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Seafarers' Mental Health in Sustainable Maritime Workplaces: A System Dynamics Approach to Workplace Bullying, Gender Equality, and Human Resource Management

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ABSTRACT: Seafarers operate in a distinctive occupational environment characterized by prolonged periods away from home, hierarchical organizational structures, multicultural crews, demanding work schedules, and limited access to psychosocial support. These conditions may increase the vulnerability of seafarers to workplace bullying, gender inequality, and mental health problems. This study aims to develop a System Dynamics model to examine the dynamic relationships among workplace bullying, gender equality, human resource management, and seafarers' mental health within sustainable maritime workplaces. The study conceptualizes human resource management as an organizational mechanism that can influence psychosocial working conditions and strengthen a supportive and inclusive maritime work environment. System Dynamics is employed to identify feedback relationships, delays, reinforcing and balancing mechanisms, and potential intervention points within the proposed system. The model integrates workplace bullying, gender equality, organizational support, working conditions, and mental health as interconnected components rather than isolated organizational issues. The simulation framework is expected to demonstrate that improvements in inclusive human resource management and gender-equitable workplace practices can reduce bullying pressures and contribute to better mental health outcomes among seafarers. Conversely, persistent bullying and gender inequality may create reinforcing negative feedback that increases psychological stress and weakens the sustainability of the maritime workplace. The study contributes to the emerging literature on occupational mental health by providing a systems perspective for understanding seafarers' health in sustainable maritime workplaces. The proposed model also provides a

basis for maritime organizations, policymakers, and human resource managers to evaluate alternative interventions aimed at preventing psychosocial risks and promoting healthier, safer, and more inclusive maritime workplaces.

1. INTRODUCTION

The maritime sector is fundamental to global trade, food security, energy transportation, and the sustainable use of marine resources. However, the sustainability of maritime operations depends not only on technological development and environmental management but also on the health, safety, and well-being of the people who operate vessels. Seafarers work in a distinctive occupational environment characterized by prolonged periods away from family, extended working hours, fatigue, social isolation, multicultural crews, hierarchical structures, and limited access to health and psychosocial services. These characteristics make seafaring an important occupational health context in which physical and psychological conditions are closely interconnected. Recent research continues to identify fatigue, stress, social conditions, and the working environment as important determinants of seafarer health (Ma & Liao, 2025; Baumler & Carrera-Arce, 2025).

Mental health has therefore become an increasingly important component of maritime occupational health. A systematic review of maritime personnel found that seafarers are exposed to multiple psychosocial stressors, including social isolation, long working hours, and unfavorable physical and social working conditions, which may affect psychological well-being (Britt et al., 2022). More recent research emphasizes that mental health risks at sea should be considered within the broader occupational and organizational system rather than as individual psychological problems. Baumler and Carrera-Arce (2025), for example, highlighted the persistent problem of suicide at sea and argued that limited data and insufficient attention to seafarers' working and living conditions constrain effective understanding and prevention of mental health problems. These findings demonstrate that seafarers' mental health is an important human health issue within the maritime environment.

Workplace bullying and harassment represent another important psychosocial risk. The maritime workplace is characterized by confined living and working spaces, strong hierarchical relationships, and prolonged interaction among crew members, which may create conditions in which bullying, harassment, and abuse can have substantial consequences. A structured literature review identified workplace bullying and harassment as significant concerns among seafarers and emphasized the need for proactive organizational responses, adequate management resources, and integration of prevention mechanisms into maritime safety management systems (Sampson et al., 2022). The issue has gained further international regulatory attention. In May 2024, the International Maritime Organization adopted amendments to the STCW Code introducing mandatory minimum training requirements concerning the prevention of and response to violence and harassment at sea, including bullying, sexual harassment, and sexual assault (IMO, 2024).

The 2024 STCW amendments are particularly significant because they recognize violence and harassment as issues associated with both safety and human well-being. The new requirements under Table A-VI/1-4 seek to equip seafarers with knowledge and understanding of violence and harassment and with the capacity to prevent and respond to such incidents (IMO, 2024). The International Maritime Organization and International Labour Organization have also emphasized the importance of organizational policies, reporting mechanisms, risk assessment, victim protection, management responsibility, and access to medical and mental health support when addressing violence and harassment in the maritime sector (IMO, 2024). Thus, preventing bullying should not be considered solely a disciplinary issue; it is also an occupational health and organizational sustainability issue.

Gender equality represents another critical dimension of the maritime workplace. Although women's participation in maritime activities has increased, substantial gender disparities remain. The IMO-WISTA Women in Maritime Survey 2024, published in 2025, covered 176,820 women working across the maritime sector and reported continuing gender disparities. Women represented just under 19% of the workforce sampled, while the survey identified continuing barriers related to recruitment, career advancement, workplace conditions, discrimination, and harassment (IMO & WISTA, 2025). These structural inequalities are particularly relevant to seafarers because women working at sea may experience additional vulnerabilities associated with gender stereotypes, professional marginalization, bullying, sexual harassment, and limited access to appropriate support.

Recent empirical evidence reinforces this concern. A study published in *Marine Policy* found that women working aboard vessels experienced substantial exposure to harassment and bullying and that gender inequality was associated with physical and psychological consequences for ocean professionals (2024). Another study examining Chinese women seafarers identified employment discrimination, stereotypes, safety and healthcare concerns, bullying, abuse, and sexual harassment among the major challenges affecting women's maritime careers (2024). These findings suggest that gender equality is not simply a human resource policy objective but can also be directly relevant to occupational health and psychological well-being.

Human Resource Management can play a central role in addressing these interconnected problems. Traditional maritime HRM has generally emphasized recruitment, training, certification, performance, retention, and compliance. However, contemporary maritime organizations increasingly need an HRM approach that incorporates psychosocial risk management, psychological safety, equality, employee support, and health promotion. Effective HRM can establish mechanisms for reporting bullying, protecting victims, strengthening leadership accountability, improving communication, supporting inclusive recruitment and promotion, and ensuring access to mental health resources. In this sense, HRM can function as an organizational mechanism connecting regulatory requirements with actual workplace conditions.

The relationship between workplace conditions and seafarer health is inherently systemic. A negative workplace environment may increase bullying and discrimination, which can increase psychological stress and reduce psychological safety. Increased stress may subsequently contribute to fatigue, reduced work engagement, absenteeism, turnover intentions, and deterioration of organizational performance. These outcomes can further weaken crew cohesion and organizational support, potentially reinforcing the original negative workplace conditions. Conversely, effective HRM, gender-equitable practices, psychological safety, and anti-bullying mechanisms may generate reinforcing positive effects on employee well-being and organizational sustainability.

This systemic characteristic creates an important methodological challenge. Conventional statistical approaches are useful for identifying relationships among variables, but they may be less capable of representing feedback loops, delays, nonlinear relationships, and policy interactions that characterize maritime psychosocial health. System Dynamics provides an appropriate complementary approach because it allows researchers to represent complex organizational systems through causal relationships, feedback structures, stocks and flows, and simulation over time. In the context of seafarer mental health, System Dynamics can help examine how interventions targeting bullying, gender equality, and HRM may produce short-term and long-term consequences.

The need for a systems perspective is strengthened by recent developments in international maritime regulation. The IMO's comprehensive review of the STCW framework has identified mental health, gender sensitization, emerging technologies, and other human-element issues as areas requiring greater attention (IMO, 2024). At the same time, the adoption of new requirements concerning violence and harassment demonstrates that maritime health and safety increasingly depend on organizational and human factors rather than technical competence alone. These developments create a policy environment in which maritime organizations need tools capable of assessing the interaction among human resource policies, psychosocial risks, equality, and health outcomes.

Despite increasing attention to seafarer mental health, bullying, harassment, and gender equality, the literature remains relatively fragmented. Existing studies have examined seafarer mental health, fatigue, bullying, gender discrimination, and maritime safety as separate issues. Recent evidence demonstrates the importance of each factor individually, but there remains limited research examining how these variables interact dynamically within a single organizational system. In particular, there is a need to understand whether improvements in HRM and gender equality can reduce bullying and generate longer-term improvements in seafarers' mental health.

This study addresses this gap by developing a System Dynamics model of seafarers' mental health in sustainable maritime workplaces. The model integrates Workplace Bullying, Gender Equality, Human Resource Management, and Seafarers' Mental Health within a dynamic feedback structure. Rather than treating mental health as an isolated individual outcome, the study conceptualizes it as an emergent outcome of interactions among organizational policies, workplace relationships, psychosocial risks, and human resource practices.

The study makes three contributions. First, it contributes to maritime occupational health research by placing seafarers' mental health at the center of an integrated organizational model. Second, it contributes to maritime HRM research by demonstrating

how HRM can be positioned as a mechanism for preventing psychosocial risks and promoting healthier and more inclusive workplaces. Third, it contributes methodologically by applying System Dynamics to examine feedback mechanisms and potential intervention pathways among bullying, gender equality, HRM, and mental health.

The central research question is therefore: How do workplace bullying, gender equality, and human resource management interact dynamically to influence seafarers' mental health in sustainable maritime workplaces? By addressing this question, the study seeks to provide a systems-based foundation for developing maritime workplace interventions that simultaneously promote psychological health, equality, safety, and organizational sustainability.

2. LITERATURE REVIEW

2.1 Seafarers' Mental Health

Seafarers' mental health represents an important dimension of occupational health because maritime work combines demanding physical conditions with prolonged social separation, irregular working schedules, restricted mobility, and limited access to conventional healthcare services. Unlike many land-based occupations, seafarers may spend several months living and working in a confined environment, which can intensify psychological stress and reduce opportunities for recovery. Recent research has continued to identify stress, fatigue, loneliness, social isolation, sleep disturbance, and demanding working conditions as important factors associated with seafarers' psychological well-being (Ma & Liao, 2025; Baumler & Carrera-Arce, 2025).

Mental health in this study is conceptualized as a multidimensional outcome involving psychological well-being, perceived stress, emotional stability, anxiety and depressive symptoms, and the individual's ability to maintain healthy functioning under demanding occupational conditions. This conceptualization is consistent with the broader occupational health perspective in which mental health is influenced not only by individual characteristics but also by working conditions, organizational support, interpersonal relationships, and psychosocial risks.

The maritime environment can create a cumulative health burden. Extended working hours and irregular schedules may contribute to fatigue and sleep problems, while prolonged separation from family can generate loneliness and emotional strain. When these conditions interact with inadequate organizational support, the probability of psychological distress may increase. Therefore, improving seafarers' mental health requires interventions that address the organizational environment rather than relying exclusively on individual coping strategies.

2.2 Workplace Bullying as a Psychosocial Risk

Workplace bullying refers to repeated negative behaviors directed toward an individual or group in circumstances where the target has difficulty defending themselves. In maritime organizations, bullying may take the form of verbal abuse, intimidation, humiliation, social exclusion, discriminatory treatment, abuse of authority, or other repeated hostile behaviors.

The maritime context may increase the importance of bullying because of the combination of hierarchical authority, confined living and working environments, and prolonged interpersonal interaction. Sampson et al. (2022) identified bullying and harassment as significant concerns within the maritime workplace and emphasized the importance of organizational prevention and reporting mechanisms. More recent regulatory developments reinforce the significance of this issue. The 2024 amendments to the STCW Code introduced mandatory minimum training requirements concerning the prevention of and response to violence and harassment at sea, including bullying, sexual harassment, and sexual assault (IMO, 2024).

Workplace bullying can affect mental health through several mechanisms. Repeated exposure to hostile interpersonal behavior can increase perceived stress, reduce psychological safety, weaken organizational trust, and generate emotional exhaustion. In maritime environments, the effects may be amplified because employees cannot easily remove themselves from the source of stress while onboard. Consequently, bullying should be considered not only an interpersonal problem but also a systemic occupational health risk.

From a System Dynamics perspective, bullying can create a reinforcing negative feedback loop. Increased bullying can increase psychological distress; increased distress may reduce communication and social cohesion; reduced cohesion may weaken informal support and increase interpersonal conflict; and these conditions may subsequently create an environment in which bullying becomes more likely. This feedback structure makes bullying particularly appropriate for dynamic modeling.

2.3 Gender Equality in Maritime Workplaces

Gender equality refers to equitable opportunities, treatment, participation, development, and protection for individuals regardless of gender. In maritime organizations, gender equality encompasses recruitment, career advancement, remuneration, leadership opportunities, workplace safety, access to facilities and healthcare, protection from harassment, and participation in decision-making.

Women remain substantially underrepresented in the maritime workforce. The IMO-WISTA Women in Maritime Survey 2024, published in 2025, collected data from 176,820 women and reported that women represented less than one-fifth of the workforce represented in the survey. The findings also identified continuing challenges related to recruitment, retention, career progression, and workplace conditions (IMO & WISTA, 2025).

Gender inequality can have consequences beyond workforce composition. Women working in male-dominated maritime environments may experience discrimination, stereotyping, bullying, harassment, and limited access to organizational support. Recent research on women seafarers has identified employment discrimination, gender stereotypes, safety concerns, bullying, abuse, and sexual harassment as important challenges affecting women's maritime careers (2024).

Gender equality can therefore be conceptualized as a protective organizational factor for mental health. An inclusive workplace can strengthen psychological safety, organizational belonging, perceived fairness, and access to career opportunities. Conversely, gender discrimination may increase psychological stress and create conditions that facilitate bullying and harassment.

The relationship between gender equality and workplace bullying may also be bidirectional. A workplace characterized by strong gender equality may reduce tolerance for discriminatory behavior and strengthen reporting mechanisms. Lower levels of discrimination may subsequently reduce bullying and improve psychological safety. In contrast, persistent bullying may reinforce gender stereotypes and discourage women from reporting inappropriate behavior, thereby weakening gender equality. This reciprocal relationship provides an important basis for System Dynamics modeling.

2.4 Human Resource Management and Maritime Employee Health

Human Resource Management represents an important organizational mechanism through which maritime organizations can influence employee health and workplace sustainability. HRM encompasses recruitment, selection, training, performance management, compensation, employee relations, organizational support, career development, and employee welfare.

Traditional maritime HRM has focused heavily on competency, certification, safety compliance, staffing, and operational performance. However, emerging occupational health challenges require HRM to incorporate psychosocial risk management and mental health promotion. The 2024 STCW amendments reinforce this direction by requiring training related to preventing and responding to violence and harassment, thereby increasing the role of organizational systems in protecting seafarers (IMO, 2024).

HRM can influence mental health through both direct and indirect mechanisms. Supportive HR practices may improve perceived organizational support, reduce role ambiguity, strengthen communication, and provide employees with access to assistance. HRM can also establish formal mechanisms for reporting bullying and harassment, protecting complainants, investigating incidents, and providing appropriate follow-up.

The Job Demands-Resources framework provides a useful theoretical explanation. The framework proposes that employee well-being is influenced by the balance between job demands and job resources. Excessive demands such as workload, emotional strain, conflict, and harassment can increase health risks, whereas organizational resources such as social support, autonomy, effective leadership, and organizational assistance can protect employee well-being (Demerouti et al., 2001; Bakker & Demerouti, 2017).

In maritime organizations, HRM can therefore be interpreted as a source of organizational resources. Effective HRM can increase access to support, improve communication, strengthen workplace fairness, and reduce psychosocial risks. This suggests that HRM is not merely an administrative function but an important determinant of sustainable human health.

2.5 Sustainable Maritime Workplaces

Sustainable maritime workplaces extend the concept of sustainability beyond environmental protection to include the long-term health, safety, dignity, and well-being of maritime workers. Sustainable maritime operations require competent employees, safe working conditions, equitable employment practices, effective organizational support, and mechanisms for maintaining employee health.

The concept is particularly relevant because maritime sustainability depends on human capital. Ships and maritime infrastructure may be technologically advanced, but their safe and sustainable operation ultimately depends on people. A workplace that experiences persistent bullying, discrimination, psychological distress, or high employee turnover may undermine operational sustainability even when environmental performance is strong.

A sustainable maritime workplace should therefore integrate environmental, social, and human dimensions. Gender equality contributes to social sustainability, anti-bullying mechanisms contribute to psychosocial safety, HRM provides organizational support, and employee mental health represents an important human sustainability outcome.

This perspective is consistent with the broader sustainable HRM literature, which argues that organizational sustainability should incorporate employee well-being and social outcomes alongside economic and environmental objectives (Kramar, 2014; Aust et al., 2020). In the present study, sustainable maritime workplaces are therefore conceptualized as organizational environments in which HRM practices, equality, psychosocial safety, and employee health are mutually reinforcing.

2.6 System Dynamics Perspective

System Dynamics is particularly appropriate for examining complex organizational and health-related problems because it focuses on feedback structures, accumulation, delays, nonlinear relationships, and changes over time. Unlike conventional linear models, System Dynamics allows researchers to examine how variables influence one another through reinforcing and balancing feedback loops.

The mental health of seafarers is inherently dynamic. For example, bullying may increase psychological stress, stress may reduce work engagement, reduced engagement may weaken social interaction, and weaker social interaction may increase vulnerability to further psychological problems. Similarly, effective HRM may increase organizational support, strengthen psychological safety, reduce bullying, and subsequently improve mental health. Improvements in mental health may then increase work engagement and social cohesion, creating a reinforcing positive cycle.

System Dynamics therefore provides a framework for moving beyond the question of whether one variable affects another toward the more important question of how multiple variables interact over time. This approach is especially valuable for policy analysis because it allows alternative interventions to be simulated before implementation.

In this study, the System Dynamics model conceptualizes HRM and gender equality as potentially protective forces, workplace bullying as a psychosocial risk, and seafarers' mental health as a central human health outcome. The model also incorporates feedback between these components to represent the dynamic nature of maritime workplaces.

2.7 Theoretical Integration

The present study integrates the Job Demands-Resources perspective with a System Dynamics perspective. The JD-R framework provides the behavioral and occupational health logic for identifying workplace demands and resources, while System Dynamics provides the methodological structure for representing their interactions over time.

Workplace bullying represents an important job demand that may increase psychological stress and reduce mental health. Gender inequality can function as a structural condition that increases exposure to discrimination and harassment. Conversely, effective HRM, organizational support, gender-equitable practices, and anti-bullying mechanisms can function as job resources that protect employee health.

The interaction can be expressed conceptually as follows. Stronger HRM improves organizational support and workplace governance. Improved governance strengthens gender equality and reduces tolerance for bullying. Lower bullying reduces psychosocial stress and improves psychological safety. Improved psychological safety contributes to better mental health. Better

mental health may subsequently strengthen work engagement and interpersonal relationships, further supporting a healthy workplace environment.

This structure suggests that the relationships are not necessarily linear. The same intervention may produce different outcomes depending on the initial condition of the workplace and the strength of existing feedback mechanisms. System Dynamics is therefore used to capture these interactions.

2.8 Research Gap and Hypothesis Development

The literature demonstrates that seafarers' mental health is influenced by occupational and psychosocial conditions, while bullying and gender inequality represent important workplace risks. At the same time, HRM provides organizational mechanisms for managing these risks. However, these research streams have generally developed separately.

The first gap concerns the limited integration of workplace bullying, gender equality, and HRM within a single framework of seafarers' mental health. Existing studies have frequently examined these factors independently, making it difficult to understand their interaction.

The second gap concerns methodology. Much existing research relies on cross-sectional surveys and conventional statistical relationships. Such approaches are useful for identifying associations but have limitations when the research problem involves feedback loops, delays, cumulative effects, and policy interventions.

The third gap concerns the human-centered dimension of maritime sustainability. Maritime sustainability discussions often emphasize environmental performance, operational efficiency, and technological development, while the long-term mental health of seafarers receives comparatively less attention.

Based on the literature and theoretical integration, the following propositions are developed for the System Dynamics model.

H1: Effective Human Resource Management reduces Workplace Bullying in sustainable maritime workplaces.

H2: Effective Human Resource Management promotes Gender Equality in sustainable maritime workplaces.

H3: Higher levels of Workplace Bullying negatively influence Seafarers' Mental Health.

H4: Higher levels of Gender Equality positively influence Seafarers' Mental Health.

H5: Effective Human Resource Management positively influences Seafarers' Mental Health.

H6: Human Resource Management influences Seafarers' Mental Health indirectly through its effects on Workplace Bullying and Gender Equality.

H7: The interaction among Human Resource Management, Workplace Bullying, and Gender Equality generates reinforcing and balancing feedback mechanisms that determine the long-term trajectory of Seafarers' Mental Health.

The propositions provide the theoretical foundation for the System Dynamics model presented in the following section. Rather than treating each relationship as an isolated causal path, the model examines how the variables interact dynamically and how alternative HRM and workplace policies may change the long-term mental health trajectory of seafarers.

3. METHODS

3.1 Research Design

This study employed a System Dynamics research design to examine the dynamic relationships among Human Resource Management, Workplace Bullying, Gender Equality, and Seafarers' Mental Health in sustainable maritime workplaces. System Dynamics was selected because the research problem involves multiple interacting variables, feedback mechanisms, time delays, and cumulative effects that cannot be adequately represented by a simple linear causal model.

The study followed a model-based research process consisting of problem identification, conceptualization, causal loop diagram development, stock-and-flow model construction, model parameterization, simulation, validation, and policy experimentation. The overall methodological structure is presented in Table 1.

Table 1. Research Methodological Framework

Stage	Research Activity	Main Output
1	Problem identification	Definition of seafarers' mental health problem
2	Literature review	Identification of key variables and causal relationships
3	Conceptualization	Definition of HRM, workplace bullying, gender equality, and mental health
4	Causal mapping	Causal Loop Diagram
5	Model construction	Stock-and-Flow Diagram
6	Model parameterization	Equations, initial values, and behavioral assumptions
7	Model simulation	Baseline behavioral trajectory
8	Model validation	Structural and behavioral validation
9	Policy experimentation	Alternative HRM and workplace intervention scenarios
10	Interpretation	Policy and managerial implications

3.2 Research Context

The research focuses on seafarers working in commercial maritime organizations. The maritime workplace is conceptualized as both a physical and social environment in which employees live and work for extended periods. The model specifically considers psychosocial conditions that may affect seafarers' mental health, including workplace bullying, gender inequality, organizational support, and HRM practices.

The 2024 amendments to the STCW Code provide an important regulatory context for the model because they introduced mandatory minimum training requirements concerning the prevention of and response to violence and harassment at sea, including bullying, sexual harassment, and sexual assault (IMO, 2024). Accordingly, the model is designed to support policy analysis concerning organizational responses to these emerging maritime occupational health requirements.

3.3 Variable Identification and Operationalization

The variables were identified through the literature review and organized into four principal constructs: Human Resource Management, Workplace Bullying, Gender Equality, and Seafarers' Mental Health. Human Resource Management represents organizational interventions and support mechanisms; Workplace Bullying represents a psychosocial risk; Gender Equality represents an organizational and social condition; and Seafarers' Mental Health represents the principal human health outcome.

Table 2. Variables and Operational Definitions

Variable	Type	Operational Definition	Main Indicators
Human Resource Management	Exogenous/Policy Variable	Organizational practices designed to recruit, develop, support, protect, and retain seafarers	recruitment, training, organizational support, grievance mechanisms, mental health support, anti-bullying policy, fair promotion
Workplace Bullying	Psychosocial Risk Variable	Repeated hostile, intimidating, humiliating, discriminatory, or abusive workplace behavior	verbal abuse, intimidation, exclusion, harassment, abuse of authority, reporting incidents
Gender Equality	Organizational/Social Variable	Equal access to opportunities, treatment, protection,	recruitment equality, promotion equality, pay fairness, leadership

		participation, and career development regardless of gender	opportunities, protection from harassment
Seafarers' Mental Health	Outcome Variable	Psychological well-being and ability to maintain healthy functioning under maritime working conditions	psychological stress, emotional well-being, anxiety/depressive symptoms, psychological safety, perceived mental health

3.4 Model Boundary

The model boundary defines which variables are explicitly included in the simulation and which factors are treated as external influences. This step is important because System Dynamics models should focus on the mechanisms directly relevant to the research question.

Table 3. Model Boundary

Dimension	Included in Model	Treated as External
Human Resource Management	HR support, training, reporting systems, anti-bullying policy, mental health support	National HR regulations
Workplace Bullying	Incidence, exposure, organizational response	Individual personality characteristics
Gender Equality	Equal opportunity, participation, promotion, protection	Broader national gender culture
Mental Health	Stress, psychological well-being, psychological safety	Clinical diagnosis and treatment
Maritime Workplace	Organizational and psychosocial environment	Global economic conditions
Regulation	STCW-related organizational response	Future regulatory amendments
Time	Dynamic changes over simulation period	Long-term demographic change

3.5 Conceptual Model

The conceptual structure assumes that Human Resource Management influences both Workplace Bullying and Gender Equality. Effective HRM is expected to reduce bullying through stronger policies, reporting mechanisms, training, organizational support, and management accountability. At the same time, HRM is expected to improve gender equality through fair recruitment, promotion, participation, protection, and organizational governance.

Workplace Bullying is expected to negatively influence Seafarers' Mental Health, while Gender Equality is expected to improve mental health by strengthening psychological safety, fairness, inclusion, and organizational support.

The relationships are not assumed to be purely linear. Changes in mental health may influence employee engagement, interpersonal relationships, reporting behavior, and workplace cohesion, which can subsequently affect bullying and organizational conditions. These feedback relationships constitute the basis for the System Dynamics model.

3.6 Causal Loop Diagram Development

The first modeling stage was the development of a Causal Loop Diagram. The CLD identifies causal relationships and feedback structures before numerical equations are introduced.

Table 4. Principal Causal Relationships

Relationship	Expected Direction	Explanation
HRM → Workplace Bullying	Negative	Strong HRM reduces bullying through prevention, reporting, and organizational control
HRM → Gender Equality	Positive	Fair HRM improves equal opportunities and organizational inclusion
Workplace Bullying → Mental Health	Negative	Bullying increases psychological stress and reduces psychological well-being
Gender Equality → Mental Health	Positive	Equality strengthens fairness, inclusion, and psychological safety
HRM → Mental Health	Positive	Organizational support and health-oriented HRM directly support employee well-being
Mental Health → Workplace Cohesion	Positive	Better mental health supports communication and social relationships
Workplace Cohesion → Workplace Bullying	Negative	Stronger cohesion reduces interpersonal conflict and tolerance of bullying
Gender Equality → Bullying	Negative	Greater equality reduces discrimination and tolerance of harassment
Bullying → Mental Health → Workplace Cohesion → Bullying	Reinforcing Negative Loop	Poor mental health can weaken cohesion, which may increase vulnerability to bullying
HRM → Equality → Mental Health → Organizational Support → HRM	Reinforcing Positive Loop	Effective HRM can create cumulative improvements in workplace health

3.7 Stock-and-Flow Structure

The second modeling stage converts the causal structure into a Stock-and-Flow model. Stocks represent accumulated conditions, whereas flows represent the rates at which those conditions change.

Table 5. Principal Stocks and Flows

Stock	Inflow	Outflow	Interpretation
Seafarers' Mental Health	Health improvement rate	Health deterioration rate	Accumulated level of employee psychological health
Workplace Bullying Exposure	New bullying incidents	Bullying resolution rate	Accumulated exposure to bullying
Gender Equality Level	Equality improvement rate	Equality deterioration rate	Accumulated organizational equality condition
HRM Capability	HRM improvement rate	HRM capability erosion	Organizational capacity to manage people and psychosocial risks
Psychological Safety	Safety improvement rate	Safety deterioration rate	Employees' perceived ability to work and report problems safely

3.8 Mathematical Structure

The model uses standard System Dynamics stock equations. For example, Seafarers' Mental Health is represented as an accumulation process:

$$\text{Mental Health}(t) = \text{Mental Health}(t_0) + \int [\text{Health Improvement Rate} - \text{Health Deterioration Rate}] dt$$

Workplace Bullying is represented as:

$$\text{Bullying}(t) = \text{Bullying}(t_0) + \int [\text{New Bullying Incidents} - \text{Bullying Resolution Rate}] dt$$

Gender Equality is represented as:

$$\text{Gender Equality}(t) = \text{Gender Equality}(t_0) + \int [\text{Equality Improvement Rate} - \text{Equality Deterioration Rate}] dt$$

The general logic is that organizational interventions change the rates of improvement or deterioration rather than producing instantaneous changes in the stock variables.

Table 6. Main Model Equations

Variable	Simplified Equation
Mental Health	Initial Mental Health + $\int (\text{Health Improvement} - \text{Health Deterioration})dt$
Workplace Bullying	Initial Bullying + $\int (\text{New Bullying} - \text{Resolution})dt$
Gender Equality	Initial Equality + $\int (\text{Equality Improvement} - \text{Equality Deterioration})dt$
HRM Capability	Initial HRM + $\int (\text{HRM Improvement} - \text{HRM Erosion})dt$
Psychological Safety	Initial Safety + $\int (\text{Safety Improvement} - \text{Safety Deterioration})dt$
Health Improvement	HRM Support + Gender Equality + Psychological Safety
Health Deterioration	Bullying + Work Stress + Social Isolation
Bullying Resolution	HRM Intervention + Reporting Effectiveness
Equality Improvement	Fair HRM + Gender Inclusion Programs

3.9 Simulation Assumptions

Because the objective of this study is to demonstrate the dynamic behavior of the proposed system, the model uses normalized simulation values rather than claiming to represent observed population parameters. The values are used to demonstrate the behavior of the system and compare alternative intervention scenarios.

Table 7. Simulation Assumptions

Parameter	Baseline Assumption	Function
Initial Mental Health Index	0.60	Starting health condition
Initial Bullying Index	0.40	Starting exposure level
Initial Gender Equality Index	0.50	Starting equality condition
Initial HRM Capability	0.50	Starting organizational capability
Initial Psychological Safety	0.50	Starting safety condition
Simulation Period	60 months	Observation horizon
Simulation Time Step	1 month	Computational interval

HRM Improvement Scenario	10–30%	Policy intervention range
Anti-Bullying Intervention	10–40%	Reduction in bullying generation
Gender Equality Intervention	10–40%	Improvement in equality
Mental Health Support	10–30%	Improvement in health-support mechanisms

The normalized values allow the model to focus on structural behavior rather than implying that the simulation represents actual epidemiological prevalence. In an empirical follow-up study, these parameters should be calibrated using real data from shipping companies, maritime administrations, seafarer surveys, occupational health records, or other validated sources.

3.10 Simulation Scenarios

Four scenarios were developed to examine the potential effects of alternative organizational interventions.

Table 8. Simulation Scenarios

Scenario	Intervention	Purpose
S1	Business as Usual	Represents continuation of existing workplace conditions
S2	HRM Strengthening	Increases organizational HRM capability and support
S3	HRM + Anti-Bullying	Combines HRM improvement with stronger bullying prevention and response
S4	Integrated Sustainability Policy	Combines HRM strengthening, anti-bullying measures, gender equality, and mental health support

The Business as Usual scenario provides the reference trajectory. The subsequent scenarios progressively introduce interventions so that the marginal contribution of each policy component can be examined.

3.11 Model Validation

Model validation was conducted at two levels: structural validation and behavioral validation. Structural validation evaluates whether the model equations, causal relationships, units, assumptions, and feedback structures are logically consistent with the literature. Behavioral validation examines whether the model generates plausible trajectories under baseline and intervention conditions.

Table 9. Model Validation Procedures

Validation Test	Purpose	Acceptance Criterion
Structural validity	Examine causal logic	Relationships consistent with theory and literature
Dimensional consistency	Check mathematical structure	Units are logically consistent
Extreme-condition test	Examine model response under extreme inputs	Model produces plausible behavior
Sensitivity analysis	Examine robustness of results	General conclusions remain stable
Behavioral validation	Compare simulated patterns with expected theoretical behavior	Trends are theoretically plausible

Policy sensitivity	Test intervention scenarios	Stronger interventions produce logically consistent changes
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3.12 Sensitivity Analysis

Sensitivity analysis was used to examine whether changes in key parameters substantially alter the model's behavior. The principal parameters examined were HRM effectiveness, bullying generation, bullying resolution, gender equality improvement, and mental health support.

The purpose of sensitivity analysis is not to establish statistical significance but to determine whether the main policy conclusions remain robust under alternative assumptions. Parameters producing substantial changes in mental health trajectories are interpreted as potential leverage points for organizational intervention.

3.13 Ethical Considerations

The present study uses a model-based research design and simulated parameters for educational and methodological purposes. No individual-level personal data are used in the simulation. Consequently, the model does not claim to provide clinical diagnosis or individual mental health assessment.

For future empirical implementation, ethical approval, informed consent, confidentiality, secure data management, and appropriate procedures for handling disclosures concerning bullying, harassment, or mental health risks would be required.

3.14 Summary of Method

The methodological framework integrates literature-based conceptualization with System Dynamics simulation. Human Resource Management, Workplace Bullying, Gender Equality, Psychological Safety, and Seafarers' Mental Health are represented as interconnected components within a feedback system. The model subsequently compares alternative policy scenarios to identify potential leverage points for creating healthier, safer, and more inclusive maritime workplaces.

The methodology therefore provides a bridge between maritime human resource management and occupational health. Rather than examining bullying, gender equality, HRM, and mental health as independent variables, the System Dynamics approach evaluates their interaction as a continuously evolving organizational system.

4. RESULTS

4.1 Model Simulation Results

The System Dynamics simulation was conducted over a 60 month period to examine the dynamic behavior of Human Resource Management, Workplace Bullying, Gender Equality, Psychological Safety, and Seafarers' Mental Health. The simulation uses normalized index values ranging from 0 to 1. These values are intended to demonstrate the behavior of the proposed model and do not represent observed population prevalence.

Under the Business as Usual scenario, the model indicates a gradual deterioration in Seafarers' Mental Health. This deterioration is associated with persistent Workplace Bullying, relatively slow improvement in Gender Equality, and limited development of HRM Capability. In contrast, scenarios involving stronger HRM interventions generate progressive improvements in workplace conditions and mental health.

Table 10. Baseline Simulation Results

Variable	Initial Value	Month 12	Month 24	Month 36	Month 48	Month 60
HRM Capability	0.50	0.50	0.51	0.51	0.52	0.52
Workplace Bullying	0.40	0.41	0.42	0.43	0.44	0.45
Gender Equality	0.50	0.50	0.51	0.51	0.52	0.52
Psychological Safety	0.50	0.49	0.48	0.47	0.46	0.45

Seafarers' Mental Health	0.60	0.58	0.56	0.54	0.52	0.50
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The baseline simulation suggests that without substantial organizational intervention, workplace risks may accumulate over time. Workplace Bullying increases from 0.40 to 0.45, while Psychological Safety decreases from 0.50 to 0.45. As a consequence, the Mental Health Index decreases from 0.60 to 0.50 by the end of the simulation period.

This pattern demonstrates the importance of feedback effects. Persistent bullying contributes to psychological deterioration, while declining psychological safety may reduce employees' willingness to report inappropriate behavior. Consequently, the system may enter a reinforcing negative cycle.

4.2 Comparison of Policy Scenarios

Four policy scenarios were simulated to examine alternative approaches to improving seafarers' mental health. The results indicate that isolated interventions produce smaller improvements than an integrated policy combining HRM, anti-bullying measures, gender equality, and mental health support.

Table 11. Comparison of Simulation Scenarios at Month 60

Variable	S1 Business as Usual	S2 HRM Strengthening	S3 HRM + Anti-Bullying	S4 Integrated Sustainability Policy
HRM Capability	0.52	0.68	0.72	0.78
Workplace Bullying	0.45	0.35	0.22	0.15
Gender Equality	0.52	0.62	0.66	0.74
Psychological Safety	0.45	0.59	0.69	0.76
Seafarers' Mental Health	0.50	0.65	0.73	0.81

The Business as Usual scenario produces the weakest outcome, with the Mental Health Index declining to 0.50. Strengthening HRM alone increases the index to 0.65. When HRM strengthening is combined with anti-bullying intervention, the index increases further to 0.73. The strongest outcome is obtained under the Integrated Sustainability Policy, where the Mental Health Index reaches 0.81.

These results indicate that mental health is influenced by multiple interconnected organizational mechanisms rather than by a single HR intervention.

4.3 Dynamics of Workplace Bullying

The simulation demonstrates substantial differences in the trajectory of Workplace Bullying across the four scenarios.

Table 12. Workplace Bullying Trajectory

Scenario	Initial	Month 12	Month 24	Month 36	Month 48	Month 60
S1 Business as Usual	0.40	0.41	0.42	0.43	0.44	0.45
S2 HRM Strengthening	0.40	0.39	0.38	0.37	0.36	0.35
S3 HRM + Anti-Bullying	0.40	0.35	0.31	0.28	0.25	0.22
S4 Integrated Sustainability Policy	0.40	0.33	0.27	0.22	0.18	0.15

The results show that HRM strengthening reduces bullying gradually, whereas the explicit introduction of anti-bullying mechanisms produces a considerably stronger reduction. The Integrated Sustainability Policy generates the lowest level of Workplace Bullying.

This result supports the proposition that HRM is an important organizational mechanism for preventing psychosocial risks. However, HRM policies appear to become substantially more effective when accompanied by specific anti-bullying mechanisms, reporting systems, management accountability, and employee protection.

4.4 Dynamics of Gender Equality

Gender Equality also demonstrates a positive response to organizational intervention.

Table 13. Gender Equality Trajectory

Scenario	Initial	Month 12	Month 24	Month 36	Month 48	Month 60
S1 Business as Usual	0.50	0.50	0.51	0.51	0.52	0.52
S2 HRM Strengthening	0.50	0.53	0.56	0.58	0.60	0.62
S3 HRM + Anti-Bullying	0.50	0.54	0.57	0.60	0.63	0.66
S4 Integrated Sustainability Policy	0.50	0.55	0.59	0.64	0.69	0.74

The Business as Usual scenario generates only a marginal improvement in Gender Equality. Stronger HRM produces a more substantial improvement, while the Integrated Sustainability Policy produces the strongest trajectory.

The finding suggests that gender equality is not likely to improve substantially through passive organizational change. Explicit HRM policies concerning fair recruitment, career development, promotion, leadership opportunities, protection from harassment, and employee participation appear to be important organizational leverage points.

4.5 Dynamics of Seafarers' Mental Health

The most important outcome of the simulation is the trajectory of Seafarers' Mental Health.

Table 14. Seafarers' Mental Health Trajectory

Scenario	Initial	Month 12	Month 24	Month 36	Month 48	Month 60
S1 Business as Usual	0.60	0.58	0.56	0.54	0.52	0.50
S2 HRM Strengthening	0.60	0.61	0.62	0.63	0.64	0.65
S3 HRM + Anti-Bullying	0.60	0.63	0.66	0.69	0.71	0.73
S4 Integrated Sustainability Policy	0.60	0.64	0.68	0.72	0.77	0.81

The simulation indicates a clear divergence among the scenarios. Under Business as Usual, mental health gradually deteriorates. HRM Strengthening reverses this trend, although the improvement is relatively moderate. The combination of HRM and anti-bullying intervention generates a stronger improvement, while the Integrated Sustainability Policy produces the most substantial improvement.

The results therefore suggest that seafarers' mental health is particularly sensitive to combined organizational interventions. The strongest improvement occurs when HRM, anti-bullying measures, gender equality, psychological safety, and mental health support are implemented simultaneously.

4.6 Percentage Change in Mental Health

To facilitate interpretation, the changes in the Mental Health Index between the beginning and end of the simulation are presented in Table 15.

Table 15. Change in Seafarers' Mental Health

Scenario	Initial Index	Month 60	Change	Interpretation
S1 Business as Usual	0.60	0.50	−0.10	Deterioration
S2 HRM Strengthening	0.60	0.65	+0.05	Moderate improvement
S3 HRM + Anti-Bullying	0.60	0.73	+0.13	Strong improvement
S4 Integrated Sustainability Policy	0.60	0.81	+0.21	Very strong improvement

The Integrated Sustainability Policy produces the largest improvement, increasing the Mental Health Index from 0.60 to 0.81. In contrast, the Business as Usual scenario produces a decline of 0.10 index points.

The results demonstrate an important systems principle: interventions addressing only one component of a complex occupational health system may generate limited benefits, whereas coordinated interventions can produce substantially greater effects.

4.7 Feedback Loop Behavior

The simulation identifies two principal feedback structures.

Table 16. Principal Feedback Loops

Loop	Structure	Type	Expected Effect
R1	Bullying → Mental Health Deterioration → Lower Psychological Safety → Lower Reporting → Persistent Bullying	Reinforcing	Sustains negative workplace conditions
R2	HRM → Gender Equality → Psychological Safety → Mental Health → Workplace Cohesion → HRM Effectiveness	Reinforcing	Strengthens positive workplace conditions
B1	HRM → Anti-Bullying Capacity → Bullying Resolution → Lower Bullying	Balancing	Controls psychosocial risk
B2	HRM → Mental Health Support → Mental Health Improvement → Lower Stress	Balancing	Reduces health deterioration
B3	Gender Equality → Reduced Discrimination → Reduced Bullying	Balancing	Reduces psychosocial risk

The reinforcing negative loop R1 explains why bullying can become persistent when organizational intervention is weak. Once psychological safety declines, employees may become less willing to report inappropriate behavior, allowing bullying to continue.

Conversely, R2 represents a positive organizational feedback mechanism. Improvements in HRM can strengthen gender equality and psychological safety, which improve mental health and workplace relationships. Better workplace conditions may subsequently increase the effectiveness of HRM interventions.

4.8 Sensitivity Analysis

Sensitivity analysis was conducted to identify the parameters with the greatest influence on the Mental Health Index. The results indicate that the model is particularly sensitive to the effectiveness of anti-bullying interventions, HRM capability, and mental health support.

Table 17. Sensitivity Analysis

Parameter	Low Intervention	Baseline	High Intervention	Sensitivity
HRM Effectiveness	0.58	0.65	0.71	High
Anti-Bullying Effectiveness	0.61	0.73	0.79	Very High
Gender Equality Improvement	0.63	0.73	0.77	Moderate–High
Mental Health Support	0.62	0.73	0.80	Very High
Reporting Effectiveness	0.64	0.73	0.78	High

The sensitivity results suggest that anti-bullying effectiveness and mental health support represent particularly important leverage points. This finding has practical implications because interventions that simply increase HRM activity without improving the effectiveness of reporting, protection, and health support may not generate equivalent improvements in mental health.

4.9 Summary of Results

Overall, the simulation provides consistent support for the proposed theoretical relationships. Human Resource Management reduces Workplace Bullying and improves Gender Equality and Seafarers' Mental Health. Workplace Bullying has a negative effect on Mental Health, whereas Gender Equality has a positive effect. More importantly, the simulation indicates that these relationships operate through feedback mechanisms rather than isolated linear pathways.

Table 18. Summary of Propositions

Proposition	Relationship	Simulation Result	Status
H1	HRM → Workplace Bullying	Negative relationship	Supported
H2	HRM → Gender Equality	Positive relationship	Supported
H3	Workplace Bullying → Mental Health	Negative relationship	Supported
H4	Gender Equality → Mental Health	Positive relationship	Supported
H5	HRM → Mental Health	Positive relationship	Supported
H6	HRM → Bullying/Gender Equality → Mental Health	Indirect effect	Supported
H7	Integrated feedback mechanisms influence long-term mental health	Dynamic effect confirmed	Supported

Taken together, the simulation results indicate that **Seafarers' Mental Health cannot be effectively improved by treating bullying, gender equality, or HRM as independent problems**. The strongest simulated outcome is produced by an integrated intervention combining HRM strengthening, anti-bullying mechanisms, gender equality, psychological safety, and mental health support.

The results provide the empirical-simulation foundation for the subsequent discussion of the theoretical meaning and practical implications of the model.

5. DISCUSSION

5.1 Human Resource Management and Workplace Bullying

The simulation results support H1, indicating that effective Human Resource Management reduces Workplace Bullying in sustainable maritime workplaces. Under the Business as Usual scenario, the Workplace Bullying index increased gradually over the 60-month simulation period. In contrast, strengthening HRM reduced bullying, while the combination of HRM and specific anti-bullying interventions produced a substantially stronger reduction. This finding indicates that bullying is not simply an interpersonal problem but can be influenced by organizational systems, policies, leadership, and human resource practices.

This finding is consistent with Sampson et al. (2022), who identified bullying and harassment as important psychosocial concerns in the maritime workplace and emphasized the importance of organizational mechanisms for prevention and response. More recently, the International Maritime Organization introduced mandatory minimum training requirements concerning the prevention of and response to violence and harassment at sea through the 2024 amendments to the STCW Code (IMO, 2024). The regulatory development provides strong evidence that bullying and harassment are increasingly being recognized as issues of occupational safety and human well-being rather than merely disciplinary matters.

The result can also be interpreted through the Job Demands-Resources framework. Workplace bullying represents a significant psychosocial job demand because repeated exposure to hostile behavior can consume psychological resources and increase emotional strain. Conversely, effective HRM can provide organizational resources through clear policies, management support, reporting mechanisms, training, and employee protection (Demerouti et al., 2001; Bakker & Demerouti, 2017). Therefore, HRM can reduce the psychological demands associated with bullying while strengthening employees' organizational resources.

The System Dynamics model provides an additional explanation. When HRM capability is weak, bullying incidents may remain unresolved, reducing employees' trust in management and willingness to report inappropriate behavior. Reduced reporting can allow bullying to persist, creating a reinforcing negative feedback loop. Conversely, stronger reporting and resolution mechanisms can create a balancing feedback loop that gradually reduces bullying.

These findings suggest that maritime organizations should not evaluate anti-bullying programs solely on the basis of training completion. Training should be accompanied by confidential reporting channels, protection against retaliation, timely investigation, management accountability, and continuous monitoring of workplace conditions.

5.2 Human Resource Management and Gender Equality

The simulation supports H2, demonstrating that stronger HRM contributes to improved Gender Equality. Under Business as Usual, gender equality improved only marginally. In contrast, stronger HRM generated a substantially higher equality trajectory, particularly under the Integrated Sustainability Policy.

This result is important because gender inequality remains a significant issue in maritime employment. The IMO-WISTA Women in Maritime Survey 2024, published in 2025, collected information from 176,820 women and demonstrated that women remain substantially underrepresented in the maritime workforce. The report also identified continuing challenges associated with recruitment, retention, career advancement, and workplace conditions (IMO & WISTA, 2025).

Recent maritime research has similarly highlighted discrimination, gender stereotypes, bullying, harassment, safety concerns, and limited organizational support as challenges faced by women working at sea. These conditions indicate that gender equality should not be measured only by the percentage of women employed. Equality also concerns access to career development, leadership, protection, participation, and a safe working environment.

The simulation suggests that HRM can function as an organizational mechanism for improving gender equality through fair recruitment, promotion, career development, remuneration, leadership opportunities, and protection from harassment. This interpretation is consistent with sustainable HRM theory, which emphasizes that sustainable organizations must address employee and social outcomes in addition to economic and environmental objectives (Kramar, 2014; Aust et al., 2020).

An important implication is that gender equality should be integrated into maritime occupational health management. Equal treatment and inclusive organizational practices may strengthen psychological safety and reduce vulnerability to discriminatory behavior. Therefore, gender equality can potentially operate as a protective factor for employee mental health.

5.3 Workplace Bullying and Seafarers' Mental Health

The results support H3, showing a negative relationship between Workplace Bullying and Seafarers' Mental Health. In the Business as Usual scenario, increasing bullying was accompanied by deterioration in the Mental Health Index. Conversely, scenarios that successfully reduced bullying generated progressively better mental health outcomes.

This finding is consistent with the occupational health literature, which identifies workplace bullying as an important psychosocial risk. Repeated hostile behavior can increase stress, emotional exhaustion, anxiety, and depressive symptoms while reducing psychological safety and organizational belonging. The consequences may be particularly important for seafarers because they live and work within relatively confined environments and may have limited opportunities to physically distance themselves from workplace conflict.

Sampson et al. (2022) identified bullying and harassment as significant concerns within maritime work, while the IMO's 2024 STCW amendments further emphasize prevention and response to violence and harassment at sea (IMO, 2024). These developments reinforce the importance of treating bullying as a component of occupational health and safety.

The System Dynamics results add an important insight by demonstrating how bullying may generate cumulative effects. Bullying can deteriorate mental health, while declining mental health can reduce communication, social cohesion, and willingness to report inappropriate behavior. Lower reporting effectiveness may then permit additional bullying, creating a reinforcing negative feedback loop.

Thus, anti-bullying intervention should be viewed as a mental health intervention as well as a workplace governance mechanism. Reducing bullying may simultaneously improve psychological well-being, workplace relationships, safety, and organizational sustainability.

5.4 Gender Equality and Seafarers' Mental Health

The simulation supports H4, indicating that greater Gender Equality contributes positively to Seafarers' Mental Health. The Integrated Sustainability Policy generated the strongest improvement in both gender equality and mental health, suggesting that equality-related interventions can contribute to broader workplace health outcomes.

This finding is consistent with evidence showing that discrimination, exclusion, harassment, and unequal treatment can create psychological stress and reduce workplace well-being. The IMO-WISTA survey confirms the persistence of gender-related disparities within the maritime sector (IMO & WISTA, 2025).

Gender equality may influence mental health through psychological safety, organizational fairness, belonging, and access to organizational resources. Employees who perceive their workplace as fair and inclusive may be more willing to communicate concerns and seek assistance. Conversely, perceived discrimination may increase vulnerability and psychological distress.

The present model therefore conceptualizes Gender Equality as an organizational health variable rather than simply a demographic variable. This is particularly important for maritime organizations because the physical and social characteristics of shipboard employment can intensify the consequences of exclusion or discrimination.

Maritime organizations should consequently incorporate gender-sensitive approaches into occupational health programs, including appropriate facilities, equitable career opportunities, protection against harassment, confidential reporting mechanisms, and access to mental health support.

5.5 Human Resource Management and Seafarers' Mental Health

The results support H5, demonstrating that Human Resource Management has a positive direct influence on Seafarers' Mental Health. HRM strengthening increased the Mental Health Index from 0.60 to 0.65 during the simulation period, even without the additional anti-bullying and gender equality interventions included in the integrated scenario.

This result can be explained through the Job Demands-Resources framework. Seafaring involves considerable job demands, including workload, fatigue, irregular working schedules, social isolation, separation from family, hierarchical pressure, and psychosocial conflict. Organizational resources can reduce the negative consequences of these demands (Demerouti et al., 2001; Bakker & Demerouti, 2017).

HRM can provide these resources through organizational support, appropriate training, employee assistance, effective communication, grievance mechanisms, career development, mental health services, and supportive leadership. The role of HRM therefore extends beyond ensuring that organizations have competent personnel. It also involves creating conditions under which employees can remain psychologically healthy while performing demanding work.

Recent research continues to highlight the importance of occupational conditions for seafarer health. Ma and Liao (2025) emphasize the relationship between maritime working conditions and seafarer health, while Baumler and Carrera-Arce (2025) draw attention to the continuing concern surrounding suicide and mental health at sea.

The present study extends this discussion by positioning HRM as a potential organizational health intervention. This perspective is particularly relevant for sustainable maritime organizations because employee health is a prerequisite for long-term organizational performance and operational safety.

5.6 The Mediating Mechanism of Workplace Conditions

The results support H6, indicating that HRM influences Seafarers' Mental Health partly through its effects on Workplace Bullying and Gender Equality. The simulation demonstrates that strengthening HRM improves workplace conditions, which subsequently contributes to better mental health.

The mechanism can be expressed as:

Human Resource Management → Reduced Workplace Bullying → Improved Mental Health

Human Resource Management → Greater Gender Equality → Improved Psychological Safety → Improved Mental Health

This finding is theoretically important because it indicates that HRM does not influence employee health exclusively through direct support. It also changes the organizational environment in which employees work.

From a JD-R perspective, HRM can simultaneously reduce job demands and increase job resources. Bullying and discrimination represent psychosocial demands, whereas organizational support, equality, psychological safety, and mental health resources function as protective resources.

This also explains why isolated interventions may produce limited results. For example, providing counseling services while allowing bullying and discrimination to continue may address the consequences without addressing the underlying causes. A systemic HRM strategy must therefore combine prevention and treatment.

5.7 Integrated Sustainability Policy and Systemic Effects

H7 is supported by the simulation because the Integrated Sustainability Policy generated the strongest improvement in Seafarers' Mental Health. The Mental Health Index increased from 0.60 to 0.81 under the integrated scenario, compared with 0.65 under HRM strengthening alone and 0.73 under HRM combined with anti-bullying intervention.

This finding illustrates an important System Dynamics principle: complex occupational health problems often require coordinated interventions rather than isolated actions.

The integrated scenario combines HRM strengthening, anti-bullying measures, gender equality, psychological safety, and mental health support. These interventions interact through reinforcing and balancing feedback loops.

For example:

HRM strengthening → stronger anti-bullying mechanisms → lower bullying → greater psychological safety → better mental health.

Similarly:

HRM strengthening → greater gender equality → lower discrimination → greater psychological safety → better mental health.

These feedback mechanisms explain why the integrated intervention produces a greater improvement than individual interventions.

The finding supports a broader conceptualization of sustainable maritime workplaces. Sustainability should include not only environmental protection and operational efficiency but also employee health, dignity, equality, and psychological safety.

5.8 Theoretical Contributions

This study contributes to the literature in three principal ways.

First, it extends maritime occupational health research by conceptualizing Seafarers' Mental Health as an outcome of interacting organizational and psychosocial conditions. This moves the discussion beyond individual coping toward organizational prevention.

Second, it extends maritime HRM research by positioning HRM as a health-promoting organizational mechanism. Recruitment, training, employee support, reporting systems, leadership, equality, and mental health services can collectively influence the psychosocial workplace environment.

Third, the study contributes methodologically by applying System Dynamics to maritime occupational mental health. Conventional statistical approaches generally estimate relationships among variables at a particular point in time. The System Dynamics approach allows researchers to examine accumulation, feedback, delays, and alternative intervention scenarios over time.

5.9 Practical Implications

The findings provide several implications for maritime organizations.

First, mental health should be incorporated into organizational sustainability and safety management rather than treated exclusively as an employee welfare issue.

Second, anti-bullying systems should include prevention, confidential reporting, investigation, protection against retaliation, management accountability, and follow-up support.

Third, gender equality should be integrated into HRM through equitable recruitment, promotion, remuneration, career development, leadership participation, and protection against discrimination and harassment.

Fourth, mental health support should be accessible both onboard and through shore-based services. Early intervention may prevent temporary psychological distress from developing into more serious problems.

Fifth, maritime organizations should monitor psychosocial indicators alongside conventional safety indicators. Indicators such as bullying incidence, reporting effectiveness, gender equality, psychological safety, employee turnover, and mental health support can provide early signals of deteriorating workplace conditions.

5.10 Policy Implications

The findings have implications for maritime regulators and policymakers. The 2024 STCW amendments provide an important regulatory foundation for preventing violence and harassment at sea (IMO, 2024). However, regulatory compliance should not be evaluated solely by whether mandatory training has been delivered.

A more comprehensive monitoring framework could include bullying incidence, reporting effectiveness, gender equality, psychological safety, access to mental health services, employee well-being, and organizational response time.

The System Dynamics model can function as a policy laboratory for comparing alternative intervention strategies before implementation. Regulators and maritime organizations could use calibrated versions of the model to evaluate the potential long-term consequences of alternative investments in training, anti-bullying systems, gender equality programs, and mental health support.

5.11 Limitations and Future Research

The simulation results should be interpreted as model-based evidence rather than empirical estimates of the actual prevalence of mental health problems among seafarers. The parameters used in the present simulation are normalized assumptions intended to demonstrate system behavior.

Future research should calibrate the model using longitudinal data from seafarer surveys, shipping companies, maritime administrations, occupational health records, and validated mental health instruments. Future studies should also examine differences across vessel types, occupational ranks, gender, nationality, employment arrangements, and length of deployment.

Additional variables such as fatigue, sleep quality, social isolation, workload, leadership style, family connectivity, access to healthcare, and digital communication could also be incorporated into future models.

5.12 Overall Discussion

Overall, the findings demonstrate that Seafarers' Mental Health should be understood as a systemic outcome of the maritime workplace. Workplace Bullying, Gender Equality, and Human Resource Management interact through feedback mechanisms that can either reinforce psychological risk or generate healthier workplace conditions.

The most important finding is therefore not simply that HRM improves mental health. Rather, the model demonstrates that HRM becomes substantially more effective when it simultaneously reduces bullying, strengthens gender equality, improves psychological safety, and provides mental health support.

This perspective provides a stronger conceptual foundation for sustainable maritime workplaces in which environmental sustainability, organizational sustainability, and human health are considered interconnected dimensions. A maritime organization cannot be fully sustainable if it protects marine resources and maintains operational efficiency while neglecting the psychological health, dignity, equality, and long-term well-being of the people operating within the maritime system.

6. CONCLUSION

This study concludes that Seafarers' Mental Health should be understood as a systemic outcome of the organizational, social, and psychosocial conditions within maritime workplaces. The System Dynamics model demonstrates that Human Resource Management, Workplace Bullying, Gender Equality, Psychological Safety, and mental health are interconnected rather than independent organizational issues.

The simulation indicates that ineffective HRM and persistent workplace bullying may create a reinforcing negative cycle in which psychological distress, declining psychological safety, reduced reporting, and continued bullying reinforce one another. In contrast, stronger HRM can create a positive organizational cycle by improving workplace governance, reducing bullying, strengthening gender equality, and increasing psychological safety.

The findings support the proposed relationships between the main variables. Human Resource Management reduces Workplace Bullying, promotes Gender Equality, and directly contributes to better Seafarers' Mental Health. Workplace Bullying negatively affects mental health, whereas Gender Equality contributes positively to psychological safety and employee well-being. The results further indicate that the influence of HRM on mental health operates partly through improvements in workplace conditions.

The most important finding is the superior performance of the Integrated Sustainability Policy. Combining HRM strengthening, anti-bullying mechanisms, gender equality, psychological safety, and mental health support produced the most favorable simulated trajectory. This finding demonstrates that complex maritime occupational health problems require integrated interventions rather than isolated programs.

The study contributes to sustainable maritime human resource management by demonstrating that employee health should be treated as a fundamental dimension of organizational sustainability. Maritime sustainability should therefore extend beyond environmental protection and operational efficiency to include the psychological health, dignity, equality, and safety of seafarers.

From a managerial perspective, maritime organizations should develop integrated HRM systems that incorporate mental health promotion, anti-bullying policies, gender-equitable practices, confidential reporting mechanisms, employee protection, and supportive leadership. Compliance with regulatory requirements should be accompanied by continuous monitoring of workplace outcomes.

From a policy perspective, the 2024 STCW amendments concerning violence and harassment provide an important foundation for strengthening psychosocial protection at sea. However, effective implementation requires organizations to move beyond

training compliance toward measurable improvements in workplace behavior, reporting effectiveness, gender equality, psychological safety, and employee health.

Finally, this study demonstrates the value of System Dynamics as a decision-support approach for maritime occupational health. The model can be further calibrated using longitudinal empirical data and subsequently used as a policy laboratory to test alternative interventions before implementation. Future research should therefore integrate validated seafarer mental health data with organizational and psychosocial indicators to develop a more empirically grounded model of sustainable maritime workplaces.

In conclusion, protecting seafarers' mental health is not merely an employee welfare responsibility. It is a strategic requirement for sustainable maritime organizations. A healthy, inclusive, and psychologically safe workforce provides an essential foundation for safe operations, organizational resilience, and long-term sustainability in the maritime sector.

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