

# Swarms of Autonomous Drones in Logistics Within Smart City: Opportunities, Challenges and Future Directions

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## Abstract

The exponential growth of interest and investigations in unmanned aerial vehicles (UAVs) is strongly pushing the emergence of autonomous flying robots. Over the past few decades, sophisticated communication technologies (e.g. 5G, 6G) and custom microcontrollers embedded with cutting-edge AI techniques have developed, and the autonomy of UAVs—self-governing in the aerospace discipline—has emerged as a remarkable research area. UAVs equipped with advanced miniaturised avionics, multiple sensors, actuators and onboard autonomous flight management control systems can be deployed economically with a high degree of rapid response time to accomplish many different types of urban tasks collaboratively with a high degree of mobility, such as logistics.

The advent of autonomous drones instilled with swarm intelligence (i.e., using clusters of them to accomplish various collaborative tasks with collective behaviour) is causing a paradigm shift in the logistics sector in urban areas. By offering quicker, more effective, and more affordable delivery options, these intelligent aerial vehicles have the potential to transform the logistics industry substantially. The safe use of drones in urban areas, particularly, considering collision risks with urban structures and other aerial vehicles in dense aerial traffic (mid-air collision), is the essential concern of all stakeholders. Moreover, the constraints of drones such as technical limitations (e.g. limited battery and payload capacity, communication range, and state and situation awareness (SSA) difficulties in unstructured environments) and the difficulties in collaborating with other drones, human-in-the-loop (HITL) systems and base stations (BS) (e.g., communication, data sharing, remote control and manipulation) shall be mitigated for efficient use.

On the other hand, Smart Cities (SCs) are being implemented to combine governors, organisations, institutions, citizens, environment, and emerging technologies in a highly synergistic synchronised ecosystem to increase the quality of life (QoL) and enable a more sustainable future for urban life with increasing natural resource constraints. Combining the abilities of autonomous drones and intelligent facilities (e.g. distributed charging stations) of SCs paves the way for the development of more synergistic ecosystems accommodating both a high level of efficient and safe mobility for drones and a high level of sustainability for cities.

This presentation analyses the potential contributions of SCs in deploying swarms of autonomous drones in logistics. Moreover, it explores the challenges (e.g. regulatory framework, technical difficulties, security and privacy) with solutions (e.g. infrastructure requirements, public acceptance) and future directions (e.g. further technical improvements, harnessing energy sources from the SC ambient environment), integration with SC facilities, required regulations) with opportunities (e.g. drone taxis) to increase the efficacy of using swarms of autonomous drones in the logistics industry.

**Index Terms**— Autonomous drones, swarm intelligence, 6G, 5G, logistics, delivery, smart city, artificial intelligence, cybernetics.

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