

OPTIMIZING ENERGY CONSUMPTION IN ELEVATOR THROUGH SMART DELIVERY SYSTEMS

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1. ABSTRACT

The explosive growth of doorstep delivery services ranging from groceries to online orders has intensified elevator usage in both residential and commercial buildings. These vertical trips, often made for single-package deliveries, now account for 3% to 10% of a building's total electricity consumption. This not only escalates operational costs but also increases energy demand and elevator wear. To address this pressing issue, we propose a smart, sustainable delivery infrastructure that reroutes vertical logistics away from traditional elevators.

At the heart of this system are automated side carrier boxes equipped with a motorized push-and-pull mechanism, capable of transporting goods weighing 15 to 20 kg directly to designated floors. Each level is equipped with secure, tamper-proof smart lockers, allowing for unattended delivery and retrieval. The integration of Internet of Things (IoT) technology enables centralized coordination, prioritizing (Statista, 2024) delivery routes, managing traffic loads, and sending real-time updates to recipients. Through these innovations, the need for delivery personnel to enter elevators is virtually eliminated, reducing both energy usage and transit congestion.

The proposed model is further enhanced by compatibility with advanced elevator systems, including destination dispatching, remote performance monitoring, and robotic integration. Together, these layers of technology result in smarter traffic distribution, streamlined deliveries, and significant reductions in building energy consumption.

Beyond operational efficiency, the system contributes to sustainability goals by decreasing carbon emissions and extending elevator lifespans through reduced usage. It also enables scalable applications, such as modular retrofitting in existing buildings and integration with broader last-mile logistics networks, including drones and electric vehicles. This approach aligns with green building certification standards and promotes smarter urban living by combining automation, security, and sustainability into a unified delivery ecosystem.

2. INTRODUCTION

The rapid rise in doorstep deliveries for groceries, meals, and other essentials has significantly increased elevator usage in residential and commercial buildings. Elevators are among the most energy-intensive systems in such environments, often accounting for 3% to 10% of a building’s total electricity consumption, (Al-Kodmany, 2015) with some estimates reaching even higher during peak usage. This growing demand underscores the need to optimize energy consumption across all sectors, especially as frequent, often single-person elevator trips for deliveries contribute disproportionately to overall energy use.

To address this, smart delivery approaches are being proposed to reduce unnecessary elevator movements and improve efficiency. Concepts such as using side carrier boxes or integrating smart storage solutions can minimize the number of elevator trips required for deliveries, directly lowering daily electricity consumption. Additionally, integrating IoT devices and smart elevator technologies such as destination dispatch, remote monitoring, and service robot integration can further streamline delivery operations, reduce wait times, and enhance building efficiency. These innovations not only save energy and costs but also contribute to a more sustainable and user-friendly environment for both residents and service providers.

The chart shows a strong growth trend in users of grocery and meal delivery services from 2017 to 2029. Meal delivery users are projected to rise from 30.9 million in 2017 to 351.2 million in 2029, while grocery delivery users will grow from 39.3 million in 2018 to 263.8 million by 2029. This rapid increase reflects changing consumer habits and highlights the growing demand for delivery services. The surge will impact building logistics and energy use, emphasizing the need for smarter delivery and elevator systems to manage increased traffic efficiently.

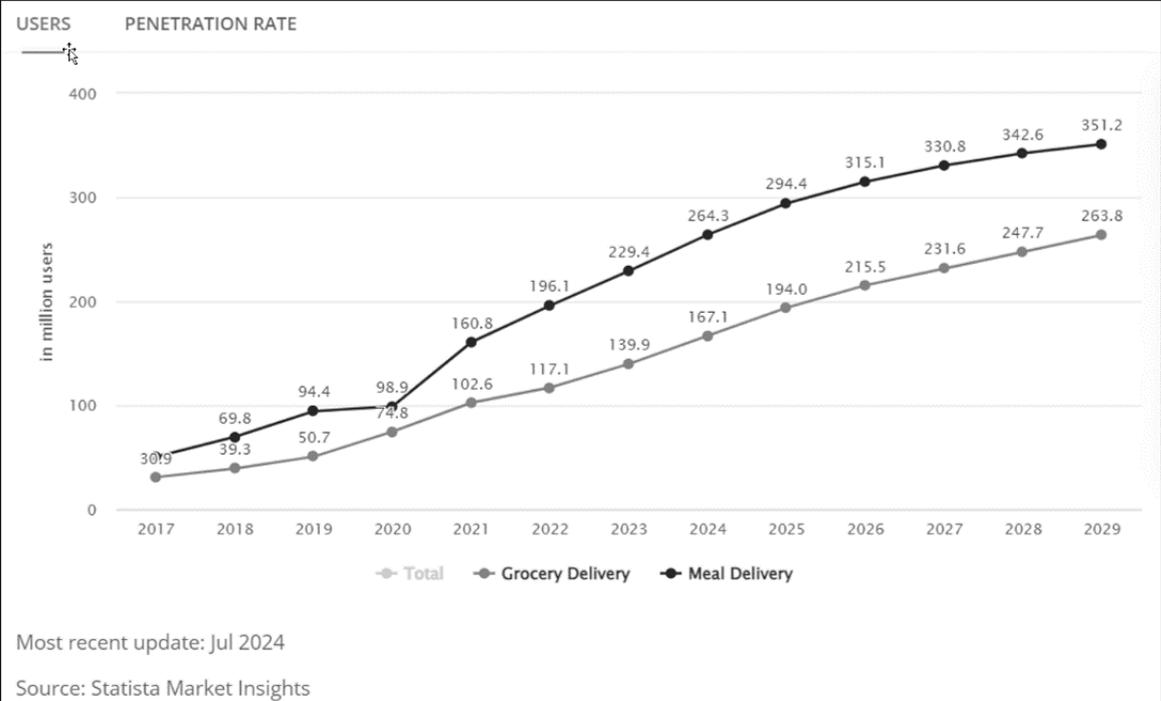


Chart-01 Growth trend of delivery (Statista, 2024)

3. ENERGY-SAVING ELEVATOR SOLUTIONS

To improve elevator efficiency, it is essential to prepare and analyse specific data points, including the number of movements per hour per day, the number of floors served, the size and speed of the elevator, the elevator’s electrical control system, and its load-carrying capacity.

There are two concepts proposed for optimizing elevator energy use in delivery scenarios:

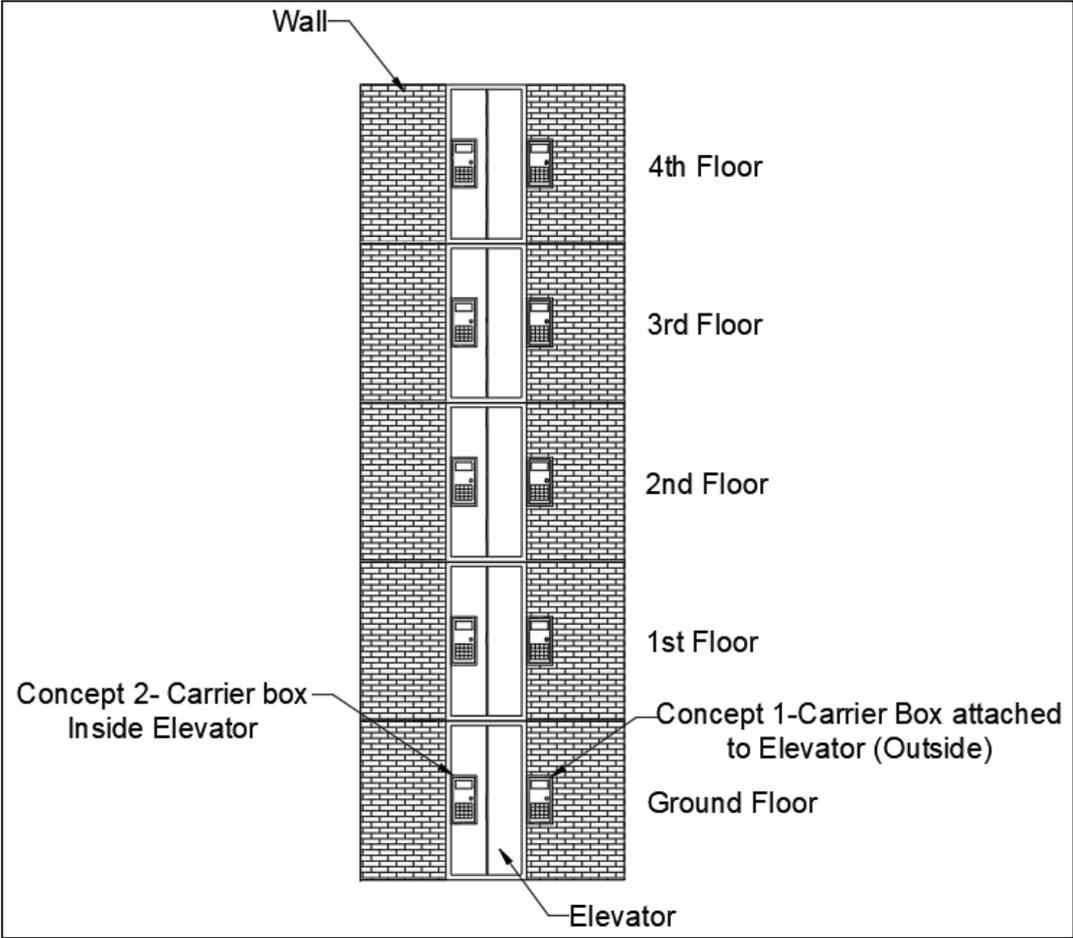


Fig.-01 Concept design of delivery

3.1 Concept-1:

A side carrier box is used to transport materials weighing between 15 kg and 20 kg. This box, equipped with a push-and-pull mechanism, allows goods to be loaded at the ground floor and delivered directly to the respective floors, without requiring the delivery person to ride the elevator. Currently, delivery personnel frequently use elevators to deliver groceries, meals, and utensils, often making multiple trips and increasing energy consumption due to repeated up-and-down movements. By implementing the side carrier box, goods can be delivered efficiently, and each floor can be equipped with a storage box to receive items. IoT devices can be integrated to set delivery priority and notify delivery personnel as needed, further streamlining the process.

3.2 Concept-2:

This approach places the carrier box inside the elevator car itself, while the rest of the delivery process remains unchanged. This method also reduces unnecessary elevator trips by separating the transport of goods from the movement of delivery personnel.

Both concepts lead to a reduction in the number of elevator movements per hour or day, which directly decreases daily electricity consumption, resulting in cost savings and improved energy efficiency. (Carlos Patrão, 2009)

Smart elevators are central to these improvements. They leverage advanced technologies such as destination dispatch systems, remote monitoring, and integration with service robots to optimize delivery processes, reduce wait times, and enhance building efficiency. Features like touchless controls, secure access, real-time monitoring, and IoT integration enable elevators to learn usage patterns, minimize unnecessary trips, and further lower energy consumption. (Zhang, 2021)

Key features of smart elevators in delivery systems include:

1. **Destination Dispatch & Optimized Routing:** Smart elevators group passengers and deliveries based on their destinations, optimizing routes to minimize travel time and reduce congestion. (Terziev, 2021)
2. **Integration with Service Robots:** Service robots used for food delivery and package handling can autonomously call elevators, travel to designated floors, and complete deliveries without human intervention.
3. **Remote Monitoring and Predictive Maintenance:** Building managers can remotely monitor elevator performance, identify potential issues early, and schedule maintenance proactively, reducing downtime.
4. **Touchless and Secure Access:** Smart elevators offer touchless controls and secure access methods such as mobile credentials or facial recognition, ensuring safe and efficient use by delivery personnel and robots.
5. **Enhanced User Experience:** By optimizing traffic flow and minimizing wait times, smart elevators improve convenience for all users. Features like ventilation and information screens further enhance the elevator environment.

Examples of smart delivery system integration include hospitals (for delivering medications and supplies), office buildings (for food, mail, and package deliveries), and warehouses (for moving goods between different levels). (AG., 2021)

By combining these smart elevator technologies with innovative delivery concepts, buildings can achieve highly efficient, automated delivery systems that save time, reduce costs, and support sustainable operations.

4. CONCLUSION:

The rapid growth in delivery services has placed unprecedented demand on building elevator systems, driving up energy consumption and operational costs. By adopting smart delivery solutions such as side carrier boxes and IoT-enabled smart elevators buildings can significantly reduce unnecessary elevator trips and optimize energy use. These measures not only achieve substantial energy and cost savings but also enhance user experience and support sustainable building operations. As delivery volumes continue to rise, the integration of advanced elevator technologies and automated delivery systems will be essential for efficient, eco-friendly building management.

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