# Conclusions

In this research, we study an Energy Harvesting-based WSN with an auxiliary regular battery, which may have different regular battery usage probabilities based on the quality of service (QoS). We consider the possible attributes of packets, including non-preemptive priority and impatience, and for a more realistic scenario, we assume the packet arrival process to be a batch arrival process. For simplicity, we assume that a batch includes the arrival of one or two packets at a time. Additionally, we study two scenarios: (1) a system with a single node, and (2) a network composed of three interconnected nodes.

Initially, we derive the balance equations of the analytical model through a four-dimensional Markov chain. In addition, we obtain the steady-state probability distribution and calculate various performance metrics using iterative algorithms. We then investigate the impact of different parameters on the system's performance. Finally, we use the C language to write the simulation programs and in the majority of research cases, the analytical results are in good agreement with the simulation results.

In conclusion, based on our simulation and analytical results, we have made several interesting observations. First, it is interesting that the curves of expected number of all and LP packets in queue and system for batch arrival are higher than those for single arrival first and then they cross over in scenario 1. Additionally, there is the same pattern in node 1 and the average network in scenario 2. In a related manner, waiting time has the same pattern. Second, compared to Energy Harvesting-based WSNs, our models exhibit noticeable enhancements in performance across various metrics, particularly in terms of throughput. Third, among the aforementioned two scenarios, the maximum average RECR reaches approximately 0.6. This indicates that our model can extend the lifetime of a standard battery by a minimum of 40% when compared to relying only on a regular battery as an energy source.

Moving forward, further studies can delve deeper into the complexities uncovered in this research and uncover new possibilities. In light of the complex computational nature, it is important to note that three potential directions have been identified for further exploration. First, the optimization of using regular battery probability might dynamically changes as increases. Second, to better reflect real-world scenarios, the number of packets in a batch arrival should be set as an arbitrary positive integer, instead of limiting it to just one or two packets. Third, waiting time should conclude the time until an impatient departure occurs in order to accurately account for such scenarios. These directions, although not elaborated upon in this paper due to their intricacy, hold significant promise for future investigation and advancement in the field. By delving into these avenues, researchers can potentially overcome the computational challenges and uncover novel insights and solutions.