

## OVERVIEW

Environmental sanitation is a major issue in developing countries and an effective means of collection and management of such waste has been a great concern to their governments. This proposal solidly looks into this area in unison with the targets and indicators of the 6th Sustainable Development Goal (SDG) of ensuring availability and sustainable management of water and sanitation for all. It further describes the development of a system that optimally manages waste by using mechanism design principles. The methodology utilizes the security game that can effectively and optimally map the geographical location of waste to the respective collector. The case-study of this proposal is the Lagos state, which is the largest city in Nigeria and one of the most populous urban areas in the world. The methodology can be scaled to a wider geographic and administrative area upon completion of the project

## PROBLEM

The problem of solid waste collection and disposal in Nigeria includes ineffective collection mechanisms, insufficient coverage of the total area, indiscriminate disposal of waste, the problem of narrow and unpaved roads, lack of modern machines, political and economic framework. According to the World Bank, the generation of solid waste is tied to population, income and urbanization. A typical instance to this is a mega-city like Lagos. It is clearly known that the generation outweighs the official figure of 13,000 tons per day. The Lagos state government stated that the waste generation rate per capital is at 1.2 kg per person per day. Also, the fact that the per waste generation has been projected to rise to 1.42 kg in the next fifteen years presents a serious cause for concern. Although, there have been some difficulties due to the lapses of waste collectors reaching all areas optimally, devising strategies for waste transportation routing, lucid pickup logic, effective scheduling based on collection frequencies and fair charging fees. There is a need to develop an effective strategy for allocating the waste collectors to the waste depositors based on an efficient pickup logic and an advantageous mapping system for all the stakeholders outcome.

- Waste collectors are acting in their own best interest, and are trying to shirk responsibility and not actually go on the pickup routes required of them
- Lagos state have a population of about **21 millions**
- Limited resources** for waste management
- Generates more than **13,000 tons per day**, with a per capital rate of **1.2 kg per person per day** These have resulted into:
  - the lapses of waste collectors reaching all areas optimally
  - problem of waste transportation routing and lucid pickup logic
  - ineffective scheduling which does not comply to frequencies and fair charging fees.

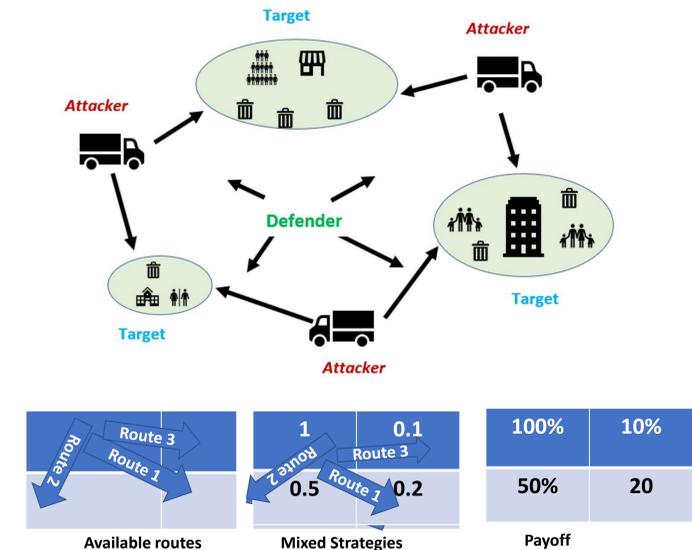
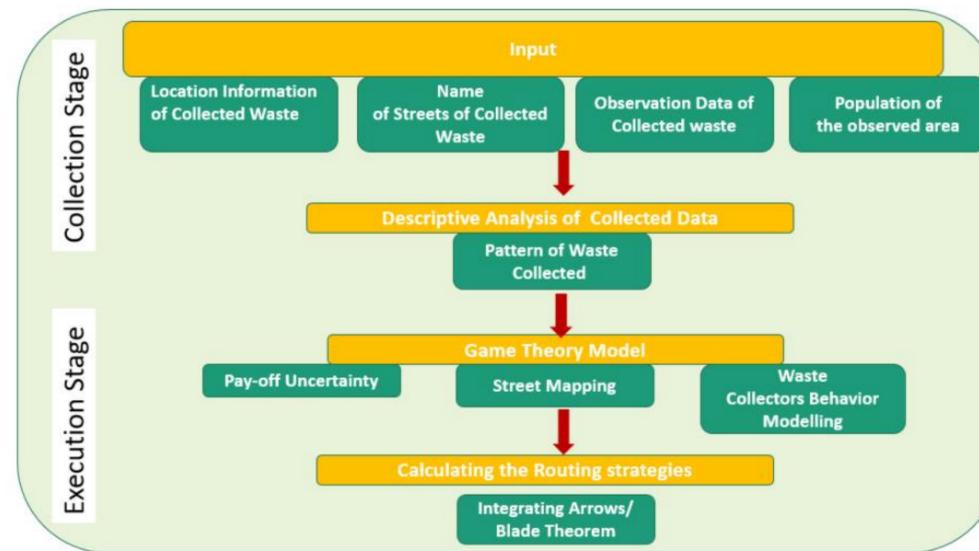
## METHODOLOGY

The problem of waste management can be seen as a security game with three types of players. The "attacker" is the agent collecting waste (i.e., the private waste collector or government vendor). An "attacker" is failing to properly collect waste in some part of the city. The "targets" are all the locations for which waste is supposed to be collected.

The "defender" is the agent that monitors whether disposals were correctly performed. The defender must choose some monitoring route to ensure that waste is properly being collected. The players have conflicting interests and there is a strategic interaction between the players. The defender must account for the attacker's actions and vice versa. To optimize pick up location and routing in waste management, so as to achieve a clean city, the defender conducts randomized patrols monitoring waste collectors while balancing the priorities of different locations with different population densities. If collection routes are not randomized and are deterministic instead (i.e., no randomization), waste collectors are not able to optimize the collection from 'targets' and also, they will be able to exploit this predictability and thus circumvent any efforts by the defender. To decide which 'target' route need to be considered and patrol routes need to be considered and how often each of them should be taken so as to optimize the waste collection process

Geographic Information Systems GIS) will be used to Label location spatially. This will provide spatial reference. We have also adopted the use of a participatory approach and crowd-sourcing framework with the aid of a data collection app like DataCrowd and Kobo 360, Location information of collected waste, name of the street where waste is collected, observation data such as the density of waste, waste category, days of the week when waste is collected at a particular location, geo-location and population of the area where waste is collected from. This will help us to gain insight and build a game theory model that will make use of the waste collectors behaviour modelling, street map and the pay off uncertainty to calculate the routing strategies for an optimise waste collection process.

## CONCEPTUAL FRAMEWORK



## CONCLUSION

With the efficiency of the proposed algorithm, we will be able to solve the issue of sanitation which is a Sustainable Development Goals with the support of LAWMA (government agencies in charge of managing waste in Lagos). This can be successfully deployed or proposed to other cities in Nigeria facing the same problem.

## REFERENCE

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- The "attacker" is the agent collecting waste (i.e., the private waste collector or government vendor).
- The "targets" are all the locations for which waste is supposed to be collected
- The "defender" is the agent that monitors whether disposals were correctly performed.
- Unlike a standard security game, in this model, an 'attack' occurs when the attacker fails to visit a target it was supposed to.
- We want to find an optimal monitoring strategy for the defender."