KHATIB & ALAMI

SMART INFRASTRUCTURE TO ENHANCE CITIES' OPERATIONAL EFFICIENCY

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As per the United Nations, 70% of the world population will live in urban areas by 2050, highlighting the increasing need for smart spaces in cities. The challenge is to make cities safer, more sustainable, healthier, and livable for everyone. Cities' livability is greatly affected by their landmarks and infrastructure comprising various sectors such as transportation systems, railways, roads, water and energy distribution networks, telecommunications, stadiums, retail outlets, corporate offices, university campuses, hospitals, airports, parking lots, and other essential infrastructures.

These sectors can be publicly or privately owned or operated, depending on the chosen operation strategy, such as a Public Private Partnership (PPP) strategy.

By merging digitalization with a city's physical infrastructure, the cost of ownership can be reduced, and the return on investment can be increased. Automating city operations will make city operations smoother, more efficient, safer, and cost-effective. The combination of digitalization and physical infrastructure is called Smart Infrastructure.

However, cities face many challenges when it comes to their infrastructure. Each sector of the city's infrastructure should see itself as a part of the larger picture, working towards achieving city-wide goals such as reducing carbon emissions, improving pedestrian safety, or enhancing residents' quality of life.

For instance, sports and entertainment venues and retail spaces are closely connected to mobility and utility infrastructure in a city-wide context. By addressing each other's challenges and needs, they can both benefit. This can be facilitated using the right digital tools that capture, document, integrate, and analyze real-time data across the lifecycle. These tools can provide the best operational scenarios by leveraging Artificial Intelligence (AI) and Machine Learning (ML) technologies.

Transit stations can use real-time and predictive data analytics to identify abandoned items, manage queues, and detect anomalies in ticket machines, enhancing emergency response and security operations. Similarly, data analytics and AI can be used to anticipate the influx of people entering and exiting the sports areas and their timing, which will improve dynamic control of crowds and staffing deployment plans, allowing them to manage the parking occupancy intelligently. Moreover, the digital twin technology gives community developers limitless options in planning, designing, and operating the city's physical infrastructure. By digitizing the city's infrastructure and deploying AI to provide prediction analytics and simulation capabilities, decision-making can be improved, and complete insights into the city's functions can be achieved.

Therefore, with the emerging technologies in AI, the Internet of Things (IoT), and management platforms, coupled with the increased processing power of electronic devices and video analytics, the physical infrastructure is becoming smarter and more intelligent. This development will achieve the objectives of sustainable living, enhanced safety, and operational excellence, leading to a better personal experience and increased revenue generation.

Table 1 below illustrates some of the significant challenges of this transformation.

City Infrastructure	Infrastructure Components	Challenges
Projects	Public & Private Transport, Airports, Eaports, Railways, Light Rails, Metro Systems, Micro-Mobility	• Population Growth • CO2 Emission Reduction • Security & Safety Operations
Critical Infrastructure	Roads/Highways, Water/Energy, Hospitals, Civic Infrastructure, Communications	• Pollution Reduction • EVAC • Vision-Zero • Detect and repair roads impairments (potholes, flooding, and debris)
Education Network	Universities, Schools, Colleges, R&D Institutes	• Remote Learning • Digital Connectivity • Smart Assessments
Commercial Real Estate	Malls, Venues, Corporate campus, Trade Shows, Conference Venues	• ESG Considerations • Digital Economy growth • Workforce Housing Shortage • Retail Services Investments
Sports & Entertainment Venues	Stadiums, Museums, Opera Houses, Cinemas, etc...	• High volume of people • Logistics, freights, F&B deliveries • Queuing time • Parking Management • Safe entrance & exit in highly dense areas • Retail Mmanagement • Sanitary & Waste Management

2- SMART INFRASTRUCTURE ENABLERS

Effective management of stakeholders in city infrastructure governance is one of the most essential success factors of the smart infrastructure model. It ensures that interested parties can interact with each other, leading to collective management of city sectors.

Another crucial element is statistics and metrics collection from various sources like electronic sensors that comply with the Internet of Things (IoT) standards. This data is essential for local government and city stakeholder officials to make intelligent and responsible decisions.

City Command & Control Center

Moreover, an automated centralized command and control center is necessary for simple and efficient operations management.

IoT Cybersecurity Model

CYBER SECURITY

Cybersecurity plays a crucial role in enabling a smart infrastructure. It effectively blocks threats at their source without introducing latency or network bottlenecks like traditional Intrusion Protection Systems (IPS). A flexible Self-Defending Network solution for wired and wireless networks adds to the security and improves the end-user experience.

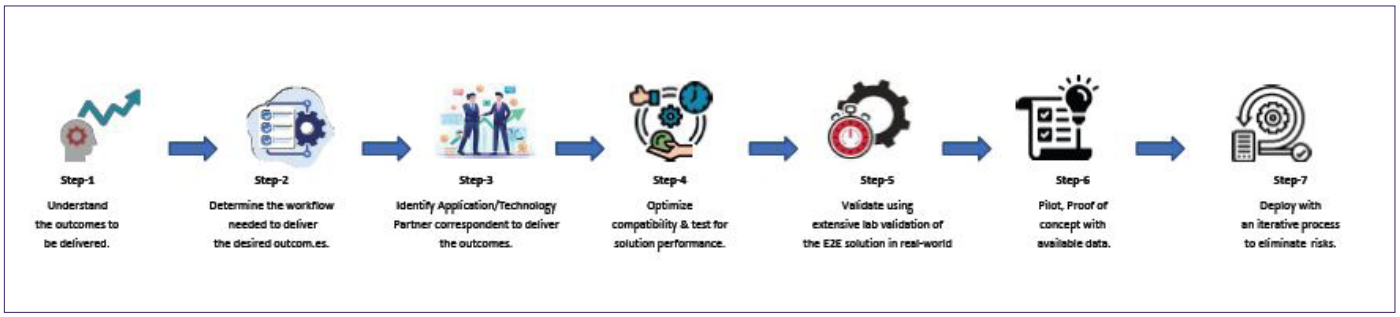
IoT combines ubiquitous and pervasive computing, wireless sensor networks, Internet communication protocols, sensing technologies, 5G, and embedded devices.

Smart infrastructures are moving towards a pervasive, integrated, and intelligent environment where IoT is used to seamlessly interconnect, interact, control, and provide insights about the various silos of fragmented systems within cities.

The vast number of interconnected devices and the significant amount of data they generate provide unprecedented opportunities to solve urban challenges. These technologies are integrated with city systems to form an environment where the real and digital worlds meet and interact synergistically. This intelligent and pervasive environment forms the basis of the interconnected city sectors.

3- SMART INFRASTRUCTURE IMPLEMENTATION APPROACH

Developers should adopt an outcomes-focused approach to mitigate risks and increase success factors of smart infrastructure design. This approach should ensure that all design activities achieve targeted city outcomes. Figure 5. Illustrates the different steps involved in this approach



Outcomes-focused approach

STEP 01

To create effective desired smart infrastructure solutions, it is crucial to define measurable goals and timeframes while considering the impact on both the developer/owner organization and the city sectors. Various strategies may be implemented to achieve these goals depending on the established outcomes. These outcomes result from interfacing and communicating with multiple city stakeholders.

STEP 02

Multiple steps are involved to determine the workflow required for achieving the desired outcomes. These steps can be depicted as a sequence or list of required actions, such as identifying the starting and end points of each required action, mapping out each step to move from the beginning to the endpoint, assessing the order of each stage, allocating resources, and distributing roles and responsibilities. AI capabilities will significantly affect the efficiency of this workflow and its management.

STEP 03

A technology partner is a vendor who provides solutions/ products for smart infrastructure outcomes. They can help city developers keep up with the latest industry trends, offer expert guidance, and implement new technologies to improve their operations. When identifying the best-fit technology partners, it's essential to consider their project-related experience over their knowledge, their intrinsic understanding of the business outcomes and goals, and their cost-effective solutions and innovative approaches.

STEP 04

Thoroughly exploring the challenges and problem scope is necessary to optimize compatibility and test solution performance. This includes benchmarking and applying the best practices to challenge the existing regulations and standards and select the best-fit solution for hardware, software, and infrastructure. The solution's performance is tested using various scenarios on different platforms to ensure end-user satisfaction and business outcomes. It's also important to consider the interdependencies between other city sectors. Finally, the cost and implementation roadmap are optimized accordingly.

STEP 05

Validate the selected solutions for real-life implementation through lab testing.

STEP 06

Engage in a proof-of-concept pilot project using limited resources to minimize risks and avoid uncertainty.

STEP 07

Continuously deploy successful pilot iterations to eliminate risks and prevent overbudgeting and change requests. Conduct interim checks for KPIs and business outcomes to align the design progress and the deployment strategy.

About the author:

Dr Houssam al Masri has more than 30 years' technical and management experience working with multidisciplinary teams on broadband communication networks and smart city infrastructure.

As a Senior Project Manager at Khatib & Alami, Dr. Al Masri's current responsibilities include leading the smart city design of a significant development project in the Kingdom of Saudi Arabia.

In his previous positions in the MENA region's telecommunications industry, Dr. Al Masri was instrumental in managing major telecommunication projects related to Smart Cities and solutions, Smart Buildings and Smart Homes, Fiber-to-Homes, and Broadband Access. He led project rollouts in many countries in MENA related to private and public sectors.

Dr. Al Masri earned a PhD in Computer engineering from MIT. He has been Chairman of the Smart City Opt. and App Committee for the FiberConnect Council MENA since 2019. He is a member of ESRI GIS community professionals, the IEEE IT Society, the Green Building Association, and the ISO Smart City Technical Committee.

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