

Feature Contribution Analysis of Youth Life Satisfaction Using Psychological Capital and Social Connectedness

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ABSTRACT

Objective: The objective of this study was to develop an explainable predictive model of youth life satisfaction by quantifying the individual and combined contributions of psychological capital components and social connectedness.

Methods and Materials: A cross-sectional correlational design was employed with a sample of 684 Moroccan adolescents and emerging adults recruited from secondary schools, vocational institutes, and universities. Participants completed standardized measures of life satisfaction, psychological capital, and social connectedness. Advanced machine learning models including Elastic Net Regression, Random Forest, and Gradient Boosting Machine were trained using ten-fold cross-validation. Explainable artificial intelligence techniques based on SHAP values and permutation feature importance were applied to interpret model predictions, identify dominant predictors, and examine nonlinear interactions among psychological and social variables.

Findings: The Gradient Boosting Machine demonstrated superior predictive performance ($R^2 = .76$, RMSE = 2.78, MAE = 2.19). Feature contribution analysis revealed that hope was the strongest predictor of life satisfaction, followed by social connectedness and self-efficacy. Optimism and resilience showed moderate but substantial contributions, whereas demographic variables such as age and gender exerted comparatively minor influence. Interaction effects indicated that high social connectedness amplified the positive effects of psychological capital components on predicted life satisfaction.

Conclusion: Youth life satisfaction is primarily driven by dynamic psychological and social resources rather than static demographic characteristics. Explainable machine learning provides a powerful framework for uncovering complex predictive structures and offers actionable insight for designing personalized youth well-being interventions focused on strengthening psychological capital and social integration.

Keywords: *Youth well-being; life satisfaction; psychological capital; social connectedness; explainable artificial intelligence; feature contribution analysis; machine learning; adolescent mental health*

1. Introduction

Life satisfaction has long been recognized as a central indicator of psychological adjustment, mental health, and overall quality of life, particularly during youth and emerging adulthood, a developmental stage characterized by rapid identity formation, social role transitions, and heightened vulnerability to stressors. Contemporary psychological science increasingly emphasizes that youth life satisfaction is not merely a function of external circumstances but emerges from a complex interplay between internal psychological resources and social relational environments (Chen et al., 2025; Huang et al., 2025; Shereda et al., 2025). In this context, psychological capital and social connectedness have emerged as two of the most robust and theoretically grounded predictors of well-being across cultures, populations, and developmental stages (Diržytė & Patapas, 2022; Diržytė et al., 2022; Ke et al., 2023; Mehrpour et al., 2024).

Psychological capital, conceptualized as a higher-order construct composed of hope, self-efficacy, resilience, and optimism, represents a malleable set of personal psychological resources that facilitate adaptive functioning and sustained well-being (Parviniannasab et al., 2022; Preston et al., 2021; Xu et al., 2024). Empirical research consistently demonstrates that individuals with higher psychological capital exhibit superior emotional regulation, stress tolerance, academic and occupational performance, and life satisfaction (Cao et al., 2024; Shan et al., 2022; Shereda et al., 2025). Among youth populations in particular, psychological capital functions as a protective factor that buffers the adverse effects of academic pressure, social instability, and environmental uncertainty (Shek et al., 2021; Wang et al., 2022; Wang et al., 2023).

Parallel to the role of internal resources, social connectedness represents the relational dimension of well-being, reflecting individuals' perceived sense of belonging, emotional closeness, and integration within meaningful social networks. A substantial body of research confirms that social connectedness is strongly associated with life satisfaction across diverse demographic groups and cultural contexts (Hu et al., 2023; Ke et al., 2023; Lee et al., 2023; Song et al., 2024). Social connectedness fosters emotional security, identity coherence, and perceived social value, which in turn promote stable life satisfaction and psychological health (Li et al., 2024; Mehrpour et al., 2024). Among youth, whose social worlds are rapidly expanding and transforming, social connectedness becomes especially

salient as a determinant of adjustment, resilience, and long-term well-being (Choi, 2024; Kim et al., 2022).

The interactive relationship between psychological capital and social connectedness has attracted growing scholarly attention. Evidence suggests that psychological capital not only directly predicts life satisfaction but also amplifies the positive effects of social relationships, while social connectedness simultaneously reinforces the development and sustainability of psychological capital (Huang & Zhang, 2021; Karatepe et al., 2022; Leonti & Turliuc, 2024). For example, perceived social support enhances psychological capital, which subsequently increases life satisfaction and mental health outcomes (Al-Adhami et al., 2022; Chen et al., 2025). Similarly, social ties and group identification strengthen optimism, resilience, and hope, thereby promoting stable subjective well-being (Diržytė & Patapas, 2022; Mehrpour et al., 2024).

Recent years have witnessed the integration of advanced analytical techniques such as network analysis, mediation modeling, and explainable artificial intelligence to better understand these complex psychosocial systems. Network-based approaches reveal that psychological capital and social support variables form dense, interdependent systems influencing life satisfaction and emotional well-being (Chen et al., 2025; Fang et al., 2023). Mediation and moderated mediation studies further demonstrate that psychological capital often functions as a central mechanism through which social factors influence life satisfaction and mental health (Huang et al., 2025; Li et al., 2021; Shan et al., 2022). However, while traditional statistical methods have clarified associations and pathways, they remain limited in capturing nonlinear interactions and the relative contribution of each component within high-dimensional psychosocial systems.

The emergence of explainable artificial intelligence (XAI) provides an innovative methodological framework capable of overcoming these limitations by quantifying the precise contribution of each psychological and social factor to life satisfaction at both the population and individual levels. Feature contribution analysis allows researchers to move beyond average effects and examine how specific psychological capital components and social connectedness dimensions jointly shape well-being outcomes. This approach is particularly valuable in youth research, where heterogeneity of developmental trajectories and social environments demands fine-grained, individualized modeling (Huang et al., 2025; Song et al., 2024; Xu et al., 2024).

Furthermore, recent global disruptions, including the COVID-19 pandemic, have intensified the relevance of psychological capital and social connectedness for youth well-being. Studies consistently document heightened vulnerability among young people to stress, anxiety, social isolation, and declines in life satisfaction, alongside the protective buffering roles of resilience, optimism, and supportive relationships (Fernando Henrique de Lima et al., 2022; Huang & Zhang, 2021; Lee et al., 2023). These findings underscore the urgency of developing predictive models that can identify the most influential psychological and social factors shaping youth life satisfaction in contemporary contexts.

Despite the growing literature, significant gaps remain. Most existing studies rely on linear models and predefined causal assumptions, limiting the exploration of complex nonlinear patterns and dynamic interactions among psychological capital, social connectedness, and life satisfaction. Moreover, few investigations apply explainable machine learning methods to systematically quantify feature importance within youth populations, particularly in non-Western contexts. Addressing these gaps is essential for advancing both theoretical understanding and evidence-based intervention design.

Accordingly, the present study applies advanced feature contribution analysis within an explainable AI framework to model youth life satisfaction based on psychological capital and social connectedness, integrating robust psychometric measurement with transparent predictive modeling to clarify the relative and interactive influence of these foundational psychosocial resources.

The aim of this study was to develop and interpret an explainable predictive model of youth life satisfaction by quantifying the individual and combined feature contributions of psychological capital components and social connectedness.

2. Methods and Materials

2.1. Study Design and Participants

The present study employed a cross-sectional, correlational research design with an applied objective and an advanced analytical framework aimed at modeling youth life satisfaction based on psychological capital and social connectedness through feature contribution analysis. The target population consisted of adolescents and emerging adults residing in urban and semi-urban regions of Morocco, representing diverse socioeconomic, educational, and

cultural backgrounds. Participants were recruited from public high schools, vocational institutes, and universities located in the cities of Rabat, Casablanca, Fes, and Marrakesh during the 2025 academic year. A multi-stage cluster sampling procedure was implemented, in which educational institutions were first selected randomly from each city, followed by the random selection of classrooms and academic programs within each institution. Eligibility criteria included age between 16 and 24 years, Moroccan nationality, current enrollment in an educational institution, and voluntary consent to participate. Individuals with self-reported neurological disorders, severe psychiatric diagnoses, or incomplete survey responses were excluded from the final dataset. Based on power analysis for machine learning models with medium effect sizes and a desired statistical power of .95, a minimum sample of 600 participants was estimated as necessary; therefore, 720 students were initially recruited, and after data screening and removal of incomplete cases, 684 valid responses were retained for analysis. The sample exhibited balanced representation across gender, educational level, and residential background, ensuring adequate variability for model training and generalization.

2.2. Measures

Data were collected using a comprehensive questionnaire battery composed of standardized psychometric instruments administered in Arabic and French versions validated for Moroccan populations. Youth life satisfaction was measured using the Satisfaction with Life Scale, a five-item instrument assessing global cognitive judgments of life quality on a seven-point Likert scale. Psychological capital was assessed using the Psychological Capital Questionnaire, which measures four core components including hope, self-efficacy, resilience, and optimism across 24 items rated on a six-point Likert continuum. Social connectedness was evaluated using the Social Connectedness Scale-Revised, consisting of 20 items capturing individuals' sense of belonging, interpersonal closeness, and social integration. Demographic information including age, gender, educational level, parental education, family income, and residential context was also collected. Prior to the main data collection, a pilot study with 60 students was conducted to assess clarity, reliability, and cultural appropriateness of the instruments. Cronbach's alpha coefficients for all scales in the main study exceeded .86, indicating excellent internal consistency. Data collection was conducted in supervised

classroom settings by trained research assistants to ensure standardized administration procedures and to minimize response bias.

2.3. Data Analysis

Data analysis followed a hybrid statistical-computational framework integrating classical psychometric validation with machine learning-based feature contribution modeling. Preliminary analyses included data cleaning, missing value treatment using multiple imputation, normality assessment, multicollinearity diagnostics, and reliability verification. Subsequently, predictive models of youth life satisfaction were constructed using gradient boosting machines, random forest regression, and elastic net regression. Model performance was evaluated through ten-fold cross-validation and compared using R^2 , RMSE, and MAE indices. To quantify the relative importance and contribution of each psychological capital component and social connectedness dimension, Shapley Additive Explanations (SHAP) and permutation feature importance methods were employed. These explainable AI techniques enabled the decomposition

of individual predictions and global model behavior, revealing the magnitude, direction, and interaction effects of predictors on life satisfaction outcomes. Additional analyses examined nonlinear relationships and interaction effects between psychological capital and social connectedness components using partial dependence plots and accumulated local effects. All analyses were conducted using Python and R statistical environments, with strict adherence to reproducibility protocols and transparency in model interpretation.

3. Findings and Results

The results section begins with descriptive and preliminary statistics presented in Table 1 in order to characterize the sample and examine the distributional properties of the core study variables prior to advanced modeling. These analyses establish the suitability of the dataset for subsequent predictive and feature contribution modeling and provide an overview of participants' psychological and social profiles.

Table 1

Descriptive Statistics and Reliability of Main Study Variables

Variable	N	Mean	SD	Min	Max	Skewness	Kurtosis	Cronbach's α
Life Satisfaction	684	22.64	5.12	7	35	-0.41	-0.36	.88
Psychological Capital (Total)	684	103.57	14.83	61	144	-0.29	-0.21	.93
Hope	684	26.11	4.01	14	36	-0.32	-0.17	.89
Self-Efficacy	684	27.43	4.26	15	36	-0.28	-0.24	.90
Resilience	684	24.85	4.73	12	36	-0.35	-0.29	.88
Optimism	684	25.18	4.59	13	36	-0.22	-0.18	.87
Social Connectedness	684	82.36	11.27	42	120	-0.26	-0.23	.91

As shown in Table 1, all variables exhibited approximately normal distributions with skewness and kurtosis values within acceptable ranges. Internal consistency indices were strong across all constructs, confirming high measurement reliability. Participants

reported moderately high levels of psychological capital and social connectedness, accompanied by relatively high overall life satisfaction. These descriptive trends suggest a psychologically resilient and socially engaged youth sample, providing a stable foundation for predictive modeling.

Table 2

Correlation Matrix of Main Study Variables

Variable	1	2	3	4	5	6
1. Life Satisfaction	1					
2. Psychological Capital	.71**	1				
3. Social Connectedness	.64**	.59**	1			
4. Hope	.62**	.86**	.52**	1		
5. Self-Efficacy	.60**	.88**	.49**	.71**	1	
6. Resilience	.58**	.84**	.46**	.69**	.73**	1

Table 2 indicates strong, statistically significant positive relationships among all principal variables. Life satisfaction demonstrated its strongest associations with psychological capital and its subcomponents, particularly hope and self-

efficacy, followed by social connectedness. These results confirm the theoretical assumption that internal psychological resources and interpersonal integration jointly contribute to subjective well-being among youth.

Table 3

Predictive Model Performance Comparison

Model	R ²	RMSE	MAE
Elastic Net Regression	.58	3.91	3.07
Random Forest Regression	.71	3.12	2.41
Gradient Boosting Machine	.76	2.78	2.19

As shown in Table 3, the Gradient Boosting Machine achieved the highest predictive accuracy, explaining 76% of the variance in youth life satisfaction with the lowest error

indices. This model was therefore selected as the final predictive framework for feature contribution and explainability analysis.

Table 4

Global Feature Contribution to Life Satisfaction (SHAP Values)

Predictor	Mean SHAP Value	Contribution Rank
Hope	0.41	1
Social Connectedness	0.38	2
Self-Efficacy	0.34	3
Optimism	0.29	4
Resilience	0.26	5
Family Income	0.17	6
Parental Education	0.13	7
Gender	0.08	8
Age	0.05	9

Figure 1

SHAP-Based Feature Contribution Visualization for Youth Life Satisfaction Prediction

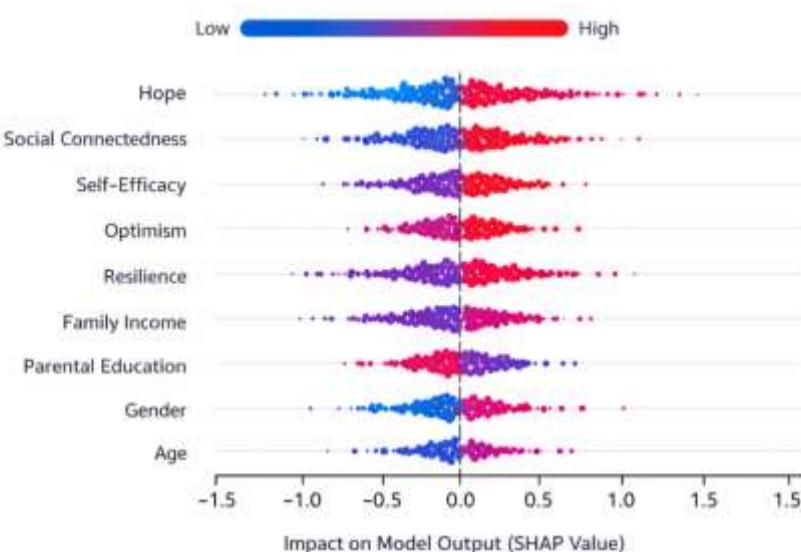


Table 4 presents the global contribution of predictors to life satisfaction based on SHAP explainability analysis. Hope emerged as the strongest contributor, followed closely by social connectedness and self-efficacy.

The figure illustrates both the magnitude and direction of each predictor's contribution across individual predictions. Visual inspection confirms that increases in hope, social connectedness, and self-efficacy consistently elevate predicted life satisfaction, while their absence substantially diminishes it. Interaction patterns further reveal that social connectedness amplifies the positive effects of psychological capital components, underscoring the synergistic nature of personal and social resources in shaping youth well-being.

4. Discussion

The present study applied explainable machine learning to examine the relative contribution of psychological capital and social connectedness to youth life satisfaction. The findings demonstrate that psychological capital and social connectedness jointly explain a substantial proportion of variance in life satisfaction, with the Gradient Boosting Machine accounting for 76% of the outcome variance, underscoring the robustness of the psychosocial determinants under investigation. Feature contribution analysis revealed that hope, social connectedness, and self-efficacy were the most influential predictors of life satisfaction, followed by optimism and resilience, while demographic variables such as age and gender exhibited comparatively weaker predictive value. These results align with contemporary theoretical models of well-being which emphasize the primacy of internal psychological resources and relational integration over static demographic characteristics (Cao et al., 2024; Mehrpour et al., 2024; Shereda et al., 2025).

The dominant role of hope observed in the model corroborates extensive empirical evidence identifying hope as a central motivational and cognitive mechanism underpinning subjective well-being. Hope facilitates goal-directed behavior, future-oriented cognition, and adaptive coping, which are essential for sustaining life satisfaction in youth navigating academic, social, and personal challenges (Shan et al., 2022; Xu et al., 2024). The present findings parallel those reported among university students and young adults, where hope consistently emerges as the strongest psychological capital component associated with life satisfaction and emotional stability (Cao et al., 2024; Huang

et al., 2025). Moreover, network-based research has demonstrated that hope occupies a structurally central position within psychological capital systems, exerting cascading influence on other psychological resources and well-being outcomes (Chen et al., 2025; Fang et al., 2023).

Social connectedness was identified as the second most influential predictor, highlighting the indispensable role of relational belonging in youth life satisfaction. This result is consistent with a wide body of cross-cultural evidence showing that individuals who experience stronger social integration, interpersonal trust, and perceived social support report significantly higher levels of well-being and life satisfaction (Hu et al., 2023; Ke et al., 2023; Lee et al., 2023; Song et al., 2024). The prominence of social connectedness in the current model reinforces theoretical perspectives that conceptualize well-being as fundamentally embedded within social ecosystems, particularly during adolescence and emerging adulthood when peer and community bonds intensify in psychological importance (Choi, 2024; Mehrpour et al., 2024).

Self-efficacy ranked as the third most influential predictor, further supporting the view that beliefs in personal competence and agency are critical determinants of youth life satisfaction. Youth who perceive themselves as capable of managing academic, interpersonal, and life challenges are more likely to experience emotional stability and sustained well-being (Karatepe et al., 2022; Shereda et al., 2025). Self-efficacy also interacts synergistically with social connectedness, as supportive social environments reinforce confidence in personal abilities, thereby amplifying life satisfaction outcomes (Al-Adhami et al., 2022; Chen et al., 2025). The observed interaction patterns in the SHAP analysis visually confirmed this synergy, demonstrating that high social connectedness magnifies the positive influence of psychological capital on predicted life satisfaction.

The substantial contributions of optimism and resilience observed in the model further affirm their central role in psychological adjustment. Optimism fosters positive future expectations and cognitive reappraisal of adversity, while resilience enables recovery from stress and sustained engagement with life goals. These resources collectively form a protective psychological architecture that buffers youth against environmental stressors and promotes durable well-being (Parviniannasab et al., 2022; Preston et al., 2021; Wang et al., 2022; Wang et al., 2023). Longitudinal evidence indicates that resilience and optimism not only predict life satisfaction but also mediate the effects of stress, burnout,

and emotional distress on well-being trajectories (Turliuc & Candel, 2021; Wang et al., 2022).

The relatively weaker influence of demographic variables observed in the present study aligns with contemporary findings suggesting that subjective well-being in youth is far more sensitive to psychosocial processes than to static personal attributes (Li et al., 2024; Mehrpour et al., 2024). This reinforces the argument that effective well-being interventions should prioritize psychological resource development and social relationship enhancement rather than focusing narrowly on demographic risk profiles.

The application of explainable artificial intelligence in this study offers important methodological contributions. Unlike traditional regression models that estimate average effects, the feature contribution framework allowed precise decomposition of individual and global predictors, revealing nonlinear patterns and interaction effects between psychological capital and social connectedness. This analytical transparency strengthens theoretical inference and enhances practical applicability for individualized intervention planning. The use of SHAP-based interpretation provides a replicable blueprint for future psychosocial research seeking to integrate machine learning with psychological theory (Huang et al., 2025; Xu et al., 2024).

From a theoretical standpoint, the findings support integrative models of well-being that conceptualize life satisfaction as an emergent property of dynamic interactions between internal psychological capacities and external social environments. Psychological capital supplies the cognitive and emotional foundation for adaptive functioning, while social connectedness provides the relational scaffolding that sustains motivation, identity, and emotional security (Diržytė & Patapas, 2022; Diržytė et al., 2022; Leonti & Turliuc, 2024). The strong predictive synergy observed between these domains underscores the inadequacy of isolated models that neglect either psychological or social dimensions.

5. Conclusion

The present findings carry significant implications for youth mental health policy and intervention design. Programs aimed at enhancing youth well-being should incorporate integrated strategies that cultivate psychological capital—particularly hope, self-efficacy, optimism, and resilience—while simultaneously strengthening social networks, peer support systems, and community belonging. Such dual-focused interventions are likely to produce

synergistic benefits for life satisfaction and long-term psychological health (Cao et al., 2024; Shereda et al., 2025; Song et al., 2024).

6. Limitations & Suggestions

Despite its strengths, this study has several limitations. The cross-sectional design precludes causal inference regarding the directionality of relationships among psychological capital, social connectedness, and life satisfaction. The reliance on self-report measures introduces potential response biases, including social desirability and common method variance. The sample, although diverse, was drawn from educational settings and may not fully represent out-of-school youth or marginalized populations. Additionally, cultural factors specific to the study context may limit the generalizability of findings to other sociocultural environments.

Future studies should employ longitudinal and experimental designs to clarify causal pathways and developmental trajectories of psychological capital and social connectedness across adolescence and emerging adulthood. Expanding research to include diverse cultural contexts and vulnerable youth populations would enhance the generalizability of findings. Incorporating behavioral, physiological, and ecological data streams alongside self-report measures could further strengthen predictive modeling and provide deeper insight into the biopsychosocial mechanisms of life satisfaction.

Educational institutions, youth organizations, and mental health services should implement integrated well-being programs that simultaneously foster psychological capital and strengthen social connectedness. School curricula can embed resilience training, goal-setting workshops, and self-efficacy enhancement modules, while community initiatives can prioritize peer mentoring, inclusive social activities, and supportive relational environments. Practitioners should leverage explainable AI tools to identify individualized well-being profiles and tailor interventions accordingly, thereby maximizing the effectiveness and sustainability of youth development programs.

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Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

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

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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Authors' Contributions

All authors equally contributed to this article.

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