Masters Thesis Information Showcase
Spring Semester-2026
Year 2026

	Department: Mathematics Programme: Masters of Science Specialization: Applied Mathematics
1	**Title of the Thesis** Sport Injury Prediction And Tactical Optimization Using AI and ML Approaches.
2	**Abstract** (min 300 to 500 words) Sports injuries are influenced by multiple interacting factors, including workload imbalance, fatigue, inadequate recovery, previous injury history, player characteristics, and match-related demands. This study develops an artificial intelligence and machine learning framework that integrates injury-risk prediction with tactical decision support to improve player well-being and team performance. The proposed pipeline uses football player profile, injury history, and performance data, which are merged and systematically preprocessed through duplicate removal, missing-value imputation, categorical encoding, normalization, and class-imbalance handling. Feature engineering is employed to construct meaningful indicators, including workload index, offensive contribution, and aggression index, representing player activity, performance intensity, and playing behavior. Multiple machine learning models, including Logistic Regression, Random Forest, XGBoost, LightGBM, and CatBoost, are developed and comparatively evaluated using precision, recall, F1-score, ROC-AUC, PR-AUC, and confusion-matrix behavior. Threshold optimization and feature-importance analysis are further incorporated to improve practical interpretation and decision-making. Experimental findings identify balanced Logistic Regression as the best-performing model, with an optimized decision threshold of 0.41, test F1-score of 0.2909, ROC-AUC of 0.7710, and PR-AUC of 0.2676. Competition context, player age, aggression index, and playing position emerge as influential predictors of injury risk. The predicted probabilities are subsequently transformed into low-, medium-, and high-risk categories and integrated into a tactical optimization module. This module supports coaching decisions regarding starting lineups, substitutions, workload control, playing-time restrictions, and player rotation while preserving tactical formation requirements. The framework demonstrates how injury prediction can be translated into practical, interpretable coaching recommendations rather than remaining solely a classification task. The findings support data-driven injury prevention, safer player management, and tactical planning. Future research should investigate larger multi-season datasets, external validation, deep learning, computer vision, wearable technologies, and real-time monitoring to enhance generalizability, interpretability, and practical deployment in sports environments. Explainable AI may strengthen transparency and acceptance among coaches, trainers, clinicians, and sports staff.
3	**Impact on SDG#___"** (min 500 words) (Please mention the impact of the relevant attained SDG) The proposed research directly contributes to the attainment of the **United Nations Sustainable Development Goal 3 (SDG 3): Good Health and Well-Being**, which emphasizes the promotion of health, safety, and well-being across populations. Within the context of sports, maintaining athletes' physical health and reducing preventable injuries are

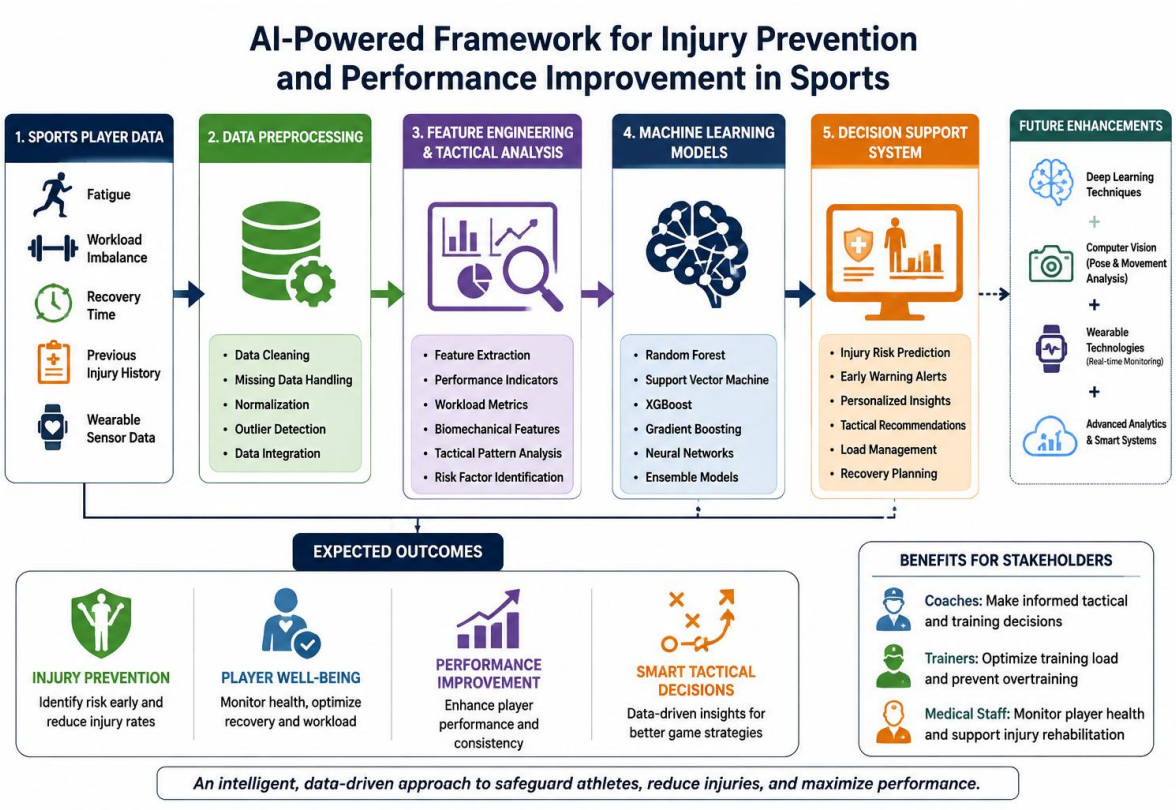
essential for sustainable participation, professional performance, and long-term well-being. Sports injuries can have substantial physical and performance-related consequences for athletes and can also affect the overall efficiency and competitiveness of sports teams. Therefore, the development of intelligent technologies capable of identifying injury risks before serious injury occurs represents an important contribution toward preventive health management in sports.

The proposed artificial intelligence (AI) and machine learning (ML) framework supports SDG 3 by adopting a **preventive and data-driven approach to athlete health and injury management**. Rather than focusing only on injury treatment after occurrence, the framework aims to identify players who may be at increased risk and support appropriate preventive interventions. The thesis integrates information related to player workload, performance, injury history, and playing behavior and develops engineered indicators such as workload index, offensive contribution, and aggression index for injury-risk assessment. Such information can enable a more comprehensive assessment of the physical demands placed on individual athletes and support safer management of their participation.

A particularly important contribution toward SDG 3 is the integration of **injury-risk prediction with tactical decision-making**. The framework does not limit machine learning to the classification of players according to injury risk. Instead, predicted injury probabilities are translated into actionable recommendations for coaches and other sports professionals. Players are categorized according to their predicted risk, and these predictions can inform decisions regarding whether a player should start a match, have restricted playing time, be rotated, or be rested. This approach establishes a direct connection between predictive analytics and preventive athlete-health management.

The framework can consequently assist **coaches, trainers, sports scientists, and medical staff** in making decisions that consider both competitive requirements and player well-being. For example, tactical optimization can prioritize lower-risk players while maintaining required team formations, whereas controlled playing time can be recommended to manage workload. The thesis demonstrates this concept by integrating predicted injury probabilities with tactical constraints to produce balanced lineups and actionable coaching recommendations. Therefore, AI is employed not merely to maximize athletic performance but also to support safer participation and responsible workload management.

The research also contributes to the broader concept of **sustainable athlete performance**. Maintaining high performance over time requires an appropriate balance among training intensity, competition demands, workload, recovery, and injury prevention. Reducing avoidable injuries may help athletes maintain continuity in training and competition while minimizing unnecessary physical stress. The proposed decision-support framework therefore aligns performance optimization with athlete health rather than treating these objectives independently.

Furthermore, the study provides a foundation for future intelligent sports-health systems. Integration with **wearable sensors, real-time monitoring, computer vision, deep learning, and explainable AI** could enable continuous assessment of physiological, biomechanical, workload, and movement-related information. Such developments may facilitate earlier identification of potentially harmful patterns and provide more personalized preventive

	recommendations. However, further validation using larger and more diverse real-world datasets will be important before such systems can be reliably deployed in professional sports environments. Overall, the proposed research contributes to **SDG 3: Good Health and Well-Being** by promoting injury prevention, safer workload management, early risk identification, and data-driven decision support in sports. Its main societal and practical impact lies in shifting sports injury management toward a **proactive, preventive, and athlete-centered approach**, where AI and machine learning assist sports professionals in protecting athlete health while simultaneously supporting sustainable performance and informed tactical decision-making.
4	**Scholar Name** (along with contact details) Iffat Batool iffatriaz2005@gmail.com
5	**Supervisor & Co-supervisor Name** (along with contact details) Dr. Ubaida Fatima
6	**Graphical Abstract**