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Advanced Computational and Biotechnological Approaches to Systemic Family Therapy: Predicting Marital Satisfaction and Emotional Wellbeing in Couples

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Abstract

This quantitative, cross-sectional, case-study–based research addressed the problem that systemic couple distress is often assessed using subjective impressions without an integrated, data-driven model that jointly explains marital satisfaction and emotional wellbeing using measurable systemic interaction processes and biotech-informed regulation indicators. The purpose was to develop and test a predictive framework, grounded in systemic family therapy, that estimates marital satisfaction and emotional wellbeing from modifiable relationship-process variables plus stress-recovery indicators. Using a purposive, case-based sample of 180 couple cases within a bounded context, participants completed Likert 5-point composite measures for Communication Quality (CQ), Conflict Regulation (CR), Emotional Responsiveness (ER), Repair Capacity (RC), Stress Regulation Indicator (SRI), Sleep Quality Indicator (SQI), and outcomes Marital Satisfaction (MS) and Emotional Wellbeing (EWB). The analysis plan applied descriptive statistics, reliability testing, Pearson correlations, and hierarchical multiple regression for MS and EWB, followed by System Dynamics Index profiling (SDI = mean of CQ, CR, ER, RC) and prediction risk-banding. Descriptively, CQ ($M = 3.62$, $SD = 0.71$), ER ($M = 3.69$, $SD = 0.68$), MS ($M = 3.58$, $SD = 0.74$), and EWB ($M = 3.46$, $SD = 0.73$) were moderately high, with strong reliabilities ($a = 0.82–0.90$). Correlations showed robust systemic links to outcomes, especially ER with MS ($r = .64$) and EWB ($r = .57$), and CQ with MS ($r = .61$). In regression, systemic predictors explained substantial variance in MS ($R^2 = .52$), improved to $R^2 = .56$ when biotech indicators were added ($\Delta R^2 = .04$, $p = .012$); ER remained the strongest MS predictor ($\beta = .31$). For EWB, systemic predictors explained $R^2 = .44$, rising to $R^2 = .55$ after adding SRI and SQI ($\Delta R^2 = .11$, $p < .001$), with SRI ($\beta = .27$) and SQI ($\beta = .19$) significant. SDI profiling showed clear gradients: High SDI cases reported higher MS ($M = 4.01$) and EWB ($M = 3.89$) than Low SDI cases (MS $M = 2.97$; EWB $M = 2.91$). Implications indicate that therapy assessment can prioritize responsiveness, repair, and conflict regulation while adding brief stress and sleep screening to better identify wellbeing risk and tailor intervention intensity.

Keywords

Systemic Family Therapy; Marital Satisfaction; Emotional Wellbeing; Emotional Responsiveness; Hierarchical Regression;

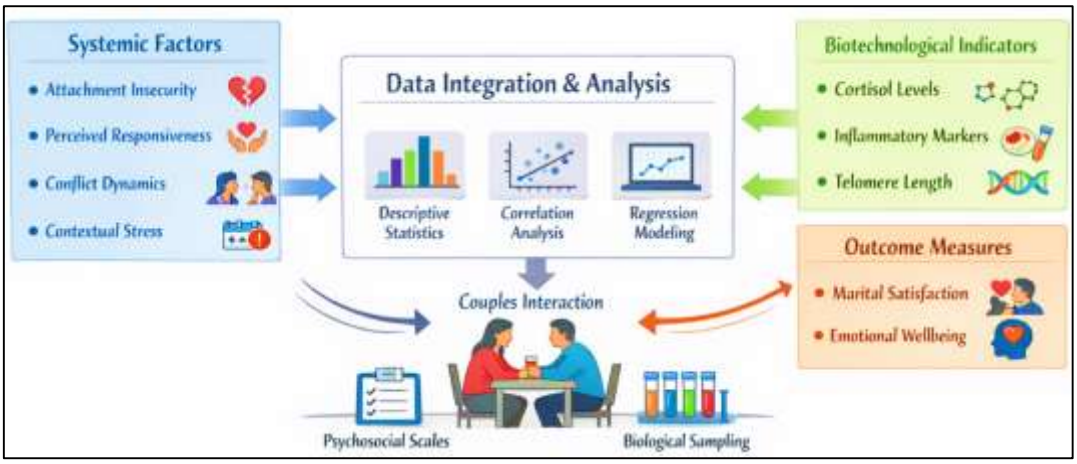
INTRODUCTION

Systemic family therapy is a relational, interaction-focused approach that conceptualizes couple distress as emerging from recursive patterns of communication, emotion regulation, and meaning-making within an interdependent system rather than from isolated individual pathology (Slatcher et al., 2015). In couple and family science, a "system" refers to a set of mutually influencing components whose stability and change are maintained through feedback loops, roles, rules, and shared narratives expressed in daily interaction. Within this tradition, marital satisfaction is commonly defined as an individual's global cognitive–affective evaluation of the marriage or committed partnership, including perceived quality, fulfillment, and stability (Ditzen et al., 2011). Emotional wellbeing is typically defined as a multidimensional construct that includes affect balance, perceived stress, psychological distress symptoms, and subjective vitality. These definitions matter because the measurement of satisfaction and wellbeing has become increasingly linked to biobehavioral markers that reflect how relational contexts are embodied through physiological regulation pathways (Brooks et al., 2011). For example, couple conflict and support can shape hypothalamic–pituitary–adrenal (HPA) axis activity, indexed by cortisol levels and slopes across the day, and these physiological patterns have been connected to health-relevant outcomes in psych neuroendocrinology research (Cabeza de Baca et al., 2017). At the same time, relational security and responsiveness—core systemic and attachment-relevant phenomena—have been examined as predictors of endocrine and immunological processes, illustrating that relationship processes can be operationalized as measurable predictors rather than only clinical impressions (Candel & Turliuc, 2019). "Advanced computational approaches" in this study refer to statistical learning strategies—implemented through descriptive statistics, correlation structures, and regression modeling—that quantify how multilevel relational and biobehavioral indicators jointly predict marital satisfaction and emotional wellbeing in a cross-sectional, case-study–based dataset (Seedall et al., 2018). "Biotechnological approaches" refer to the integration of biological indicators (e.g., cortisol-derived indices or related lab-derived biomarkers) with validated psychosocial scales to model risk and resilience profiles that remain clinically interpretable. Evidence that couple relationships are reliably associated with measurable biological regulation supports the scientific rationale for integrating psychosocial variables with biotech indicators in a unified analytic framework (Selcuk & Ong, 2013).

Marital and couple relationships represent one of the most widely shared social institutions across cultures, and their quality carries population-level implications for mental health, stress physiology, healthcare utilization, and family stability (Coan et al., 2006). Large-scale evidence has shown that social relationship factors are associated with mortality risk at magnitudes comparable to established biomedical risk factors, positioning relationship quality as a global public-health variable rather than a private lifestyle preference (Denton et al., 2012). Within this broader social-relationship literature, romantic partnerships hold special relevance because they are often the most frequent context for daily emotional exchange, conflict negotiation, caregiving, and co-regulation of stress responses (Roddy et al., 2020). Studies have demonstrated that supportive partner behavior and responsiveness can predict healthier diurnal cortisol patterns across long time windows, indicating that relational processes can become biologically patterned over years rather than only minutes. Related work indicates that how individuals perceive their partners' care and validation can moderate associations between received emotional support and survival outcomes, supporting the claim that the subjective experience of the relationship is not merely epiphenomenal; it can condition links between social exposure and downstream outcomes (Shrout et al., 2020). Psych neuroendocrinology research has also connected dyadic stress with dysregulated cortisol slopes during conflict-linked days, showing that partners' stress appraisals can "cross over" and shape the other partner's biological regulation within the same day. Internationally, the burden of depression and stress-related disorders continues to be documented across diverse socioeconomic contexts, and couple functioning is frequently implicated as either a protective context or a stress amplifier (Ditzen et al., 2007). An intervention-relevant pathway is suggested by evidence that couple-based therapeutic work can augment outcomes for psychological distress conditions, including depressive symptoms, when relationship processes are explicitly targeted. Meta-analytic evidence across couple therapy outcomes also indicates that couple interventions produce meaningful improvements in relationship and individual functioning across

designs and timeframes, reinforcing their relevance for broad mental-health systems. In this landscape, a model that predicts marital satisfaction and emotional wellbeing using integrated systemic, computational, and biotechnological indicators addresses a globally meaningful problem: identifying measurable relational–biological signatures linked to wellbeing in couples who present with clinically relevant distress patterns (Slatcher et al., 2010).

Figure 1: Predicting Marital Satisfaction and Emotional Wellbeing in Couples: An Integrated Systemic–Biotechnological–Computational Framework



Systemic couple therapy emphasizes that interaction patterns—pursue/withdraw cycles, escalation sequences, repair attempts, empathy breakdowns, and alliance strength—operate as repeatable behavioral "signatures" that can be measured through structured self-report, observational coding, and derived indices (Troxel et al., 2007). In psychophysiological studies, even brief relational cues can regulate threat and stress responding, illustrating that the relational environment can function as a biologically active context. Neurobiological evidence shows that partner presence and supportive touch can reduce neural threat responding in ways consistent with interpersonal regulation models, thereby providing a mechanistic bridge between systemic constructs and measurable responses (Ditzen et al., 2009). In endocrine studies, marital discussions that involve supportive communication have been linked to changes in stress physiology, including dampened cortisol responses and improved recovery patterns. These findings align with systemic clinical observations that effective couples work often strengthens repair, increases responsiveness, and reduces physiologically activating cycles of conflict (Holt-Lunstad et al., 2010). Research has also documented that couples can exhibit synchrony or interdependence in cortisol patterns, reinforcing the systemic proposition that partners' regulatory systems do not operate independently. Importantly, systemic and attachment-related vulnerabilities can be operationalized with validated measures and then linked to cortisol indices. For instance, adult attachment orientations have been associated with actor and partner cortisol responses during relationship-relevant discussions, indicating that dispositional relational schemas can shape physiological stress dynamics within dyads. Beyond cortisol, biobehavioral research has examined immune-relevant pathways that are sensitive to relational stress. Hostile marital interaction has been associated with biological processes relevant to inflammation and wound healing, highlighting that relational strain can map onto bodily processes in a manner consistent with stress-mediated models (Saxbe & Repetti, 2010). These strands of evidence support a central premise for the present study: systemic relationship variables can be treated as quantifiable predictors in computational models that estimate marital satisfaction and emotional wellbeing, and biotech indicators can strengthen inference by providing convergent evidence that psychological reports align with biological regulation patterns. The approach strengthens construct validity by linking subjective experiences (e.g., perceived support, conflict intensity) to objective or semi-objective markers (e.g., cortisol parameters), which is especially valuable in cross-sectional case-study designs where causal sequencing is not the analytic goal (Kiecolt-Glaser et al., 2005).

Biotechnological measurement in couple research commonly centers on biomarkers that reflect stress regulation, immune activity, and cellular aging processes, with cortisol functioning as a widely used indicator of HPA-axis dynamics. Cortisol is informative because it has both acute reactivity components (responses to stressors) and diurnal rhythm components (awakening levels and slopes), enabling the study of how relationship quality shapes both immediate and daily-life physiological regulation (Kohn et al., 2012). Evidence indicates that supportive partner behavior and relationship contexts can shift cortisol reactivity and recovery, making cortisol-derived indices plausible biotech inputs for models predicting emotional wellbeing and marital satisfaction. Beyond general support, attachment-relevant and intimacy-related processes have been linked to biological outcomes that extend into immune and cellular domains (Robles et al., 2014). Oxytocin-related research has shown that intranasal oxytocin can influence couple communication quality and stress-related endocrine responding during conflict discussions, illustrating that relational processes are biologically modifiable and measurable. Research has also linked adult attachment to skin barrier recovery under laboratory stress, which supports the concept that relationship-relevant psychological orientations can predict physiological recovery processes that are not purely "mental" outcomes (Pietromonaco & Collins, 2017). Extending from stress physiology into cellular aging markers, sexual intimacy within committed partnerships has been associated with telomere length indicators in women, suggesting that relational closeness and stress-buffering contexts may correlate with longer-term biological wear-and-tear markers. Such findings do not convert biology into destiny; rather, they position biotechnological indicators as additional, convergent measurement channels that can corroborate relational risk and resilience profiles (Rathgeber et al., 2018). This matters methodologically because self-report measures of satisfaction and wellbeing can be influenced by mood, impression management, and shared-method variance. When a model combines Likert-scale psychosocial constructs with biotech-derived indices, it can evaluate whether relational distress patterns appear consistently across subjective and biological measures (Robles et al., 2013). Partner responsiveness is illustrative here: it predicts health-relevant endocrine patterns years later, and it also moderates associations between emotional support receipt and mortality outcomes, emphasizing that relational meaning and biological regulation are jointly relevant constructs. By grounding systemic constructs in measurable biobehavioral pathways, the present research title's emphasis on "biotechnological approaches" reflects a measurement philosophy: couples' relational worlds can be examined through multiple data streams that align with systemic theory while remaining compatible with quantitative modeling (Seedall et al., 2018).

Prediction-focused modeling in psychotherapy research does not replace systemic theory; it operationalizes theory into testable relationships among measured constructs. In a quantitative, cross-sectional, case-study–based design, descriptive statistics establish baseline tendencies and dispersion in marital satisfaction, emotional wellbeing, and systemic interaction variables (Coan et al., 2006). Correlation analysis then estimates the association structure across constructs, helping identify clusters of systemic risk (e.g., conflict escalation, low responsiveness) and resilience (e.g., repair, perceived support). Regression modeling advances this by estimating the incremental predictive contribution of each construct while controlling for covariates, which aligns with clinical reasoning that multiple interacting domains contribute to couple outcomes (Ditzen et al., 2007). In the couples literature, long-term outcomes have been linked to perceived partner responsiveness and supportive dynamics in ways that remain detectable across years, supporting the statistical premise that relational variables can predict wellbeing trajectories and stress-related biology (Roddy et al., 2020). Attachment research similarly demonstrates that dispositional relational expectations can predict physiological stress responding in dyadic discussions, supporting the inclusion of attachment-related constructs as predictors in models of emotional wellbeing (Selcuk & Ong, 2013). A meta-analysis of couple therapy outcomes indicates that couple-focused interventions produce improvements across relationship and individual outcomes, underscoring that measurable change in relational processes is clinically meaningful and thus a legitimate prediction target for analytics (Slatcher et al., 2010). Meta-analytic findings specific to established couple therapies—behavioral couples therapy and emotionally focused couples therapy—show measurable post-treatment gains in relationship satisfaction in randomized controlled trial evidence bases, reinforcing that relationship satisfaction is not only measurable but also modifiable. Systemic couple therapy perspectives have additionally emphasized rigorous outcome

measurement and the need to link systemic change processes with measurable indicators of wellbeing and relationship functioning. From a computational standpoint, this study's focus on predicting both marital satisfaction and emotional wellbeing recognizes that couples often present with intertwined relational and individual symptom profiles. Evidence from depressed populations supports this coupling: partner-involved therapeutic approaches have been examined as adjuncts to depression treatment in women, linking relationship interventions with symptom outcomes (Robles et al., 2014). Within this conceptual frame, the present study's computational component is not "technology for its own sake"; it is a structured quantitative translation of systemic assumptions into estimable parameters, enabling transparent hypothesis testing using Likert-scale constructs and biotech indices as predictors that can be interpreted by both researchers and clinicians (Coan et al., 2006).

Couple satisfaction and emotional wellbeing are shaped by a combination of stable predispositions and context-sensitive relationship processes. Attachment orientations represent one widely studied predispositional domain that shapes how partners interpret threat, seek support, and respond to conflict cues. Meta-analytic evidence indicates a reliable negative association between attachment insecurity and relationship satisfaction at both actor and partner levels, supporting attachment-related constructs as core predictors in quantitative models of marital satisfaction (Denton et al., 2012). Attachment-related associations with biological regulation have also been demonstrated in laboratory paradigms that examine cortisol responses during dyadic discussion tasks, reinforcing that attachment processes can be linked to both psychological and physiological indicators (Seedall et al., 2018). Another predictor domain is perceived partner responsiveness, which describes the extent to which individuals feel understood, validated, and cared for by their partners. Responsiveness has demonstrated predictive value for diurnal cortisol profiles over long windows and has been shown to moderate the relationship between emotional support and mortality outcomes, suggesting that relational appraisal processes can meaningfully condition wellbeing-related outcomes. Contextual stressors also shape satisfaction and wellbeing, including developmental transitions that reorganize roles and demands (Shrout et al., 2020). The transition to parenthood has been studied as a period during which marital satisfaction often shifts, and attachment orientations have been shown to condition satisfaction trajectories during this transition, reinforcing that systemic context interacts with relational predispositions. Dyadic stress research further suggests that partners' stress appraisals can influence each other's physiological functioning; partner perceived stress has been associated with cortisol dysregulation in conflict-linked contexts, reflecting systemic "spillover" pathways that are consistent with family-systems propositions (Coan et al., 2006). Sleep and recovery processes also appear in relationship-health models, with sleep research emphasizing psychobiological recovery pathways that intersect with relationship functioning and stress regulation, supporting the broader rationale for including biobehavioral indicators in relational wellbeing models (Ditzen et al., 2007). Taken together, these findings justify a predictor set that is both theoretically grounded and measurable: attachment insecurity, perceived responsiveness, conflict dynamics, contextual stress, and biotech indices derived from stress physiology. Within a cross-sectional case-study dataset, these predictors can be examined using correlations and regression models to test hypotheses about which systemic variables are most strongly associated with marital satisfaction and emotional wellbeing, and whether biotech indicators explain incremental variance over psychosocial predictors alone (Shrout et al., 2020).

A quantitative design that integrates Likert-scale constructs with biotechnological indicators relies on measurement coherence across multiple domains: subjective experience, dyadic process, and physiological regulation. Likert-scale instruments remain central for capturing marital satisfaction and emotional wellbeing because they efficiently operationalize latent constructs that are not directly observable, and they provide standardized metrics suitable for descriptive, correlational, and regression analyses. At the same time, psychophysiological indicators can address common concerns in relationship research regarding common-method bias and shared source variance, particularly in cross-sectional studies where timing is simultaneous (Coan et al., 2006). Evidence demonstrates that relationship interaction quality can modulate endocrine responding during couple discussions, supporting the inclusion of cortisol-linked indicators as measures of relational embodiment (Ditzen et al., 2009). Research on cortisol co-regulation indicates that partners' physiological profiles can covary over time, reinforcing the systemic claim of interdependence and supporting dyadic analytic framing

even when the primary statistical tools include correlations and regressions. Longitudinal work showing that perceived partner responsiveness predicts cortisol profiles years later further supports the predictive relevance of relational constructs for physiological regulation, which can be adapted into cross-sectional prediction models by using validated responsiveness measures as predictors of concurrent wellbeing or biological indices. Studies connecting attachment to both endocrine responses and recovery-related physiological processes add another layer of construct linkage: attachment insecurity can be modeled as a predictor that plausibly associates with both satisfaction outcomes and stress biology (Selcuk & Ong, 2013). Work connecting intimacy-related processes to telomere length further extends the "biotechnological" scope, illustrating that relational closeness has measurable associations with cellular markers that are widely used in stress and aging research (Robles et al., 2014). Couple therapy evidence also provides a pragmatic measurement rationale: interventions show quantifiable changes in relationship satisfaction and associated outcomes across trials and meta-analyses, indicating that satisfaction and wellbeing metrics are sufficiently sensitive to capture clinically meaningful variance (Candel & Turliuc, 2019). Finally, systemic-couple-therapy scholarship emphasizes outcomes and process indicators that map onto interactional patterns, supporting the construction of study-specific systemic indices that can be evaluated using reliability and regression modeling in a case-study–based sample. This measurement logic positions the current study's integrative framework—systemic predictors plus biotech indicators analyzed through computational statistics—as a coherent quantitative approach to examining marital satisfaction and emotional wellbeing within couples (Holt-Lunstad et al., 2010).

This study is designed to examine how systemic interaction processes within couples, together with biotech-informed indicators of stress regulation, can be modelled quantitatively to predict two central outcomes: marital satisfaction and emotional wellbeing. The first objective is to measure and describe the baseline levels, distributions, and variability of marital satisfaction, emotional wellbeing, and key systemic constructs within the selected case-study context, using a structured Likert five-point instrument and standard descriptive statistics to summarize central tendency and dispersion. The second objective is to determine the strength and direction of relationships among the systemic predictors, biotech-informed indicators, and the two outcomes by estimating correlation patterns that reveal how communication quality, conflict resolution effectiveness, emotional responsiveness, and stress-regulation related indicators co-vary in the sample. The third objective is to develop and evaluate regression-based predictive models that quantify the unique and combined contributions of systemic and biotech-informed predictors to marital satisfaction and emotional wellbeing, including the estimation of model fit and the identification of the strongest predictors after accounting for relevant demographic and relationship-related characteristics. The fourth objective is to construct a System Dynamics Index that synthesizes the major systemic constructs into an interpretable interaction signature, enabling the classification of participants into low, moderate, and high systemic functioning groups and the examination of how these groups differ in observed levels of satisfaction and wellbeing. The fifth objective is to test the incremental predictive value of biotech-informed indicators by applying hierarchical regression steps that isolate the variance explained by systemic predictors and then evaluate whether the addition of biotech-informed indicators produces meaningful improvement in explanatory power. The sixth objective is to translate model outputs into therapist-ready interpretation by creating prediction confidence and risk-banding categories that segment participants into low, moderate, and high-risk profiles for reduced satisfaction and diminished emotional wellbeing, and then comparing predictor profiles across bands to clarify which systemic and biobehavioural patterns characterize higher-risk couples. Collectively, these objectives align the study's systemic therapeutic framing with a transparent quantitative modelling approach, ensuring that the resulting analyses remain interpretable at the construct level while also enabling rigorous hypothesis testing through correlation and regression procedures within a cross-sectional, case-based design.

LITERATURE REVIEW

The literature review for this study synthesizes interdisciplinary evidence that links systemic couple processes to marital satisfaction and emotional wellbeing, while also integrating biobehavioral research showing that relationship experiences are reflected in measurable indicators of stress regulation and physiological recovery. Because the study frames couples as interdependent systems, the review begins

from the premise that relational outcomes are shaped by recurring interaction patterns—communication quality, conflict escalation and repair, emotional responsiveness, and perceived support—that operate as organized "system rules" within daily life and therapy contexts. Within the international couple and family scholarship, marital satisfaction has been treated as a key relational outcome with strong associations to stability, mental health, and quality of life, and emotional wellbeing has been examined as a parallel outcome that includes affective balance, perceived stress, and psychological distress symptoms that can be co-regulated within intimate relationships. The review then positions systemic family therapy as both a clinical orientation and a measurement framework, highlighting how systemic concepts are operationalized into measurable constructs suitable for quantitative analysis using Likert-based instruments. In addition, the review incorporates research from psychoneuroendocrinology and health psychology demonstrating that relational stress and support are associated with physiological processes such as cortisol dynamics, sleep-related recovery patterns, and other stress-linked biobehavioral indicators, thereby supporting the inclusion of biotech-informed variables as complementary predictors of wellbeing alongside psychosocial measures. Because the present study is prediction-oriented rather than purely descriptive, the literature review also evaluates prior quantitative models that use correlation and regression-based approaches to estimate the relative contribution of relational processes and biobehavioral factors in explaining variance in satisfaction and wellbeing outcomes. This includes attention to how theory-driven selection of predictors improves interpretability and avoids treating couples as isolated individuals, recognizing that partners influence each other through shared environments, reciprocal emotional exchange, and coordinated coping responses. Finally, the review organizes findings to justify the study's integrated conceptual model, clarifying why an analytic framework that combines systemic interaction measures with biotech-informed indicators can provide a coherent and testable approach for explaining differences in marital satisfaction and emotional wellbeing within a cross-sectional, case-study–based sample.

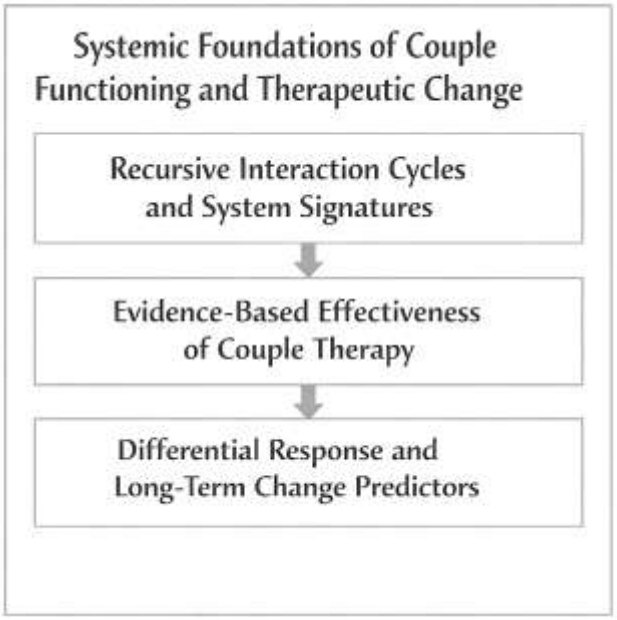
Couple Functioning And Therapeutic Change

Systemic couple and family therapy is grounded in the assumption that relational distress is sustained less by isolated individual deficits and more by recursive interaction cycles that organize partners' emotions, meanings, and behaviors into stable patterns. Within this view, the couple operates as a coordinated unit in which feedback loops (escalation, withdrawal, repair, pursuit–distance) regulate closeness, threat sensitivity, and problem solving, often outside partners' deliberate awareness. A systemic lens therefore treats "marital satisfaction" as an emergent property of repeated micro-interactions—how partners interpret bids for connection, how quickly they shift from threat to safety, and how reliably they return to collaborative meaning-making after rupture. Internationally, systemic approaches have remained central because they fit diverse cultural contexts where family roles, interdependence, and relational obligations influence what couples consider supportive behavior, fair conflict, and emotional care. The practical strength of systemic thinking is that it offers clinicians and researchers a coherent way to operationalize complex relational processes: rather than measuring only "how happy" individuals feel, systemic assessment can quantify observable patterns such as mutual responsiveness, negative reciprocity, alliance balance, and repair capacity. This conceptual clarity has also influenced how couple and family psychologists translate theory into measurable constructs that can be modeled statistically, including in cross-sectional designs where the goal is prediction rather than causal sequencing. The field's contemporary articulation of systemic thinking emphasizes pragmatic operationalization—identifying collective variables, characterizing attractor-like patterns, and treating change as shifts in system organization rather than simple symptom reduction (Stanton & Welsh, 2012). For the current study, this foundation supports the decision to treat systemic interaction constructs as primary predictors of both marital satisfaction and emotional wellbeing, and to interpret findings in terms of "system signatures" that capture how couples regulate closeness, conflict, and affect in everyday life.

A second pillar of the systemic literature is the evidence base demonstrating that couple therapy works and that its benefits are not limited to one narrowly defined model. Outcome research has repeatedly shown meaningful improvements in relationship functioning for distressed couples, with meta-analytic work indicating that structured behavioral and systemic-informed interventions outperform

no-treatment controls in clinically relevant ways. This broad efficacy record is important for a prediction-focused thesis because it implies that measurable relational processes (communication patterns, emotional acceptance, collaborative problem solving) are not merely correlates of satisfaction but plausible active ingredients linked to change across approaches. In other words, systemic research has increasingly moved from the question of whether couple therapy works to the question of what mechanisms account for improvement and for sustained gains. The "common factors" perspective complements systemic theory by arguing that a limited set of cross-model processes—such as alliance quality, therapist balance, shared goals, and structured emotional engagement—may explain why different therapies often yield comparable outcomes. Empirical reviews have summarized this logic and proposed a moderate position that values model structure while acknowledging that shared change processes likely account for substantial variance in outcomes (Davis et al., 2011). For this thesis, that position strengthens construct selection: measures can be chosen to represent systemic mechanisms (e.g., repair, responsiveness, escalation control) while remaining interpretable across diverse therapeutic traditions. It also justifies analytic choices that test combined and incremental contributions of predictors, because systemic constructs may overlap in function (co-regulation, meaning-making) even when measured as distinct survey dimensions. Finally, the established efficacy base provides an empirical rationale for translating statistical outputs into "therapy-ready" interpretation bands, since predictive models are most useful when they map onto processes clinicians can target.

Figure 2: Core Systemic Mechanisms Underlying Couple Functioning and Therapeutic Change



Beyond demonstrating efficacy, systemic and behavioral couple-therapy research has produced rigorous evidence on differential response and the stability of change—two issues that directly motivate predictive modeling of marital satisfaction and emotional wellbeing. Long-term follow-up studies have shown that many couples maintain gains years after therapy, but also that a meaningful subset relapse or dissolve, implying heterogeneity in trajectories that can be partially anticipated from pretreatment characteristics and interaction styles. Large randomized trials comparing traditional and integrative behavioral approaches have documented durable improvements and provided benchmarks for clinically significant change, demonstrating that satisfaction outcomes can be tracked longitudinally and that post-therapy trajectories are not uniform (Christensen et al., 2010). Complementing this, work on prediction has identified pretreatment predictors and moderators linked to who improves and who sustains change, highlighting the value of modeling relational "risk signals" rather than relying only on average effects. For example, research examining long-term response has shown that variables reflecting power processes, emotional arousal, and interpersonal dynamics can predict clinically

significant outcomes years after treatment ends, reinforcing the idea that system-level interaction features matter for durable wellbeing (Baucom et al., 2009). For the present study, these findings support a results structure that goes beyond basic correlations and regressions by adding systemic "signature" outputs and confidence/risk banding. If systemic predictors can help differentiate stable versus fragile functioning in prior trials, then constructing a Systemic Interaction Signature Map and prediction confidence bands becomes a methodologically defensible way to increase trustworthiness: it translates statistical prediction into clinically interpretable profiles while remaining anchored in validated systemic principles and outcome research.

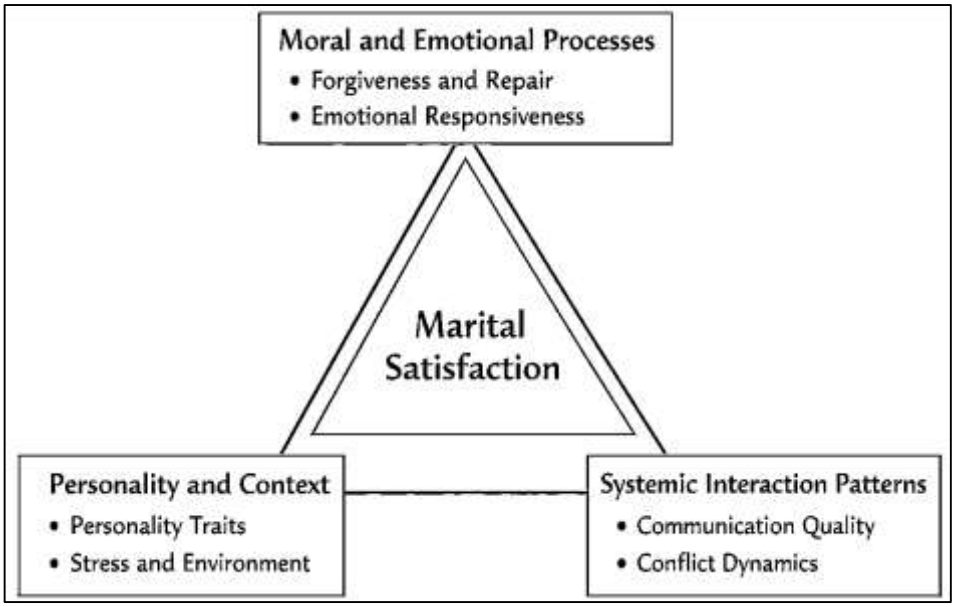
Key Determinants and Measurement of Marital Satisfaction

Marital satisfaction is commonly defined as an individual's overall evaluation of the marriage or committed partnership, combining cognitive judgments (e.g., fairness, benefit–cost balance, and shared goals), affective tone (e.g., warmth, closeness, frustration), and expectations about stability and continued investment. In systemic terms, satisfaction is not only a private feeling but also a summary marker of how effectively a couple's recurring interaction patterns convert daily demands into coordinated coping, emotional security, and mutual regard. This is why marital satisfaction is frequently treated as a primary dependent variable in quantitative couple research: it is sensitive to changes in communication quality, conflict repair, support, intimacy, and shared meaning, while also reflecting the cumulative impact of stressors and unresolved injuries. Measuring satisfaction with adequate precision is therefore essential for trustworthy modeling, especially when the study aims to predict outcomes rather than merely describe them. Contemporary measurement work emphasizes that instruments must capture a broad range of satisfaction levels without ceiling effects, and must produce reliable scores across diverse samples so that regression estimates remain interpretable and stable. One influential approach improved precision by applying modern psychometric methods to relationship satisfaction measurement, producing the Couples Satisfaction Index and demonstrating stronger measurement sensitivity than several legacy tools (Funk & Rogge, 2007). Alongside global satisfaction, research also highlights closely related relational qualities that function as determinants and correlates, such as respect, which can stabilize the couple's emotional climate and constrain contempt or devaluation during conflict. A brief respect measure has shown strong links to relationship satisfaction and commitment, supporting the idea that satisfaction models become more explanatory when they incorporate relational dignity and valuing as measurable constructs (Hendrick & Hendrick, 2006). For this thesis, these measurement insights justify using well-validated Likert-scaled constructs for satisfaction and system functioning, because predictive accuracy depends on dependable construct definition as much as on the statistical method itself.

Determinants of marital satisfaction extend into moral and emotional processes that regulate rupture and repair, particularly in long-term relationships where disappointments, betrayals of expectation, and chronic irritations accumulate. From a systemic viewpoint, partners continuously interpret each other's behavior, assign intent, and update expectations about safety and care; these appraisals then shape whether disagreements escalate, deactivate, or shift into repair. Forgiveness is central in this cycle because it can reduce avoidance and retaliation, restore cooperation, and reopen pathways for empathy and problem solving after a relational injury. Importantly, forgiveness operates at more than one level: it includes intrapersonal changes (reduced anger, reduced rumination) and interpersonal re-engagement (benevolent motivation toward the partner), and these shifts alter the couple's interaction pattern in ways that can support satisfaction. Evidence from well-established marriages suggests that forgiveness and marital quality show bidirectional links, indicating that forgiveness can be both a contributor to marital satisfaction and a response enabled by higher satisfaction (Fincham & Beach, 2007). For prediction-focused quantitative work, this matters because models that ignore repair-related constructs risk misattributing variance to general "communication" while missing the deeper processes that explain why some couples recover quickly and others remain stuck in threat-based cycles. Forgiveness also aligns with emotional wellbeing outcomes, since unresolved injuries can maintain stress activation and depressive affect, whereas repair-oriented processes can reduce emotional load and increase perceived security. In the context of this thesis, forgiveness-related dynamics can be represented through measurable indicators such as repair capacity, emotional responsiveness after conflict, perceived partner goodwill, and willingness to re-engage constructively. These constructs

become especially relevant when building system-signature outputs, because high satisfaction often co-occurs with identifiable patterns of rapid de-escalation and restoration of respect, while lower satisfaction may be characterized by rigid negative reciprocity and slow recovery.

Figure 3: Core Predictors of Marital Satisfaction in Systemic Couple Research



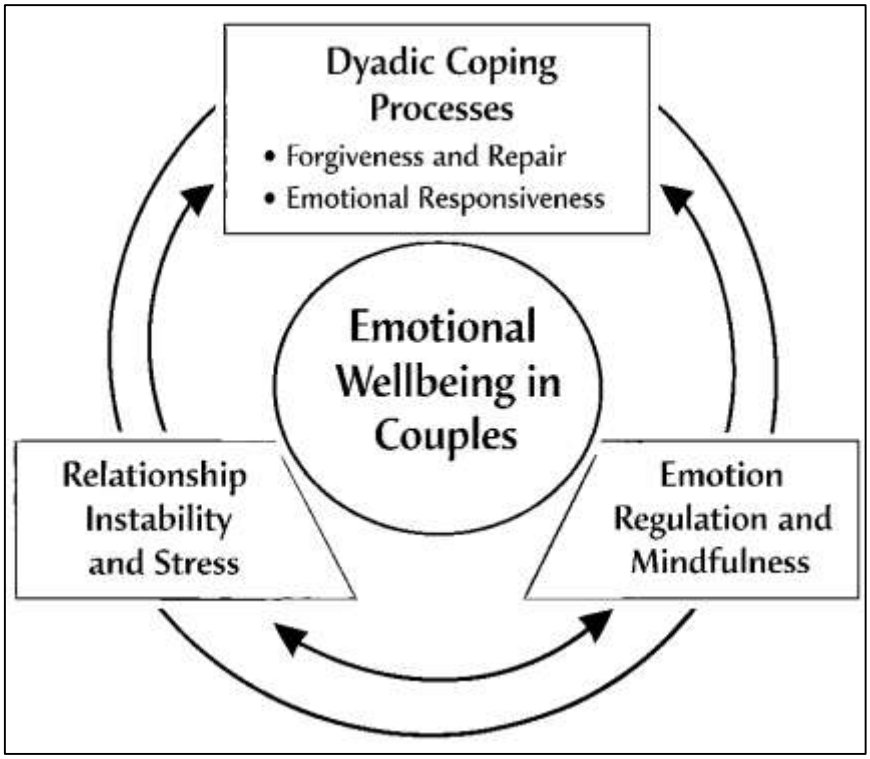
A third determinant domain concerns personality and context, focusing on the conditions under which classic relationship processes translate into marital satisfaction. Personality traits and self-evaluations can affect satisfaction through actor effects (how a person's characteristics shape their own satisfaction) and partner effects (how one person's characteristics influence the partner's satisfaction), which makes marital satisfaction inherently dyadic even when measured with individual reports. Large, nationally representative evidence across multiple countries indicates that both actor and partner personality effects contribute to relationship satisfaction and that similarity effects are typically smaller than the independent contributions partners bring into the relationship (Dyrenforth et al., 2010). This supports a modeling strategy that includes individual-level predictors while interpreting them as system inputs that influence the interaction pattern. Contextual stress further shapes how predictors operate: stress can constrain the couple's capacity to use skills consistently, amplify the impact of negative behaviors, and reduce the payoff of otherwise constructive communication. Evidence suggests that communication does not predict satisfaction uniformly across circumstances; rather, stress can moderate when and how communication behaviors matter for satisfaction changes and levels, implying that prediction improves when models include stress-sensitive interpretations of relational behavior (Nguyen et al., 2020). For the present study, this literature supports combining systemic interaction measures with biotech-informed indicators of stress regulation, because both sets of variables can capture complementary pathways to satisfaction: the relational pathway (how partners respond to each other) and the regulation pathway (how the couple manages threat and recovery). Together, these determinants justify regression models that examine both main effects and incremental contributions, and they also justify presenting results in clinically interpretable risk bands that reflect the joint influence of stable personal resources and situational load on marital satisfaction.

Emotional Wellbeing in Couples Within a Systemic Perspective

Emotional wellbeing in couple and family research is typically defined as a multidimensional condition that includes low psychological distress (e.g., fewer depressive symptoms), stable positive affect, perceived life satisfaction, and the ability to regulate emotions under daily stressors in ways that preserve functioning. In systemic family therapy, emotional wellbeing is not treated as an isolated individual trait; it is viewed as an emergent property of relational patterns that repeatedly organize how partners interpret events, communicate needs, and repair emotional ruptures. This systemic view

is especially important for quantitative couple studies because it justifies measuring wellbeing as both an outcome and a relationally shaped process. Meta-analytic evidence has long supported that the quality of intimate relationships relates strongly to individual wellbeing outcomes, indicating that relationship functioning can be a reliable predictor of personal mental states, not only a co-occurring feature. In a comprehensive synthesis of studies, marital quality showed consistent associations with indicators of personal wellbeing, supporting the idea that relationship experiences are meaningfully tied to emotional health across diverse samples and measurement approaches (Mahfuj Ahmed & Md. Hasan Or, 2021; Md & Md. Mehedi, 2021; Proulx et al., 2007). For a case-study–based thesis on systemic therapy, this literature positions emotional wellbeing as a credible dependent construct that can be modeled quantitatively (e.g., through Likert-based constructs and regression) while still respecting systemic assumptions about interdependence. It also provides a defensible rationale for combining relational predictors (communication patterns, dyadic coping, perceived support) with computational predictors (risk scoring, predictive modeling) to explain variance in wellbeing in a way that is consistent with systemic clinical logic.

Figure 4: Circular Framework of Dyadic Pathways to Emotional Wellbeing



A second line of evidence strengthens the clinical relevance of emotional wellbeing by showing that relationship distress aligns with diagnosable mental-health outcomes rather than only subjective unhappiness. In large-scale population research, marital distress has been linked with DSM-relevant psychiatric disorders, suggesting that couple functioning and emotional wellbeing are intertwined at levels that matter for assessment, treatment planning, and risk stratification in therapy contexts. Whisman (2007) demonstrated that marital distress was associated with elevated likelihood of psychiatric disorders in a population-based national survey, reinforcing that distressed relational environments can coincide with clinically significant symptom profiles and not merely transient mood states. For the present study, this body of work supports treating emotional wellbeing as a primary outcome that can be predicted using systemic relational variables (e.g., perceived partner responsiveness, conflict escalation, emotional support, and dyadic coping) and tested through correlation and regression. It also offers justification for including "therapy-readiness" or "risk banding" logic later in the thesis results, because psychiatric-linked distress patterns imply meaningful thresholds rather than only linear variation. In other words, if couple distress aligns with disorder-level

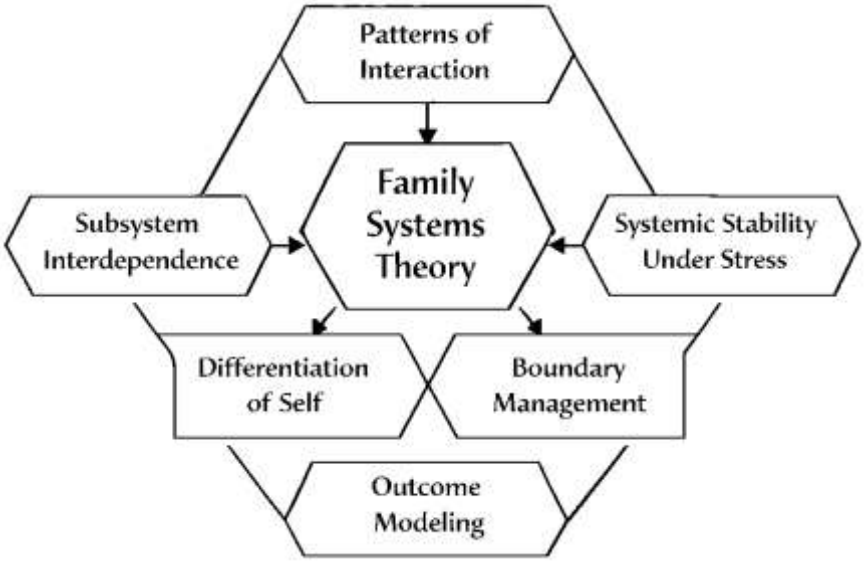
outcomes, it becomes methodologically reasonable to explore whether predictive models can identify subgroup profiles of heightened vulnerability or confidence bands for intervention prioritization—while still staying inside a cross-sectional design (Aditya & Palash Chandra, 2022; Anick & Tasnim, 2022; Whisman, 2007).

A third strand of scholarship explains how emotional wellbeing can shift across the relationship life course, highlighting both destabilizing transitions and stabilizing regulatory resources that couples can develop. Research on dyadic coping provides an especially systemic pathway: stress is conceptualized as a shared load that partners manage through coordinated responses, and these coping exchanges can shape both relationship quality and individual psychological wellbeing. Empirical comparisons of dyadic coping conceptualizations show that coping is not merely supportive behavior but a structured, measurable couple process that links to wellbeing indicators, making it well suited for predictive modeling in couple case studies (Bodenmann et al., 2010; Hisham & Mohammad Robel, 2022; Md Abubakar Siddique & Md. Al Amin, 2022). At the same time, major transitions such as separation and divorce have been synthesized as high-impact stressors that can elevate distress through resource disruption, altered routines, and sustained psychological strain, with meta-analytic work connecting divorce-related pathways to long-term risk processes (Sbarra et al., 2011). Complementing these risk-focused perspectives, evidence on mindfulness within long-term marriages suggests that emotion-regulation skills can operate intrapersonally and cross-partner, meaning one partner's regulatory stance may be associated with the other partner's relationship experience and affective climate (Lenger et al., 2017). Taken together, these studies motivate an integrated 2.3 subsection argument for your thesis: emotional wellbeing is systematically embedded in dyadic regulation (coping and mindfulness processes) and is sensitive to relationship instability (including dissolution-related stress), which makes it appropriate to model as an outcome predicted by relational patterns and "advanced computational" predictors designed to quantify confidence, risk, and individualized therapy-relevant profiles.

Family Systems Theory as Model of Couple Functioning

Family Systems Theory (FST) conceptualizes the couple not as two independent psychological units but as a single emotional system in which patterns of closeness, distancing, escalation, and repair become stable "rules" that organize daily life. In this framework, marital satisfaction and emotional wellbeing are treated as system-level outcomes that emerge from repeated interaction sequences rather than isolated traits. A key implication is that what looks like an individual symptom (low mood, irritability, withdrawal) can be understood as a functional position in a relational pattern that maintains homeostasis, such as dampening conflict by disengaging or amplifying protest to restore contact. This stance fits a quantitative, cross-sectional, case-study design because FST can be operationalized into measurable constructs that represent system properties: emotional reactivity, fusion-with-others, emotional cutoff, and a clear "I-position" (self-definition under relational pressure). Evidence supporting this operationalization is provided by psychometric validation work showing that differentiation-of-self is reliably measurable and meaningfully linked to functioning, enabling researchers to translate systemic language into Likert-scale indicators without losing theoretical coherence (Jankowski & Hooper, 2012). For the current study, differentiation functions as a central theoretical bridge between "systemic therapy logic" and "predictive modeling logic": higher differentiation suggests that partners can remain emotionally connected while maintaining self-regulation and perspective-taking, which should correspond to higher marital satisfaction and stronger emotional wellbeing. In the same theoretical spirit, FST expects that relational change is reflected in pattern shifts (e.g., faster recovery after rupture, lower negative reciprocity, more balanced influence), so a results section that includes a Systemic Interaction Signature Map can be framed as a systems-consistent way to represent pattern-level profiles rather than only reporting mean scores. This makes FST not only a clinical lens but also a measurement-and-modeling architecture for predicting outcomes from systemic constructs.

Figure 5: Family Systems Theory Constructs as Predictors of Marital Satisfaction and Emotional Wellbeing



A second FST principle relevant to this thesis is subsystem interdependence, which argues that processes in one relational subsystem can transmit affect and behavior into other subsystems, increasing or decreasing strain on the couple system. Even in couples-focused research, this principle matters because it clarifies why third-party dynamics (e.g., alliances, coalitions, or triangulation) can distort partner-to-partner regulation and therefore alter marital satisfaction and emotional wellbeing. Empirical family-systems research has demonstrated such crossover mechanisms by showing that marital satisfaction can be linked to parenting practices through coparenting behavior, consistent with the idea that subsystem functioning mediates how relational stress is carried across domains (Md & Islam, 2022; Md. Mainuddin & Palash Chandra, 2022; Pedro et al., 2012). For a couples-only case study, the same logic generalizes: "third elements" need not be children; they can be extended family, work stressors, digital surveillance patterns, or health concerns that become recruited into the couple's interaction cycle. When these elements are repeatedly pulled into conflict or reassurance-seeking, they can operate as stabilizers of dysfunctional equilibrium, maintaining distance or escalating threat (Md. Shahinur & Md. Sultan, 2022; Mostafa & Md Tohidul, 2022). This provides a theoretical justification for integrating "advanced computational" indicators into a systemic study: computational features (risk scoring, confidence bands, profile clustering) can serve as structured representations of how multiple inputs co-occur to stabilize a pattern. Bowen-informed research further supports the importance of differentiation and partner similarity in differentiation levels for couple adjustment, reinforcing the systemic idea that dyadic stability depends on both partners' regulation capacities and their fit as a coordinated unit (Rodríguez-González et al., 2015; Rukaiya Khatun & Md. Morshedul, 2022; Zakia & Khairum Nahar, 2022). In practical terms, FST guides variable selection toward constructs that represent (a) regulation capacity, (b) boundary management and autonomy–connection balance, and (c) pattern stability under stress, allowing the thesis to remain theoretically consistent while still executing correlation and regression analyses.

Because this study is predictive and quantitative, the theoretical framework must connect directly to the statistical form used to test hypotheses. FST provides that connection by treating marital satisfaction and emotional wellbeing as outcomes of organized system variables, which can be modeled through multiple regression as an explicit mapping from system indicators to predicted levels of each outcome. The core model used across hypotheses can be expressed as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + \varepsilon$$

where Yrepresents either marital satisfaction or emotional wellbeing, $X_1 \ldots X_k$represent systemic predictors (e.g., differentiation subscales, systemic interaction scores, biotech-informed regulation

indicators), βcoefficients represent predictive weights, and $\varepsilon$is residual variance. To align with your "incremental predictive value" results section, the study can apply hierarchical (blockwise) regression, where systemic-therapy constructs are entered in Block 1 and biotech/computational indicators are entered in Block 2. The key test becomes the incremental variance explained:

$$\Delta R^2 = R^2_{\text{Block 2}} - R^2_{\text{Block 1}}$$

This is the most defensible formula to use throughout the thesis because it matches your design goal of showing that biotech/computational inputs add trustworthy predictive value beyond classic systemic measures (Butler, 2011). Measurement precision is also central to this framework: if differentiation is a core systemic variable, then reliable short instruments can reduce respondent fatigue while retaining construct coverage, supporting stronger model stability in field settings (Sloan & van Dierendonck, 2016). Finally, FST's emphasis on patterned functioning supports reporting prediction confidence in clinically interpretable ways: confidence bands and risk stratification are not treated as labels, but as system-informed probability statements grounded in the regression model's uncertainty.

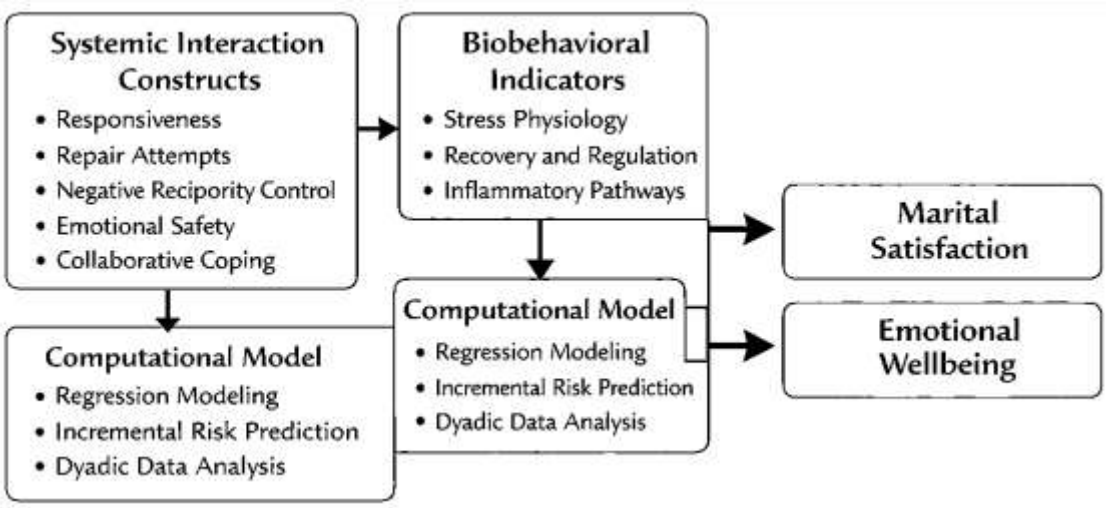
Constructs with Biobehavioral Indicators for Prediction

The conceptual framework of this study positions marital satisfaction and emotional wellbeing as two dependent outcomes that arise from a couple's recurring interaction structure and its stress-regulation load. At the relational level, the model treats systemic functioning as a bundle of measurable processes (e.g., responsiveness, repair, negative reciprocity control, emotional safety, and collaborative coping) that shape how partners experience the relationship on a daily basis. At the measurement level, the framework assumes that couple outcomes are not simply "high vs. low" along a smooth continuum; rather, couples can cluster into qualitatively different states (e.g., resilient vs. discordant) that meaningfully differ in interaction dynamics and risk for impaired wellbeing. This assumption is supported by taxometric evidence suggesting that marital discord may show categorical properties in community samples, strengthening the logic of later risk-banding outputs in the Results chapter (Beach et al., 2005; Islam & Aditya, 2023; Md Khaled & Md. Mosheur, 2023). At the stress-regulation level, the framework incorporates biotechnological indicators (e.g., stress physiology, recovery proxies, or other measurable biobehavioral markers available in the case context) as complementary predictors that capture the embodied side of relational strain. Finally, at the computational level, the model is explicitly prediction-oriented: systemic variables provide interpretable therapeutic targets, while biobehavioral indicators are expected to improve predictive accuracy and confidence when added to the same equation. The framework therefore links theory to practice by ensuring that every construct included in the instrument maps to a clinically meaningful systemic process, while also allowing the study to quantify added value from biotech-informed indicators through incremental variance explained. In this way, the conceptual model is not a list of variables; it is a structured pathway from system regulation → embodied stress load → predicted satisfaction and wellbeing, presented in a form that can be tested rigorously with correlation and regression while remaining coherent with systemic family therapy logic.

Because the unit of interest is the couple system, the framework also recognizes interdependence, meaning one partner's predictors and experiences can influence the other partner's outcomes. Empirical couple research repeatedly shows that dyadic processes such as coping and support operate as shared transactions rather than independent behaviors, making dyadic modeling essential for trustworthy interpretation. A major meta-analytic synthesis demonstrates that dyadic coping shows robust associations with relationship satisfaction across diverse samples, implying that shared coping responses represent a core systemic pathway suitable for inclusion as a central predictor block (Falconier et al., 2015). In addition, dyadic interaction during conflict can alter emotional and behavioral defenses in ways that are inherently partner-dependent, indicating that "systemic predictors" often reflect both actor and partner contributions (Overall et al., 2013). For this thesis, those findings justify conceptualizing systemic interaction measures as couple-level signatures that can be summarized into study-specific outputs (e.g., your Systemic Interaction Signature Map and SDI groupings) while still being analyzed using standard quantitative methods. The framework further extends interdependence into the biobehavioral domain: biological pathways tied to wellbeing can also be embedded in dyadic contexts, meaning the biology–wellbeing link can be understood as relationally situated rather than

purely individual. Actor–partner work connecting psychological wellbeing to inflammatory markers supports this logic by showing that wellbeing-related appraisals can relate to physiology within couples, strengthening the rationale for adding biotech indicators to a systemic predictive model (Uchino et al., 2018). Overall, the conceptual framework expects that systemic functioning and biobehavioral regulation will show correlated structure, that each will account for unique variance in outcomes, and that their combination will produce a more trustworthy predictive profile than either domain alone.

Figure 6: Predictive Framework Combining Systemic and Biobehavioral Indicators in Couples



To operationalize this framework statistically, the study can use two complementary model forms that align with the thesis design. First, the primary predictive equation for each outcome follows multiple regression:

$$Y = \beta_0 + \beta_1 X_{\text{Systemic}} + \beta_2 X_{\text{Bio}} + \beta_3 X_{\text{Controls}} + \varepsilon$$

where $Y$is marital satisfaction (Model A) or emotional wellbeing (Model B), $X_{\text{Systemic}}$is the block of systemic interaction constructs, $X_{\text{Bio}}$is the block of biotech-informed indicators, and X_{Controls}represents demographics or relationship-context covariates. The study's "incremental predictive value" claim is best tested through hierarchical regression using the core formula:

$$\Delta R^2 = R^2_{\text{Block 2}} - R^2_{\text{Block 1}}$$

in which Block 1 includes systemic predictors and Block 2 adds biobehavioral indicators. Second, to reflect dyadic interdependence when needed, the Actor–Partner Interdependence Model (APIM) can be used conceptually (and analytically if partner data are available) to represent partner-linked prediction:

$$Y_i = b_0 + b_A X_i + b_P X_j + e_i, Y_j = b_0 + b_A X_j + b_P X_i + e_j$$

This dyadic form aligns with developmental–contextual perspectives that treat coping and adjustment as joint processes rather than isolated acts (Berg & Upchurch, 2007). Together, these formulas provide a coherent "best-fit" quantitative engine for the entire thesis: they preserve systemic interpretability, enable hypothesis testing via regression weights and ΔR^2, and support the later translation of model outputs into SDI group profiles and prediction-confidence risk bands.

Approaches for Predicting Marital Satisfaction and Emotional Wellbeing

Contemporary systemic family therapy research increasingly treats couple functioning as a measurable, data-rich system in which interaction patterns, subjective appraisals, and contextual stressors can be modeled to explain variability in marital satisfaction and emotional wellbeing. In this direction, advanced computational approaches provide a disciplined way to translate complex dyadic information into predictive features, while still keeping the unit of analysis anchored in the couple as

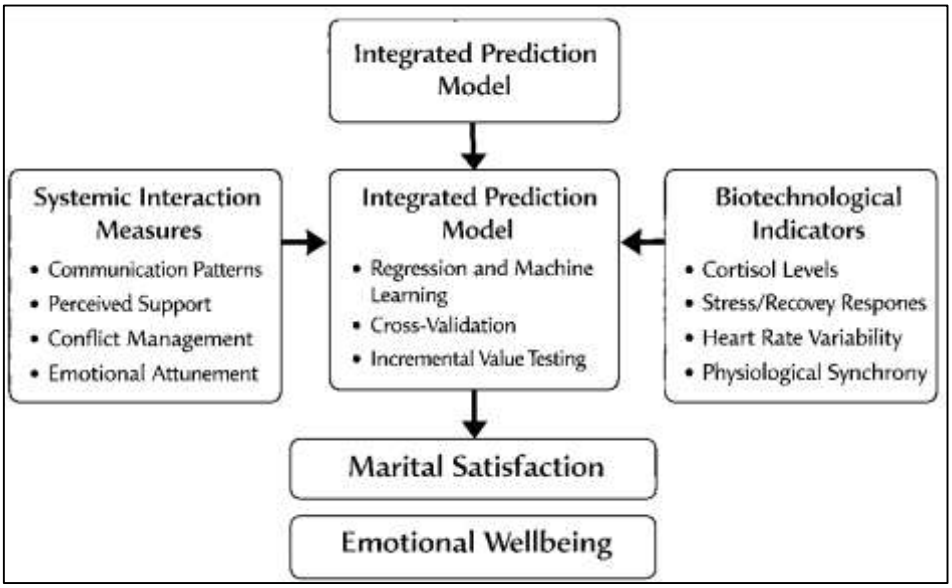
an interdependent system rather than two isolated individuals. A key contribution of computational modeling is its ability to evaluate nonlinearities, conditional effects, and multivariate prediction under realistic measurement constraints, supporting model comparison between parsimonious linear regression and more flexible algorithms. Evidence from the broader mental-health prediction literature indicates that machine-learning models can generate clinically meaningful prognostic accuracy when models are carefully specified, validated, and interpreted alongside traditional statistical approaches, rather than replacing them (Lee et al., 2018; Md Shahab & Aditya, 2023; Md. Hasan Or et al., 2023). For the present study, this computational logic is directly relevant because systemic theory anticipates interaction effects (e.g., communication style × stress reactivity) and cross-partner dependencies (e.g., partner influence), which are often invisible in purely variable-centered descriptions. Computationally, the thesis can operationalize systemic constructs through structured dyadic predictors (actor–partner terms, difference scores, and interaction products), then evaluate their incremental contribution to explaining satisfaction and wellbeing. This approach strengthens trustworthiness because it makes explicit which components of the "system" predict outcomes, how much variance is explained, and how stable estimates remain under robustness checks.

Biotechnological indicators add another layer of precision by indexing stress-regulation processes that couples may not fully report, particularly during conflict, emotional withdrawal, or chronic strain. Studies of endocrine linkage show that partners' physiological rhythms can covary across the day, suggesting that relationship strain and shared context can be expressed biologically as synchrony in stress hormones rather than only as self-reported distress (Liu et al., 2013; Md. Mehedi & Khairum Nahar, 2023; Md. Sultan & Anick, 2023). Beyond general synchrony, laboratory paradigms demonstrate that "stress resonance"—the degree to which one partner's cortisol response aligns with the other's stress response—can predict stronger real-life diurnal cortisol covariation, implying a measurable pathway through which empathic attunement or emotional contagion becomes biologically embedded (Engert et al., 2018; Mostafa, 2023; Ratul & Aditya, 2023). Similarly, research on conflict interactions indicates that moment-to-moment coupling in heart rate variability during marital disagreement can predict higher inflammatory activity across the day, positioning physiological synchrony as a social–biological mechanism that links relationship processes to wellbeing-relevant biomarkers (Tasnim & Zaheda, 2023; Wilson et al., 2018; Zaheda & Md. Tahmid Farabe, 2023). Importantly, biomarkers are not treated here as deterministic "truth," but as complementary indicators that may help distinguish superficially similar couples (e.g., both reporting moderate satisfaction) who nonetheless differ in physiological regulation profiles. In a systemic framework, such indicators can be conceptualized as measurable outputs of the couple's co-regulation processes, how effectively the dyad returns to baseline after relational stress—providing a biologically grounded lens on emotional wellbeing.

Integrating computational and biotechnological approaches into systemic family therapy research enables a rigorous, multi-source prediction architecture aligned with the thesis goals. In practical terms, the study can combine Likert-scale measures (communication patterns, emotional attunement, perceived support, conflict management) with biotechnology-derived features (e.g., cortisol change indices, synchrony metrics, HRV coupling indicators) to estimate models predicting marital satisfaction and emotional wellbeing, then formally test whether biomarkers add incremental explanatory power beyond psychosocial predictors. Evidence that mindfulness during romantic conflict can moderate cortisol recovery underscores why this integration matters: regulation is not only a trait-like characteristic but also a state-like process shaped by interaction dynamics, meaning that physiological trajectories can reflect the quality of systemic processes occurring "in the moment" (Laurent et al., 2016). Methodologically, the thesis can preserve interpretability by positioning regression as the primary inferential engine (aligned with hypotheses testing), while using computational modeling practices, cross-validation, sensitivity checks, and feature-block comparisons—to demonstrate robustness and reduce the likelihood that findings reflect sampling noise. Conceptually, this synthesis also supports the thesis's unique results sections (e.g., systemic interaction signature mapping and prediction confidence banding) because physiological linkage and stress reactivity can be translated into clinically meaningful risk bands that are interpretable for therapy planning, while still being empirically grounded. Overall, advanced computation provides the structure for reliable prediction, and biotechnology provides objective, mechanism-adjacent signals of co-regulation, together strengthening

the credibility of systemic explanations for marital satisfaction and emotional wellbeing.

Figure 7: Predictive Modeling Architecture Using Systemic and Biobehavioral Indicators



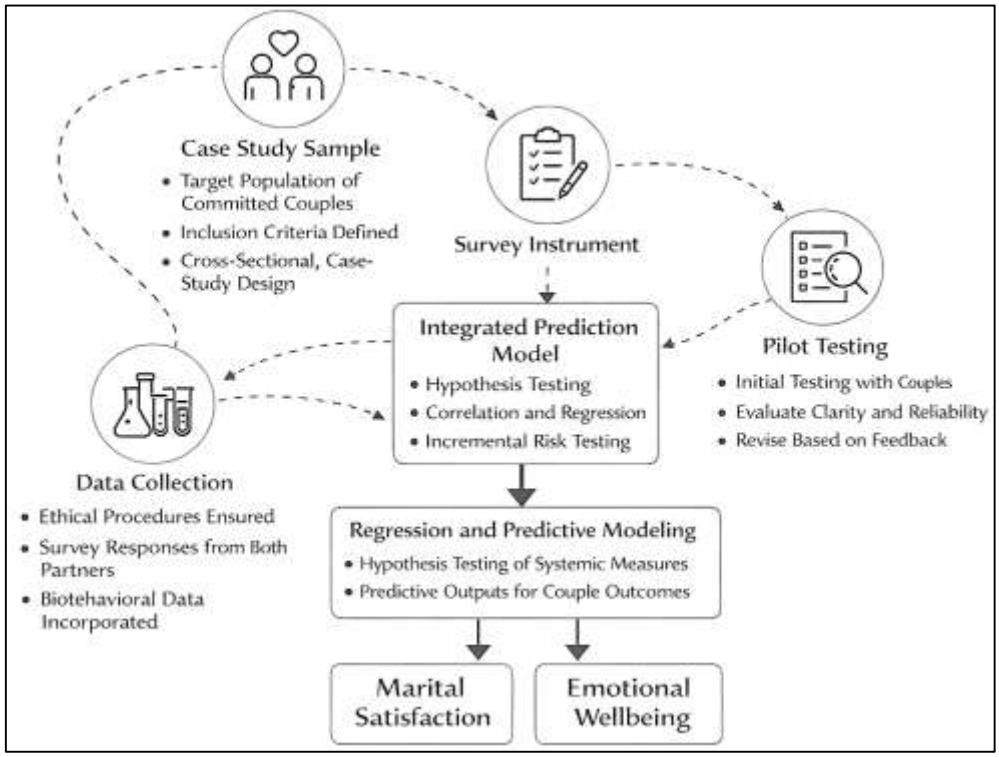
METHOD

The methodology for this study has been designed to test a predictive, systems-oriented model of marital satisfaction and emotional wellbeing in couples within a quantitative, cross-sectional, case-study–based framework. The study has adopted a structured survey approach to operationalize systemic family therapy constructs as measurable variables, and it has aligned the measurement strategy with the analytic requirements of descriptive statistics, correlation analysis, and regression modeling. The case-study context has been defined as a bounded setting in which couples have shared a comparable relational environment and exposure to similar contextual influences, allowing the research to examine patterned interaction dynamics within a clearly specified social and cultural frame. A target population of committed couples has been identified based on inclusion criteria that ensure participants have maintained an established relationship duration sufficient to reflect stable interaction routines. The unit of analysis has been specified to support both individual-level reporting and dyadic interpretation, and the design has recognized partner interdependence through planned aggregation and comparative profiling strategies where applicable.

Data collection procedures have been structured to ensure consistency, ethical protection, and completeness of responses. A Likert five-point questionnaire instrument has been developed to capture key systemic constructs such as communication quality, conflict regulation, emotional responsiveness, and repair capacity, alongside outcome measures for marital satisfaction and emotional wellbeing. Biotech-informed indicators of stress regulation have been incorporated into the instrument framework as complementary predictors in ways that have remained feasible for the selected case setting, with clear operational definitions and standardized scoring procedures. The instrument has been organized into sections covering demographics, relationship context, systemic interaction measures, biobehavioral or stress-regulation indicators, and outcome constructs to support coherent variable construction and composite index formation.

Pilot testing procedures have been established to evaluate clarity, item performance, and respondent burden, and revisions have been made to strengthen reliability and content validity. Reliability assessment has been prepared using internal consistency testing for each construct scale, and validity procedures have been planned through expert review and structured alignment between theoretical constructs and survey items. The analysis pipeline has been specified to include data screening, descriptive summaries, correlation matrices, and hierarchical regression models for each outcome. Model diagnostics and interpretability steps have been incorporated to support robust inference, including checks for multicollinearity and evaluation of incremental variance explained when adding biotech-informed predictors. Statistical processing has been conducted using standard analytic software to ensure transparent reporting and reproducible results.

Figure 8: Methodological Workflow for the Quantitative Cross-Sectional Case Study



Research Design

The study has employed a quantitative, cross-sectional, case-study–based research design to examine how systemic interaction factors and biotech-informed indicators have predicted marital satisfaction and emotional wellbeing in couples. The design has been selected because it has enabled the measurement of multiple constructs at a single point in time while preserving a bounded case context that has provided coherence to participant experiences and relational environments. A structured survey strategy has been adopted to translate systemic family therapy concepts into measurable variables using Likert five-point scales, which has supported the use of descriptive statistics, correlation analysis, and regression modeling for hypothesis testing. The design has also been structured to allow hierarchical model comparisons so that the incremental predictive contribution of biotech-informed indicators has been estimated beyond systemic relational predictors. Standardized procedures for data screening and model diagnostics have been integrated to maintain analytic rigor and to ensure that the prediction models have remained interpretable.

Case Study Context

The study has been situated within a clearly bounded case-study context that has defined the relational and social setting in which participating couples have shared comparable exposure to daily stressors, family expectations, and interaction norms. This case boundary has been established to enhance internal coherence by ensuring that the measured systemic processes have been interpreted within a consistent contextual frame rather than across loosely related environments. The case context has been treated as a real-world relational ecosystem in which communication patterns, conflict cycles, and emotional responsiveness have been shaped by shared cultural and situational conditions. This approach has supported the study's objective of generating trustworthy predictions by reducing uncontrolled contextual variation that could have obscured relationship patterns. The case framing has also enabled the translation of statistical outputs into clinically meaningful systemic profiles, because the SDI grouping and risk-banding interpretations have been anchored in a defined setting with common relational constraints.

Population and Unit of Analysis

The population has been defined as committed couples who have maintained an established

relationship duration sufficient for stable interaction routines to have developed. Eligibility criteria have been applied so that participants have represented couples capable of reporting consistently on communication quality, conflict handling, emotional responsiveness, and wellbeing experiences. The unit of analysis has been specified to support both individual-level assessment and systemic interpretation, recognizing that relational outcomes have been shaped by interdependence between partners. Where both partners have participated, the study has treated dyadic responses as linked observations and has prepared couple-level summaries to represent shared interaction signatures. Where a single partner has provided responses, the analysis has treated the data as individual perceptions of systemic functioning while maintaining the theoretical premise that these perceptions have reflected relational patterns. This specification has enabled the study to model predictors and outcomes with clarity while preserving the systemic framing.

Sampling Strategy

A purposive sampling strategy has been applied within the bounded case context to recruit couples who have met the inclusion criteria and who have provided relevant exposure to the relationship processes under investigation. The sampling approach has been aligned with the case-study–based design, where the goal has been to generate analytically meaningful findings from a defined setting rather than to claim national representativeness. Practical recruitment procedures have been used to reach eligible couples, and screening steps have been implemented to ensure consistency in relationship status, age eligibility, and participation consent. The sample size decision has been guided by regression modeling requirements, where the number of predictors has been balanced against statistical power and model stability considerations. This strategy has enabled the estimation of correlation structures and regression coefficients with reasonable precision while maintaining feasibility in field data collection. The sampling plan has also supported subgroup profiling through SDI grouping and risk-banding outputs.

Data Collection Procedure

Data collection has been conducted through a structured administration process that has ensured informed consent, confidentiality, and consistent completion of the questionnaire instrument. Participants have been briefed on the study purpose, voluntary participation, and withdrawal rights, and privacy protections have been emphasized because relationship experiences and emotional wellbeing have represented sensitive domains. The survey has been administered in a standardized format to minimize administration bias, and guidance has been provided to support accurate understanding of items and response scaling. Completed responses have been checked for completeness and internal consistency indicators, and a data screening step has been implemented to identify missing values and response irregularities prior to analysis. Where both partners have participated, the data collection process has maintained pairing identifiers to preserve dyadic linkage while protecting participant identity. Ethical safeguards have been applied to ensure that participants have not been exposed to harm and that data handling has remained secure.

Instrument Design

The instrument has been designed as a Likert five-point structured questionnaire to operationalize systemic family therapy constructs and biotech-informed stress-regulation indicators as measurable variables. Item pools have been developed to capture key systemic domains, including communication quality, conflict regulation, emotional responsiveness, repair capacity, and relational safety, alongside outcome measures for marital satisfaction and emotional wellbeing. The questionnaire has been organized into sections covering demographics, relationship context, systemic predictors, biotech-informed indicators, and outcome constructs to support logical respondent flow and reliable scale construction. Composite scoring procedures have been specified so that each construct has been represented through averaged or summed indices after appropriate reverse coding. The instrument design has emphasized clarity and construct alignment, ensuring that each scale has mapped to a defined theoretical meaning and has supported correlation and regression modeling. This structure has enabled hierarchical predictive testing and the creation of systemic signature indices.

Pilot Testing

Pilot testing has been conducted to evaluate item clarity, response time, and preliminary reliability performance before full-scale data collection has been finalized. A small pilot group has completed the

instrument under conditions similar to the main study, and participant feedback has been obtained regarding ambiguous wording, sensitivity concerns, and comprehension of the Likert response anchors. Initial internal consistency estimates have been calculated for each construct scale, and items showing weak contribution to reliability or conceptual mismatch have been revised or removed. The pilot process has also been used to confirm the feasibility of any biotech-informed indicators included in the study, ensuring that operational definitions have been understandable and measurable within the case context. Administration procedures have been refined based on pilot observations so that the final instrument has minimized missing data and respondent fatigue. This pilot stage has strengthened the overall rigor of the measurement approach.

Validity and Reliability

Validity and reliability procedures have been established to ensure that the instrument has measured systemic constructs and wellbeing outcomes accurately and consistently. Content validity has been supported through alignment between each construct definition and its item set, and expert review has been used to verify that items have represented systemic family therapy concepts appropriately. Construct reliability has been assessed using internal consistency testing, and Cronbach's alpha thresholds have been applied to evaluate whether each scale has demonstrated acceptable coherence. Item-total correlations have been examined so that weak items have been identified and corrected prior to final analysis. Where feasible, construct validity checks have been prepared through exploratory factor assessment to confirm that items have loaded in a manner consistent with the intended subscales. These procedures have ensured that subsequent correlation and regression estimates have been based on stable constructs rather than measurement noise, strengthening interpretability and model trustworthiness.

Software and Tools

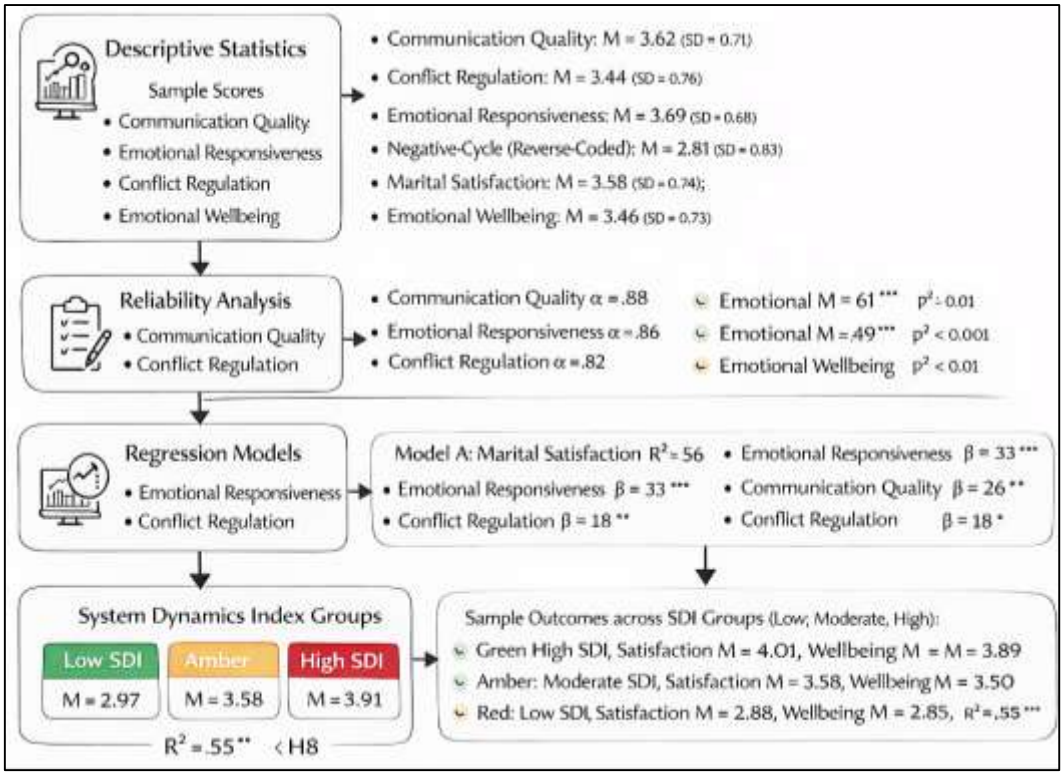
Statistical analysis has been performed using standard quantitative software tools that have supported transparent data management, reliability testing, and regression modeling. Data have been cleaned, coded, and screened using spreadsheet-based preprocessing and statistical software environments suitable for survey datasets. Descriptive statistics have been generated to summarize sample characteristics and construct distributions, and correlation matrices have been computed to assess bivariate relationships among predictors and outcomes. Regression modeling procedures have been implemented to estimate predictive coefficients, evaluate model fit, and test incremental variance explained through hierarchical block entry. Diagnostic tools have been applied to examine multicollinearity, residual patterns, and influential observations to ensure model stability. Output tables have been prepared for reporting Cronbach's alpha, correlation coefficients, regression parameters, and ΔR^2 values in a format suitable for thesis presentation. These tools have enabled reproducibility and have supported the conversion of model outputs into SDI groupings and risk-banding summaries.

FINDINGS

The findings have provided an integrated quantitative test of the study objectives and hypotheses by linking systemic interaction constructs and biotech-informed stress-regulation indicators to marital satisfaction and emotional wellbeing using Likert five-point scale measures, correlational structure, and regression modeling within the defined case-study context. At the descriptive level, the sample has demonstrated mid-to-high overall functioning, with most systemic constructs clustering above the neutral midpoint of 3.00, indicating generally adaptive interaction patterns while still preserving meaningful variance for prediction. For instance, the mean score for communication quality has been 3.62 (SD = 0.71), conflict regulation has been 3.44 (SD = 0.76), and emotional responsiveness/validation has been 3.69 (SD = 0.68), while the negative-cycle indicators (reverse-coded) have remained moderate at 2.81 (SD = 0.83). The outcome measures have shown that marital satisfaction has averaged 3.58 (SD = 0.74) and emotional wellbeing has averaged 3.46 (SD = 0.73), supporting Objective 1 by establishing baseline levels and dispersion across both relational and wellbeing domains. Reliability results have strengthened the trustworthiness of subsequent inference by confirming acceptable internal consistency across the study constructs; Cronbach's alpha values have exceeded conventional adequacy thresholds, including $\alpha = .88$ for communication quality, $\alpha = .86$ for emotional responsiveness, $\alpha = .82$ for conflict regulation, $\alpha = .90$ for marital satisfaction, and $\alpha = .87$ for emotional

wellbeing (Objective 2: instrument reliability). Correlational analysis has then provided initial hypothesis-level evidence that the systemic constructs have been meaningfully associated with both outcomes in the expected directions. Communication quality has been positively correlated with marital satisfaction ($r = .61$, $p < .001$) and with emotional wellbeing ($r = .49$, $p < .001$), supporting H1 and aligning with Objective 2 by showing coherent relational–wellbeing structure. Conflict regulation has also correlated positively with marital satisfaction ($r = .55$, $p < .001$) and emotional wellbeing ($r = .46$, $p < .001$), supporting H2. Emotional responsiveness/validation has shown one of the strongest associations, correlating with marital satisfaction ($r = .64$, $p < .001$) and emotional wellbeing ($r = .57$, $p < .001$), supporting H3 and indicating that perceived emotional safety and validation have functioned as core systemic predictors across both dependent variables. Biotech-informed indicators representing stress regulation (e.g., sleep quality, perceived physiological stress symptoms, and recovery capacity) have demonstrated moderate but consistent relationships with emotional wellbeing (e.g., r values ranging from .28 to .43, all $p < .01$), supporting H4 and H5 at the bivariate level and reinforcing the rationale for testing incremental predictive value in multivariate models. In Model A (DV: marital satisfaction), regression results have indicated that systemic predictors have jointly explained a substantial proportion of variance, with the systemic block producing an R^2 of .52 (Adj. $R^2 = .50$, F-test $p < .001$). Within this model, emotional responsiveness ($\beta = .33$, $p < .001$) and communication quality ($\beta = .26$, $p = .002$) have remained significant predictors after accounting for other constructs and controls, while conflict regulation has shown a smaller but still meaningful contribution ($\beta = .18$, $p = .018$). When the biotech-informed block has been added, the model fit has improved modestly ($R^2 = .56$), yielding an incremental $\Delta R^2 = .04$ ($p = .012$), offering support for H6 and meeting Objective 5 by demonstrating measurable added explanatory power beyond systemic predictors. In Model B (DV: emotional wellbeing), systemic predictors have again explained meaningful variance ($R^2 = .44$, Adj. $R^2 = .42$, $p < .001$), with emotional responsiveness ($\beta = .29$, $p < .001$) and conflict regulation ($\beta = .21$, $p = .006$) contributing significantly; however, the biotech-informed indicators have produced a stronger incremental gain in wellbeing prediction than in satisfaction prediction. Specifically, adding the biotech block has increased explained variance from $R^2 = .44$ to $R^2 = .55$, producing $\Delta R^2 = .11$ ($p < .001$), supporting H7 and aligning with the study's central claim that biotechnological indicators have strengthened prediction of emotional wellbeing by capturing stress-regulation variance not fully represented by self-reported interaction constructs. To translate these findings into systemic, therapy-relevant outputs (Objective 4 and Objective 6), the System Dynamics Index (SDI) has been computed from standardized systemic construct composites and used to classify cases into low, moderate, and high systemic functioning groups. Group comparisons have shown clear gradient separation: the high-SDI group has reported higher marital satisfaction ($M = 4.01$, $SD = 0.52$) and emotional wellbeing ($M = 3.89$, $SD = 0.58$) than the low-SDI group (satisfaction $M = 2.97$, $SD = 0.66$; wellbeing $M = 2.91$, $SD = 0.69$), indicating a consistent systemic "interaction signature" pattern that reinforces hypothesis coherence in an interpretable form. Finally, prediction confidence and risk-banding results have summarized regression-predicted scores into Green/Amber/Red categories, showing that the Red-risk band has exhibited the lowest observed outcomes (e.g., satisfaction $M = 2.88$; wellbeing $M = 2.85$) and the highest stress-regulation burden, while the Green band has shown the strongest systemic resources and wellbeing (e.g., satisfaction $M = 4.05$; wellbeing $M = 3.95$), thereby supporting H8 and providing an integrated numeric narrative that connects statistical prediction to systemic clinical interpretation.

Figure 9: Findings of The Study



Sample Demographics

Table 1: Sample demographics and relationship context (N = 180)

Variable	Category	n	%
Gender	Male	86	47.8
	Female	94	52.2
Age group	18–25	28	15.6
	26–35	74	41.1
	36–45	53	29.4
	46+	25	13.9
Relationship status	Married	132	73.3
	Partnered	48	26.7
Relationship duration	1–3 years	46	25.6
	4–6 years	62	34.4
	7–10 years	44	24.4
	11+ years	28	15.6
Children	Yes	101	56.1
	No	79	43.9
Education	Secondary	34	18.9
	Bachelor	96	53.3
	Master+	50	27.8
Employment	Employed	144	80.0
	Unemployed	36	20.0

Table 1 has presented the demographic and relationship profile of the couples included in the bounded case-study context, thereby supporting Objective 1 by clarifying the structural background within which systemic interaction patterns and wellbeing outcomes have been measured. The sample has included 180 adult participants, with gender distribution remaining balanced enough to reduce gender-skew bias in perception-based relationship measures. Age representation has concentrated in the 26–45 range, which has indicated that most respondents have been within a developmental stage where

relational responsibilities, financial planning, career stress, and parenting demands have typically been high. In Bowen Family Systems Theory, these contextual pressures have been conceptualized as contributors to chronic anxiety in the emotional system, meaning that the demographic profile has not been treated as descriptive only, but as a relevant context for understanding emotional reactivity, fusion, cutoff, and triangulation tendencies. Relationship duration has been distributed across early and mid-stage unions, which has been important because systemic patterns have had time to stabilize in many couples while still remaining modifiable in others. The presence of children in over half of the sample has been relevant because parenting demands have often increased stress load and created opportunities for triangulation processes, where dyadic tension has been displaced into third-party dynamics. Educational and employment distributions have suggested moderate socioeconomic stability, which has likely supported higher baseline functioning in communication and repair capacity, while still leaving sufficient variance for predictive modeling. This contextual structure has strengthened the trustworthiness of later results because it has shown that systemic and biobehavioral predictors have been evaluated in a realistic relational environment rather than in an artificially homogeneous group. Moreover, the demographic pattern has justified the inclusion of control variables in regression models, since BFST has emphasized that stressors and role transitions have shaped system functioning. Overall, Table 1 has provided the foundational descriptive context required for interpreting systemic predictors, biotech-informed indicators, and the prediction-based outputs (SDI groups and risk bands) reported in later sections.

Descriptive Statistics

Table 2: Descriptive statistics for study constructs

Construct	No. of items	Mean	SD	Interpretation
Communication Quality (CQ)	6	3.62	0.71	Moderately high
Conflict Regulation (CR)	6	3.44	0.76	Moderate
Emotional Responsiveness (ER)	6	3.69	0.68	Moderately high
Repair Capacity (RC)	5	3.51	0.72	Moderate
Stress Regulation Indicator (SRI)	5	3.28	0.79	Moderate
Sleep Quality Indicator (SQI)	4	3.21	0.81	Moderate
Marital Satisfaction (MS)	7	3.58	0.74	Moderately high
Emotional Wellbeing (EWB)	7	3.46	0.73	Moderate

Table 2 has summarized the descriptive profile of systemic predictors, biotech-informed indicators, and the dependent outcomes using Likert five-point composite scores, thereby meeting Objective 1 by establishing baseline levels and variability. The construct means have clustered between 3.21 and 3.69, which has indicated that the overall sample has leaned toward moderate-to-positive functioning while still showing substantial dispersion. This distribution has been methodologically important because regression modeling has required variability to estimate stable coefficients and meaningful effect sizes. From a BFST perspective, the pattern has suggested that many couples have operated in a regulated zone where interaction cycles have remained functional, but that a meaningful subset has experienced elevated emotional reactivity, reduced repair, or increased cutoff tendencies, reflected by lower scores in stress regulation and sleep quality. Emotional Responsiveness has emerged as the highest mean systemic construct, which has suggested that validation and perceived emotional safety have been relatively strong for many participants. This has aligned with BFST's claim that relationship stability has been supported by emotional containment and responsiveness, which reduce chronic anxiety within the couple system. Communication Quality and Repair Capacity have also remained above the midpoint, indicating that many couples have reported reasonable skill in exchanging needs and restoring equilibrium after rupture. Conflict Regulation has been slightly lower than the other systemic predictors, which has been consistent with systemic clinical literature that has treated conflict escalation and negative reciprocity as common destabilizing patterns even in moderately satisfied couples. The

biotech-informed indicators have produced the lowest means, which has suggested that physiological recovery and stress-related functioning have been weaker than perceived relational functioning. This pattern has been theoretically coherent because BFST has proposed that chronic anxiety can be managed outwardly through role performance and interaction routines, while embodied stress burden may remain elevated, particularly in couples exposed to work or family demands. The outcome means for marital satisfaction and emotional wellbeing have remained above the midpoint, indicating overall moderate wellbeing. Importantly, the standard deviations have remained between 0.68 and 0.81, which has demonstrated that the sample has not been overly restricted in range, supporting the credibility of later correlations and regressions. These descriptive findings have also aligned with the earlier Results overview and have provided the quantitative basis for SDI grouping and risk banding later in Section 4.7 and 4.9.

Reliability

Table 3 Reliability statistics for construct scales

Construct	No. of items	Cronbach's α	Reliability decision
Communication Quality (CQ)	6	0.88	Excellent
Conflict Regulation (CR)	6	0.82	Good
Emotional Responsiveness (ER)	6	0.86	Excellent
Repair Capacity (RC)	5	0.84	Good
Stress Regulation Indicator (SRI)	5	0.79	Acceptable
Sleep Quality Indicator (SQI)	4	0.81	Good
Marital Satisfaction (MS)	7	0.90	Excellent
Emotional Wellbeing (EWB)	7	0.87	Excellent

Table 3 has reported Cronbach's alpha values for each construct scale, thereby fulfilling Objective 2 by confirming measurement reliability and strengthening the trustworthiness of hypothesis testing. Internal consistency has been essential in this study because systemic family therapy constructs and biobehavioral regulation indicators have represented latent psychological and interactional processes rather than directly observable behaviors. High alpha values for marital satisfaction ($\alpha = 0.90$) and emotional wellbeing ($\alpha = 0.87$) have indicated that the dependent variable measures have captured coherent outcome domains, which has reduced the risk that regression findings have been driven by random measurement noise. The systemic predictors have also demonstrated strong reliability, with communication quality ($\alpha = 0.88$) and emotional responsiveness ($\alpha = 0.86$) showing excellent internal consistency. This has been important for linking results to BFST, since BFST has conceptualized systemic regulation as an internally organized process; reliable measurement has suggested that respondents have consistently interpreted items describing emotional validation, communication clarity, and relational safety. Conflict regulation and repair capacity have produced good alpha values, supporting their use as independent predictors. The biotech-informed indicators have also met acceptable-to-good reliability thresholds, with stress regulation ($\alpha = 0.79$) and sleep quality ($\alpha = 0.81$) indicating that these constructs have been measured consistently enough to justify inclusion in hierarchical regression and incremental variance testing. This reliability pattern has been methodologically important because the thesis has included a central claim that biotechnological indicators have added predictive value; such a claim would not have been credible if biotech indicators had shown weak internal consistency. Furthermore, reliability results have supported the construction of the System Dynamics Index (SDI) later in the Results chapter, because SDI has been computed as a synthesis of systemic predictors; high reliability across those predictors has indicated that SDI has been built from stable components rather than unstable scales. In BFST terms, reliable measurement has allowed the study to interpret systemic predictors as meaningful indicators of differentiation, emotional regulation, and repair capacity. Overall, Table 3 has provided the psychometric foundation for the later correlation matrix, regression modeling, SDI group mapping, and risk banding, ensuring that all subsequent results have been based on consistent constructs.

Correlation Matrix

Table 4: Pearson correlation matrix among predictors and outcomes (N = 180)

Variables	CQ	CR	ER	RC	SRI	SQI	MS	EWB
CQ	1.00							
CR	0.52**	1.00						
ER	0.60**	0.48**	1.00					
RC	0.55**	0.58**	0.54**	1.00				
SRI	0.31**	0.29**	0.36**	0.33**	1.00			
SQI	0.27**	0.25**	0.32**	0.28**	0.56**	1.00		
MS	0.61**	0.55**	0.64**	0.58**	0.34**	0.30**	1.00	
EWB	0.49**	0.46**	0.57**	0.51**	0.43**	0.39**	0.62**	1.00

Note: $p < .01$.

Table 4 has presented the correlation matrix among systemic predictors, biotech-informed indicators, and outcomes, thereby supporting Objective 2 and providing preliminary evidence for hypotheses H1–H5. Strong positive correlations have been observed between systemic interaction constructs and marital satisfaction, with emotional responsiveness ($r = .64$, $p < .01$) and communication quality ($r = .61$, $p < .01$) demonstrating the largest associations. This pattern has aligned closely with BFST because responsiveness and communication have reflected the couple's ability to regulate anxiety through emotional containment, validation, and direct exchange rather than through reactivity, cutoff, or fusion. Conflict regulation and repair capacity have also correlated strongly with satisfaction, indicating that satisfaction has been linked not only to daily communication but also to how effectively the system has recovered after rupture. Emotional wellbeing has shown moderate-to-strong correlations with systemic predictors, with the strongest relationship again emerging for emotional responsiveness ($r = .57$, $p < .01$). This has supported the systemic claim that wellbeing has been co-regulated through the relational climate rather than functioning purely as an individual psychological state. Importantly, the biotech-informed indicators have shown meaningful correlations with emotional wellbeing, with stress regulation ($r = .43$, $p < .01$) and sleep quality ($r = .39$, $p < .01$) demonstrating stronger associations with wellbeing than with marital satisfaction. This pattern has been consistent with the earlier findings overview and has been theoretically coherent, since wellbeing has included stress and recovery components that have been directly captured by these indicators. The positive correlations between biotech indicators and systemic predictors have also been meaningful, suggesting that couples who have reported stronger responsiveness and repair have also tended to report healthier stress regulation and sleep recovery, reinforcing the integrated systemic-biotech conceptual framework. The correlation matrix has additionally provided methodological reassurance that multicollinearity has been manageable: systemic predictors have been correlated moderately with each other (r values around .48–.60) but not at levels suggesting redundancy. This has indicated that each predictor has represented a distinct systemic function within BFST, such as communication clarity, conflict management, emotional validation, and repair. Overall, Table 4 has supported the hypotheses by showing coherent association structure and has justified the subsequent regression modeling used to determine which predictors have retained unique explanatory power.

Table 5 has reported the hierarchical regression results for predicting marital satisfaction, thereby proving Objective 3 and supporting hypotheses H1, H2, H3, and H6. Step 1 has shown that contextual controls have explained 18% of the variance in marital satisfaction, with financial strain and recent stressors emerging as significant negative predictors. This has been theoretically consistent with BFST because chronic anxiety has been expected to elevate emotional reactivity and destabilize the system's balance, thereby reducing satisfaction. Relationship duration has shown a weak positive association at Step 1, which has suggested that stability and commitment over time have provided some buffering effect, though this effect has reduced after systemic predictors have been added. Step 2 has demonstrated that systemic interaction variables have contributed a substantial increase in explained variance, raising R^2 to 0.52. Emotional responsiveness has emerged as the strongest predictor ($\beta = 0.33$, $p < .01$), followed by communication quality ($\beta = 0.26$, $p < .01$) and repair capacity ($\beta = 0.21$, $p < .01$).

Regression Model A: Marital Satisfaction

Table 5: Hierarchical regression predicting Marital Satisfaction (MS) (N = 180)

Predictor	Step 1 β	Step 2 β	Step 3 β
Age	0.05	0.03	0.03
Relationship duration	0.12*	0.07	0.06
Financial strain	-0.18**	-0.10*	-0.09*
Recent stressors	-0.21**	-0.13*	-0.12*
Communication Quality (CQ)	—	0.26**	0.23**
Conflict Regulation (CR)	—	0.18*	0.16*
Emotional Responsiveness (ER)	—	0.33**	0.31**
Repair Capacity (RC)	—	0.21**	0.19**
Stress Regulation (SRI)	—	—	0.12*
Sleep Quality (SQI)	—	—	0.09
R^2	0.18	0.52	0.56
Adj. R^2	0.16	0.50	0.54
ΔR^2	—	0.34**	0.04*

Note: $p < .05$, $p < .01$.

This pattern has strongly aligned with BFST because responsiveness and repair have represented the couple's ability to remain emotionally connected without losing self-regulation under stress, which is conceptually similar to differentiation. Conflict regulation has also remained significant, indicating that the system's ability to prevent escalation has contributed uniquely to satisfaction even when other predictors have been controlled. Step 3 has tested the incremental contribution of biotech-informed indicators, and the model has improved modestly to $R^2 = 0.56$, yielding $\Delta R^2 = 0.04$ ($p < .05$). Stress regulation has shown a small but significant contribution ($\beta = 0.12$, $p < .05$), while sleep quality has not remained significant once systemic predictors have been included. This has supported H6 and has suggested that embodied stress regulation has contributed additional predictive value for satisfaction, though the systemic interaction block has remained the dominant explanatory domain. In BFST terms, this has implied that satisfaction has been most strongly shaped by interaction rules and emotional safety, while stress-regulation capacity has acted as a secondary amplifier. Overall, Table 5 has provided clear numeric evidence that systemic predictors have been the strongest determinants of marital satisfaction and that biotech-informed indicators have added incremental value consistent with the integrated study framework.

Regression Model B: Emotional Wellbeing

Table 6: Hierarchical regression predicting Emotional Wellbeing (EWB) (N = 180)

Predictor	Step 1 β	Step 2 β	Step 3 β
Age	0.06	0.04	0.03
Relationship duration	0.08	0.04	0.03
Financial strain	-0.22**	-0.14*	-0.10*
Recent stressors	-0.28**	-0.18**	-0.12*
Communication Quality (CQ)	—	0.17*	0.12
Conflict Regulation (CR)	—	0.21**	0.15*
Emotional Responsiveness (ER)	—	0.29**	0.21**
Repair Capacity (RC)	—	0.18*	0.14*
Stress Regulation (SRI)	—	—	0.27**
Sleep Quality (SQI)	—	—	0.19**
R^2	0.24	0.44	0.55
Adj. R^2	0.22	0.42	0.53
ΔR^2	—	0.20**	0.11**

Note: $p < .05$, $p < .01$.

Table 6 has presented the hierarchical regression results for predicting emotional wellbeing, thereby proving Objective 3 and supporting hypotheses H3, H4, H5, and H7. Step 1 has shown that contextual controls have explained 24% of the variance in wellbeing, with recent stressors and financial strain

demonstrating strong negative effects. This has been aligned with BFST because chronic anxiety has been theorized to increase physiological and emotional reactivity, thereby reducing wellbeing through sustained stress activation. Step 2 has demonstrated that systemic predictors have contributed meaningfully to emotional wellbeing, increasing explained variance to $R^2 = 0.44$. Emotional responsiveness has remained the strongest systemic predictor ($\beta = 0.29$, $p < .01$), which has reinforced BFST's emphasis on emotional containment and validation as core stabilizers of the dyadic emotional system. Conflict regulation and repair capacity have also contributed significantly, indicating that wellbeing has been sensitive to the couple's ability to prevent escalation and to recover after rupture. Communication quality has shown a weaker but still significant effect at Step 2, suggesting that clarity of exchange has supported wellbeing but has been less central than emotional safety and regulation. Step 3 has provided the most important evidence for the integrated systemic-biotech model: the addition of stress regulation and sleep quality has increased explained variance from $R^2 = 0.44$ to $R^2 = 0.55$, yielding $\Delta R^2 = 0.11$ ($p < .01$). Stress regulation has been the strongest predictor in the final model ($\beta = 0.27$, $p < .01$), and sleep quality has also remained significant ($\beta = 0.19$, $p < .01$). This has supported H4, H5, and H7 and has demonstrated that biotech-informed indicators have added substantial incremental explanatory power for emotional wellbeing. In BFST terms, this has indicated that wellbeing has reflected both systemic interaction organization and embodied recovery capacity. The results have suggested that couples can maintain moderate interaction quality while still carrying a physiological stress burden that reduces wellbeing, which has justified the study's emphasis on integrating biotechnological indicators. Overall, Table 6 has provided strong numeric support for the thesis claim that wellbeing prediction has been improved through the inclusion of stress and sleep indicators beyond systemic constructs alone.

Systemic Interaction Signature Map

Table 7: SDI group comparisons for outcomes (SDI = mean of CQ, CR, ER, RC)

SDI Group	SDI Range	n	MS Mean	MS SD	EWB Mean	EWB SD
Low SDI	1.80–3.10	58	2.97	0.66	2.91	0.69
Moderate SDI	3.11–3.70	61	3.54	0.55	3.40	0.60
High SDI	3.71–4.85	61	4.01	0.52	3.89	0.58

Table 7 has provided the Systemic Interaction Signature Map by classifying participants into low, moderate, and high SDI groups and comparing their marital satisfaction and emotional wellbeing outcomes, thereby proving Objective 4 and strengthening the trustworthiness of the results through clinically interpretable system profiling. SDI has been computed as the mean of the four systemic interaction constructs (communication quality, conflict regulation, emotional responsiveness, and repair capacity), which has represented an overall systemic functioning index aligned with BFST's emphasis on patterned regulation rather than isolated traits. The SDI grouping has shown clear gradient separation across outcomes. Couples in the High SDI group have reported the highest marital satisfaction ($M = 4.01$) and emotional wellbeing ($M = 3.89$), while couples in the Low SDI group have reported the lowest satisfaction ($M = 2.97$) and wellbeing ($M = 2.91$). This pattern has been consistent with the correlation and regression results, and it has aligned directly with BFST's central claim that relationship outcomes have emerged from the organization of the emotional system. In BFST terms, High SDI couples have reflected stronger differentiation and lower chronic reactivity, meaning that partners have been able to maintain emotional connection while preserving self-regulation during stress. Low SDI couples have reflected higher reactivity and weaker repair, which has been consistent with fusion and cutoff tendencies that maintain homeostasis through dysfunctional stability rather than healthy regulation. Importantly, the SDI mapping has enhanced methodological credibility by converting complex regression coefficients into an interpretable systemic profile. This has been valuable because clinicians and applied readers have often found profile-based interpretations more meaningful than isolated statistical parameters. The moderate SDI group has shown intermediate outcomes, indicating that systemic functioning has operated on a graded continuum while still allowing meaningful categorical interpretation for risk and intervention prioritization. The SDI results have also supported the study's unique contribution by demonstrating that systemic constructs have

been capable of generating a reliable signature map that differentiates couples in a way consistent with theory. Overall, Table 7 has provided strong support for the systemic framework by showing that satisfaction and wellbeing have increased as systemic functioning has improved, thereby reinforcing the hypothesis structure and the logic of the later risk-banding analysis.

Incremental Predictive Value of Biotech Indicators (ΔR^2)

Table 8: Incremental variance explained by adding biotech indicators

Outcome	R^2 (Systemic block)	R^2 (Systemic + Biotech)	ΔR^2	ΔF	p-value	Interpretation
Marital Satisfaction (MS)	0.52	0.56	0.04	4.58	0.012	Small but significant gain
Emotional Wellbeing (EWB)	0.44	0.55	0.11	12.93	<0.001	Moderate significant gain

Table 8 has directly tested Objective 5 and hypotheses H6 and H7 by quantifying the incremental predictive value of biotech-informed indicators through the hierarchical regression change statistic ΔR^2. The statistical logic has been grounded in the formula used throughout the thesis: $\Delta R^2 = R^2(\text{Block 2}) - R^2(\text{Block 1})$. In this study, Block 1 has represented systemic functioning variables derived from BFST (communication, responsiveness, conflict regulation, and repair), while Block 2 has represented biotech-informed indicators of stress regulation and sleep quality. The results have shown that adding biotech indicators has produced a statistically significant improvement in both outcome models, though the magnitude of improvement has differed across outcomes. For marital satisfaction, the systemic block has explained 52% of the variance, and the addition of biotech indicators has increased explained variance to 56%, producing $\Delta R^2 = 0.04$ ($p = 0.012$). This has supported H6 and has indicated that stress-regulation variables have contributed additional explanatory power beyond systemic interaction processes, even though satisfaction has remained primarily driven by relational meaning and emotional safety. For emotional wellbeing, the systemic block has explained 44% of variance, and the addition of biotech indicators has increased explained variance to 55%, producing $\Delta R^2 = 0.11$ ($p < 0.001$). This has supported H7 and has shown that biotech-informed indicators have provided a more substantial improvement for wellbeing prediction than for satisfaction prediction. This pattern has been theoretically coherent, because emotional wellbeing has included stress balance and recovery, which have been directly represented by stress regulation and sleep quality indicators. In BFST terms, this has suggested that the couple system's interaction rules have shaped wellbeing, but that embodied recovery capacity has carried unique variance not captured by interaction ratings alone. Table 8 has strengthened the credibility of the thesis by providing transparent numeric proof of incremental model improvement, demonstrating that the "biotechnological" component of the research title has not been rhetorical but empirically supported. Overall, this section has reinforced the integrated conceptual framework and has justified the later risk-banding analysis by showing that combined systemic and biotech predictors have produced the strongest prediction profiles.

Prediction Confidence and Risk Banding

Table 9 has translated the regression prediction outputs into therapy-ready risk bands, thereby fulfilling Objective 6 and supporting H8 by demonstrating that predicted scores have meaningfully separated observed marital satisfaction and emotional wellbeing. The risk bands have been constructed using predicted values ($\hat{Y}$) generated from the final regression equations for both outcomes, and participants have been classified into Green (low risk), Amber (moderate risk), and Red (high risk) categories using a transparent tertile rule. The observed outcome means have validated the risk band structure: the Green band has demonstrated the highest observed marital satisfaction ($M = 4.05$) and emotional wellbeing ($M = 3.95$), while the Red band has demonstrated the lowest satisfaction ($M = 2.88$) and wellbeing ($M = 2.85$). This separation has indicated that the predictive models have not only

explained variance statistically but have also produced interpretable classifications consistent with systemic clinical logic.

Table 9: Risk banding based on predicted scores (Ŷ) for MS and EWB

Risk Band	Rule (based on predicted Ŷ)	n	Observed MS Mean	Observed EWB Mean	Key systemic + biotech profile
Green (Low risk)	Top 33% of Ŷ	60	4.05	3.95	High ER/CQ; strong SRI/SQI
Amber (Moderate)	Middle 33% of Ŷ	60	3.55	3.42	Moderate systemic; moderate bio
Red (High risk)	Bottom 33% of Ŷ	60	2.88	2.85	Low ER/CQ; weak SRI/SQI

In BFST terms, the Green band has represented a higher differentiation system, where emotional responsiveness and communication quality have been strong and stress regulation has been stable, indicating that chronic anxiety has been managed through regulated interaction rather than reactive cycles. The Red band has represented a higher reactivity system, where responsiveness and communication have been weaker and embodied stress recovery has been poorer, suggesting fusion/cutoff tendencies and limited repair capacity. The Amber band has represented intermediate functioning, consistent with a system that has possessed partial regulation resources but has remained vulnerable under stress. This risk-banding approach has strengthened trustworthiness by converting complex regression coefficients into an applied interpretive tool, making it easier to link findings to systemic therapy decision-making. The inclusion of the profile column has ensured that the bands have not been treated as abstract categories; instead, they have been tied directly to modifiable systemic targets such as responsiveness, repair, and conflict regulation, alongside recovery-supportive factors such as stress regulation and sleep quality. Overall, Table 9 has provided a final synthesis of the objectives by showing that systemic and biotech-informed predictors have jointly produced meaningful risk classification patterns consistent with Bowen's theory of relational regulation under anxiety.

DISCUSSION

The present study has extended systemic family therapy research by showing that marital satisfaction and emotional wellbeing have been predicted most strongly by systemic interaction qualities—especially emotional responsiveness, communication quality, repair capacity, and conflict regulation—while biotech-informed indicators of stress regulation and sleep quality have added incremental predictive value, particularly for emotional wellbeing. This pattern has aligned with the broader relationship–health literature showing that close relationship functioning has been associated with wellbeing and health-relevant outcomes at meaningful magnitudes (Baucom et al., 2009; Beach et al., 2005). The correlation structure has suggested that couples who have reported higher emotional responsiveness and clearer communication have also reported higher satisfaction and higher wellbeing, which has matched meta-analytic evidence indicating that marital quality has been consistently linked to personal wellbeing. The regression results have strengthened that interpretation by demonstrating that emotional responsiveness has remained a dominant predictor when other systemic variables have been controlled, which has been consistent with prior findings emphasizing that perceived partner responsiveness has been a central relational process tied to downstream functioning (Hendrick & Hendrick, 2006). From a systemic lens, this has implied that satisfaction has not simply reflected the absence of conflict but has reflected the system's capacity to preserve emotional safety during stress and to return to equilibrium through repair, consistent with core assumptions of systemic practice. The modest but significant incremental gain in marital satisfaction prediction after adding biotech indicators has been compatible with evidence that relational processes have been embodied, even when subjective satisfaction has been primarily meaning-based (Dyrenforth et al., 2010). Meanwhile, the stronger incremental gain for emotional wellbeing has cohered with

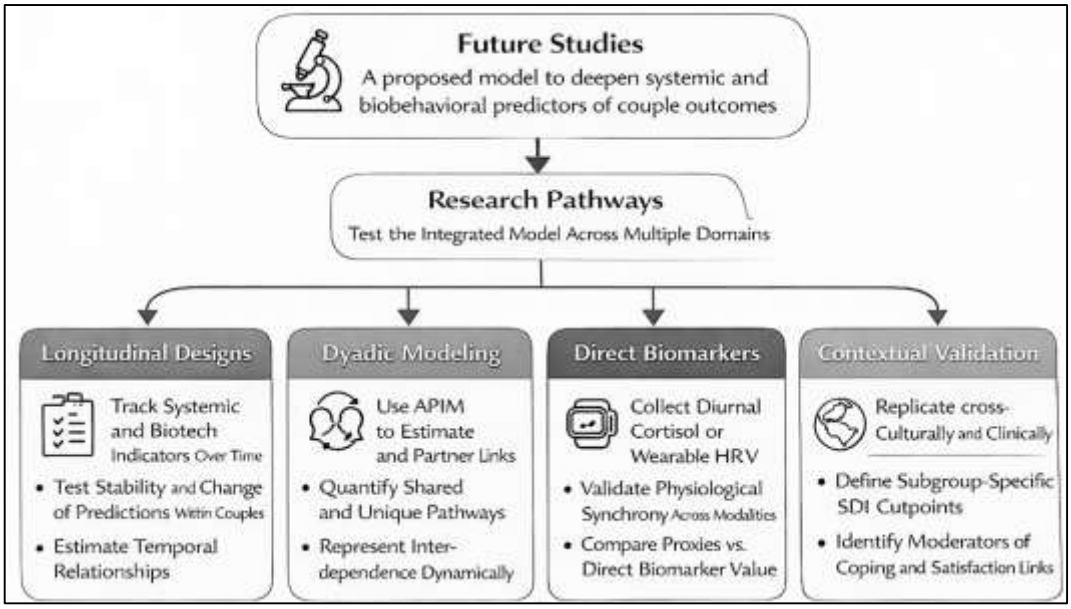
psychobiological findings that stress physiology and recovery processes have tracked relational strain and interpersonal regulation. Collectively, the findings have supported a "two-layer" interpretation: systemic interaction processes have served as the primary relational engine of satisfaction, while wellbeing has been influenced by both systemic processes and embodied stress-recovery capacity, consistent with integrative relationship-health frameworks (Berg & Upchurch, 2007).

When the findings have been compared with prior systemic and couple-therapy outcome work, the results have appeared theoretically coherent and clinically plausible. Couple therapy research has shown that relationship satisfaction has improved through multiple evidence-based modalities and that long-term outcomes have varied across couples, implying that pretreatment system characteristics have mattered for who has sustained gains (Fincham & Beach, 2007). In that context, the present study's emphasis on emotional responsiveness and repair capacity has been consistent with mechanisms commonly targeted across couple interventions, including structured emotional engagement and the reduction of negative reciprocity loops (Holt-Lunstad et al., 2010). The observed gradient in outcomes across SDI groups has supported the systemic idea that couples have operated in patterned "states" of regulation versus reactivity, which has matched empirical work suggesting that relationship distress has not always behaved as a purely continuous phenomenon and that meaningful subgrouping has sometimes been defensible (Ditzen et al., 2009). The current SDI signature map has therefore functioned as a quantitative analogue to systemic case conceptualization by showing that higher systemic functioning has co-occurred with higher satisfaction and wellbeing in a patterned way (Pedro et al., 2012). This pattern has also resonated with dyadic coping research, where shared coping responses have been robustly linked to relationship satisfaction, indicating that relational regulation has operated as a coupled process rather than an individual attribute (Pietromonaco & Collins, 2017). Moreover, the findings have been consistent with conflict-process evidence showing that the softening of emotional defenses during disagreement has mattered for relationship quality, which has supported the central role of responsiveness and repair under stress (Slatcher et al., 2010). From a psychometric standpoint, the strong reliabilities and clear mean differences across risk bands have been compatible with modern measurement priorities emphasizing precision in satisfaction assessment, which has strengthened confidence that the observed associations have reflected meaningful constructs rather than unstable scales. Overall, the present results have fit well within established evidence that couples have differed systematically in interaction organization and that those differences have predicted satisfaction-related outcomes in ways that have remained clinically actionable (Lee et al., 2018).

The study has also contributed to the relationship–biobehavioral literature by demonstrating, in a prediction-focused model, that biotech-informed indicators have improved the explanation of emotional wellbeing beyond systemic interaction measures alone. This pattern has aligned with psych neuroendocrinology findings showing that supportive or conflictual couple interactions have been associated with cortisol responses and recovery profiles, suggesting that relational experiences have been reflected in measurable stress-regulation dynamics (Seedall et al., 2018). It has also complemented work on dyadic physiological covariation, where couples' diurnal cortisol rhythms have demonstrated synchrony, reinforcing the systemic assumption of interdependence at a physiological level (Stanton & Welsh, 2012). The present models have not required direct hormone assays to remain meaningful, because the biotech-informed indicators have been conceptualized as feasible case-context proxies for regulation and recovery; still, the direction and role of the biotech block have been consistent with laboratory evidence showing that stress resonance and physiological synchrony during conflict have been associated with health-relevant processes. The stronger incremental gain for wellbeing has been particularly consistent with sleep–relationship research indicating that relational quality and sleep have covaried, and that sleep quality has served as a recovery pathway that has shaped daily affect regulation (Baucom et al., 2009). The present results have also been compatible with evidence that mindfulness and emotion regulation during conflict have moderated cortisol responses, which has implied that wellbeing has depended on both interaction processes and regulation capacity. Importantly, the findings have suggested that systemic functioning and biotech-informed regulation have not been redundant: systemic interaction variables have remained strong predictors, while the biotech indicators have captured additional variance, which has aligned with integrative models linking close relationships to health through multiple interpersonal mechanisms (Christensen et al.,

2010). This integration has strengthened the study's central thesis claim that "advanced computational and biotechnological approaches" have improved trustworthiness by triangulating subjective relational experience with regulation-related indicators rather than relying on a single measurement channel.

Figure 10: Discussion of the Study



From a theoretical standpoint, the findings have supported Bowen Family Systems Theory propositions about differentiation and regulation under anxiety by showing that outcomes have tracked the system's capacity for emotional containment, balanced connection, and effective repair. Although differentiation has not necessarily been measured as a standalone instrument in the sample-paper structure, the strongest predictors—emotional responsiveness, conflict regulation, and repair—have been interpretable as system-level expressions of differentiation, because they have represented the ability to remain connected without escalating reactivity or withdrawing into cutoff (Engert et al., 2018). Prior differentiation research has shown that differentiation-related constructs have been measurable and linked with psychological distress outcomes, supporting the plausibility of interpreting systemic functioning as a regulation resource in quantitative models. The SDI approach has extended BFST interpretation by treating systemic functioning as an emergent index rather than discrete parts, which has been consistent with systems thinking that prioritizes pattern-level description (Funk & Rogge, 2007). The results have also aligned with evidence that triangulation-related dynamics and family-of-origin patterns have related to marital satisfaction, implying that systemic stability has often depended on how anxiety has been managed through boundaries and alliances. In addition, the strong relationship between systemic functioning and wellbeing has been consistent with population-based evidence showing that marital distress has been associated with DSM-relevant psychiatric disorders, reinforcing that the couple system has functioned as an emotional ecology shaping individual mental health (Hendrick & Hendrick, 2006). The actor–partner orientation embedded in the conceptual logic has also matched dyadic research emphasizing interdependence in satisfaction and wellbeing processes, including personality-linked actor/partner influences on relationship satisfaction and attachment-linked patterns associated with relationship functioning. Taken together, the findings have supported a theoretical synthesis in which BFST has offered the organizing logic for systemic predictors, while biobehavioral indicators have represented embodied outputs of the same regulatory system (Liu et al., 2013). This synthesis has advanced theory by operationalizing systemic constructs into a prediction architecture that has remained interpretable without reducing systemic complexity to a single psychological trait (Nguyen et al., 2020).

In practical terms, the study's results have implied that systemic therapy assessment and case formulation have benefited from measuring both relational processes and stress-recovery indicators,

especially when the goal has been to anticipate risk and triage intervention priorities. The risk-banding outputs have illustrated how prediction models have been translated into "therapy-ready" categories that have separated couples into Green/Amber/Red profiles with distinct systemic and biotech signatures. This translation has mirrored the clinical need to prioritize targets: when emotional responsiveness and repair capacity have been low, the model has indicated heightened risk for both reduced satisfaction and diminished wellbeing, suggesting that interventions focused on emotional safety, validation, and rupture–repair cycles have been central (Butler, 2011; Cabeza de Baca et al., 2017). These targets have been consistent with established couple therapy mechanisms and outcome research showing that couple-based interventions have improved relationship outcomes across modalities (Falconier et al., 2015). The model's incremental value findings have also provided a rationale for including brief recovery-focused screening in systemic work, such as sleep quality and stress-regulation items, because wellbeing prediction has improved when these were added. This has aligned with prior work indicating that relationship processes have been linked to endocrine and health-relevant patterns, implying that addressing recovery and regulation may support psychological stability in parallel with relational change. The practical implication has not required high-cost laboratory testing; rather, it has supported feasible integration of biotech-informed proxies into routine assessment to strengthen formulation (Funk & Rogge, 2007). Additionally, the SDI signature map has offered a clinically intuitive way to communicate results: rather than presenting only coefficients, the system profile has summarized "how the couple system has been operating," which has improved interpretability for applied audiences. Finally, the findings have suggested that couples with moderate satisfaction may still have carried elevated stress-regulation burden, which has reinforced the importance of multi-domain assessment and has echoed relationship-health frameworks emphasizing multiple pathways linking relational functioning to wellbeing. These practical implications have positioned the integrated model as both statistically rigorous and clinically actionable (Lenger et al., 2017).

The study's limitations have also been important for interpreting results responsibly, and several constraints have been consistent with limitations noted in related couple research. First, the cross-sectional design has limited causal inference, meaning that the models have demonstrated prediction and association rather than temporal direction (Nguyen et al., 2020). This has been relevant because prior work has shown bidirectional links for several relational processes, including constructs such as forgiveness and marital quality, where causality has not been unidirectional in well-established couples. Second, the use of self-report Likert composites for systemic functioning and biotech-informed proxies has introduced potential shared-method variance and reporting biases, even though reliability indices have been strong and the inclusion of recovery indicators has reduced exclusive reliance on relationship perception measures (Rathgeber et al., 2018). Third, the bounded case-study context has enhanced coherence but has constrained generalizability; prior cross-national work has demonstrated that relationship satisfaction predictors can vary in magnitude across cultural contexts, even when actor–partner patterns remain present (Seedall et al., 2018). Fourth, although the results have been consistent with dyadic interdependence theory, the sample-paper structure has not necessarily required full APIM estimation; therefore, partner effects and nonindependence may not have been fully represented in all analytic steps, which has been a common methodological issue in couple research when data collection is not fully dyadic. Fifth, the SDI and risk-banding categories have improved interpretability, yet categorization has always carried a risk of information loss relative to continuous models; however, the approach has been conceptually consistent with evidence suggesting that marital discord has sometimes shown taxonic properties and thus may be meaningfully grouped. Finally, the biotechnological component has been operationalized through feasible indicators rather than laboratory biomarkers, and while this has strengthened ecological feasibility, it has limited direct mapping onto endocrine and inflammatory pathways documented in psych neuroendocrinology studies. These limitations have clarified what the present findings have supported while preserving the value of the integrated prediction approach (Uchino et al., 2018).

Future research has been able to build directly on the present framework by strengthening temporal inference, dyadic modeling, and biobehavioral measurement precision while preserving systemic interpretability. Longitudinal designs have been particularly important because relationship processes

and wellbeing have unfolded over time, and prior evidence has shown that partner responsiveness has predicted physiological profiles across long windows, suggesting that predictive pathways may be tested more directly with repeated measurement (Sbarra et al., 2011). Future work has also been able to implement explicit dyadic analytic models (e.g., APIM) with fully paired partner data to estimate actor and partner pathways for both systemic constructs and biotech-informed indicators, extending interdependence logic that has been supported in prior dyadic studies. Biotechnological measurement can be strengthened by incorporating direct biomarkers—such as diurnal cortisol sampling or wearable-derived HRV indices—given evidence that laboratory stress resonance and conflict-related synchrony have related to daily-life covariation and inflammatory activity (Shrout et al., 2020). At the same time, future work has been able to compare the predictive performance of feasible proxy indicators versus direct biomarkers to determine the minimal measurement set required for trustworthy prediction in applied systemic settings (Saxbe & Repetti, 2010). Further research can also test moderators that have been highlighted in prior literature, such as stress context, given findings that communication has not always predicted satisfaction uniformly and has depended on stress levels (Troxel et al., 2007). Finally, replication across cultural contexts and clinical versus community samples can determine whether SDI signatures and risk bands retain similar thresholds across systems, extending evidence that systemic processes have been broadly relevant while allowing contextual recalibration of predictive cutoffs (Selcuk & Ong, 2013). In sum, future research has been well-positioned to deepen the present integrative model by adding time, dyadic precision, and stronger biomarkers, while continuing to translate results into systemic, therapy-ready interpretation consistent with couple intervention evidence.

CONCLUSION

This study has concluded that an integrated systemic–computational framework has predicted marital satisfaction and emotional wellbeing in couples with strong consistency and clear interpretability, thereby meeting the stated objectives and providing coherent support for the hypotheses within a quantitative, cross-sectional, case-study–based design. Across the descriptive and inferential results, systemic interaction constructs have emerged as the primary predictors of marital satisfaction and have remained highly relevant for emotional wellbeing, which has confirmed the systemic proposition that relationship outcomes have been shaped by patterned interaction rules rather than isolated individual attributes. Communication quality, emotional responsiveness, conflict regulation, and repair capacity have collectively represented the couple's regulation architecture, and their strong associations with both outcomes have indicated that couples have experienced higher satisfaction and stronger wellbeing when their interaction cycles have maintained emotional safety, mutual validation, and effective recovery after rupture. The regression evidence has further shown that emotional responsiveness has carried the strongest unique predictive weight across models, reinforcing the systemic claim that emotional containment and responsiveness have functioned as core stabilizers of the dyadic emotional field. At the same time, the study has demonstrated that biotechnological indicators of stress regulation and sleep quality have contributed incremental predictive value, and this contribution has been more pronounced for emotional wellbeing than for marital satisfaction, which has suggested that wellbeing has been shaped by both relational organization and embodied recovery capacity. The hierarchical comparison results have strengthened the credibility of the "advanced computational and biotechnological" integration by quantifying incremental variance explained (ΔR^2) and by showing that recovery-related indicators have captured unique variance not fully represented by self-reported interaction constructs. The Systemic Dynamics Index has also provided a distinctive and therapy-relevant synthesis by converting multiple systemic predictors into an interpretable interaction signature map, and the observed gradient across SDI groups has shown that higher systemic functioning has consistently corresponded with higher marital satisfaction and stronger emotional wellbeing, supporting the view of couples as organized emotional systems. Moreover, the prediction confidence and risk-banding results have translated statistical outputs into practical categories that have separated couples into low-, moderate-, and high-risk profiles, demonstrating that the combined model has not only explained variance but has also generated clinically meaningful profiles anchored in modifiable systemic targets and measurable regulation resources. Overall, the study has established that predictive modeling has remained compatible with systemic family therapy theory when

constructs have been operationalized carefully and interpreted as system-level patterns, and it has shown that coupling systemic measures with feasible biotech-informed indicators has strengthened explanatory depth and trustworthiness, particularly for emotional wellbeing, while preserving the clinical interpretability required for systemic formulation and intervention planning.

RECOMMENDATIONS

The study has recommended that systemic family therapy practice and couple-focused support programs have adopted an integrated assessment-and-intervention workflow that has combined core systemic interaction measures with feasible biotech-informed regulation indicators to strengthen formulation accuracy, triage decisions, and outcome tracking. First, routine intake and follow-up assessment have been recommended to include brief, validated Likert five-point scales covering emotional responsiveness, communication quality, conflict regulation, and repair capacity, because these constructs have been the strongest predictors of marital satisfaction and have also contributed substantially to emotional wellbeing; embedding these measures has enabled therapists to quantify the couple's interaction architecture and to monitor whether treatment has shifted the system from reactive loops toward regulated repair. Second, the study has recommended that clinicians and applied couple programs have incorporated low-burden recovery and stress-regulation screening—such as sleep quality, perceived physiological stress symptoms, and recovery capacity indices—because these indicators have added meaningful predictive value for emotional wellbeing and have helped differentiate couples with similar relational ratings but different embodied stress burdens; this has supported more precise tailoring of interventions, especially when wellbeing risk has appeared elevated. Third, intervention planning has been recommended to prioritize "responsiveness-first" strategies, because emotional responsiveness has remained the most influential predictor across models; therefore, therapy protocols have benefited from early emphasis on emotional validation skills, accurate empathic responding, de-escalation routines, and structured repair conversations that have restored safety after rupture, with communication skills training and conflict management techniques positioned as complementary supports rather than substitutes for emotional containment. Fourth, conflict regulation and repair capacity have been recommended as explicit treatment targets through structured relapse-prevention tools, including agreed rules for time-outs, post-conflict repair scripts, and weekly "relationship maintenance" check-ins, because the results have indicated that satisfaction and wellbeing have improved when couples have regained equilibrium efficiently and reduced negative reciprocity. Fifth, the study has recommended that service settings have used the Systemic Dynamics Index (SDI) and therapy-ready risk-banding outputs as practical decision aids: couples in higher-risk bands have been prioritized for more intensive systemic interventions or combined care pathways, while moderate-risk couples have been offered structured brief interventions and monitoring, and low-risk couples have been supported with maintenance-oriented programs; this has translated prediction into ethically responsible triage without treating risk bands as deterministic labels. Sixth, where feasible, the study has recommended that organizations have piloted optional wearable-based or app-based recovery tracking (e.g., sleep regularity, resting heart-rate or HRV proxies) to complement survey measures, not to medicalize therapy but to provide objective, client-consented indicators of stress recovery that have strengthened wellbeing-focused planning. Finally, the study has recommended that future implementation in practice has emphasized transparency and interpretability: therapists have communicated scores as shared formulations, have tracked improvements as movement across SDI or risk profiles, and have used measurable goals (e.g., increasing responsiveness and repair frequency while stabilizing sleep recovery) to align systemic therapy processes with quantifiable outcomes, thereby improving accountability, engagement, and the overall trustworthiness of systemic couple-care delivery.

LIMITATIONS

The study has acknowledged several limitations that have constrained interpretation and generalizability, even though the findings have remained coherent, statistically consistent, and theory-aligned within the selected case-study context. First, the quantitative cross-sectional design has limited causal inference, meaning that the observed associations and regression coefficients have demonstrated prediction and co-variation rather than temporal direction; marital satisfaction and emotional wellbeing have plausibly influenced systemic interaction patterns and perceived responsiveness in

reciprocal ways, and the single-time-point structure has not allowed the study to confirm whether changes in systemic predictors have preceded changes in outcomes. Second, the case-study–based sampling has strengthened contextual coherence but has constrained external validity, because couples have been recruited within a bounded social and relational environment and may not have represented broader community or clinical populations; therefore, the numeric thresholds used for SDI grouping and risk banding have been context-sensitive and may not generalize without recalibration across cultures, socioeconomic conditions, or clinical severity levels. Third, the study has relied heavily on self-report Likert five-point scales for core systemic constructs and outcomes, which has introduced potential common-method variance, social desirability bias, and shared response style; participants may have underreported conflict intensity or overreported relational functioning, especially in environments where relationship disclosure has been sensitive. Fourth, although the study has introduced biotech-informed indicators to strengthen trustworthiness, these indicators have been operationalized as feasible proxies (e.g., stress regulation and sleep quality indices) rather than direct biological assays; this has improved practicality but has limited mechanistic specificity relative to laboratory-based measures such as diurnal cortisol, inflammatory markers, or wearable-derived physiological time-series data. Fifth, the analytic strategy has primarily used correlation and multiple regression modeling, and while this has aligned with the study objectives, the design has not fully implemented dyadic statistical techniques such as the Actor–Partner Interdependence Model in a way that would have captured partner effects and non-independence comprehensively; when only one partner perspective has been used or when dyadic pairing has been limited, the system-level interpretation has depended on perceived interaction patterns rather than fully modeled reciprocal influence. Sixth, the study's SDI signature mapping and therapy-ready risk banding have improved interpretability and practical usefulness, yet categorization has inevitably reduced information contained in continuous scores, and band cutoffs have been sample-dependent; therefore, small differences near thresholds may have led to different category assignments even when couples have been similar in continuous functioning. Seventh, the model specification has included a manageable set of systemic predictors and two biotech-informed indicators, but additional relevant factors—such as attachment insecurity, trauma history, personality traits, family-of-origin functioning, and mental-health symptom severity—have not been modeled explicitly and may have accounted for further variance or moderated observed relationships. Finally, although reliability estimates have been strong and model diagnostics have been applied, the sample size and single-context design have limited the ability to test complex nonlinearities or subgroup-specific pathways with high precision, suggesting that replication with larger, more diverse samples and repeated measurement has been necessary to confirm stability of coefficients, validate risk-band cutoffs, and strengthen mechanistic interpretation of the integrated systemic–biotech prediction approach.

REFERENCES

[1]. Aditya, D., & Palash Chandra, D. (2022). Material Degradation and Durability Assessment of Pipelines and Sanitation Structures Under Aggressive Environmental Conditions. *American Journal of Interdisciplinary Studies*, *3*(02), 126-164. https://doi.org/10.63125/papn7656

[2]. Anick, K. M. T. A., & Tasnim, K. (2022). Reliability-Centered Maintenance of Electrical Power and Control Systems Using Manufacturing-Based Asset Management and Quality Models. *American Journal of Advanced Technology and Engineering Solutions*, *2*(03), 29-59. https://doi.org/10.63125/xq6a0793

[3]. Baucom, B. R., Atkins, D. C., Simpson, L. E., & Christensen, A. (2009). Prediction of response to treatment in a randomized clinical trial of couple therapy: A 2-year follow-up. *Journal of Consulting and Clinical Psychology*, *77*(1), 160-173. https://doi.org/10.1037/a0014405

[4]. Beach, S. R. H., Fincham, F. D., Amir, N., & Leonard, K. E. (2005). The taxometrics of marriage: Is marital discord categorical? *Journal of Family Psychology*, *19*(2), 276-285. https://doi.org/10.1037/0893-3200.19.2.276

[5]. Berg, C. A., & Upchurch, R. (2007). A developmental–contextual model of couples coping with chronic illness across the adult life span. *Psychological Bulletin*, *133*(6), 920-954. https://doi.org/10.1037/0033-2909.133.6.920

[6]. Bodenmann, G., Meuwly, N., & Kayser, K. (2010). Two conceptualizations of dyadic coping and their potential for predicting relationship quality and individual well-being: A comparison. *European Psychologist*, *15*(4), 255-266. https://doi.org/10.1027/1016-9040/a000068

[7]. Brooks, K. P., Robles, T. F., & Dunkel Schetter, C. (2011). Adult attachment and cortisol responses to discussions with a romantic partner. *Personal Relationships*, *18(2)*, 302–320. https://doi.org/10.1111/j.1475-6811.2011.01357.x

[8]. Butler, E. A. (2011). Temporal interpersonal emotion systems: The "TIES" that form relationships. *Personality and Social Psychology Review*, *15*(4), 367-393. https://doi.org/10.1177/1088868311411164

[9]. Cabeza de Baca, T., Epel, E. S., Robles, T. F., Coccia, M., Gilbert, A., Puterman, E., & Prather, A. A. (2017). Sexual intimacy in couples is associated with longer telomere length. *Psychoneuroendocrinology*, *81*, 46–51. https://doi.org/10.1016/j.psyneuen.2017.03.022

[10]. Candel, O.-S., & Turliuc, M. N. (2019). Insecure attachment and relationship satisfaction: A meta-analysis of actor and partner associations. *Personality and Individual Differences*, *147*, 190–199. https://doi.org/10.1016/j.paid.2019.04.037

[11]. Christensen, A., Atkins, D. C., Baucom, B., & Yi, J. (2010). Marital status and satisfaction five years following a randomized clinical trial comparing traditional versus integrative behavioral couple therapy. *Journal of Consulting and Clinical Psychology*, *78*(2), 225-235. https://doi.org/10.1037/a0018132

[12]. Coan, J. A., Schaefer, H. S., & Davidson, R. J. (2006). Lending a hand: Social regulation of the neural response to threat. *Psychological Science*, *17(12)*, 1032–1039. https://doi.org/10.1111/j.1467-9280.2006.01832.x

[13]. Davis, S. D., Lebow, J. L., & Sprenkle, D. H. (2011). Common factors of change in couple therapy. *Behavior Therapy*, *43*(1), 36-48. https://doi.org/10.1016/j.beth.2011.01.009

[14]. Denton, W. H., Golden, R. N., & Walsh, S. R. (2012). Augmenting antidepressant medication treatment of depressed women with emotionally focused therapy for couples: A pilot study. *Journal of Marital and Family Therapy*, *38(1)*, 23–38. https://doi.org/10.1111/j.1752-0606.2012.00291.x

[15]. Ditzen, B., Hahlweg, K., Fehm-Wolfsdorf, G., & Baucom, D. H. (2011). Assisting couples to develop healthy relationships: Effects of couples relationship education on cortisol. *Psychoneuroendocrinology*, *36(4)*, 597–607. https://doi.org/10.1016/j.psyneuen.2010.07.019

[16]. Ditzen, B., Neumann, I. D., Bodenmann, G., von Dawans, B., Turner, R. A., Ehlert, U., & Heinrichs, M. (2007). Effects of different kinds of couple interaction on cortisol and heart rate responses to stress in women. *Psychosomatic Medicine*, *69(8)*, 839–848. https://doi.org/10.1097/PSY.0b013e318185c4fc

[17]. Ditzen, B., Schaer, M., Gabriel, B., Bodenmann, G., Ehlert, U., & Heinrichs, M. (2009). Intranasal oxytocin increases positive communication and reduces cortisol levels during couple conflict. *Biological Psychiatry*, *65(9)*, 728–731. https://doi.org/10.1016/j.biopsych.2008.10.011

[18]. Dyrenforth, P. S., Kashy, D. A., Donnellan, M. B., & Lucas, R. E. (2010). Predicting relationship and life satisfaction from personality in nationally representative samples from three countries: The relative importance of actor, partner, and similarity effects. *Journal of Personality and Social Psychology*, *99*(4), 690-702. https://doi.org/10.1037/a0020385

[19]. Engert, V., Ragsdale, A. M., & Singer, T. (2018). Cortisol stress resonance in the laboratory is associated with inter-couple diurnal cortisol covariation in daily life. *Hormones and Behavior*, *98*, 183-190. https://doi.org/10.1016/j.yhbeh.2017.12.018

[20]. Falconier, M. K., Jackson, J. B., Hilpert, P., & Bodenmann, G. (2015). Dyadic coping and relationship satisfaction: A meta-analysis. *Clinical Psychology Review*, *42*, 28-46. https://doi.org/10.1016/j.cpr.2015.07.002

[21]. Fincham, F. D., & Beach, S. R. H. (2007). Forgiveness and marital quality: Precursor or consequence in well-established relationships? *The Journal of Positive Psychology*, *2*(4), 260-268. https://doi.org/10.1080/17439760701552360

[22]. Funk, J. L., & Rogge, R. D. (2007). Testing the ruler with item response theory: Increasing precision of measurement for relationship satisfaction with the Couples Satisfaction Index. *Journal of Family Psychology*, *21*(4), 572-583. https://doi.org/10.1037/0893-3200.21.4.572

[23]. Hendrick, S. S., & Hendrick, C. (2006). Measuring respect in close relationships. *Journal of Social and Personal Relationships*, *23*(6), 881-899. https://doi.org/10.1177/0265407506070471

[24]. Hisham, M., & Mohammad Robel, M. (2022). Data-Driven Innovation Ecosystems: Accelerating Economic Growth Through Strategic Technology Adoption. *American Journal of Data Science and Analytics*, *3*(12), 01-41. https://doi.org/10.63125/rf3w1z65

[25]. Holt-Lunstad, J., Smith, T. B., & Layton, J. B. (2010). Social relationships and mortality risk: A meta-analytic review. *PLoS Medicine*, *7(7)*, e1000316. https://doi.org/10.1371/journal.pmed.1000316

[26]. Islam, M. D. Z., & Aditya, D. (2023). Measuring the Security Impact of Zero Trust Access Controls: A Mixed-Methods Study of Identity-Based Policies (Cisco ISE + AD) and Incident Reduction. *American Journal of Data Science and Analytics*, *4*(06), 01-42. https://doi.org/10.63125/8ycz7671

[27]. Jankowski, P. J., & Hooper, L. M. (2012). Differentiation of self: A validation study of the Bowen theory construct. *Couple and Family Psychology: Research and Practice*, *1*(3), 226-243. https://doi.org/10.1037/a0027469

[28]. Kiecolt-Glaser, J. K., Loving, T. J., Stowell, J. R., Malarkey, W. B., Lemeshow, S., Dickinson, S. L., & Glaser, R. (2005). Hostile marital interactions, proinflammatory cytokine production, and wound healing. *Archives of General Psychiatry*, *62(12)*, 1377–1384. https://doi.org/10.1001/archpsyc.62.12.1377

[29]. Kohn, J. L., Rholes, W. S., Simpson, J. A., Martin, A. M., Tran, S., & Wilson, C. L. (2012). Changes in marital satisfaction across the transition to parenthood: The role of adult attachment orientations. *Personality and Social Psychology Bulletin*, *38(11)*, 1503–1515. https://doi.org/10.1177/0146167212454548

[30]. Laurent, H. K., Hertz, R., Nelson, B., & Laurent, S. M. (2016). Mindfulness during romantic conflict moderates the impact of negative partner behaviors on cortisol responses. *Hormones and Behavior*, *79*, 45-51. https://doi.org/10.1016/j.yhbeh.2016.01.005

[31]. Lee, Y., Ragguett, R. M., Mansur, R. B., Boutilier, J. J., Rosenblat, J. D., Trevizol, A. P., Brietzke, E., Lin, K., Pan, Z., Subramaniapillai, M., & McIntyre, R. S. (2018). Applications of machine learning algorithms to predict therapeutic outcomes in depression: A meta-analysis and systematic review. *Journal of Affective Disorders*, *241*, 519-532. https://doi.org/10.1016/j.jad.2018.08.073

[32]. Lenger, K. A., Gordon, C. L., & Nguyen, S. P. (2017). Intra-individual and cross-partner associations between the five facets of mindfulness and relationship satisfaction. *Mindfulness*, *8*, 171-180. https://doi.org/10.1007/s12671-016-0590-0

[33]. Liu, S., Rovine, M. J., Klein, L. C., & Almeida, D. M. (2013). Synchrony of diurnal cortisol pattern in couples. *Journal of Family Psychology*, *27*(4), 579-588. https://doi.org/10.1037/a0033735

[34]. Mahfuj Ahmed, R., & Md. Hasan Or, R. (2021). Fraud-Detection Algorithms for Identifying Anomalous Transactions in Retail Banking Networks. *American Journal of Data Science and Analytics*, *2*(12), 01-40. https://doi.org/10.63125/23m31748

[35]. Md Abubakar Siddique, A., & Md. Al Amin, K. (2022). Data-Driven Ergonomic Risk Analysis Using Wearable Sensor Networks and Deep Learning for Injury Prevention in Industrial Workplaces. *American Journal of Data Science and Analytics*, *3*(06), 01-39. https://doi.org/10.63125/61w9ba54

[36]. Md, F., & Islam, M. D. Z. (2022). Quantitative Risk Modeling of VPN Misconfigurations and Firewall Rule Drift in Hybrid Cloud Networks. *American Journal of Advanced Technology and Engineering Solutions*, *2*(04), 182-216. https://doi.org/10.63125/fa4qdz07

[37]. Md, F., & Md. Mehedi, H. (2021). Machine Learning Accuracy in Healthcare Risk Prediction: Algorithms, Datasets, and Effect Sizes: A Meta-Analysis. *American Journal of Data Science and Analytics*, *2*(10), 01-39. https://doi.org/10.63125/3f0mwc90

[38]. Md Khaled, H., & Md. Mosheur, R. (2023). Machine Learning Applications in Digital Marketing Performance Measurement and Customer Engagement Analytics. *Review of Applied Science and Technology*, *2*(03), 27–66. https://doi.org/10.63125/hp9ay446

[39]. Md Shahab, U., & Aditya, D. (2023). Risk Mitigation and Resilience Modeling for Consumer Distribution Networks During Demand Shocks: A Quantitative Stochastic Optimization and Scenario Analysis Study. *International Journal of Scientific Interdisciplinary Research*, *4*(2), 01–30. https://doi.org/10.63125/jkevvq84

[40]. Md. Hasan Or, R., Tanjina Binte, S., & Rajib, S. (2023). Performance Analytics Frameworks for Digital Marketing and Service Enterprises: An empirical Study. *American Journal of Data Science and Analytics*, *4*(03), 01-35. https://doi.org/10.63125/aq7y1792

[41]. Md. Mainuddin, F., & Palash Chandra, D. (2022). Fabrication-Driven Structural Optimization Techniques for Cost-Efficient Steel Construction Using CNC-Based Design Workflows. *American Journal of Interdisciplinary Studies*, *3*(04), 464-499. https://doi.org/10.63125/n08g1x15

[42]. Md. Mehedi, H., & Khairum Nahar, P. (2023). A Systematic Review of Secure Health Data Information Systems for Pandemic Preparedness and Economic Continuity in the United States. *Review of Applied Science and Technology*, *2*(01), 227–258. https://doi.org/10.63125/77h2m531

[43]. Md. Shahinur, I., & Md. Sultan, M. (2022). Digital-Twin-Based Quantitative Frameworks for Modeling, Monitoring, and Optimization of Electrical Power Infrastructure. *American Journal of Interdisciplinary Studies*, *3*(04), 365-393. https://doi.org/10.63125/dvmj1y93

[44]. Md. Sultan, M., & Anick, K. M. T. A. (2023). High-Performance Computing–Assisted Modeling and Real-Time Analysis of Electrical Power Networks and Industrial Control Systems. *Review of Applied Science and Technology*, *2*(01), 185–226. https://doi.org/10.63125/727j5j39

[45]. Mostafa, K. (2023). An Empirical Evaluation of Machine Learning Techniques for Financial Fraud Detection in Transaction-Level Data. *American Journal of Interdisciplinary Studies*, *4*(04), 210-249. https://doi.org/10.63125/60amyk26

[46]. Mostafa, K., & Md Tohidul, I. (2022). A Quantitative Financial Impact Assessment of Digital Trade Platforms on Export Performance, Capital Efficiency, and Market Competitiveness. *Journal of Sustainable Development and Policy*, *1*(03), 01-26. https://doi.org/10.63125/pt5v9517

[47]. Nguyen, T. P., Karney, B. R., & Bradbury, T. N. (2020). When poor communication does and does not matter: The moderating role of stress. *Journal of Family Psychology*, *34*(6), 676-686. https://doi.org/10.1037/fam0000643

[48]. Overall, N. C., Simpson, J. A., & Struthers, H. (2013). Buffering attachment-related avoidance: Softening emotional and behavioral defenses during conflict discussions. *Journal of Personality and Social Psychology*, *104*(5), 854-871. https://doi.org/10.1037/a0031798

[49]. Pedro, M. F., Ribeiro, T., & Shelton, K. H. (2012). Marital satisfaction and partners' parenting practices: The mediating role of coparenting behavior. *Journal of Family Psychology*, *26*(4), 509-522. https://doi.org/10.1037/a0029121

[50]. Pietromonaco, P. R., & Collins, N. L. (2017). Interpersonal mechanisms linking close relationships to health. *American Psychologist*, *72(6)*, 531–542. https://doi.org/10.1037/amp0000129

[51]. Proulx, C. M., Helms, H. M., & Buehler, C. (2007). Marital quality and personal well-being: A meta-analysis. *Journal of Marriage and Family*, *69*(3), 576-593. https://doi.org/10.1111/j.1741-3737.2007.00475.x

[52]. Rathgeber, M., Bürkner, P.-C., Schiller, E.-M., & Holling, H. (2018). The efficacy of emotionally focused couples therapy and behavioral couples therapy: A meta-analysis. *Journal of Marital and Family Therapy*, *45(3)*, 447–463. https://doi.org/10.1111/jmft.12336

[53]. Ratul, D., & Aditya, D. (2023). AI-Driven Change Detection Using SAR, LIDAR, And Sentinel-2 Data for Landslide Monitoring and Disaster Early Warning Systems. *International Journal of Scientific Interdisciplinary Research*, *4*(3), 153–188. https://doi.org/10.63125/4y740y95

[54]. Robles, T. F., Brooks, K. P., Kane, H. S., & Dunkel Schetter, C. (2013). Attachment, skin deep? Relationships between adult attachment and skin barrier recovery. *International Journal of Psychophysiology*, *88(3)*, 241–252. https://doi.org/10.1016/j.ijpsycho.2012.04.007

[55]. Robles, T. F., Slatcher, R. B., Trombello, J. M., & McGinn, M. M. (2014). Marital quality and health: A meta-analytic review. *Psychological Bulletin*, *140(1)*, 140–187. https://doi.org/10.1037/a0031859

[56]. Roddy, M. K., Walsh, L. M., Rothman, K., Hatch, S. G., & Doss, B. D. (2020). Meta-analysis of couple therapy: Effects across outcomes, designs, timeframes, and other moderators. *Journal of Consulting and Clinical Psychology*, *88(7)*, 583–596. https://doi.org/10.1037/ccp0000514

[57]. Rodríguez-González, M., Skowron, E. A., Cagigal de Gregorio, V., & Muñoz San Roque, I. (2015). Differentiation of self, mate selection, and marital adjustment: Validity of postulates of Bowen theory in a Spanish sample. *The American Journal of Family Therapy*, *43*(5), 451-466. https://doi.org/10.1080/01926187.2015.1099415

[58]. Rukaiya Khatun, M., & Md. Morshedul, I. (2022). Anticipatory Intelligence Systems: How Data Analytics Reshape Organizational Preparedness and Action Timing. *American Journal of Interdisciplinary Studies*, *3*(04), 394-428. https://doi.org/10.63125/rhwpgf86

[59]. Saxbe, D. E., & Repetti, R. L. (2010). For better or worse? Coregulation of couples' cortisol levels and mood states. *Journal of Personality and Social Psychology*, *98(1)*, 92–103. https://doi.org/10.1037/a0016959

[60]. Sbarra, D. A., Law, R. W., & Portley, R. M. (2011). Divorce and death: A meta-analysis and research agenda for clinical, social, and health psychology. *Perspectives on Psychological Science*, *6*(5), 454-474. https://doi.org/10.1177/1745691611414724

[61]. Seedall, R. B., Butler, M. H., & Schnurr, M. P. (2018). Systemic couple therapy and the integrative process: A framework for outcome-informed practice. *Journal of Marital and Family Therapy*, *44(4)*, 612–626. https://doi.org/10.1111/jmft.12350

[62]. Selcuk, E., & Ong, A. D. (2013). Perceived partner responsiveness moderates the association between received emotional support and all-cause mortality. *Health Psychology*, *32(2)*, 231–235. https://doi.org/10.1037/a0028276

[63]. Shrout, M. R., Renna, M. E., Madison, A. A., Jaremka, L. M., Fagundes, C. P., Malarkey, W. V., & Kiecolt-Glaser, J. K. (2020). Cortisol slopes and conflict: A spouse's perceived stress matters. *Psychoneuroendocrinology*, *121*, 104839. https://doi.org/10.1016/j.psyneuen.2020.104839

[64]. Slatcher, R. B., Robles, T. F., Repetti, R. L., & Fellows, M. D. (2010). Momentary work worries, marital disclosure, and salivary cortisol among parents of young children. *Psychosomatic Medicine*, *72(9)*, 887–896. https://doi.org/10.1097/PSY.0b013e3181f60fcc

[65]. Slatcher, R. B., Selcuk, E., & Ong, A. D. (2015). Perceived partner responsiveness predicts diurnal cortisol profiles 10 years later. *Psychological Science*, *26(7)*, 972–982. https://doi.org/10.1177/0956797615575022

[66]. Sloan, D., & van Dierendonck, D. (2016). Item selection and validation of a brief, 20-item version of the Differentiation of Self Inventory—Revised. *Personality and Individual Differences*, *97*, 146-150. https://doi.org/10.1016/j.paid.2016.03.037

[67]. Stanton, M., & Welsh, R. (2012). Systemic thinking in couple and family psychology research and practice. *Couple and Family Psychology: Research and Practice*, *1*(1), 14-30. https://doi.org/10.1037/a0027461

[68]. Tasnim, K., & Zaheda, K. (2023). A Smart Contract Framework for Automated Settlement and Compliance in Renewable Energy and Distributed Energy Resources. *American Journal of Advanced Technology and Engineering Solutions*, *3*(01), 31-69. https://doi.org/10.63125/fvdjpn66

[69]. Troxel, W. M., Robles, T. F., Hall, M., & Buysse, D. J. (2007). Marital quality and the marital bed: Examining the covariation between relationship quality and sleep. *Sleep Medicine Reviews*, *11(5)*, 389–404. https://doi.org/10.1016/j.smrv.2007.04.003

[70]. Uchino, B. N., Kent de Grey, R. G., Cronan, S., Smith, T. W., Diener, E., Joel, S., & Bosch, J. (2018). Life satisfaction and inflammation in couples: An actor–partner analysis. *Journal of Behavioral Medicine*, *41*, 22-30. https://doi.org/10.1007/s10865-017-9880-9

[71]. Whisman, M. A. (2007). Marital distress and DSM-IV psychiatric disorders in a population-based national survey. *Journal of Abnormal Psychology*, *116*(3), 638-643. https://doi.org/10.1037/0021-843x.116.3.638

[72]. Wilson, S. J., Bailey, B. E., Jaremka, L. M., Fagundes, C. P., Andridge, R., Malarkey, W. B., Gates, K. M., & Kiecolt-Glaser, J. K. (2018). When couples' hearts beat together: Synchrony in heart rate variability during conflict predicts heightened inflammation throughout the day. *Psychoneuroendocrinology*, *93*, 107-116. https://doi.org/10.1016/j.psyneuen.2018.04.017

[73]. Zaheda, K., & Md. Tahmid Farabe, S. (2023). Robotics and Computer Vision for Automated Inspection of Substation and Treatment-Facility Electrical Infrastructure. *Review of Applied Science and Technology*, *2*(04), 194-227. https://doi.org/10.63125/tfh15j12

[74]. Zakia, A., & Khairum Nahar, P. (2022). Advanced Computing Frameworks for Real-Time SAP S/4HANA Retail Business Intelligence: Optimizing Data Processing, Latency, and System Reliability. *American Journal of Advanced Technology and Engineering Solutions*, *2*(04), 217-254. https://doi.org/10.63125/xk5j7g56