SOFTWARE IS MAKING A DIFFERENCE IN OUR VERTICAL TRANSPORTATION INDUSTRY

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ABSTRACT:

This paper explores the transformative impact of advanced software technologies on the vertical transportation industry, specifically focusing on elevators and escalators. The integration of artificial intelligence (AI), augmented reality (AR), virtual reality (VR), and machine learning is driving significant changes in predictive maintenance, user experience, operational efficiency, and safety enhancements.

AI powered predictive maintenance systems utilize machine learning algorithms to analyze sensor data, enabling the anticipation of potential failures before they occur. This proactive approach reduces downtime and maintenance costs, ensuring uninterrupted service and enhancing operational efficiency. AI also enables hyper-personalized experiences in elevators by adjusting settings such as speed, lighting, and ambient music based on individual user preferences, thereby improving user satisfaction.

Generative AI is leveraged to create innovative products, challenging traditional product development processes by introducing new tools and applications, such as CoPilot, which reduce the time taken to bring products to market. AI agents, autonomous systems that perform tasks on behalf of users, improve efficiency and reduce response times in elevators.

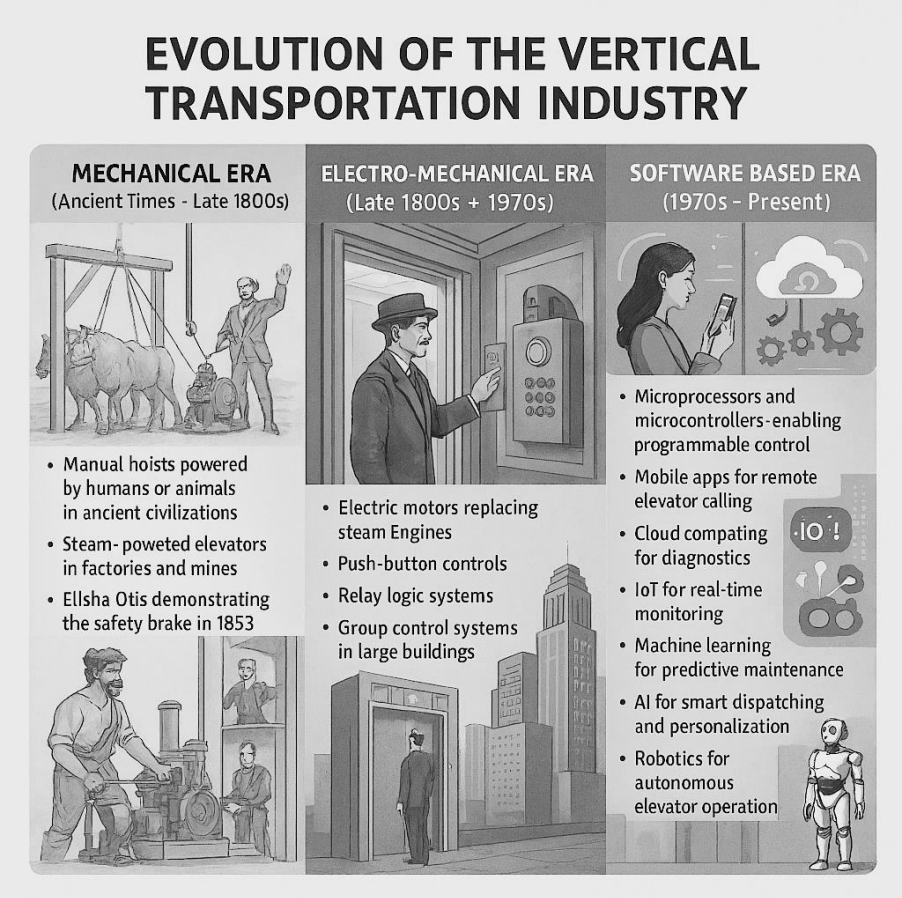
Enhanced safety features through AI include real-time monitoring and emergency response systems, with predictive analytics used to prevent accidents and ensure passenger safety. AI also optimizes the energy consumption of elevators, contributing to sustainable operations by adjusting elevator operations to minimize energy use while maintaining performance.

AR and VR are utilized for training maintenance personnel and enhancing user interactions through interactive simulations and real-time data overlays. These technologies make maintenance more efficient and user interactions more engaging. Additionally, cloud connectivity enables remote monitoring and intervention, allowing technicians to diagnose and fix issues from a distance, reducing the need for on-site visits and speeding up problem resolution.

Digital configurability allows customizable elevator solutions, while citizen development empowers users to create and modify systems, fostering a cultural shift towards user-driven innovation. Finally, generative AI models demystify industry codes and standards, facilitating compliance and standardization through automated compliance checks and reporting systems, ensuring regulatory adherence and operational efficiency.

INTRODUCTION

The evolution of the vertical transportation industry has been through three distinct eras. During the Mechanical Era (Ancient Times – Late 1800s), manual hoists powered by humans or animals were used in ancient civilizations, and steam-powered elevators were employed in factories and mines during the Industrial Revolution. A significant milestone was achieved in 1853 when Elisha Otis invented the safety brake, enabling safe passenger elevators. The Electro-Mechanical Era (Late 1800s – 1970s) saw electric motors replacing steam engines, which improved speed and reliability. Push-button controls were introduced, replacing manual operators, and relay logic systems were used for floor selection and door operations. Group control systems were developed to coordinate multiple elevators in large buildings. The Software-Based Era (1970s – Present) marked the replacement of relay logic with microprocessors, enabling programmable control in the 1970s. The 1980s saw the advent of microcontrollers, which allowed for compact, embedded control systems. In the 1990s, group control algorithms were developed to optimize elevator traffic flow. The 2000s introduced mobile apps that enabled remote elevator calling and user interaction. Cloud computing in the 2010s supported remote diagnostics and monitoring, while IoT integration in the 2015s enabled real-time data collection and system health tracking. The 2020s brought advancements in machine learning, which facilitated predictive maintenance and traffic pattern learning, as well as AI, which enabled smart dispatching, personalization, and adaptive control. Additionally, robotics integration allowed for autonomous elevator operation and the use of service robots.



As we learnt from history, how heavily technology upgrades disrupt industry and create new opportunities for creative ideas and inventions. Infact when we consider from the past to the current modern era, the rate of adaptability is much higher due to easy access to internet and digital technologies. This paper presentation touches upon key benefits of the latest software technology and engineering in vertical transportation. How the latest technologies can be leveraged to launch/rollout citizen development and resolve issues/challenges associated with elevator regulations.

1. CITIZEN DEVELOPMENT (CORELATION TO SOFTWARE ENGINEERING) IN VERTICAL TRANSPORTATION

1.1. Citizen Development Definition

In general citizen development is fundamentally reshaping software engineering. By enabling non-technical users to participate in building digital solutions—and by aligning IT departments to support, secure, and scale these initiatives—organizations can unlock new levels of innovation and efficiency, as supported by leading research from Gartner, Forrester, MIT, and Stanford.

Citizen development is rapidly emerging as a transformative force in numerous industries, and the vertical transportation sector stands at the forefront of this movement. This paper presentation offers a comprehensive exploration of citizen development in the elevator and escalatory industry, what it means, why it matters, how it is enabled by modern technologies, and the multifaceted benefits it brings to consumers, OEM companies, and regulatory inspectors. Finally, we will discuss the anticipated changes to the business ecosystem because of widespread adoption.

Citizen development refers to the empowerment of non-technical users—typically business professionals or end-users—to create, modify, and optimize digital solutions and applications without deep programming expertise. Using intuitive, low-code or no-code platforms, citizen developers can design workflows, dashboards, reporting tools, and even process automation suited to their unique operational needs.

In the context of the Vertical transportation industry, citizen development opens the door for technicians, building managers, and even consumers to customize interfaces, monitor systems, and implement improvements directly, accelerating innovation and responsiveness.

1.2. Challenges faced by our industry

The vertical transportation industry is experiencing increasing complexity and a growing demand for rapid innovation. Traditional models, in which software changes and customizations are managed solely by OEMs or external vendors, often prove slow, costly, and unresponsive to urgent requirements in the field. Citizen development fills this gap by reducing the time needed to develop customized solutions, enhancing operational agility and responsiveness, fostering a culture of continuous improvement and user-driven innovation, and empowering staff at every level to solve problems and optimize workflows.

1.3. How emerging technologies in software can help us

The adoption of citizen development in the vertical transportation industry is driven by advanced technologies such as low-code/no-code platforms, which empower non-technical users to create solutions for monitoring, maintenance scheduling, fault reporting, and analytics. Cloud connectivity enabled centralized data access and streamlined deployment of new applications across fleets. AI and machine learning provide intuitive analytics and automated diagnostics, while AR/VR technologies facilitate immersive customer experiences and visualization tools for panel designs, safety features, and modernization planning. Additionally, IoT integration delivers real-time data streams, supporting the creation of customized dashboards, alerts, and maintenance triggers tailored to specific operational needs.

Citizen development creates value across the vertical transportation industry ecosystem by offering a range of benefits to all stakeholders. For OEMs, it accelerates product innovation cycles, reduces product backlogs, enables faster responses to market requirements, and allows for greater differentiation through customizable offerings. Consumers, including building owners, facility managers, and tenants—enjoy personalized elevator settings and experiences, quicker implementation of feature requests or fixes, enhanced transparency, and the opportunity to participate directly in building operations. Service providers benefit from new opportunities to offer low-code or no-code tools and services, deeper integration and collaboration with customers, and increased efficiency in deploying updates and innovations. Inspectors and regulators can take advantage of custom compliance apps for real-time reporting and documentation, easier tracking of maintenance logs and safety standards, as well as automated alerts and checks that help ensure ongoing code compliance through intuitive, visual tools.

1.4. Vision for the future

The rise of citizen development is poised to reshape the vertical transportation industry's business demographics in several keyways:

- Broader Participation: The talent pool for digital innovation expands beyond software engineers to include domain experts and end-users, diversifying workforce skills and perspectives.
- New Business Models: Subscription-based, platform-centric offerings will become more prevalent, as companies monetize customizable app ecosystems and developer tools.
- Increased Competition and Collaboration: OEMs, manufacturers, and service providers will compete to offer the most user-friendly platforms, while also collaborating more closely with customers and regulators.
- Faster Feedback Loops: Continuous input from field and users accelerates iterative improvement, reducing the time from idea to implementation.

2 DEMYSTIFYING CODES AND STANDARDS

2.1 Codes and standards

Codes and standards in the elevator industry are technical documents that set out safety requirements, such as those specified by IS 17900, along with design and performance criteria, inspection and maintenance protocols, and guidelines for accessibility and user experience. These comprehensive documents provide the foundation for ensuring that equipments are both safe and effective for all users.

2.2 Challenges faced by our industry

To demystify codes and standards means translating complex technical language into practical, understandable guidance, making compliance transparent and accessible to all stakeholders including manufacturers, inspectors, building owners, and users and effectively bridging the gap between regulatory intent and real-world implementation.

Today, the landscape of regulation and compliance in the elevator industry is marked by several significant challenges. Standards are often lengthy and complex, sometimes spanning hundreds of pages and subject to frequent revisions. There is considerable variability as different countries adopt their own codes such as EN standards in Europe, ASME in the United States, and IS in India with individual states or regions sometimes following additional local requirements. This diversity can lead to confusion and a lack of clarity, especially for those who may not be fully aware of all the relevant standards. Manual inspections still play a central role, relying heavily on human judgment, which introduces the potential for inconsistency. Furthermore, gaps in training persist, as many academic institutions do not offer hands-on exposure to the latest elevator technologies, making it difficult to prepare new professionals for the realities of modern compliance and safety demands.

2.3 How emerging technologies can help us

Emerging technologies are poised to transform how the vertical transportation industry approaches compliance in daily operations. Artificial intelligence, including generative AI, can automate code interpretation, translating complex standards into plain language and generating practical checklists. Compliance assistants such as chatbots or digital copilots will enable inspectors and technicians to query standards in real time, while AI models analyze sensor data for predictive maintenance, identifying potential failures before they occur. Augmented reality (AR) offers on-site guidance through smart glasses, overlaying inspection steps or highlighting non-compliant components, and even enables remote audits where experts can virtually guide inspections. Virtual reality (VR) takes training to new heights by simulating elevator installations, emergency rescues, or routine inspections in immersive, risk-free environments, and supports scenario-based learning for rare but critical events like brake failures or fire evacuations. Machine learning, drawing from historical elevator data, enhances anomaly detection and optimizes inspection schedules by prioritizing visits based on learned risk profiles. Together, these technologies promise to make compliance more accessible, inspections more consistent, and safety training more effective throughout the vertical transportation industry.

Academic and talent development in the elevator industry is increasingly supported by innovative digital tools. With digital twins, students can explore virtual replicas of

elevator or escalator systems, gaining hands-on experience in a simulated environment. Curriculum integration of AI powered resources will help learners interpret standards and understand compliance logic more effectively. Virtual reality-based certification simulators offer realistic mock exams for aspiring inspectors and technicians, enhancing their preparedness for certification. Additionally, open knowledge platforms curated by AI provide access to a wealth of case studies, information on failure modes, and industry best practices, ensuring that knowledge is both accessible and up to date for all stakeholders.

2.4 Vision for the future

Envision a future where building owners can simply scan a QR code inside an elevator to instantly access its compliance status, and technicians receive real-time augmented reality overlays to guide each inspection step. Students could immerse themselves in virtual elevator simulations to learn about safety equipment firsthand, while regulators leverage artificial intelligence to monitor and analyze compliance trends across a city. This integration of digital tools promises a more efficient, transparent, and accessible landscape for everyone involved in the elevator and escalator companies.

Conclusion

The convergence of advanced software technologies with the vertical transportation industry is catalyzing a profound transformation in how elevators and escalators are designed, maintained, and operated. The integration of artificial intelligence, augmented and virtual reality, machine learning, and citizen development platforms is not only enhancing efficiency and safety but also democratizing innovation across all levels of the ecosystem. As these digital tools streamline compliance, empower end-users, and foster an agile culture of continuous improvement, the industry stands poised to meet the evolving demands of urbanization and regulatory complexity. By embracing these technological advancements, stakeholders can ensure that vertical transportation systems remain resilient, adaptive, and user-centric, ultimately delivering safer, smarter, and more sustainable mobility solutions for the future.

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