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RESILIENCE AND BURNOUT ASSESSMENT IN MECHANICAL ENGINEERING STUDENTS

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Abstract
Mechanical engineering students frequently deal with formidable academic expectations, constant cognitive strain, and competitive surroundings, all of which can culminate in psychological burnout. This study ensures subjective interpretations of burnout and resilience are examined but rather useful for people concerned about burnout, students, mental health and academics are interested in the relationship between both constructs which prompts us to explore how some students endure stressful situations of this nature, while others experience a decline in academic and emotional commitments. Psychometric measures were collected from undergraduate and postgraduate engineering students, namely, the Maslach Burnout Inventory-Student Survey (MBI-SS) and the Connor-Davidson Resilience Scale (CD-RISC), at various institutions. Analysis indicates high emotional exhaustion levels for senior year and higher resilience scores were positively related to higher student engagement. Findings emphasize resilience in mitigating burnout in performance-oriented learning environments. This proposed research identifies chief psychological risk and protective factors that offer implications not only to educators, but to mental health practitioners, curriculum developer etc. to create reflective academic environments and curriculum development for student experiences to aid their psychological well-being.
Keywords: Burnout, Resilience, Mechanical Engineering Students, Academic Stress, Psychometric Assessment, Emotional Exhaustion, Coping Mechanisms, Student Well-being, Higher Education, Mental Health in STEM

I. INTRODUCTION

When Machines Weigh Heavy: Burnout in the Making of Mechanical Minds
The process of becoming a mechanical engineer requires considerable cognitive, technical, and emotional labour. It demands long hours, a full course of study, and the various cultural factors that lead students to view performance as something they must constantly engage with, provide a ripe atmosphere for academic stress and psychological weariness. The study of mental health and the prevalence of issues in STEM fields have become a focus of university researchers, and burnout has simply been (and will likely continue to be) common among students' interminable pressures [7]. Resilience, the ability to recover from stress and adjust to challenges, has legally become a requirement of study, but the act of maintaining resilience is really a matter of psychological wellbeing [1]. This study sought to understand precisely how burnout operates within the British cohort of mechanical engineering students, and how resilience acts as a buffer [5]. By juxtaposing psychometric evaluation to more localised pedagogic inquiry, this study strived to create a nexus between theoretical psychological literature and students' day-to-day experience of learning in an engineering context; a context requiring students to navigate their own wellbeing in an extremely high-stakes, publicly accountable situation [2].

II. PSYCHOLOGY OF BURNOUT AND RESILIENCE

Burnout, as described by Freudenberger (1974) and further developed by Maslach, is a psychological syndrome characterized by emotional exhaustion, depersonalization, and reduced personal accomplishment in prolonged stressful situations. When applied to academic environments, burnout means uneventful tiredness, distance from

coursework, and a decline in performance. Resilience, on the other hand, is the ability to adapt and recover from these difficulties. Connor-Davidson Resilience Scale (CD-RISC) perceives resilience as undertaken over time and as a trait in relation to emotional strength, relatedness, problem-solving, and perseverance [12]. Ego-resilience is another model of resilience, which emphasizes the inherent flexible nature of individual adaption to changing and new demands through time. These definitions of burnout and resilience are salient for our population of interest, mechanical engineering undergraduate students due to the cognitive load they face at different tasks with different constraints, of temporal problem-solving and task performance. The simultaneous existences of a high risk for burnout and need for resilience mechanisms for this population makes it ideal to study how psychological characteristics impact academic outcomes. A conceptual framework diagram (e.g. stress-coping-outcome model) could be used to show this relationship visually [8].

III. MEASUREMENT TOOLS OF MENTAL GRIT: THE TOOLS USED

3.1. Selection and Validation of Psychometric Scales

To evaluate burnout vs resilience of mechanical engineering students, two validated psychometric instruments were used: the Maslach Burnout Inventory-Student Survey (MBI-SS) and the Connor-Davidson Resilience Scale (CD-RISC) [9].

The MBI-SS is a validated, academic-specific version of the MBI-SS; assesses emotional exhaustion, cynicism, and academic efficacy: key qualities of academic burnout. The MBI-SS has high levels of internal consistency (Cronbach's alpha >0.80) and has been used in numerous educational burnout studies worldwide [11][14].

Table 1: Summary of Psychometric Instruments Used

Instrument	Domain Measured	No. of Items	Scoring Method	Reliability (Cronbach's α)	Context of Prior Use
MBI-SS	Burnout (Emotional Exhaustion, Cynicism, Academic Efficacy)	15	7-point Likert scale	0.76 – 0.87	Higher education, global student populations
CD-RISC	Resilience (Adaptability, Control, Emotional Strength)	25	5-point Likert scale	0.85 – 0.92	College students, mental health studies

Table 1 summarizes the critical characteristics of the standardized psychometric instruments used in the study - the Maslach Burnout Inventory-Student Survey (MBI-SS) and the Connor-Davidson Resilience Scale (CD-RISC). It details the domains measured, number of items, scoring mechanism, reliability indices and previous validation context--all of which help to establish validity and contextual relevance of these forms of assessment for burnout and resilience as it applies to mechanical engineering students [10].

3.2. Cultural Adaptation and Contextual Fit for Engineering Students

The CD-RISC is a validated resilience measure, using an instrument that covers important psychological dimensions, such as emotional regulation, flexibility, and perceived control. It had good reliability (Cronbach's alpha ranging, 0.85-0.92) across student groups; has also been validated in a student population.

The two instruments were locally contextualized for Indian college students to ensure cultural context in its language and in perception of stressors. This work included preliminary analysis and linguistic modifications to foster the meaning for the student without impacting the broad way the measurement was taken. Together they provide a strong basis for examining psychological endurance in a high stress academic field.

IV. VOICES FROM THE LAB: WHAT WE STUDIED AND HOW WE STUDIED IT

A purposive sampling method was used to recruit undergraduate and postgraduate mechanical engineering students from a variety of higher education institutions. The sample comprised individuals between ages 18-25 years old [15]. The students in the sample represented a variety of gender identities, academic years, and academic progression. Informed consent was obtained from all participants in order to maintain ethical rigor, including ensuring anonymity and voluntary participation [13]. A statement of consent was made and verified, with participants having options to voluntarily withdraw their consent, as well as informed that counselling resources would be made available after the results if needed. In planning for the study proper ethical rigour was also put into consideration for maintaining psychological safety and wellbeing of the students.

Data were collected through a structured, online survey to afford students significant ease and wide participation. Both psychometric standardized measures and demographic-based questions were included in the survey, and were conceived to take the participants approximately 15-20-minute subjects to complete. Data were collected via

an internet medium to promote and safeguard anonymity, maximise standardized conditions as well as provide a stress-minimizing context for studying potentially sensitive psychological matters using students as a methodological population.

V. FINDINGS IN THE FIELD: STRESS RESISTORS AND BREAKPOINTS

The data analysis investigated patterns of burnout in relation to year of study, GPAs, and gender. Final-year students experienced the highest emotional exhaustion; lower years exhibited greater academic efficacy, but were more cynical. For all students, academic burnout was worse with lower GPAs; it seems students themselves are in a stress performance cycle.

There was an inversely proportionate correlation of resilience scores associated with the indicators of burnout, meaning those whom engage in strong coping behaviours, for example, emotion or goal reframing, experience less burnout than those with considerably less robust coping behaviours. Internal beliefs (self-efficacy, optimism) and external support (peer or faculty support) were relevant protective buffers.

Table 2: Burnout and Resilience Scores Across Academic Years

Academic Year	Emotional Exhaustion (Mean ± SD)	Resilience Score (Mean ± SD)	GPA Range	Observed Burnout Level
1st Year	2.8 ± 0.6	3.9 ± 0.5	7.5–8.5	Low
2nd Year	3.4 ± 0.7	3.6 ± 0.6	7.0–8.0	Moderate
3rd Year	4.2 ± 0.5	3.3 ± 0.7	6.5–7.5	High
Final Year	4.6 ± 0.4	3.1 ± 0.6	6.0–7.0	Very High

Table 2 helps to describe credibility and relevance of the tools in relation to measuring burnout and resilience in mechanical engineering students.It presents the mean emotional exhaustion and resilience scores across the academic years of mechanical engineering students. Indicating how burnout symptoms and resilience capacities change over the course of the academic program, it exposes periods of elevated risk and opportunities for intervention.

Mean resiliency and burnout estimates (related to all dimensions and constructs in previous studies) were statistically assessed through a Pearson correlation matrix establishing connections between the dimensions and constructs of burnout and resilience. Also, the multiple linear regression confirmed that resiliency should be considered a predictive buffer of academic stress [6]. A heatmap was developed to show intersecting areas of intensity in burnout or resilience, enabling a comparative view across different socio-demographic grouping.

VI. INTERPRETING PSYCHOLOGICAL LOAD

The results of burnout and resilience levels reveal deeper psychological processes within mechanical engineering students. High emotional exhaustion and depersonalization among senior students may be a result of cumulative cognitive overload and loss of interest in their studies. Higher resilience scores were associated with increased motivation, indicating that prior levels of psychological strength protect students from mental fatigue [3].

The results are consistent with Self-Determination Theory which posits that autonomy, competence, and relatedness are essential elements to maintain motivation. Students who have not been provided with a conducive academic environment have limited or controlled motivation which results in emotional exhaustion [4]. Cognitive Load Theory provides insight into the effects of continual exposure to highly complex tasks without periods of adequate mental recovery resulting in burnout.

Final-year students, low GPA students, and those that have reported minimal peer and/or faculty support are among the high-risk groups. Strong evidence for resilience is provided by those students who practice emotional self-regulation, make purposeful attempts to learn, and make social connections.

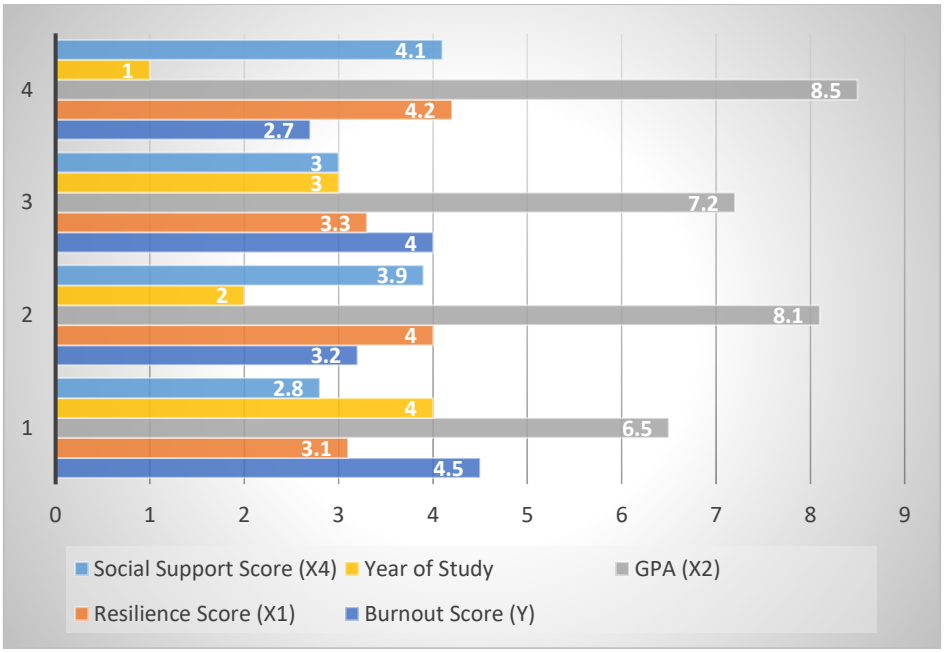

Figure 1: Regression-Based Prediction Model: Linking Resilience and Academic Factors to Burnout

Figure 1 the impact of resilience and academic variables on student burnout levels, multiple linear regression model was constructed. The dependent variable was the Burnout Score (from MBI-SS), and the independent variables were the Resilience Score (CD-RISC), GPA, Year of Study and Perceived Social Support. The results of the model suggested a significant negative correlation between resilience levels and burnout levels; therefore, students who had higher resilience levels were expected to have lower burnout levels. This model can assist in the identification of individuals who are at high risk, and can guide more direct mental health interventions.
Students voluntarily saying no to additional group work, withdrawal from programming lab work, or even reporting they feel emotionally fatigued may not be being lazy - they may be signalling to the institution they need a compassionate response to their un-identified burnout.

VII. BIGGER MINDS: RECOMMENDATIONS FOR ENGINEERING EDUCATION

Tackling burnout and building resilience requires wider institutional mechanisms than just providing academic content and transfer knowledge. Engineering curricula should include flexible deadlines, experiential learning opportunities with hands on work, and reflective assessments to decrease chronic stress and increase student agency. Also, collecting wellness checkpoints throughout project cycles could enable students to manage and monitor their psychological load.
Counselling and peer mentorsupport should be normalized and not understood simply as crisesintervention resources. Faculty should be trained to identify and recognize the early signs of burnout among students and the appropriate support mechanisms. Open door policies and empathetic academic advising can also relieve isolation and emotional exhaustion.
There can also be: stress literacy courses, in the form of curricular stress literacy modules, mindfulness workshops and resilience training for students, offered, but especially in the first and final yearsproviding students with pro-active and preventative coping mechanisms.
Finally, the educational response could include technology-based supports, such as mental health apps, emotional check-in AI (chatbot or similar features), or data dashboards categorizing student well-being indicators by different longitudinal (and cross-sectional) metricscould help to provide evidence-backed scaleable immediate supports for a broad student body to manage stress.

VIII. CONCLUSION and Future Pathways

This study reflects the psychological intricacies of mechanical engineering pedagogies, where students are faced with academic performance pressures that can produce burnout, and where resilience is important to sustenance of wellbeing and performance. We have identified associations using psychometric testing of emotional exhaustion, disengagement-non-academic, and coping strategies with clear correlations.The results show an

urgent need for the inclusion of psychological profiling into technical education for student supportnot to assign a label to all students, but to provide adequate support from universities and colleges through assessments of location and targeted interventions. If mental health were regarded equally with academic success relative to a learning organization, we could begin to influence educational approaches and institutional climate strategies.Future research should use longitudinal analyses to show the development of resilience and burnout over periods of time. Future studies using mixed-methods including interview, observation or biometric assessment as well as gathering evidence of the lived experience would show richer data insight.Finally, including tools for emotional data within academic performance reviewssuch as mood trackers or stress indexescould create feedback loops for holistic perspectives and give us not only better engineers, but healthier ones too.

REFERENCES

[1] Arnita, V., Zainal, S. R. M., & Jalaludin, D. (2018). To Be or Not to Be? The Influencing Factors Towards Pursuing as Professional Accountant Among Indonesian S1 Accounting Students. *International Academic Journal of Science and Engineering*, *5*(2), 1–10. https://doi.org/10.9756/IAJSE/V5I1/1810022

[2] Vaezzade, S. R., & Alinia, E. (2014). The effects of modern ways of teaching based on Choice Theory and Locus of Control on students' operation. *International Academic Journal of Innovative Research*, *1*(2), 25–28.

[3] Samifanni, F. (2024). Understanding the Japanese University Students' Motivation and Demotivation in Attending EFL Classes. *International Academic Journal of Social Sciences*, *11*(1), 11–25. https://doi.org/10.9756/IAJSS/V11I1/IAJSS1103

[4] Ghazanfari, M., Ramezan, M., & Vanda, M. (2018). The impact of motivation on commitment through private bank branches employees with mediating role of identity style. *International Academic Journal of Organizational Behavior and Human Resource Management*, *5*(1), 84–94. https://doi.org/10.9756/IAJOBHRM/V5I1/1810005

[5] Nandkeolyar, R. (2025). Neuromorphic processor design for ultra-low-power embedded vision applications. Electronics, Communications, and Computing Summit, 3(1), 61–70.

[6] Salave, A. P. (2025). Cloud-edge hybrid deep learning framework for real-time traffic management. Electronics, Communications, and Computing Summit, 3(2), 28–39.

[7] Kavitha, M. (2025). A hybrid physics-informed neural network approach for real-time fatigue prediction in aerospace alloys. Advances in Mechanical Engineering and Applications, 1(1), 50–58.

[8] Sahu, Y., & Kumar, N. (2024). Assessing the Effectiveness of Medication Reconciliation Programs in Reducing Medication Errors. *Clinical Journal for Medicine, Health and Pharmacy*, *2*(1), 1-8.

[9] Rao, N., & Tiwari, M. (2023). Nature-Based Solutions for Coastal Resilience: Case Studies from Southeast Asia. *International Journal of SDG's Prospects and Breakthroughs*, *1*(1), 8-10.

[10] Choudhary, M., & Deshmukh, R. (2023). Integrating Cloud Computing and AI for Real-time Disaster Response and Climate Resilience Planning. In *Cloud-Driven Policy Systems* (pp. 7-12). Periodic Series in Multidisciplinary Studies.

[11] Ali, K. S., Aljuhishi, B. I. M., & Alaraji, F. A. A. S. (2025). Impact of Applying Administrative Auditing On the Effectiveness of Government Units Analytical Study at Mustansiriya University. Quality-Access to Success, 26(205).

[12] Anand, M. D. (2024). Design and Development of Advanced Mechanical Systems. *Association Journal of Interdisciplinary Technics in Engineering Mechanics*, *2*(1), 1-6.

[13] Hawthorne, E., & Fontaine, I. (2024). An Analysis of the Relationship Between Education and Occupational Attainment. *Progression Journal of Human Demography and Anthropology*, *2*(4), 22-27.

[14] Hannah Jessie Rani, R., Verma, V. V., Guntaj, J., & Jadhav, Y. (2025). The Role of Turmeric Extract in Promoting Fish Health and Stress Resilience in Goldfish (Carassius auratus L.). Natural and Engineering Sciences, 10(1), 206-218. https://doi.org/10.28978/nesciences.1643503

[15] Hakimov, N., Karimov, N., Reshetnikov, I., Yusufjonova, N., Aldasheva, S., Soatova, N., Eshankulova, S., & Bozorova, D. (2024). Mechanical Marvels: Innovations in Engineering During the Islamic Golden Age. Archives for Technical Sciences, 2(31), 159–167. https://doi.org/10.70102/afts.2024.1631.159

[16] Torres, J., & López, M. (2024). Impact of Innovation on the Business Model on Organizational Quality and Competitiveness. National Journal of Quality, Innovation, and Business Excellence, 1(1), 1-6.

[17] Jeganathan, S., Lakshminarayanan, A. R., Parthasarathy, S., Khan, A. A. A., & Sathick, K. J. (2024). OptCatB: Optuna Hyperparameter Optimization Model to Forecast the Educational Proficiency of Immigrant Students based on CatBoost Regression. Journal of Internet Services and Information Security, 14(2), 111-132. https://doi.org/10.58346/JISIS.2024.I2.008

[18] Kumar, R. M., Velmurugan, J. S., & kumar, M. S. (2025). Knowledge and Online Learning through Skill Growth among Higher Education Students. Indian Journal of Information Sources and Services, 15(2), 420–426. https://doi.org/10.51983/ijiss-2025.IJISS.15.2.51