# Leveraging AI-integrated IoT Solutions for Real-time Solid Waste Monitoring and Classification

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Cambodia Academy of Digital Technology

Anniversary

According to the World Bank, without urgent action, global waste will increase by 70 percent from current levels by 2050, amounting to an estimated 3.40 billion tons.

| City | Population (World Population Review) | Additional Medical Waste | Total Possible Production Over 60 Days |
|---|---|---|---|
| Manila | 14 million | 280 t/d | 16,800 tons |
| Jakarta | 10.6 million | 212 t/d | 12,750 tons |
| Kuala Lumpur | 7.7 million | 154 t/d | 9,240 tons |
| Bangkok | 10.5 million | 210 t/d | 12,600 tons |
| Ha Noi | 8 million | 160 t/d | 9,600 tons |

Source: Asian Development Bank (2020)

❖ Nowadays, modern cities face significant environmental challenges related to waste collection and disposal.

**Waste in Phnom Penh - The key numbers**

CLEAN GREEN CAMBODIA

**1 million tonnes** of waste is produced each year in Phnom Penh

Amount of waste in PP is expected to **more than double by 2030**

Two main dumpsites in the city are expected to **reach their capacity by 2020**

Most waste is organic but **plastic waste (20.9% of total waste) is on the rise**

Municipal waste composition in Phnom Penh

Plastic Waste 20.9%

Organic waste 51.9%

Paper 9.9%

Other 17.3%
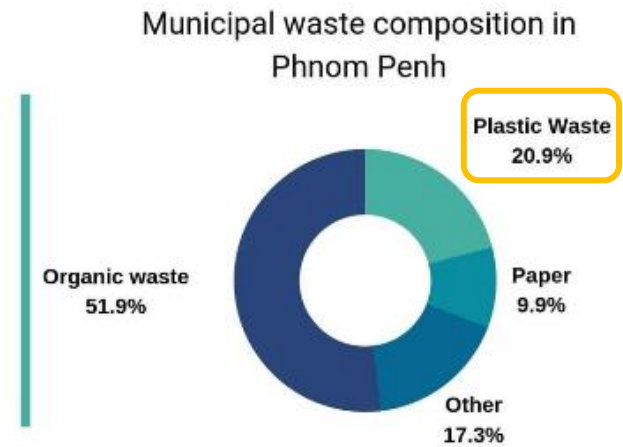
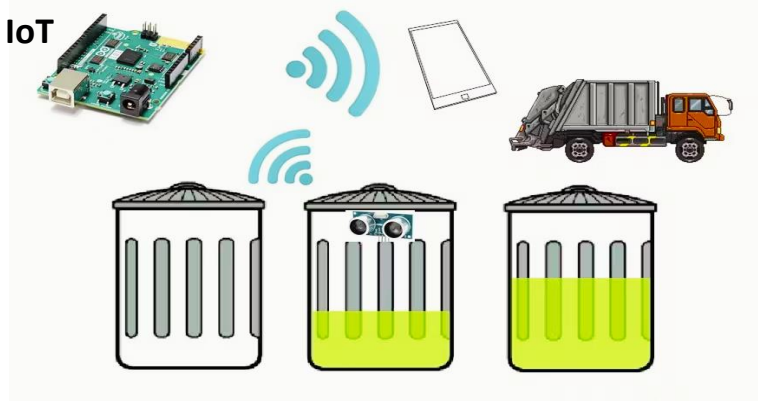(Source: Oborcapital, 2021)

**Key Issues (Cambodia):**

- No real-time monitoring system

- Insufficient collection scheduling

- Insufficient system for waste segregation
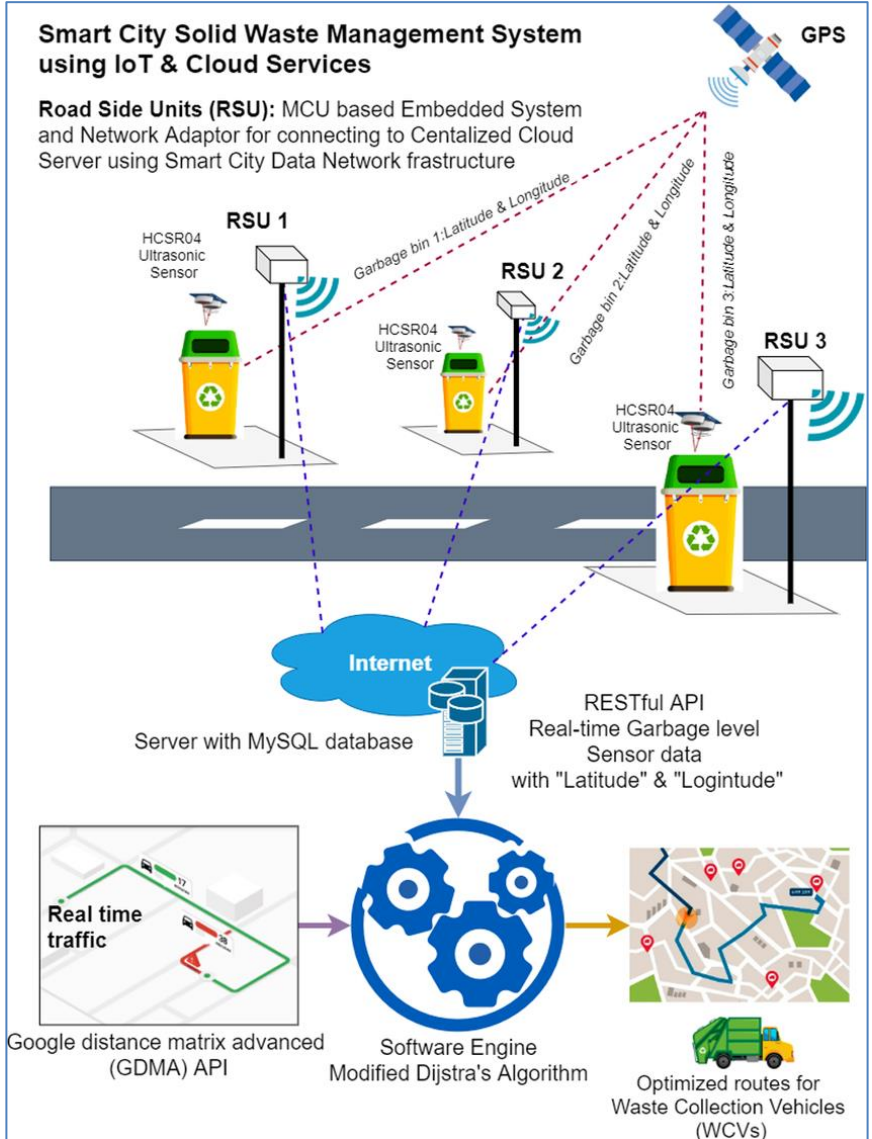
**Objective**

**Develop an IoT Monitoring System**

IoT

**Optimize Waste Collection Route**

Route Optimization

SCS

**Waste Classification Assistant at dumpsites**

ORGANIC    PLASTIC    GLASS

# Proposed Method – AI-integrated IoT Solutions



(Source: Ayaskanta Mishra, 2020)

Real-time Solid Waste Monitoring
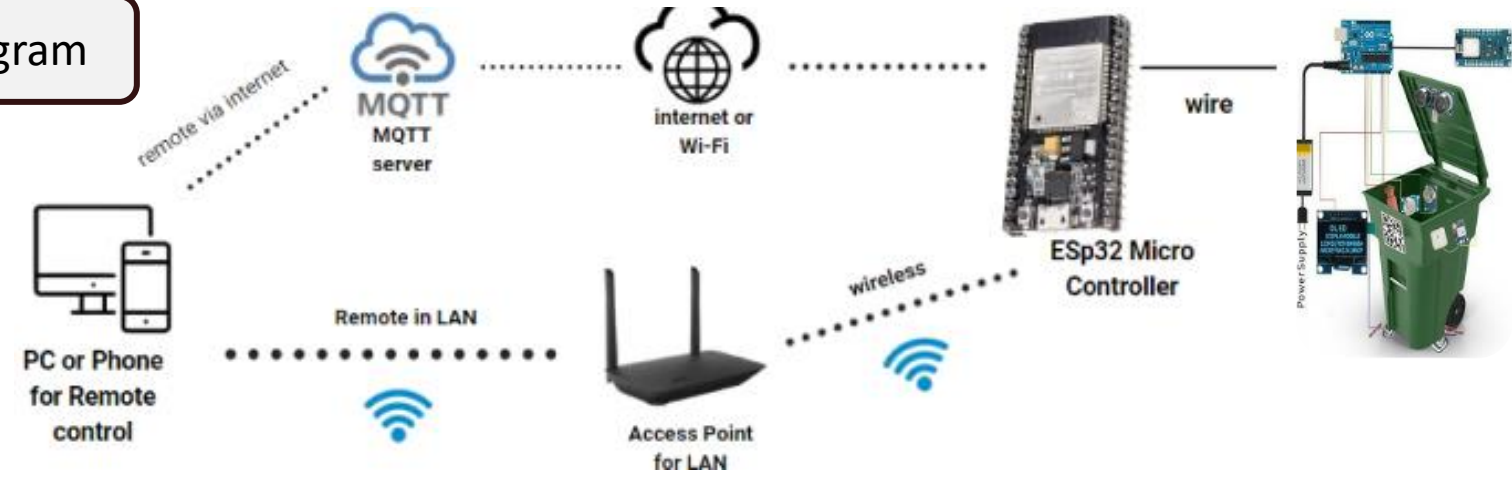
&

Classification



(Source: Greyparrot, 2019)
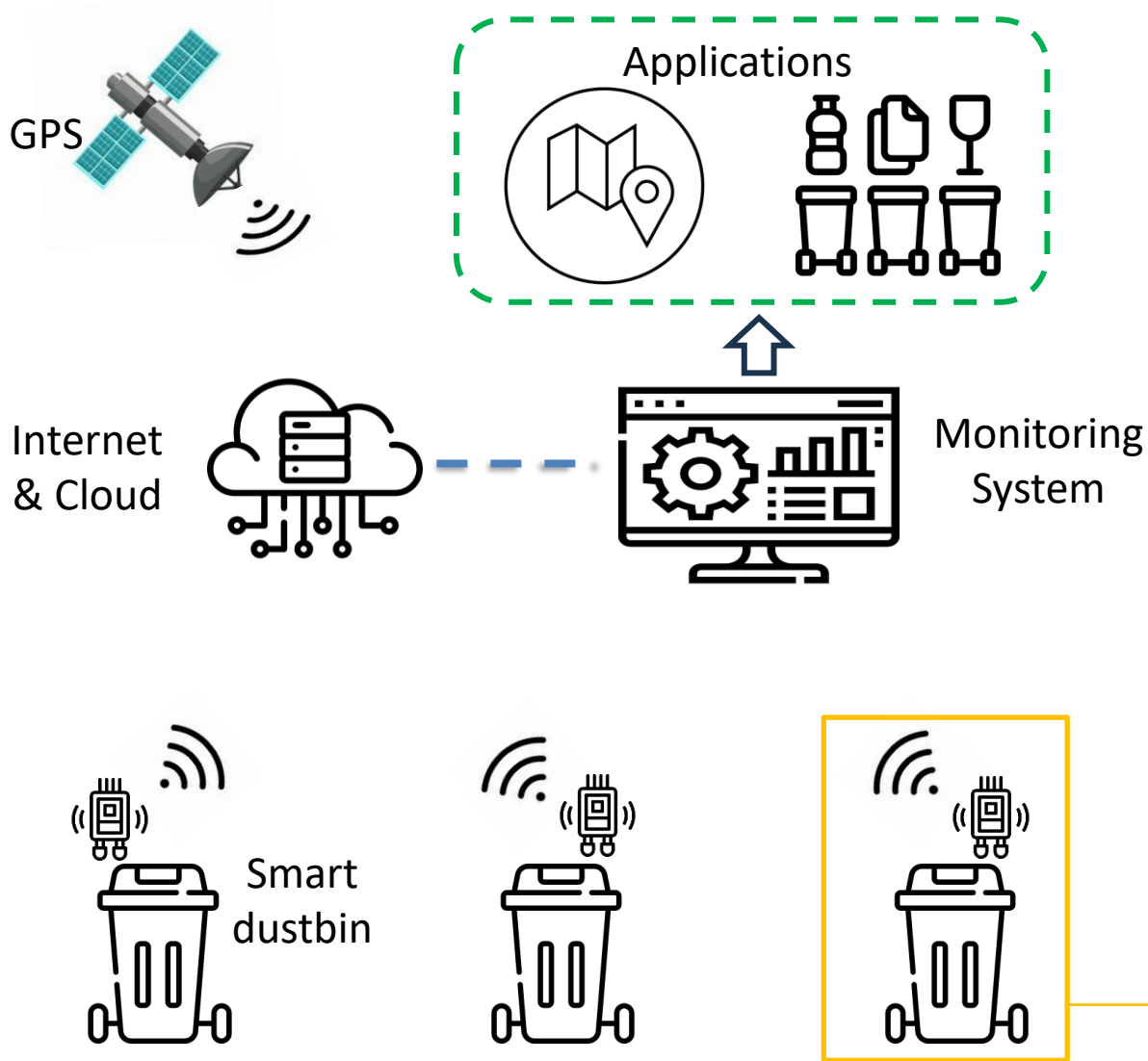
The solution integrated IoT solutions for each collection site to track its status and send the data via the internet for further processing.
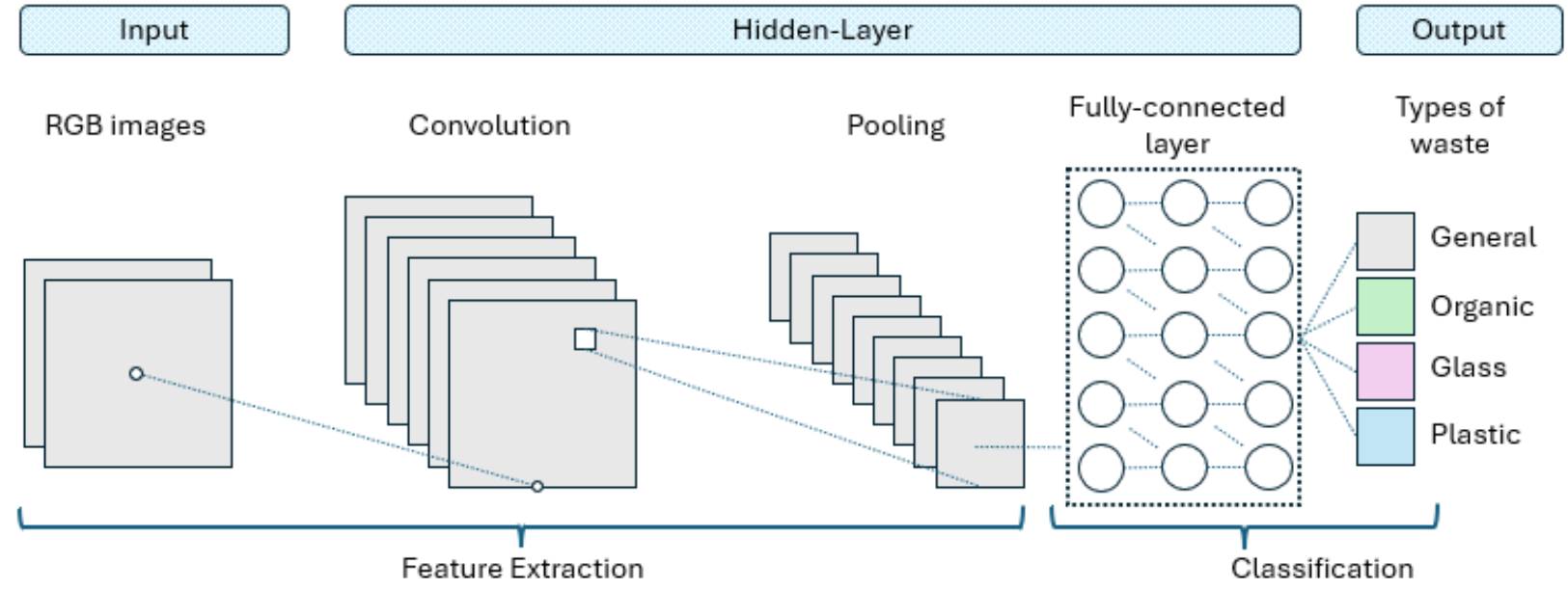
GPS

Applications

Internet & Cloud

Monitoring System

Smart dustbin

# Proposed Method – AI-integrated IoT Solutions (Cont'd)



**Connectivity Diagram**

MQTT
MQTT server

internet or Wi-Fi

wire

ESp32 Micro Controller

remote via internet

PC or Phone for Remote control

Remote in LAN

wireless

Access Point for LAN

**CNN Model**

| Input | Hidden-Layer | | | Output |
|-------|-------------|---|---|--------|

RGB images

Convolution

Pooling

Fully-connected layer

Types of waste

General
Organic
Glass
Plastic

Feature Extraction

Classification

# Impact

 **Real-time data and location tracking**

 **Cost Saving**

 **Enhanced Public Health**

# Impact (Cont'd)

**Home Users**
- Large household
- Small business-like restaurants
- Smart home enthusiasts
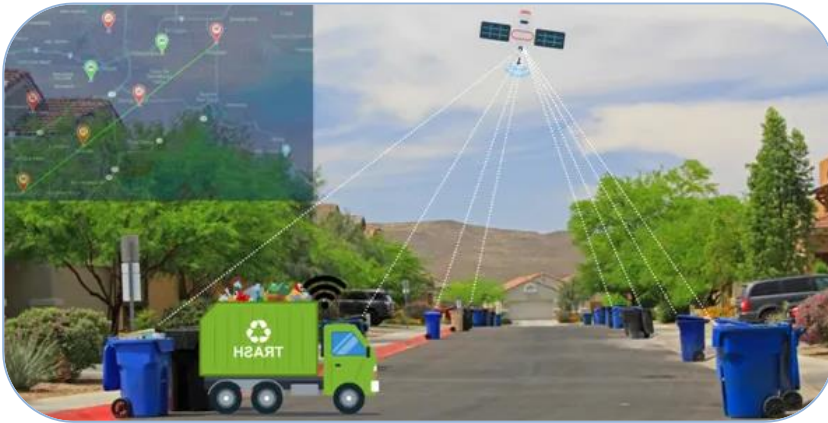
**Waste Collection Company**
- Waste collection schedule with precise location to avoid excess waste
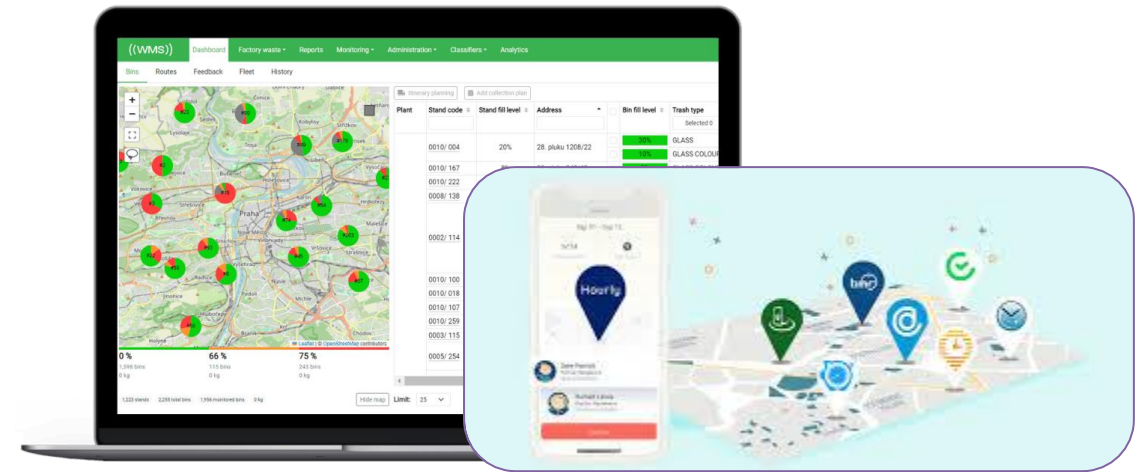- Improve service quality

**Mall/Public Place**
- Good waste management to stay cleanliness with quick response
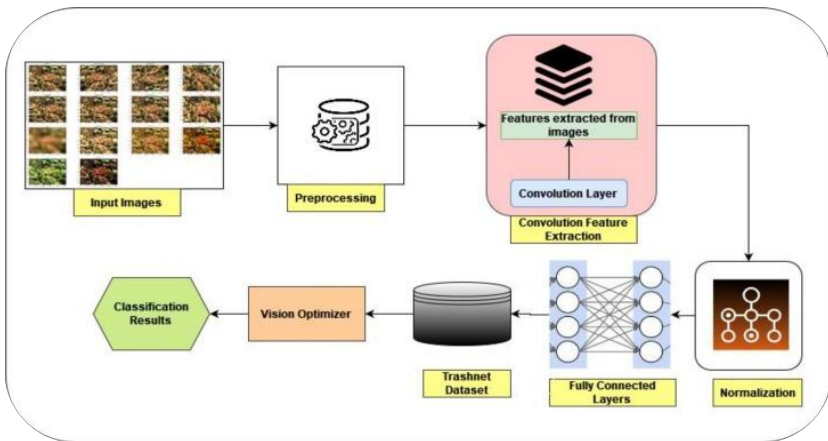- Cost saving including the labor

# Expected Outcomes

❖ An IoT prototype & Integrated waste classification system



❖ IoT waste monitoring platform



❖ Waste classification model & Dataset

# Conclusion

❖ The integration of AI algorithms with Internet of Things (IoT) systems for waste management is a great step toward the optimization and automation of most processes involved in the domain.

❖ It enables the prediction of waste generation patterns, classify different types of wastes, and determine efficient routes for collection vehicles.

❖ This solution has the potential to significantly impact public waste management practices in Cambodia, providing a scalable and adaptable framework for future expansions in other regions.

# References

Arteaga, C., Silva, J., & Yarasca-Aybar, C. (2023). Solid waste management and urban environmental quality of public space in Chiclayo, Peru. *City and Environment Interactions*, *20*, 100112. https://doi.org/10.1016/j.cacint.2023.100112

Gyawali, D., Regmi, A., Shakya, A., Gautam, A., & Shrestha, S. (2020). Comparative analysis of multiple deep CNN models for waste classification. arXiv preprint arXiv:2004.02168. https://doi.org/10.48550/arXiv.2004.02168

Mao, W. L., Chen, W. C., Wang, C. T., & Lin, Y. H. (2021). Recycling waste classification using optimized convolutional neural network. *Resources, Conservation and Recycling*, *164*, 105132. https://doi.org/10.1016/j.resconrec.2020.105132

Meng, S., & Chu, W. T. (2020, February). A study of garbage classification with convolutional neural networks. *In 2020 indo–taiwan 2nd international conference on computing, analytics and networks (indo-taiwan ican)*, IEEE, 152-157. 10.1109/Indo-TaiwanICAN48429.2020.9181311

Poudel, S., & Poudyal, P. (2022, December). Classification of waste materials using CNN based on transfer learning. *In Proceedings of the 14th Annual Meeting of the Forum for Information Retrieval Evaluation*, 29-33. https://doi.org/10.1145/3574318.3574345

Rahman, M. W., Islam, R., Hasan, A., Bithi, N. I., Hasan, M. M., & Rahman, M. M. (2022). Intelligent waste management system using deep learning with IoT. *Journal of King Saud University-Computer and Information Sciences, 34(5)*, 2072-2087. https://doi.org/10.1016/j.jksuci.2020.08.016

Rajeev Kumar Singh, Dickella Gamaralalage Jagath Premakumara, Ran Yagasa & Kazunobu Onogawa *(2020). State of Waste Management in Phnom Penh, Cambodia. Institute for Global Environmental Strategies (IGES). https://ccet.jp/publications/state-waste-management-phnom-penh-cambodia*

# Thank you for your attention!

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