger commitment, and healthier communication styles frequently co-occurred within satisfying marital relationships. The moderate magnitude of

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these correlations suggested meaningful associations while minimizing concerns regarding severe multicollinearity.

Table 2

CatBoost Model Performance on Training and Testing Datasets

Performance Metric	Training Set	Testing Set
R^2	0.892	0.847
RMSE	3.46	4.19
MAE	2.71	3.28
MAPE (%)	5.13	6.44

The predictive performance of the CatBoost model is presented in Table 2. The model demonstrated excellent predictive capability across both training and testing datasets. On the testing dataset, the model explained 84.7% of the variance in marital satisfaction scores ($R^2 = 0.847$), indicating substantial predictive accuracy. The RMSE value of 4.19 and MAE value of 3.28 suggested relatively low prediction errors considering the range of marital satisfaction scores. Furthermore, the MAPE value of 6.44% indicated that prediction errors remained well below conventional thresholds for highly accurate predictive models. Comparison between training and testing performance revealed only a modest decline in predictive accuracy, suggesting minimal overfitting and strong generalizability. Collectively, these findings indicate that the combination of attachment security, emotional regulation, relationship commitment, and communication patterns provides a highly effective basis for predicting marital satisfaction among married women.

Table 3

Relative Feature Importance Derived from the CatBoost Algorithm

Predictor Variable	Importance Score (%)
Relationship Commitment	35.84
Communication Patterns	28.63
Attachment Security	21.57
Emotional Regulation	13.96

The feature importance analysis generated by the CatBoost algorithm is shown in Table 3. Relationship commitment emerged as the most influential predictor, accounting for 35.84% of total predictive importance. This finding suggests that women's dedication, investment, and long-term orientation toward their marital relationships constitute the strongest determinants of marital satisfaction within the predictive framework. Communication patterns represented the second most influential factor (28.63%), highlighting the central role of constructive interpersonal exchanges and effective conflict management in fostering marital well-being. Attachment security contributed 21.57% of predictive importance, indicating that feelings of trust, emotional safety, and relational confidence substantially affect marital satisfaction. Emotional regulation, while still important, demonstrated the lowest relative contribution (13.96%), suggesting that although adaptive management of emotions enhances marital functioning, its influence may operate partly through its effects on commitment and communication processes. The distribution of importance scores demonstrates that interpersonal and relational dynamics collectively account for the majority of predictive variance.

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Table 4

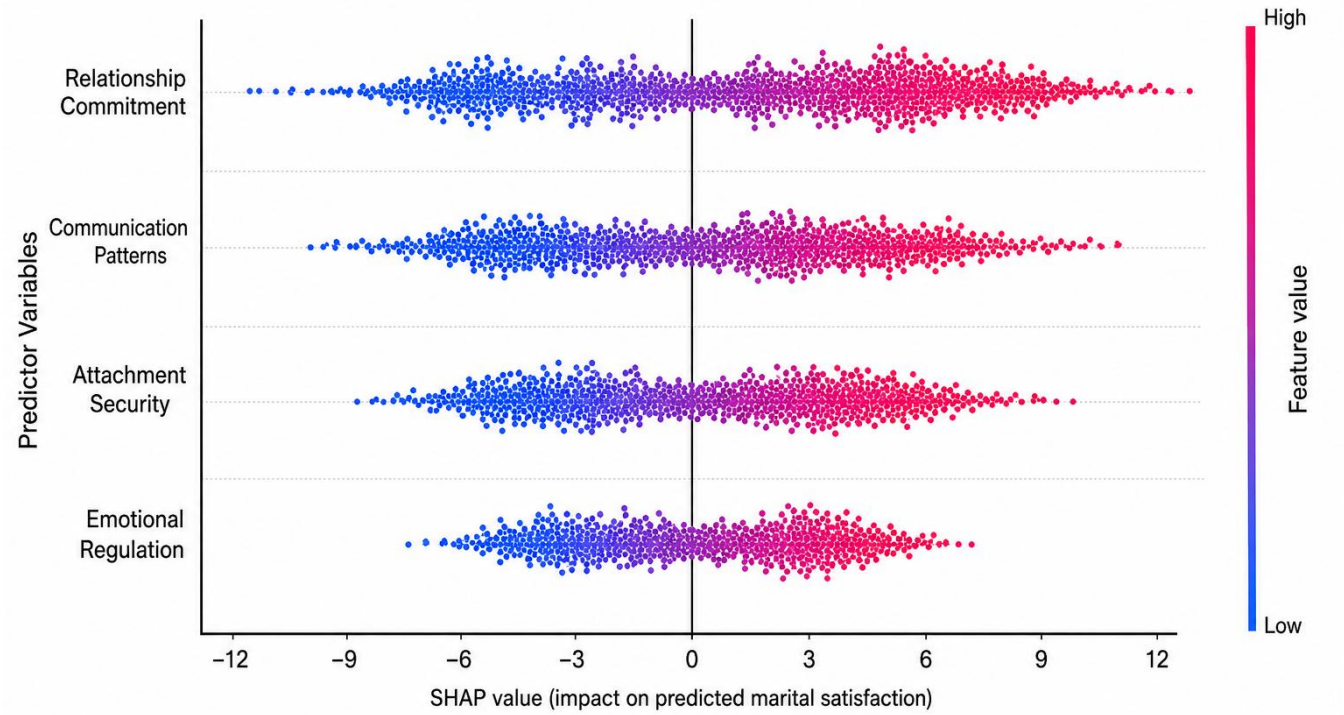
SHAP-Based Directional Effects of Predictor Variables on Marital Satisfaction

Predictor Variable	Mean SHAP Value	Positive Impact Range	Negative Impact Range
Relationship Commitment	4.84	+2.10 to +10.92	-8.43 to -1.85
Communication Patterns	3.97	+1.76 to +9.31	-7.54 to -1.47
Attachment Security	3.18	+1.22 to +7.88	-6.75 to -1.21
Emotional Regulation	2.41	+0.98 to +5.64	-5.31 to -0.84

Table 4 summarizes the SHAP-based interpretation of predictor contributions. Higher levels of relationship commitment produced the largest positive effects on predicted marital satisfaction scores, with increases of up to approximately 11 points for participants demonstrating exceptionally strong commitment. Similarly, constructive communication patterns substantially elevated predicted satisfaction levels, whereas maladaptive communication behaviors were associated with notable decreases in model predictions. Secure attachment characteristics consistently contributed positively to marital satisfaction predictions, while attachment insecurity reduced predicted outcomes. Emotional regulation exhibited a more moderate yet meaningful impact, with adaptive emotional management increasing predicted marital satisfaction and emotional suppression or dysregulation decreasing it. The SHAP analysis revealed that all four predictors contributed both independently and interactively to model outcomes, illustrating the complex and multidimensional nature of marital satisfaction among women.

Figure 1

SHAP Summary Plot Demonstrating the Relative Influence of Attachment Security, Emotional Regulation, Relationship Commitment, and Communication Patterns on Predicted Marital Satisfaction



Each dot represents one participant. Color indicates the original feature value (red = high, blue = low).
SHAP value indicates the impact of the feature on increasing (positive) or decreasing (negative) predicted marital satisfaction.

The SHAP summary plot further illustrated the hierarchical importance and distribution of predictor effects across all observations. Relationship commitment displayed the widest spread of SHAP values, indicating substantial influence on individual prediction outcomes. Communication patterns exhibited the second greatest

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distribution of effects, followed by attachment security and emotional regulation. The figure demonstrated that higher predictor values were consistently associated with positive SHAP contributions, resulting in elevated marital satisfaction predictions, whereas lower values generated negative contributions. The concentration and spread of SHAP values also indicated considerable heterogeneity among participants, suggesting that the strength of predictor effects varied across individuals. Nevertheless, the overall pattern confirmed that women characterized by stronger relationship commitment, healthier communication patterns, greater attachment security, and more adaptive emotional regulation strategies consistently obtained the highest predicted marital satisfaction scores. These findings provide robust evidence that the CatBoost model successfully identified theoretically meaningful and practically relevant determinants of marital satisfaction, while simultaneously achieving high predictive accuracy and interpretability.

4. Discussion

The present study aimed to develop and evaluate a CatBoost-based machine learning model for predicting marital satisfaction among married women using attachment security, emotional regulation, relationship commitment, and communication patterns as predictor variables. The findings demonstrated that the CatBoost model achieved excellent predictive performance, explaining approximately 84.7% of the variance in marital satisfaction within the testing dataset. Furthermore, feature importance analyses revealed that relationship commitment was the strongest predictor of marital satisfaction, followed by communication patterns, attachment security, and emotional regulation. The SHAP analyses further confirmed that higher levels of each predictor were associated with increased marital satisfaction, while lower levels contributed negatively to model predictions. These findings provide compelling evidence that marital satisfaction is a multidimensional construct influenced by the interaction of emotional, cognitive, and relational factors and that machine learning approaches can effectively capture these complex relationships.

One of the most important findings of the study was the dominant predictive role of relationship commitment. Women who reported stronger commitment to their marital relationships consistently demonstrated higher levels of marital satisfaction, and commitment accounted for the largest proportion of predictive importance within the CatBoost model. This finding aligns closely with theoretical perspectives suggesting that commitment serves as a stabilizing force in intimate relationships by motivating individuals to invest in relationship maintenance, conflict resolution, and long-term relational goals. Commitment enhances partners' willingness to prioritize the relationship during periods of stress and facilitates persistence in the face of relational difficulties. Consequently, committed individuals tend to interpret relationship challenges as manageable rather than threatening, contributing to greater relationship stability and satisfaction (Kusumawardhani et al., 2024; Tahrekhani et al., 2025).

The present findings are consistent with previous empirical studies indicating that relationship commitment is among the strongest correlates of marital adjustment and relational flourishing. Kusumawardhani et al. demonstrated that commitment contributes significantly to marital flourishing beyond the effects of attachment style alone, suggesting that remaining emotionally invested in a relationship is essential for sustaining long-term satisfaction (Kusumawardhani et al., 2024). Similarly, Adhikari and Shilpa emphasized that enduring romantic relationships are characterized by relationship maintenance efforts and resilience processes that are strongly influenced by commitment-related motivations (Adhikari & Shilpa, 2025). The current findings extend this literature by demonstrating that commitment remains the most influential predictor even when examined simultaneously alongside attachment security, emotional regulation, and communication patterns within an advanced machine learning framework.

The second most influential predictor identified in this study was communication patterns. Women who reported healthier communication styles demonstrated significantly higher levels of marital satisfaction, and constructive communication contributed substantially to model predictions. This finding is theoretically expected because communication serves as the primary mechanism through which partners exchange emotions, negotiate needs, resolve conflicts, and maintain intimacy. Effective communication fosters mutual understanding and emotional validation, whereas dysfunctional communication often contributes to misunderstanding, emotional distance, and escalating conflict.

These results are supported by previous investigations emphasizing the critical role of communication in relationship functioning. Castillo-López et al. highlighted how emotional flooding and ineffective communication strategies can undermine relationship quality by disrupting emotional regulation and conflict management processes

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(Castillo-López et al., 2024). Similarly, Adhikari and Shilpa found that communication-related relationship maintenance behaviors play a fundamental role in preserving relationship quality during stressful circumstances (Adhikari & Shilpa, 2025). The findings are also compatible with actor-partner relationship models demonstrating that communication patterns interact with attachment-related expectations and interpersonal schemas to influence marital adjustment (Uluyol & Özen-Çıplak, 2024). The present study therefore reinforces the view that communication is not merely a behavioral skill but a central relational process underlying marital satisfaction.

Attachment security emerged as the third most important predictor of marital satisfaction. Women characterized by greater attachment security reported higher marital satisfaction and received more favorable model predictions. This finding is consistent with attachment theory, which proposes that secure attachment promotes trust, intimacy, emotional openness, and confidence within close relationships. Securely attached individuals are generally more comfortable seeking support, expressing affection, and responding constructively to relationship challenges, all of which facilitate marital satisfaction.

The observed findings correspond closely with a substantial body of empirical evidence. Research has consistently demonstrated that secure attachment contributes positively to relationship quality, whereas attachment anxiety and avoidance are associated with jealousy, insecurity, conflict, and dissatisfaction (Chursina, 2023; Okonkwo, 2024). Studies examining adult romantic relationships have also shown that secure attachment is associated with greater relational resilience and psychological well-being (Fernandes et al., 2023; Muyang et al., 2023). Furthermore, research involving married women indicates that attachment security contributes to dyadic adjustment through enhanced confidence in managing marital conflicts and relational challenges (Šakotić-Kurbalija et al., 2022). The current findings support these conclusions and demonstrate that attachment security remains a significant predictor even when examined alongside other important relational variables.

Another noteworthy finding was the significant contribution of emotional regulation to marital satisfaction prediction. Although emotional regulation demonstrated the lowest relative importance among the four predictors, it remained a meaningful contributor to model performance and exhibited a positive relationship with marital satisfaction. Women who reported greater capacity to regulate their emotions effectively tended to experience higher marital satisfaction, whereas difficulties in emotional regulation were associated with lower predicted satisfaction levels.

This result is highly consistent with existing literature highlighting the role of emotional regulation in maintaining healthy relationships. Emotional regulation enables individuals to manage negative emotions constructively, reduce impulsive reactions during conflicts, and maintain supportive interpersonal interactions. Within marital contexts, emotional regulation promotes empathy, patience, and collaborative problem solving while minimizing destructive behaviors such as hostility and withdrawal. Previous research has demonstrated that emotional regulation interventions improve marital functioning and reduce vulnerability to relational problems (Yousefpouri et al., 2024). Similarly, Ibrahim et al. identified emotional regulation as a central mechanism linking attachment experiences with relational outcomes among couples (Ibrahim et al., 2023). Castillo-López et al. further emphasized that effective emotional regulation reduces emotional flooding and contributes to healthier conflict resolution processes (Castillo-López et al., 2024). The present findings provide additional support for these perspectives.

The correlation analyses also revealed significant positive associations among all predictor variables. Relationship commitment, communication patterns, attachment security, and emotional regulation were strongly interrelated, suggesting that marital satisfaction develops through interconnected relational processes rather than isolated psychological characteristics. This pattern aligns with contemporary relationship theories emphasizing the systemic nature of marital functioning. Secure attachment may facilitate better emotional regulation, which in turn promotes constructive communication and strengthens commitment. Likewise, commitment may motivate individuals to communicate more effectively and regulate emotions more adaptively during relationship challenges.

These interconnected findings are consistent with previous dyadic and relational studies. Wendołowska et al. demonstrated that attachment influences relational intimacy through dyadic coping processes (Wendołowska et al., 2022). Uluyol and Özen-Çıplak reported that attachment patterns are closely linked with interpersonal schemas that shape marital adjustment outcomes (Uluyol & Özen-Çıplak, 2024). Similarly, Geravandi et al. found that attachment-focused therapeutic interventions improve emotional

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experiences toward spouses and enhance family functioning among married women (Geravandi et al., 2023). Together, these findings suggest that the predictors examined in the present study operate within a broader relational system characterized by reciprocal influence and mutual reinforcement.

An important contribution of the current investigation lies in its methodological approach. Most previous studies examining marital satisfaction have relied on traditional statistical methods such as correlation, regression, or mediation analysis. While valuable, these approaches often assume linear relationships and may fail to capture complex interactions among predictors. The use of CatBoost enabled the identification of nonlinear relationships and relative feature contributions with a level of precision that is difficult to achieve using conventional techniques. The strong predictive performance observed in the present study indicates that machine learning methods may offer valuable complementary tools for relationship research.

The successful application of CatBoost in predicting marital satisfaction also contributes to the growing integration of artificial intelligence within psychological science. Machine learning approaches can assist researchers and practitioners in identifying high-risk relationship profiles, personalizing interventions, and improving prediction accuracy across diverse populations. The SHAP analyses used in the present study further enhanced interpretability by demonstrating how individual predictors influenced model outcomes. Such advances are particularly important because they combine predictive power with theoretical understanding, thereby bridging the gap between data-driven prediction and psychological explanation.

5. Conclusion

Overall, the findings suggest that marital satisfaction among women is best understood as the outcome of multiple interacting relational strengths. Relationship commitment appears to provide the motivational foundation for marital stability, communication patterns facilitate ongoing interpersonal functioning, attachment security establishes emotional trust and intimacy, and emotional regulation enables adaptive responses to relational challenges. Together, these factors create a relational environment conducive to marital satisfaction and long-term relationship well-being.

6. Limitations and Suggestions

Several limitations should be considered when interpreting the findings of this study. First, the cross-sectional design prevents causal conclusions regarding the relationships among attachment security, emotional regulation, communication patterns, commitment, and marital satisfaction. Second, all variables were assessed using self-report measures, which may be influenced by social desirability bias, response styles, and subjective perceptions. Third, the study included only married women from Taiwan, which may limit the generalizability of the findings to men, unmarried individuals, or populations from different cultural backgrounds. Fourth, although the CatBoost model demonstrated excellent predictive accuracy, other potentially relevant variables such as personality traits, mental health indicators, socioeconomic conditions, and spousal characteristics were not included. Finally, marital satisfaction is a dynamic construct that may fluctuate over time, whereas the present study captured participants' experiences at only one point in time.

Future studies should employ longitudinal designs to examine how attachment security, emotional regulation, communication patterns, and commitment influence changes in marital satisfaction across different stages of marriage. Researchers may also compare the predictive performance of CatBoost with other machine learning algorithms such as XGBoost, LightGBM, Random Forest, and deep learning models. Additional variables including personality traits, resilience, stress, family functioning, cultural values, and mental health indicators should be incorporated to develop more comprehensive predictive frameworks. Future investigations could also utilize dyadic data collected from both spouses to examine partner effects and reciprocal influences within marital relationships. Cross-cultural comparisons would further clarify the universality and cultural specificity of the identified predictors.

The findings suggest that marital counseling and relationship enrichment programs should prioritize strengthening relationship commitment, improving communication skills, enhancing attachment security, and developing emotional regulation capacities among couples. Counselors may benefit from implementing interventions that encourage emotional openness, constructive conflict resolution, mutual support, and long-term relational investment. Premarital education programs should include components targeting attachment awareness and emotional

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regulation skills to promote healthier relationships from the beginning of marriage. Family practitioners and mental health professionals may also use predictive assessment approaches to identify couples at risk for marital dissatisfaction and provide early preventive interventions. Ultimately, strengthening these relational resources may contribute to healthier marriages, improved psychological well-being, and greater family stability.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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