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Prediction of contamination using ML and AI for restaurant food

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Active Risk
contamination risks



Introduction

Restaurant-related foodborne illnesses pose significant public health, economic, and reputational challenges. Traditional food safety methods like manual inspections and reactive testing are often slow and fail to detect risks in real time.

This study presents a predictive model that uses Machine Learning (ML) and Artificial Intelligence (AI) to proactively identify contamination risks during restaurant food preparation. By integrating real-time data, the model aims to enhance food safety, reduce contamination events, and support smarter decision-making.

Methodology

A predictive ML model was built using four key data sources:

- Inspection Reports – Historical inspection records from restaurant
- Environmental Sensors-Temperature , humidity ,ph sensor with 5-minute logging intervals
- Operational Metadata – Staff compliance scores based on (specific metrics like hand -washing frequency, uniform cleanliness checklist)
- Customer Feedback – Online reviews mentioning quality/sickness

Predictive Model



ML Model Architecture for Contamination Prediction

We used ensemble voting classifier combining Random Forest (100 trees), Gradient Boosting (learning rate=0.1), and 3-layer by Neural Network

42 feature extracted including temperature abuse, cross-contamination, and staff compliance.

A stacked ensemble model with 10-fold cross-validation boosted prediction accuracy and robustness.

Training data :80 per , validation: 10per, Testing: 10per split

Theoretical and practical Implications

- 1.ML validation shows ensemble models work best with complex ,multi-source data
- 2.Staff stability is identified as a key hygiene factor in restaurant .
- 3.IoT-MI combo supports FDA's smart food safety goals

Results

Accuracy: 95%
(Precision: 92%, Recall 89%, F1-Score: 0,90)

87% improvement
in early
risk detection
compared to
manual
inspection
methods



Conclusion

By using AI and real-time data, we move from reacting to food safety problems to preventing them. This system helps restaurants act before harm occurs, making food safer for everyone. It's not just innovation it's a new standard for public trust and protection in every meal.

Limitations

- 1.Systems requires consistent sensor maintenance
2. Performance may vary across different restaurant types
3. Requires staff training for optimal implementation

TOP PREDICTORS

- Temperature deviation $>2^{\circ}\text{C}$ (importance: 0,23)
- Staff hand-washing compliance score (importance: 0,19)
- Equipment cleaning intervals (importance: 0,16)

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