SIEMENS

Siemens Advanta

FROM CITY THEORY TO SMART TECH REALITY

A uniquely comprehensive approach for smart cities

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DEAR READER,

Our planet is facing increasingly threatening environmental challenges spanning climate change, freshwater depletion, air and water pollution, deforestation and food security, to name a few. In this race against time, tailored and individual solutions are needed to crack the nut. However, governments and societies cannot manage on their own. Companies around the globe have an important role to play.

As the professional service arm of the Siemens corporation, we accompany our clients on their unique digital transformation journey, from beginning to end, all while helping them with their operational optimization and sustainability goals. We start with the business value: there is vast business potential in green solutions and an ocean of opportunities that only waits to be explored.

How can this be achieved? To transition toward a super-smart, sustainable society, or "Society 5.0," companies need to start by fostering innovation to connect the real and digital worlds and leverage the power of their data and cutting-edge technologies, like digital twins or AI.

We know that there must always be a holistic solution in place to make the transition successful. At Siemens, for instance, we recently established our **DEGREE** framework, consisting of measurable ambitions for **D**ecarbonization, **E**thics, **G**overnance, **R**esource Efficiency, **E**quity, and **E**mployability for our customers, suppliers, investors, people, societies we serve, and most important, our planet.

Realizing smart cities is one strong path to navigate toward Net Zero. Next to reducing its carbon footprint and improving operational efficiency, a truly sustainable city is one that offers its citizens services that improve their short- and long-term well-being while fostering its own resilience.

Nevertheless, bringing a smart city to life is easier said than done (also in the exemplary Middle East region). Starting with a clear strategy and a holistic concept will set you on the right course. From several of our projects, we were able to deduce key success factors to ensure a successful transformation to a smart city. One great example, the Red Sea Development project, focuses on creating a sustainable concept of regenerative tourism while preserving and enhancing Saudi Arabia's natural ecosystem, and acts as a front-runner for similar projects in the region and beyond.

Partnering closely within ecosystems is key as we progress toward our joint challenge. We are all in this together, and no one can do it alone. As we all strive for a sustainable digital future, I am eager to see what awaits us. One thing I can say for sure: digital solutions will be by our side.

The following whitepaper uniquely combines strategy and technology for a successful smart city realization based on real project experience. This know-how has not been brought together into a comparable comprehensive approach before.

Enjoy reading!

Aymeric Sarrazin
Chief Executive Officer
Siemens Advanta

DEAR READER,

In today's increasingly digitalized world, there is a growing demand to unlock the full potential of digital infrastructures to optimize operations, better serve visitors and businesses, encourage new forms of employment, and ensure environmental sustainability within cities as well as touristic destinations. While cities around the world are still in the transformation phase toward digitalization and smart technologies, the "Smart Destination" label has long been a critical differentiator for The Red Sea Development Company.

The Red Sea Project and AMAALA have been set up as living laboratories to test new innovations in smart and sustainable development in the Middle East, enabling us to move beyond simply sustaining the environment to actively enhancing it.

A smart destination vision is more than just technology implementation; it is a way of thinking, implementing, delivering, and running destinations. For our employees it is a way of living. A framework is needed to break new ground in the digital transformation of the tourism sector, powered by robust partnerships with industry leaders like Siemens. Together, we are configuring smart, innovative, intuitive technology to achieve seamless end-to-end experiences, prioritize hyper-personalized guest experiences, and – most important – advance the boundaries of regeneration, sustainability, and resource management.

Like Siemens Advanta, we believe that there are several key success factors behind the creation of maximum value for a project like ours. A cutting-edge digital management system helps us to bring our ambition to life, and a state-of-the-art intelligent technology infrastructure, including 52 digital services and 2,500 Internet of Things (IoT) tools, interlinks and integrates experiences for our guests, staff, and operators while allowing us to monitor our precious environment. These services enable us to automate, predict, and improve the efficiency of our operations, while helping us educate visitors about their carbon footprint.

It is clear that smart technologies can enable the achievement of climate commitments and provide a way to track performance against targets. We aim to achieve a 30% net conservation benefit over the next two decades, and digitalization is already playing a key role in realizing this ambition, whether via smart energy grids, smart mobility systems, smart waste management infrastructures, or smart water networks.

These exciting new innovations are just the beginning of realizing the full potential of smart city and destination projects in the coming years. This whitepaper illustrates how to put technology and digitalization at the center of the global smart city conversation while showcasing our projects in Saudi Arabia as examples of best practice.

Enjoy reading!

John Pagano
Chief Executive Officer
The Red Sea Development Company & AMAALA

1 EXECUTIVE SUMMARY

As more people populate urban areas, **by 2050 two-thirds of the global population is expected to live in cities**. New concepts are in demand to ensure clean energy, water, and food supply for residents. There is also a pressing need for solutions to alleviate increasing traffic, pollution, and safety concerns. In recent years, several cities around the globe have begun to meet these challenges by modernizing their traditional setup and services with the help of smart technologies. They have started their journey toward becoming smart cities.

There is no single blueprint for the city of the future – each city has its unique challenges and history, influencing its future direction. What smart cities usually have in common is widespread, accessible, and integrated technologies. These include, e.g., wireless networks, 5G, Internet of Things (IoT), artificial intelligence (AI), digital twins, and integrated command centers. With the help of these technologies, cities can provide resilient and sustainable infrastructures, services, and solutions to residents and visitors. As a result, the quality of life and overall happiness increase in economic prosperity.

Smart city transformation is often initiated by government bodies while gradually increasing by the involvement of the private sector and end users, who should actively shape the city they live in. The Middle East, for instance, is home to several exciting large-scale projects, many of which are greenfield. This provides an excellent opportunity to learn from best practices and develop with fewer existing constraints. But it also presents some key challenges as thorough planning and prioritization are required to unlock maximum value while controlling budgets. It is critical to avoid "reinventing the wheel"; the technology strategy should be developed together with experienced partners that have learned and innovated based on their experience on an international scale.

From our experience with global clients and technology partners, we have found that cutting-edge technologies and solutions are one crucial part that makes the city smart – but it is not enough. The following chapters outline five key enabling factors for successful implementation:

- Developing a holistic vision and technology strategy
- Evaluating impact and finalizing the initiatives execution roadmap
- Building an ecosystem of partners
- Developing an integrated technology platform
- Starting small, optimizing, and scaling

Cities are confronted with multifaceted problems, which require structured and interlinking action plans. These need to be based on sound and tested strategies and consider all stakeholders. Because it is impossible to achieve the smart city alone, strategies must include partners and integrate with them. Transformation toward becoming a smart city can only be successful with such a holistic concept.

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2.1 WHY CITIES NEED TO BECOME SMART

Cities are responsible for **60-80% of global energy consumption, 75% of carbon emissions,** and **up to 50% of waste generation.** The growing urban population will further strain cities' ability to provide their residents with clean and reliable energy, water, wastewater, and food. It will increase traffic congestion, pollution, and safety issues. Therefore, cities need to reevaluate and modernize their traditional processes, operations, and services through the adoption of digitalization, supported by thorough planning and policy review.

Moreover, people demand more streamlined and personalized interactions and services in their day-to-day lives. Accordingly, cities need to become more citizen-centric and provide end-to-end services such as single-pass public transport solutions, portals to access personal health records digitally, and applications to conduct secure digital transactions with government and private sectors – solutions that ensure the enhancement of overall citizen happiness and quality of life.

The ability to transform from a traditional to a smart city is becoming a determining factor for how livable and attractive a city is for residents and visitors alike. As a result, the most advanced cities embark on smart city journeys with strategies to gradually digitalize, enabling end-to-end transparency and data-driven decision-making. This results in enhanced operational efficiencies, optimized use of resources to ensure sustainability, and personalized services to improve citizens' health, well-being, and happiness.

Many cities around the globe are already striving to become smart. However, this requires a deep consideration of a city's history, culture, and current readiness for change.

Usually, transformation efforts are first initiated by the government through policymaking and public funds allocation. After a time, they gradually transition toward the private sector and the end users, granting them a much more active role in shaping the city they live in. Private participation increasingly happens through public-private partnerships (PPPs) and governmental partnerships with innovators such as technology companies and research centers.

Although no unique criteria define a smart city, some of the front-runners to explore are:

SINGAPORE

Singapore has initiated transformation with several ambitious projects. All of them are characterized by close collaboration and co-creation between public, private, and people sectors, including the international community. Sharing best practices, adopting new ideas, prototyping innovative and people-centric smart solutions benefits Singapore and the world. Siemens is actively contributing to **Singapore's smart city initiatives**, notably in mobility through deployment of a simulation and test center enabled by a digital twin and a rail asset management system, to name just a few projects.

DUBAI, UAE

Dubai has set out to become the "happiest city on earth." The main driver for achieving this vision is the Smart Dubai initiative that promotes technological advances to optimize resources, integrate services seamlessly, and protect the people and their information. The initiative aims to deliver customer, financial, resource, and infrastructure impact through six key dimensions. These are smart living, smart economy, smart governance, smart mobility, smart environment, and smart people.

As of today, Dubai has promoted the collaboration between government departments and the private sector by launching over 100 smart initiatives and more than 1,000 smart services. As a result, it has become a model smart city, increasing the city's happiness by 3%. Siemens Advanta recently completed the **smart city IoT strategy for the city of Dubai** and helped identify, prioritize, and define smart initiatives. We also assessed different central computing platforms and designed the citywide integrated command center. Implementation of these initiatives is expected to lead to substantial benefits, including operational cost savings (up to 30%), improvement in overall resident and customer satisfaction (up to 20%), reduction in emergency response times (up to 80%), and reduction in non-revenue water use (up to 35%).

VIENNA, AUSTRIA

The city of Vienna has set forth a smart city framework strategy, defining guidelines for transformation. With technology advancement, people-centric solutions, and environmental and resource sustainability at its core, the strategy focuses on the three main interlinked dimensions of quality of life, resource conservation, and innovation.

The city has built on the defined dimensions by specifying 65 individual objectives to help set a clear roadmap for realizing its smart city strategy. As a result, the city has numerous innovative projects in close collaboration among the city's administration research entties, including universities, businesses, and industry. As a local example, **Siemens is a key partner of Aspern Seestadt**, a living laboratory for research in the future of urban energy. Aspern tests, together with industry and academia partners, different technologies to prepare the grid for growing numbers of renewable sources and to increase buildings' efficiency and lifespan. Siemens Advanta supported them in finding a solution for how they can model the energy demand of electrical vehicles and their impact on the electricity grid using a digital twin of the district. The solution enabled cost savings of about 20%, while up to 25% efficiency increase was achieved. In the end, the implemented technologies helped reduce CO_2 emissions by 71%, and insights developed at Aspern are being utilized in other smart districts globally.

2.2 WHAT CHARACTERIZES A SMART CITY

According to the International Telecommunication Union, **a smart, sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life and urban operation and services efficiency.** This increases competitiveness while ensuring that present and future generations' economic, social, and environmental needs are met. Another concept is "Society 5.0," which represents a "super-smart society" where innovations such as IoT, big data, AI, robotics, and the sharing economy are utilized in all areas of city operations and services – thus enabling a more efficient, convenient, comfortable, and sustainable life for its citizens.

WHAT IS A SMART CITY?

Digital Layer

Connecting the other three layers with e.g., an IoT platform, data-enabled services, block-chain

Vertical Layer

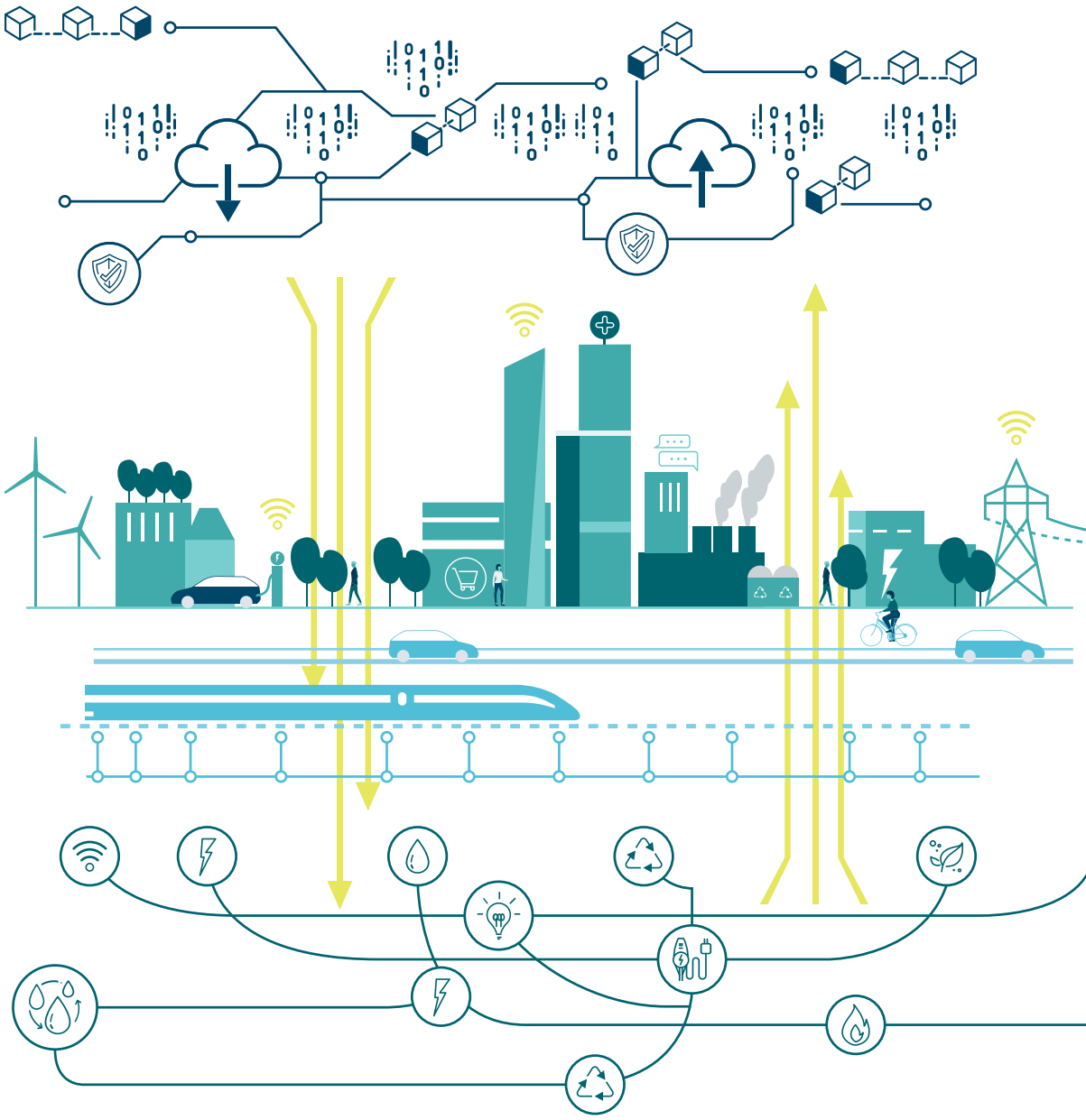
Water, cooling/heating, energy supply & consumption

Surface Layer

Transportation of people and goods, enabling of physical services, farming, and irrigation

Subsurface Layer

Operations for delivery of basic supplies (water, electricity, connectivity, etc.)



Traditionally, a city consists of three layers or levels where all activities and services occur: the subsurface, surface, and vertical layers. The subsurface layer comprises underground networks that deliver basic utility supplies such as water, electricity, and gas. The surface layer includes services and activities on a city's ground level, such as transportation, retail, and recreational activities. The vertical layer takes place aboveground and provides energy supply and consumption in residential and commercial buildings. With the advancement and propagation of innovative technologies, a fourth level, termed the digital layer, has emerged. The digital layer enables cities to be smart by replicating all three physical layers into the digital world. The digital layer enables the creation of digital twins, the application of analytics and simulations to allow insights, and the development of respective actions to manage city assets, operations, and services more effectively.

In its most basic form, smart cities perform the following functions:

- Collection: sensors and devices connected to city infrastructure, operations, and services measure and collate relevant data in real time
- Communication: collected data are transferred via connectivity modules to appropriate systems for further analysis
- Insight: data received on relevant systems are further analyzed to gain real-time insights into the status of city infrastructure, operations, and services
- Action: Based on the results of the analyzed data, action is taken to manage city infrastructure and improve operations as well as the quality of services provided to the city's residents

Data collection, communication, insight, and action: The smart city performs a wide range of actions to manage city infrastructure, enhance operations, and ultimately improve the life of its residents.

DEEP DIVE

Integrating the four levels mentioned above allows for developing a holistic and integrated smart city ecosystem. Such an ecosystem can be defined across all domains and activities of daily life. A few examples are energy, mobility, waste management, and water.

Energy

Smart grids communicate with decentralized energy networks, power generation networks, smart buildings, and electric vehicles. The grid informs building systems to reduce energy consumption during high energy demand.

On the other hand, buildings and smart vehicles serve as energy storage in times of excess production. As big data is analyzed, the grid constantly learns about generation and demand needs, adjusting them in real time based on city operations and enabling accurate predictions.

Mobility

Smart mobility systems tackle congested roads, long search times for vacant parking, multiple public transportation cards, and health risks from harmful emissions. Intelligent traffic infrastructures communicate with vehicles to optimize traffic flow around the city. Smart parking reduces search times, single transport passes create a seamless experience for public transport. This, in turn, reduces harmful emissions and hence health risks to residents.

Waste Management

Smart systems help monitor and optimize the end-to-end waste management value chain. Waste can be categorized and segregated at the source, and collection routes and fleets can be optimized. In addition, waste processing efficiency can be increased and recycling optimized to reintroduce different types of waste into the consumer life cycle. Moreover, health and environmental risks can be reduced.

Water

Smart water networks are characterized by optimized water distribution, lower energy consumption, and better water quality. In smart networks, leaks and bursts are detected or even predicted to reduce water loss substantially. As large amounts of data are analyzed, the operators can model demand and supply patterns and trends to make accurate projections and ensure access to enough clean water for all.

Cross-domain

Cross-domain integrations and analytics, or the digitalization of citywide operations, remain a largely untapped area to date due to limited digitalization of individual domains as well as the additional complexity of cross-domain integration. However, with the recent advancement of technologies such as open-source systems and the establishment of technology infrastructure, cross-domain integration increases.

In urban planning, such integrations can take the form of combining 3D digital maps, artificial intelligence, and machine learning with information on environmental conditions (e.g., air quality, temperature, humidity), traffic flows from intelligent traffic systems, and visitor patterns in public spaces. These data models can be used to analyze and proactively develop improvements and upgrades to urban plans.

Another example is the emergency response in case of flooding. Weather data combined with water network flow, blockage monitoring, and traffic flow from intelligent traffic systems can detect heavy rain and floods. Automated updates are sent to emergency services to dispatch personnel into high-risk areas. Similarly, residents can be informed and provided with location-specific updates on the condition of roads and traffic.

2.3 HOW SMART CITIES FURTHER A CITY'S OBJECTIVES

In a smart city, the digital infrastructure opens vast opportunities to optimize city operations, strengthen its resilience, and yield data that helps better serve citizens, visitors, and businesses, fuel the economy, and ensure environmental sustainability. In other words, smart cities enable city officials and their stakeholders to understand better how a city operates and how to manage it efficiently and sustainably.

Cities strive for happiness and quality of life as well as economic prosperity. These goals are achieved by ensuring that the underlying systems are efficient, resilient, and sustainable. Next-generation infrastructures, as well as seamless, connected, and user-centric public services, are key enablers.

City Goals:

Happiness & Quality of Life
Smart services should be high-quality, customized, seamless, convenient, and accessible. This saves effort, time, and cost and ensures enjoyable and memorable experiences for end users. The generated data and insights regularly review and improve the services based on feedback loops. The same logic applies to all domains of life, such as security provision, integrated healthcare services, and personalized retail services to consumers.

Economic Prosperity
Successful smart cities are attractive and competitive. This means they draw significant investments and human capital, driving technology and business model innovation. Partnerships and collaboration between the private and public sectors help advance the smart city, as private companies competitively bring in the latest technologies and funding. In contrast, the public entities ensure the proper regulatory and policy setup. This self-reinforcing cycle leads to further prosperity, investment, and innovation.

City Performance:

Efficiency
Digitalization enables cities to optimize resources and processes, resulting in more efficient operations and reduced costs. This then translates into affordability for end users and limited subsidies required by the government to deliver these services.

Resilience
Leveraging future-proof technologies and reliable, maintainable, and durable systems (e.g., against extreme weather) reduces the need for frequent resource-intensive and costly citywide infrastructure modernization. Moreover, inter-operability and interconnectivity across different domains of life and jurisdictions (e.g., municipal, regional, national) maximize benefits for the city. Real-time data analytics coupled with artificial intelligence and machine learning help identify issues rapidly or even before they occur, further contributing to the city's resilience.

Sustainability
In designing a smart city, sustainability topics such as reducing contaminants in the air and water or limiting energy consumption should be given significant consideration. The by-product of specific initiatives can be counterproductive. The provision of large highways, for example, may encourage some residents to move further away from the center and accept a longer commute to work, causing more pollution of the environment. It is essential to jointly plan housing and transport and conduct thorough scenario analyses and simulations to optimize sustainability.

2.4 MAJOR PITFALLS IN IMPLEMENTATIONS

The benefits of smart cities are obvious and multidimensional, but there are several pitfalls in planning and execution. In our experience, these challenges often lead to the complete or partial failure of smart city initiatives. Therefore, they need to be considered from the very beginning.

Starting without clear objectives and assessment criteria

Many cities do not define their smart city goals or strategy first. Instead, they rush into the smart initiative and product discussions. Without defined objectives, cities find it difficult to select, prioritize, and allocate their limited resources to the optimal initiatives. In fact, without a comprehensive assessment framework, evaluating the potential, effort, and cost of an individual initiative and assessing broader synergies with other initiatives and domains in the city is practically impossible. These initiatives might not be as valuable to the end users; they are also likely to be incoherent, have gaps, or include duplications. It is unlikely that such initiatives will yield the highest return on investment possible to the city, reducing available funds to be reinvested in new initiatives.

Deploying individual island initiatives

We commonly see different smart initiatives as stand-alone systems with limited levels of coordination and collaboration because stakeholders pursue other objectives and agendas. This translates into duplication of efforts and insights and limited synergies. But many cities also have hundreds of systems in place, many of which are legacy systems, rendering integration efforts very difficult and costly. Such a landscape puts a strain on future upgrades, scalability, and effectiveness of the different solutions across the city.

The benefits of smart cities are extensive, but there can also be pitfalls in their planning and execution that need to be avoided from the very beginning.

Making assumptions on behalf of end users and technology providers

Cities often drive smart initiatives without active participation and contribution of key stakeholders such as end users (e.g., residents) or technology providers. While this approach can sometimes lead to faster results, it won't yield the best outcome. If end users are not actively involved in the ideation, validation, and testing of smart initiatives, the implemented solutions are unlikely to be used effectively. Similarly, if technology providers, technical institutes, and universities are excluded in the design of the solutions, the review of the planned implementation timelines, and the selection or co-development of the technologies with the city, then successful implementation is unlikely. Even if the city decides to engage the different stakeholders, managing interactions is no simple task. Moreover, the governance structure is rarely well defined, leading to a lack of clarity on ownership and accountability of jobs, resulting in longer timelines and higher costs.

Lack of adjustments and flexibility

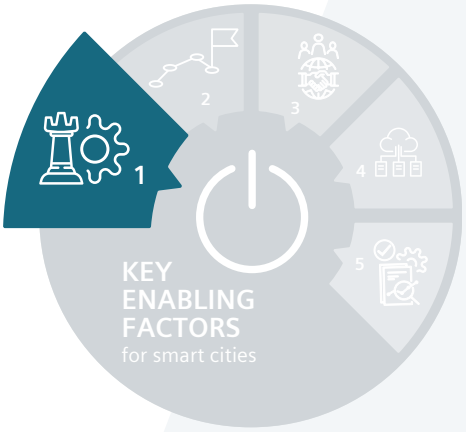
Selecting the right smart initiatives and implementing them successfully is not enough. Often, continuous monitoring of the initiatives and derivation of insights and review of the initiative with the end users are given low priority. End user requirements are rapidly evolving, and so is the smart initiative landscape across the city and the technology landscape globally. This means that solutions need to be constantly updated to ensure that they still serve their purpose in the most effective way possible vis-à-vis the stand-alone initiative and the broader integrated ecosystem. The speed and magnitude of change require frequent revision of most strategies, notably technology-related ones, to remain relevant. This is particularly challenging for cities, because developing and approving strategies consumes a lot of effort and time and cannot be regularly repeated accordingly. That is why agile strategy development and review approaches are needed, supported by continuous stakeholder participation and insight generation.

"A TRULY SUSTAINABLE CITY IS ONE THAT OFFERS ITS CITIZENS SERVICES THAT IMPROVE THEIR SHORT- AND LONG-TERM WELL-BEING."

Dr. Oliver Elbracht, MD & Head of Region Middle East

3 KEY ENABLING FACTORS FOR SMART CITIES

A holistic concept is needed to maximize the outcome of a smart city project and tackle the most common pitfalls. In our experience, five factors are significant for success:



3.1 DEVELOPING A HOLISTIC VISION AND TECHNOLOGY STRATEGY

A holistic vision and strategy provide a guideline to city officials for selecting smart initiatives that meet the requirements of key stakeholders as well as the objectives of the city. Several guiding principles and prioritization frameworks are required to do so.

Define guiding principles

Guiding principles need to be based on strategies, goals, and objectives. Therefore, city officials must ask themselves key questions, such as:

- What is the main reason for developing a smart city? How does it align with the city's other strategies and plans? For example, a city could seek to become a global center of innovation or focus on providing the best services and quality of life or achieving carbon neutrality.
- What problems are to be solved by the smart city? Issues can include increased traffic congestion in urban areas, high levels of harmful emissions within city centers, or inefficient water supply to residential areas.
- What does the current technology landscape look like, and are there any restrictions on using certain technologies? For example, is there sufficient and fast network coverage across the city? Can data be hosted in the cloud? Is integration with legacy systems required?
- What are key data sources, and how is the data quality and availability? What are the guidelines for data collection, management, and analytics?
- Does the city have the right ecosystem of partners, resources, and skills to realize the smart city initiatives successfully? How can such an ecosystem be governed and incentivized? What role will technical institutes and universities play?
- How have other cities solved these challenges? Which products and solutions have they implemented? What lessons can be derived and adapted to the local context?

City officials set a strategic foundation for the transformation journey to guide decision-making and resource allocation in answering these questions.

A clear holistic vision is a major factor in the successful implementation of smart cities. When working on their development it is important to keep in mind the diverse needs and expectations of all the stakeholders, including city officials, private businesses, and residents.

Involve all stakeholders

Stakeholders have different needs and expectations. For example, city officials might be interested in reducing operating costs in waste management, traffic management, and wastewater treatment and enhancing health, safety, and sustainability. Private businesses generally look for profitable ventures or opportunities to test innovative solutions supported by the government's funding. Residents typically look for ample job opportunities, personalized services, and a safe environment for their families.

Different and sometimes conflicting perspectives need to be included in the analysis and evaluation of suitable smart initiatives. City officials should engage with representatives of the diverse stakeholder landscape to do so. Thorough preparation is required ahead of these interactions to develop an in-depth knowledge of the existing technology landscape, ongoing smart initiatives across the city at municipal and federal levels, and the latest success and failure stories from around the globe.

Pain points and requirements of stakeholders need to be discussed before arriving at common strategic objectives. Then specific initiatives can be identified collectively, ensuring alignment and preventing duplication. Participants describe each initiative's key functionalities, benefits, and integration requirements and identify the responsible parties. Moving forward, the interaction model and governance structure need to be clearly defined to ensure ownership and accountability. The city, as the enabler, should lead such an exercise.

Short-list and prioritize your smart initiatives

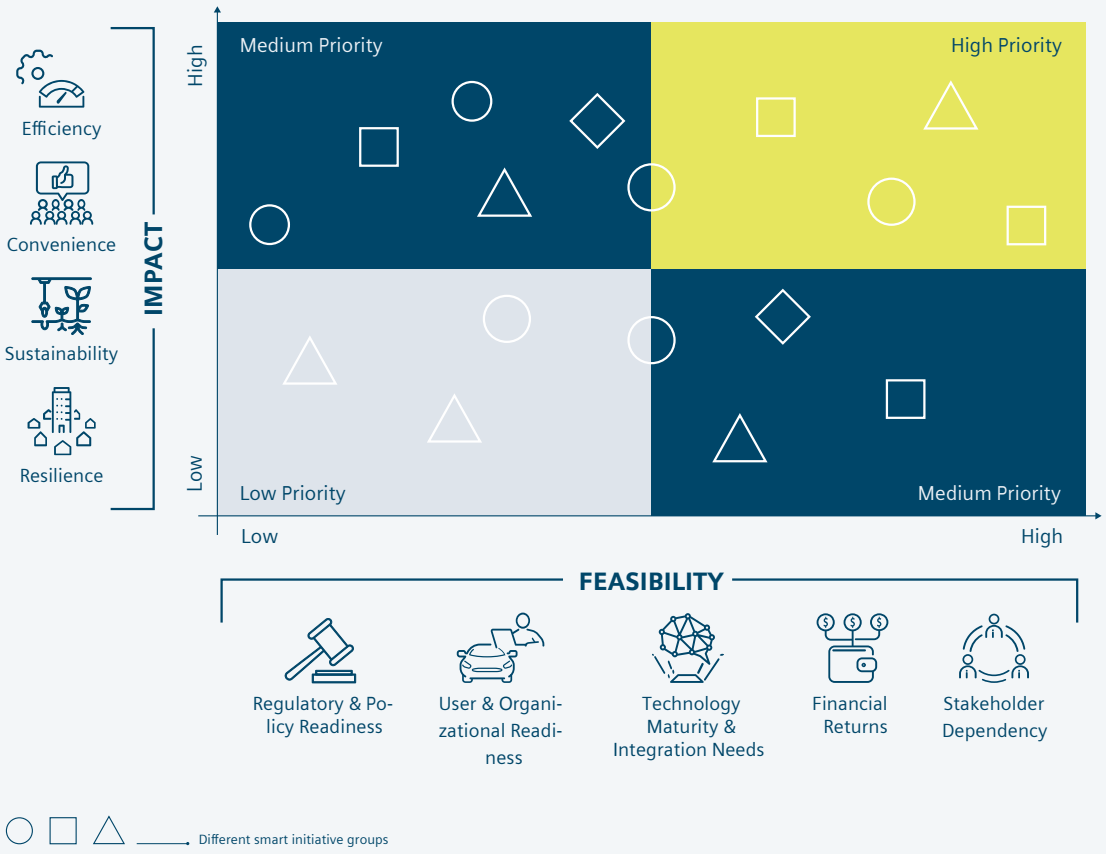
Since resources are limited, and implementation is complex, selecting/shortlisting and then prioritizing smart initiatives into different execution waves is essential. Initiatives are typically assessed about their expected impact and feasibility.

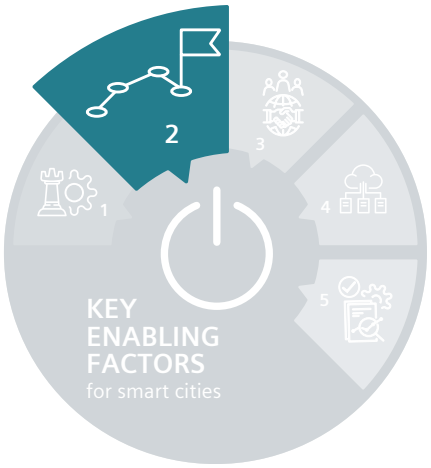
However, that's only part of the story: In fact, mutually exclusive and measurable subdimension of impact and feasibility need to be identified that can be used to select and short-list initiatives. Those subdimensions vary situationally, including efficiency, convenience, sustainability, resilience, feasibility in reg-ulatory and policy readiness, end user and organizational readiness, technology maturity and integration needs, financial returns, and stakeholder dependency.

The next challenge is to decide on the assessment model: for each subdimension, one needs to determine if a go/no-go logic, score-based logic, or even both is adopted. For example, what if an initiative scores relatively high on most subdimensions but low on one of them, such as technology maturity? Some clients looking for quick wins or having a low tolerance for (technology) risk might decide to exclude this initiative from the selection; others might choose to select it but deprioritize it. In contrast, others might even prioritize it as their mandate is to push the innovation frontier as much as possible.

Accordingly, while the main dimensions are similar, numerous selection and prioritization models are possible, depending on the context and objectives of the customer. Typically, interviews, workshops, and ideation sessions are conducted with key stakeholders to define this framework jointly. The simplest forms are a selection funnel and a 2x2 matrix (shown below), but the most-value-adding models are more complex hybrids that require human curation/validation of the output.

PRIORITIZING SMART INITIATIVES





3.2 EVALUATING IMPACT AND FINALIZING THE INITIATIVES EXECUTION ROADMAP

With the development of a holistic smart city vision and strategy, initiatives are prioritized based on a high-level assessment of their needs and fit to the city's objectives and stakeholders' requirements. However, it is imperative to dig deeper into each high-priority initiative to identify how a smart initiative can have a positive impact both as a stand-alone initiative and as part of an integrated set of initiatives providing an end-end cross-domain solution. Also, it is important to understand how to finance the initiatives, which business model to adopt, and how the city can execute them.

Identify synergies

The main characteristic of a smart city is that it connects and integrates different aspects of daily life to create a more significant impact than the city that stand-alone technologies or initiatives can generate. Accordingly, it is critical to identify synergies among initiatives and import such synergy potential into developing the implementation roadmap. Synergies might be on the technology infrastructure side, reducing the need for different systems or capacities due to shared or simultaneous use. Successfully implemented initiatives can also unlock benefits for other initiatives, especially once they are integrated.

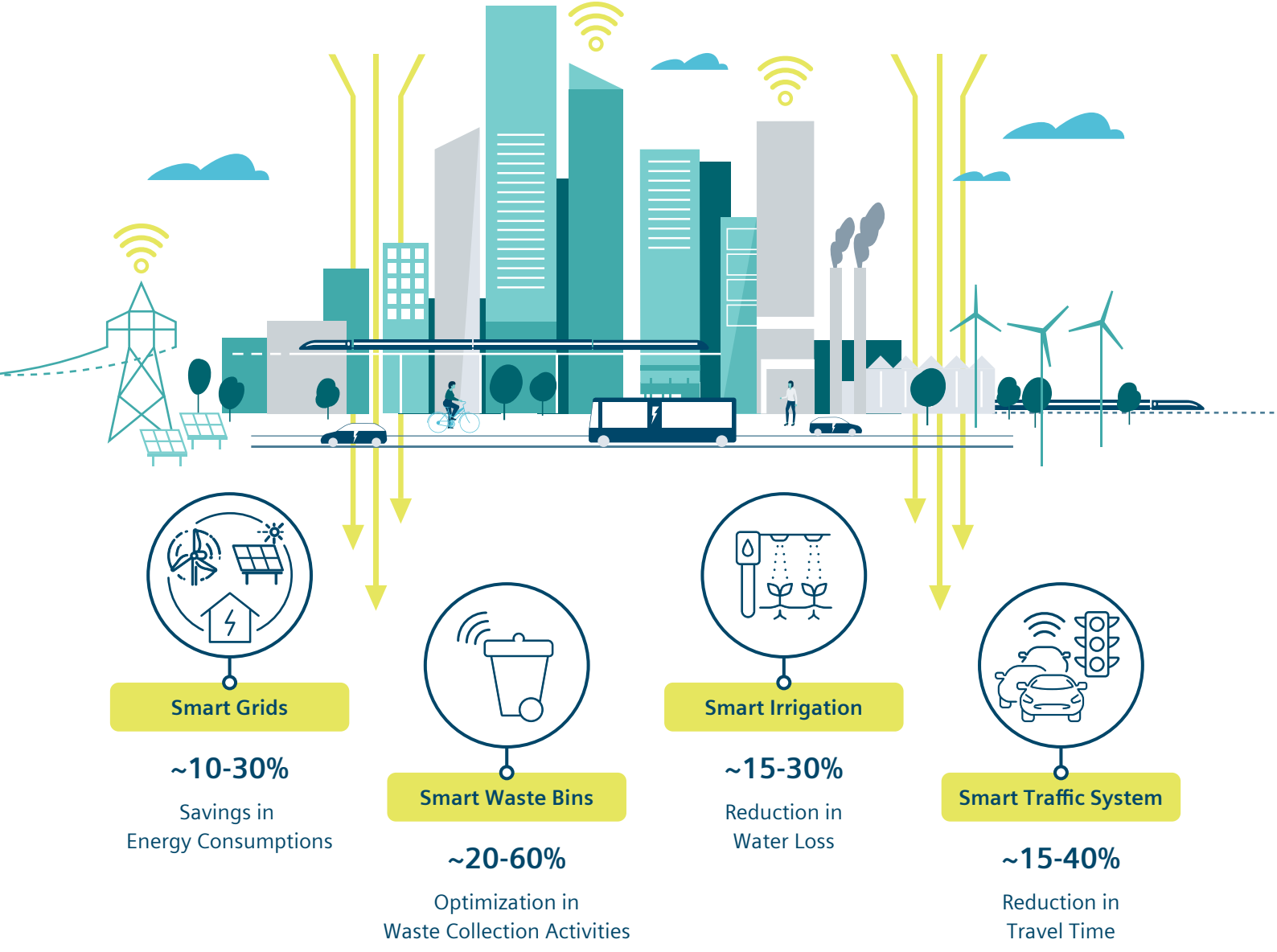
For example, measuring the fill level of waste bins provides relevant stakeholders with transparency on the amount of waste generated in a particular building or district, allowing them to take corrective actions. However, the benefits are multiplied when the smart bin initiative is integrated with smart waste collection fleet management, using the fill data to optimize fleet collection routes and resource deployment.

Define KPIs to monitor success

All envisioned goals should be translated into measurable and quantifiable key performance indicators (KPIs). The KPIs drive a smart initiative's selection and prioritization logic aligned with the strategic objectives. They should also play a vital role in the post-implementation success monitoring. KPIs should be monitored and reported regularly to identify improvement areas and used when occasionally reviewing the overall strategy.

Examples for KPIs in the smart city environment include:

- Using smart grids can monitor, regulate, and optimize energy consumption in buildings and electric vehicles by ~10-30%.
- Smart waste bins measure waste fill levels in real time and optimize waste collection resources and routes, enabling ~20-60% savings in waste management operational costs.
- By leveraging smart irrigation systems, overall water loss can be reduced by ~15-30%.
- Smart traffic systems enable monitoring traffic in real time, identifying and predicting areas of congestions and optimizing traffic flow, thus reducing travel times by ~15-40%



Assess the financial value

Smart initiatives are large-scale deployments that require substantial investment. Investors – governmental entities or the private sector – emphasize the financials, i.e., required investments and estimated returns in the planning stages. This makes thorough financial assessments essential. Because inputs needed are diverse, inherently complex, and often unknown to the public (e.g., expected energy savings), rigorous market knowledge is necessary.

A base case and several analysis scenarios that include anticipated constraints and possible partnership models are usually useful to investors for determining the most appropriate investment option. The cost of an initiative is determined not only by the direct investment for the complete technology stack, including infrastructure for data processing and storage, license or subscription fees, resources for cybersecurity, and operations and maintenance costs. Transition costs, including processes and tools, skill development, and change management, must also be considered to facilitate a successful digital transformation. The rated upside includes revenue improvements and cost reductions to be unlocked. In addition, private-public partnerships where co-investment is done to share realized savings or revenues can be assessed. Scenarios might include adding municipal fees to recoup the investment by governmental entities, especially for initiatives where the potential benefits to the end user are substantial. The output of financial assessments is financial KPIs such as total funding required, ROI, and IRR that allow estimation of the economic viability of an initiative.

For more details on business cases and ROI calculation, read our whitepaper "Internet of Things – from buzzword to business case; How to accurately calculate the ROI of IoT initiatives."

While financial assessments are essential to investors, the relative importance of non-financial parameters varies from one city's stakeholders to another. Some cities, for instance, put a higher emphasis on public policy maximizing non-financial benefits such as improved

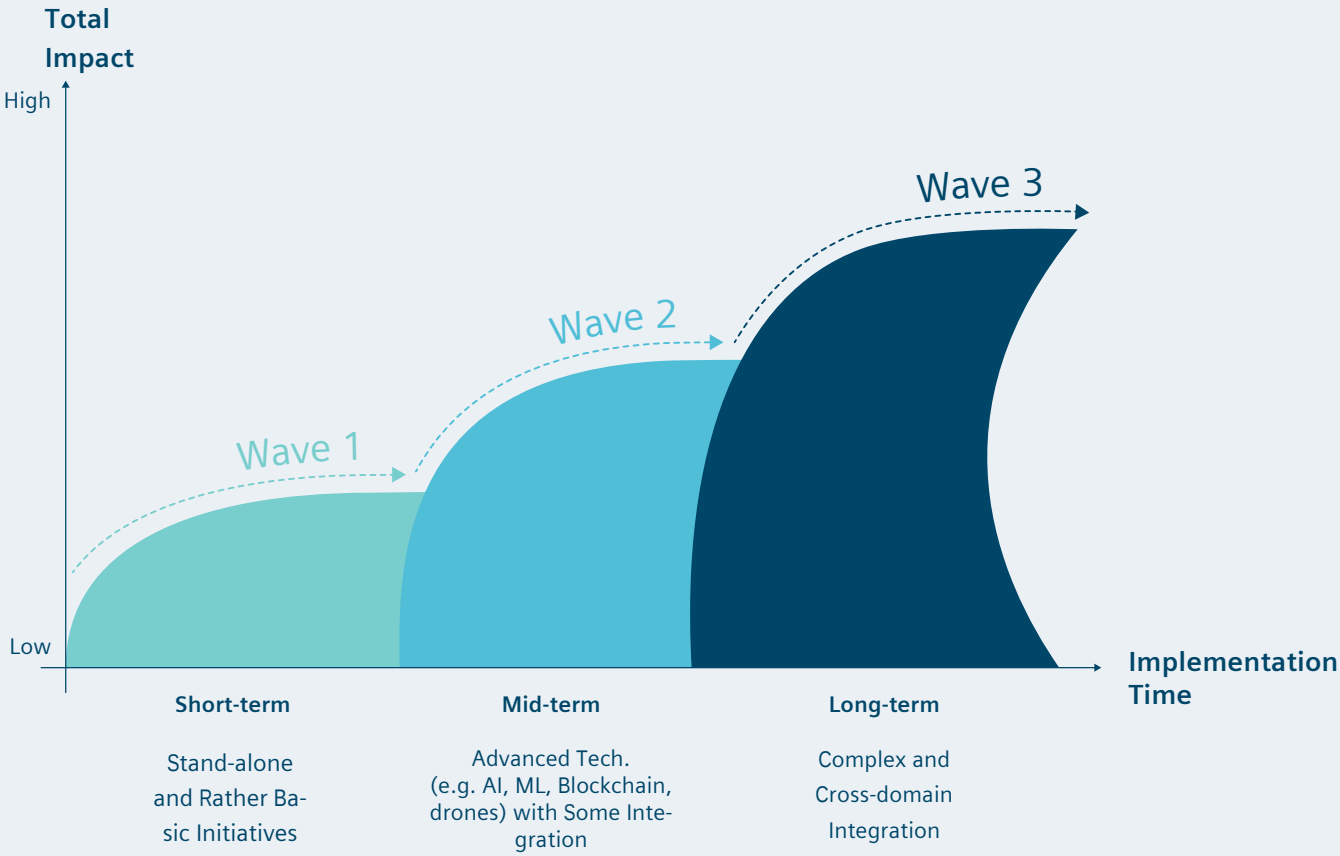
Considering only direct investment costs is not enough, since transition costs add up on the equation.

quality of life by ensuring that public services are accessible, affordable, and provided at the highest quality. Other cities focus on the general economy, encouraging competition and maximizing economic growth by promoting private sector participation to provide innovative, high-quality, and profitable services to customers.

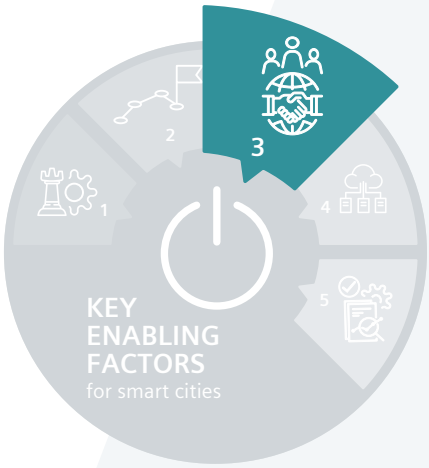
Develop an execution roadmap

After validating the impact of your initiatives, developing an execution roadmap is the next step. Ideally, the roadmap is split into several execution waves outlining the timeframe of when a specific smart initiative is best implemented and any dependencies on other initiatives.

THE EXECUTION ROADMAP



Wave 1 corresponds to initiatives implemented within 1-2 years generally. Those initiatives are often foundational and enable initiatives of subsequent waves. They typically score relatively high on impact (e.g., efficiency, resilience, safety) and feasibility (e.g., technology maturity, infrastructure readiness). The first wave is sometimes used to initiate and test the relationship with a single technology partner and usually can start rapidly by tapping into available or pre-approved budgets. Wave 2 comprises initiatives to be executed within 3-5 years, often due to a (technical) dependency on initiatives from wave 1, a lower maturity stage of an underlying technology/solution, or more extensive budgetary requirements. Finally, Wave 3 comprises futuristic solutions that might still be in an initial research phase, therefore not viable for short- to medium-term deployment. Those initiatives are often reviewed again as part of a 'strategy refresh' before they are due for implementation.



3.3 BUILDING AN ECOSYSTEM OF PARTNERS

Smart cities require a broad range of technology solutions, which cannot be provided at the highest standards by any single market player. Moreover, significant investments in research and development accelerate innovative technological solutions every year.

To meet technological requirements, smart cities need to develop a partner ecosystem. This should include technology forerunners, public authorities, telecommunications operators, universities and research and development centers, SMEs, and start-ups, to name a few.

To successfully build a partner ecosystem, partners are typically assessed according to key criteria, including:

- Current portfolio and pipeline: the relevance to a city's priorities and initiatives should be reviewed
- Relationship with the city and market presence: partnerships, collaborations, and sales history with all stakeholders in the city are indicative of the capability and commitment
- Willingness to venture into strategic partnerships: co-investment is often attractive to reduce technological risk or investment requirements
- Own partner ecosystem: ideally, selected partners either expand the technological reach of the city through their partners or have a strong relationship with the rest of the city's ecosystem, increasing the chance of success
- Previous experience in developing smart initiatives: lessons learned, success stories, and best practices that can be rapidly and successfully deployed in smart cities help reduce the budget, shorten timelines, and ensure the success of these highly complex endeavors

Technology partners collaborate to drive innovation and sometimes develop joint offerings and complementary portfolios.

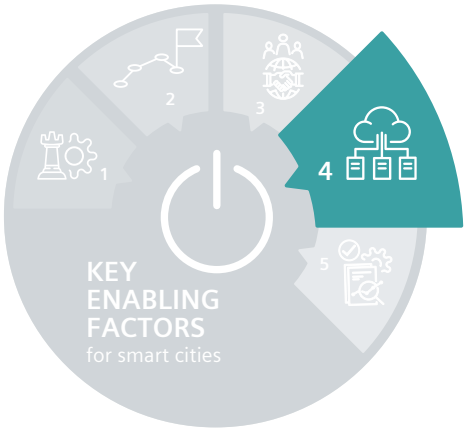
To establish a partner ecosystem, the city should differentiate between business models and management activities and technology strategy, selection, integration, and implementation.

In the following section, we focus on technology-related topics.

A smart city requires multiple systems and technology stacks, making integration efforts extremely complicated.

No single player can do it alone: The development of a partner ecosystem plays a decisive role in the implementation of smart cities. Only the collaboration of many technology partners can drive innovations forward.

This often results in the involvement of system integrators (SIs) to ensure that the complex technology landscape is working as a fully integrated system. The city has two main options regarding the involvement of system integrators. One approach is to engage one master system integrator (MSI), who will delegate different implementation packages to system integrators as required. This can be the preferred approach to minimizing the complexity of vendor management, but might result in a lower level of direct control and a risk premium (for the MSI) due to concentrated execution risks. Alternatively, a city can contract several solution integrators (SI) for selected implementation packages. This can be beneficial if higher control of partners and solutions is desired yet requires an increasingly complex landscape to navigate, especially as it requires diverse technical expertise existing in a single entity. Most commonly seen is some combination of both approaches, where cities directly engage an MSI and few SIs for critical implementation packages, leaving the remaining packages to be handled by the MSI, achieving a balance of control, complexity, and budget.



3.4 DEVELOPING AN INTEGRATED TECHNOLOGY PLATFORM

The digital layer in a smart city is highly complex. It includes many components such as sensors, actuators, connectivity gateways, computing platform(s), databases, applications, and dashboards. These components enable the continuous collection, integration, processing, and analysis of data to generate insight and recommended actions through an integrated technology platform and a command center.

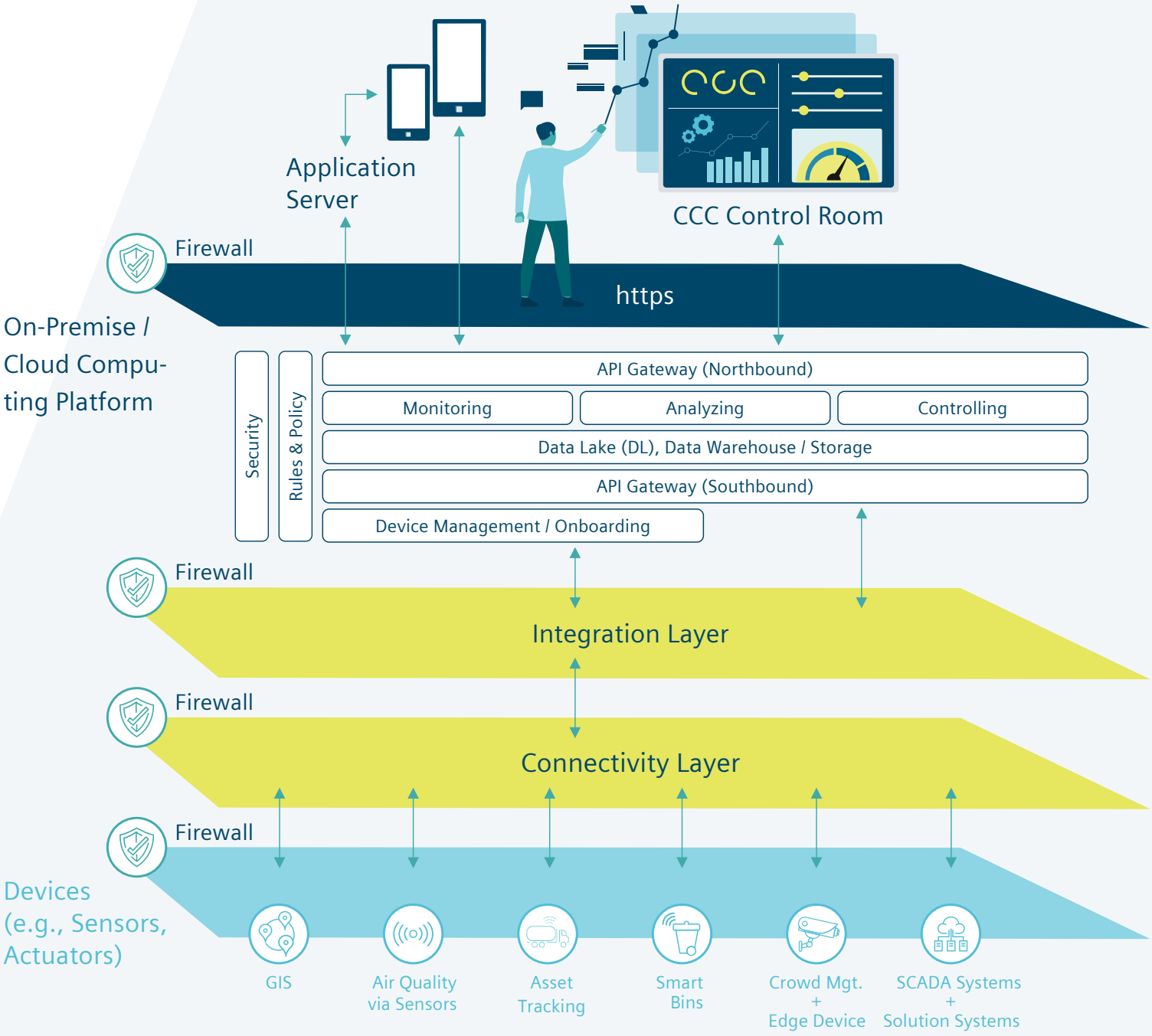
System integration is one of the most challenging technical aspects in smart cities. Several questions need to be answered:

- What will the technical architecture look like, and who will design and implement it?
- Who will be responsible for connection and integration?
- Which data inputs and output are required, and who will process or analyze them and how?
- Will the platform be deployed on-premises or in the cloud? How does either option impact data security and cost?
- How much autonomy should be provided to different technology providers?
- Is there a need for an architecture office independent from the master system integrator to review and approve their key recommendations on behalf of the city?
- What role can relevant government departments play to ensure seamless integration?
- How will synergies be unlocked across different initiatives?
- Who will drive collaboration within the technology ecosystem, and which governance should be enacted?

Given the high degree of complexity and a large number of players involved, a very detailed matrix of responsibilities needs to be developed early on, adopted by all players, and revised regularly. This matrix defines every activity and sub-activity responsible, accountable, consulted, and informed.

Moreover, city officials and technology partners need to develop a detailed solution architecture, working as one team.

SETTING UP A TECHNOLOGY PLATFORM



DEEP DIVE

To successfully set up a technology platform, five steps need to be taken:

Determine the sensing devices

Devices such as sensors and actuators record and transmit readings to a processing system and control specific mechanisms and systems based on the analyzed readings. Environmental condition monitoring sensors, for example, assess current temperature and humidity levels within a particular area; a connected actuator can control HVAC systems to maintain adequate environmental conditions.

There are many devices on the market; which device to choose is determined by criteria such as operating performance, frequency, and type of generated output (e.g., analog or digital), gateway requirements, compatibility, method of power supply, and maintenance. Moreover, location-specific constraints should be factored in. Some sensors or actuators are easily deployable in an open space and can use PV cells for power supply, for example, but do not work underground without an existing power supply. As a result, there are numerous different implementation scenarios for device deployment, which makes the benefits of collaborating with an experienced implementation partner even more straightforward. The ultimate selection of hardware is based on how well it works for a specific initiative and its potential to achieve economies of scale and other synergies. In practice, these criteria can be deduced from stakeholder interviews and site visits.

Identify the connectivity protocols

The complex nature of smart city initiatives and diverse environments usually dictate that multiple technologies are employed simultaneously. The type(s) of connectivity per initiative should be selected based on deployment locations, frequency, volume, and kind of transferred data. These criteria typically represent trade-offs that are subsequently assessed once the technical picture of the program in its entirety becomes clearer. Cellular connectivity (4G, 5G) typically offers comprehensive coverage and high bandwidth and is recommended when streaming high-definition media to devices connected to a constant power supply. Cellular connectivity is less commonly used with battery-powered devices because it consumes substantial power and would not be practical. In those cases, Low-Power Wide Area Network (LPWAN) could be used instead, because it saves battery by transmitting marginal data volumes at low frequencies. This is commonly used in smart metering, smart buildings, smart waste management, and smart wastewater management, to name a few. Local and personal area networks (LAN / PAN) such as Wi-Fi and Bluetooth Low Energy (BLE) are commonly utilized for high-bandwidth smart initiatives covering short ranges. Wi-Fi transfers large amounts of data but is difficult and expensive to install across large spaces.

On the other hand, BLE is more energy-efficient and easily connects to devices but transfers less data than Wi-Fi and at a slower rate. Mesh networks can be used when multiple devices are located nearby and communicate. They are typically used in smart waste management to gather and transfer data from waste bins to optimize waste collection routes. Another application is intelligent traffic systems that integrate video cameras and traffic signals to reduce traffic congestion and enhance safety.

Select the computing platform(s)

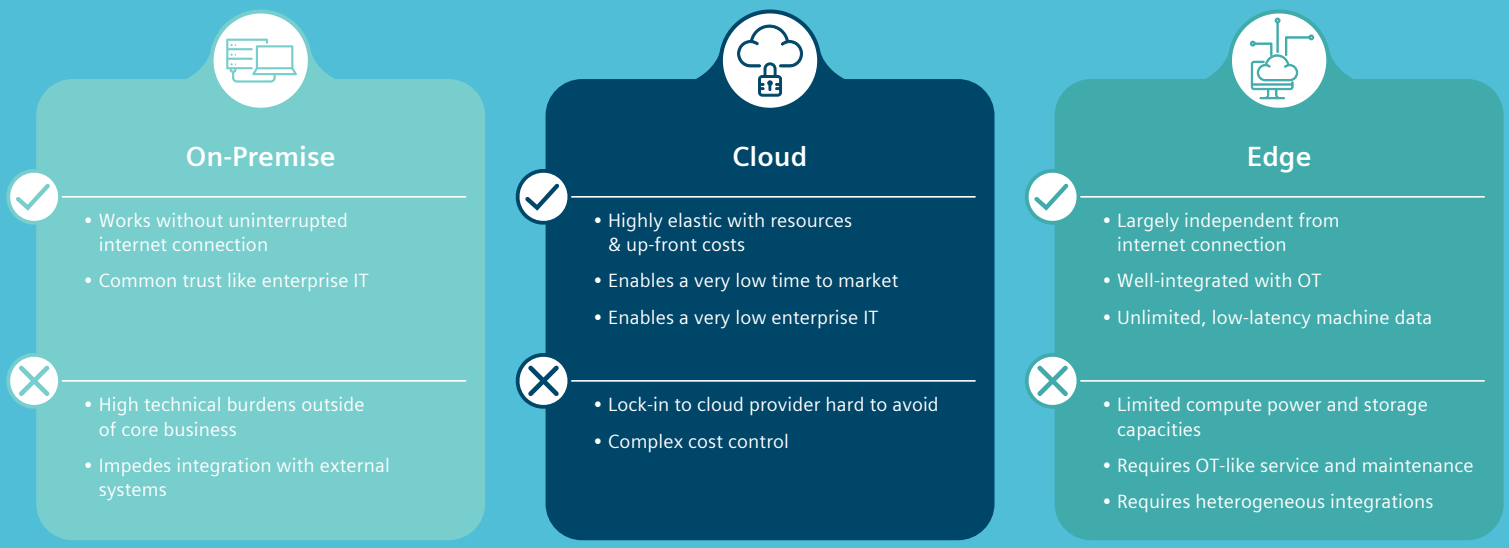
Smart systems help monitor and optimize data collected from devices and transferred via connectivity protocols to a computing platform for analysis. The choice of computing platform depends on the data analyzed. Platforms can be centrally located or on edge devices. Smart cities always require a central platform acting as its brain, integrating different solutions and holistically providing storage, robust analytics, and reporting capabilities. However, edge devices often complement this central platform for some initiatives. For example, edge computing is best fitting if a smart initiative includes a high-volume data feed such as a continuous video stream and independence from an internet connection. This is because edge solutions can process data at location and only send KPIs or notifications as outputs to the central entity, thus saving processing time

and central storage space. However, deploying edge computing citywide for smart initiatives is impractical, expensive, and, most important, unnecessary since most initiatives do not require the transfer of high-volume data feeds.

Central computing platforms can be on-premise or in the cloud. The main difference is the location of the platform and its deployment model. The technological infrastructure must be developed and deployed in a central location for on-premise platforms. At least two sites are usually selected for Traditional High Availability (HA) and Disaster Recovery (DR), one far away from the city. Cities need to project the capacity requirements and build for the future, since capacity is fixed. The platform should be interoperable and flexible and have robust cybersecurity and disaster recovery plans.

This approach is capital intensive but enables tight control and ownership of data. It also avoids lock-in risk to a single vendor, hence is preferred by some governmental entities, notably in the Middle East.

On the other hand, cloud platforms have the advantage of a quick time to market and a high degree of scalability to customers, who only use what they need in terms of infrastructure but are also highly dependent on the cloud vendor. Cloud solutions can either be building models, where a city develops its software and hosts it on the platform, or subscription models, where cities can utilize publicly available software to operate their smart initiatives. The building model requires strong in-house development capabilities to ensure product development, maintenance, and upgrades, all handled by the supplier in the subscription model.



To select the most appropriate type of central computing platform, cities must assess multiple factors such as willingness to invest in a physical forum versus becoming dependent on a cloud provider, ability to develop required software, and the best-suited supplier to assist in deploying the platform. To find the best-suited supplier, a set of strategic questions regarding data storage location, data privacy, security, support, and customization requirements have to be considered. There are a handful of leading offerings in the market, and quite often, the differences among them, although significant, are not apparent to the end customer.

Hence, a thorough technical analysis is required across the dimensions listed below to help decide on the best-suited platform.

Device Management:
includes device provisioning and authentication, configuration and control, monitoring and diagostics, and life-cycle control

Device Connectivity:
allows each device component to communicate within the system

Data Management:
handles data ingestion, storage, transformation, and processing of queries

Events / Rules Management:
enables filtering and transforming data, routes data, executes analytics in real time, processes data, and triggers automated remote-control actions

Security:
the technologies and processes employed to secure the entire architecture end-to-end against attack, unauthorized access, data leakage, privacy violations, cybercrime, or otherwise compromised

Edge Computing Capabilities:
handling of data and events locally and decentralized, including conducting analytics on a near real-time basis and providing processed data to the central platform

Platform Extensibility:
supports APIs, enterprise integration capabilities, caters for plug-in mechanisms, and provision of a software development kit

Analytics:
supports real-time analytics, database analytics, machine learning capabilities, including the ability to create dashboards and reports in a customized manner and integrate with external visualization tools

User Interface:
provides a user-friendly, configurable UI and dashboards; supports live, historical, and configurable widgets; can seamlessly and efficiently view information on a mass scale; and is integrated with maps and geofencing support

Non-functional:
includes scalability up to millions of devices; ensures service availability >99%, high availability of decentral and central systems, business continuity and disaster recovery; support for significant data ingestion and storage

While the framework with its 10 dimensions could be used across different cities, the relative weight given to each extent can vary depending on priorities, requirements, and available systems. For example, suppose the city already has a robust analytics platform. In that case, they might prefer to keep it and integrate it with the selected computing platform, which reduces the importance of the analytics dimension relative to other dimensions in the assessment and selection of the new computing platform.

Finally, cities must conduct a commercial analysis to select the platform in addition to technical analysis. The basis for this is the size of the needed IT infrastructure. To that end, required firewall throughput, storage, compute capacity, and virtual memory for the platform are estimated, because these impact the underlying hardware requirements and, consequently, the investment needed. Infrastructure estimates can be done bottom-up by aggregating the requirements per device and per initiative while assuming ramp-up rates. While these estimates will not be highly accurate due to the shared components across different industries, they indicate the overall infrastructure requirements to guide decision-makers in their final selection. These calculations are embedded in the business case assessment and budget estimations mentioned above.

Develop the technology applications

The analyzed data from smart initiatives are displayed in customized formats that need to be accessed by the relevant users for decision-making purposes. While some information might be viewed in the central command center, more granular dashboards are typically developed for specialized operational staff. Provided with the ability to drill down to the root cause, they enable users to make informed decisions and send control demands to actuators when necessary.

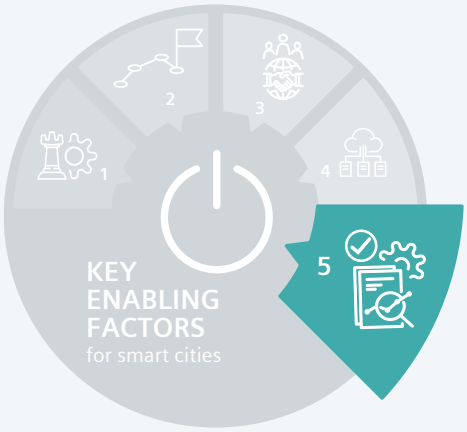
In a recently implemented use case by Siemens, a soil moisture sensor coupled with weather sensors sends moisture level data and anticipated weather conditions to a central system, monitoring the data in real time. Once low moisture levels are detected, a notification is sent to relevant personnel highlighting the low levels, predicted weather conditions, and suggested water required for irrigation. As a result, the appropriate personnel can approve the suggestion and turn on the irrigation system to bring back moisture levels to the baseline. The last step can also be automated, removing the need for human intervention.

Applications carry out these activities. The most effective applications are those whose business requirements and user journeys are defined by the different stakeholders, including end users. Then, typically a system integrator or technology vendor is contracted to translate these requirements into a visual design and a functional and scalable application.

Set up a command and control center

Command and control centers (CCC) are the eyes of the city. Any smart initiative can be connected to the command center to provide a holistic view of activities in the city in real time. The image is painted through selected KPIs and notifications triggered at preset thresholds and are shown to all conceivable users. The visualization can be sophisticated with 3D depiction and different drill-down levels for end users. Moreover, expert command center staff analyze the information at hand to send manual commands into the field – which can also be continuously and increasingly automated. The CCC helps improve operational efficiency and optimize city operations. Periodically, the data is analyzed at aggregate levels to update the smart city operating procedures and strategy.

The CCC is beneficial for crisis management. It compiles real-time information with a single truth from different sources, areas of the city, and stakeholder groups. It enables collaboration to take fast, informed, and decisive action and help control crises.



3.5 STARTING SMALL, OPTIMIZING, AND SCALING

A thorough plan needs to be developed for any smart initiative to be successfully implemented. The project includes multiple elements such as key activities, timelines, and responsibilities. Plans for individual initiatives cannot be finalized without accounting for (technical and nontechnical) interdependencies and synergies with other initiatives. The deployment of all priority initiatives can be planned accordingly. It is critical to phase the rollout of each initiative due to limited resources (workforce and money), building skills, and different dependencies. The phasing is best done in three steps:

Design and prototype new technologies to ensure that the solution works

Whenever an initiative comprises advanced or futuristic technologies or a combination of technologies that have not been used together before, a proof of concept (PoC) is required. A PoC includes designing and prototyping a new, innovative solution to tackle a unique challenge and requirement identified. It involves testing the new solution in a creative lab, building, or a small district to determine actual feasibility and impact. It is generally developed with an agile approach to promoting the continuous iterations of development and testing throughout its life cycle, ensuring a flexible response to unexpected changes and findings.

The main goal of the PoC is to enable the solution to work. It is challenging to plan the exact duration or resources required for a PoC due to the uncertainty of the solution's effectiveness and accuracy. The number of iterations and incremental improvements required in different testing scenarios to achieve the anticipated results can vastly vary.

An effective remedy is to set a date and performance levels or KPIs derived from business requirements, upon which a steering committee decides about success or possibly an adapted continuation. The value derived from the PoC is continuously monitored to ensure that it is satisfactory. Working with trusted and experienced technology partners is imperative at this stage. Their exposure to similar issues globally drives their ability to anticipate some of them and mitigate them effectively, but it sometimes means they could advise to pull the plug.

Deploy proven technologies at a small scale to confirm the value added

The solutions for different initiatives vary in complexity and market readiness. Even for the most robust solutions successfully implemented in other parts of the world, it is strongly recommended to start with small-scale deployments in the city – for example, in a few buildings or districts, or across two to three different scenarios.

There are several good reasons for this approach: First, the solution needs to be tested in the new and potentially diverse environments where it will be

used to identify any potential challenges or areas of improvement. Alterations can then be implemented at a low cost before committing to large-scale deployments and resource allocation. Second a small-scale rollout should already have a commercial aspect, such as an early-access program that involves end users (e.g., customers or beneficiaries) to determine the financial return expected at scale. Third, integration activities tend to be complex in any new environment, irrespective of the solution's maturity. Integration consists of different activities, such as joint data storage (low complexity), unified asset onboarding and management (medium complexity), cross-system workflows (e.g., HVAC occupancy controls), and analytics (high complexity).

Ideally, enough time is planned to gather insights from the field, analyze them, and optimize the use case. This allows measuring some of the set KPIs and revalidating the value before expensive full-scale rollout.

Complete large-scale initiative rollout to unlock economies of scale

A smart initiative should only be rolled-out at scale once the solution is optimized and its value is proved at a small scale. The ramp-up should be divided into more minor phases with a detailed project plan and responsibilities matrix to monitor and continue to optimize the execution and align it with other initiatives implemented in parallel.

Additionally, throughout the rollout of the initiative, cities should regularly monitor the effects of the smart initiative on defined KPIs. This is done to monitor its effectiveness, identify challenges and subsequent corrective actions or improvement areas, and analyze whether relevant smart initiatives could be integrated to generate a more significant outcome. In this regard, the continuous measurement of KPIs provides much-needed guidance to policymakers, enabling them to steer the city toward its anticipated goals and continually set global standards for the world to follow.

DEEP DIVE

Siemens recently carried out a PoC for the city of Dubai to test the viability of a solution that automatically measures the levels of fats, oils, and grease (FOG) in the siphons of restaurants and hotels across the city. The solution helps prevent overflow and leakage into the sewage network, which can cause blockages and breakages. It also optimizes FOG trap cleaning, eliminating the need for prescheduled inspections by sending an alert when fill levels reach a certain threshold.

Initially, a dual floating device was selected to measure FOG levels across large hotels and smaller restaurants in the city. During the first site visit, it became apparent that the device was not suitable for all end-user segments or location types. The device was effective for hotels with large FOG traps but not restaurants. The PoC team temporarily shifted its focus to find another device that works for restaurants.

Additionally, the PoC's application needed to be integrated with an existing analytical platform through APIs. The PoC was slightly delayed because client system access rights were difficult to secure. None of the involved parties prepared the application programming interfaces (APIs) in the agreed-to scope of work and work split. Some client policy changes were required to allow the use case to go live.

Such issues could not have been easily foreseen. However, the lessons learned from this PoC equips the team to anticipate and mitigate such problems before they occur during similar PoCs and implement the solution.

4 THE RED SEA DEVELOPMENT COMPANY – SMART DESTINATIONS

The Red Sea Development Company (TRSDC) is developing two of the world's most ambitious regenerative tourism and hospitality projects – AMAALA and The Red Sea Project. Its mandate is the development of luxury destinations across 33,000 km^2, with the Red Sea spanning an archipelago of more than 90 islands, surrounded by large coral reef habitats, mountains and wadis, and rolling desert dune landscapes along Saudi Arabia's west coast. The project aims to elevate the standard of living for its residents and local communities while minimizing environmental impact and contributing to increasing the net conservation value by 30% by 2040.

The Red Sea Project, which was initiated in 2018, is considered groundbreaking among the various mega projects underway in Saudi Arabia. Its leadership team is frequently sought after for advice on other smart city developments in the region and beyond. Further, the project can be seen as a blueprint for worldwide smart city initiatives.

During the course of the project, several crucial key learnings for the success of smart city initiatives were identified:

Developing a strategy and concept master plan approved by the board from the beginning
Senior buy-in for the smart destination strategy and concept plan has proved critical to fostering collaboration and overcoming internal resistance.

Establishing a far-reaching partner and vendor ecosystem early on
Over two years, more than 1,500 supplier meetings were conducted at expos, online, and in person. This aided in getting to know the market, factoring in the latest technology trends, building trust in market players, marketing the project, and increasing awareness of procurement opportunities.

Setting up a solid in-house team and educating people continually
An interdisciplinary expert team is crucial. In this case, the team includes enterprise architects, strategists, IoT, software & data and hosting experts, real estate developers, controllers, and change managers. At the same time, regular role-based training keeps all involved up-to-date.

The Red Sea Project is a shining example for how digital technologies shape the future of smart destinations. Its goal is to create a sustainable concept of regenerative tourism while preserving and enhancing Saudi Arabia's natural ecosystem. Therefore, it can be seen as a blueprint for worldwide smart city initiatives.

Designing smart services in conjunction with the ICT infrastructure

We often see smart services designed without an adequate network infrastructure (e.g., telecommunication network and utility connections) that has the required bandwidth and compatibility to connect systems, sensors, and actuators related to any smart service. Developing the smart service layer (e.g., smart lighting, public Wi-Fi, environmental monitoring) in conjunction with this network infrastructure is critical. In this project, the detailed design of the smart destination was tendered together with the ICT network design.

Detailing business cases for every smart service with CapEx, OpEx, and revenues

It is essential to understand early on how much smart city technologies will cost to build and run as well as their revenue potential and socioeconomic impact. This helps set cost and value expectations for the project sponsor and forms part of the operating model for the technology.

Fostering a culture of collaboration between teams

Smart destination has proved to be more than a technology implementation project. It is a way of thinking, implementing, delivering, and running a destination. It enables the entire project to achieve seamless experiences, the highest living standards, and the most increased sustainability and environmental improvements. This can only be achieved by partnering with every business department (e.g., hospitality, ICT environmental, marketing, airport, development, mobility) and aligning strictly to end user needs.

Defining a regulatory framework

Every city needs regulation in specific areas, such as construction permit requirements, vehicle licensing requirements, and environmental standards. As part of a Special Economic Zone necessitating a new set of laws combined with more detailed regulation, this project is in a unique position. This allowed the consideration of regulations from the beginning, also factoring in data regulations with the critical aim of

establishing the trust of citizens, residents, and businesses that will use the services. The project's approach follows international data privacy principles, such as GDPR, to establish a legitimate basis for data sharing. The framework, thus, ensures that smart services work in the interest of end users.

Harmonizing building technology requirements, relying on open standards and APIs

As part of the successful smart destination implementation, many smart services – such as smart traffic lights, smart lighting, smart utilities, smart transport – require some physical technology installations in buildings, streets, and the public realm. To ensure that asset development teams factor in the technology and understand the purpose, "Asset Design Guidelines" for different building types and infrastructure were established. In parallel, back-end systems and platforms with open standards and APIs were designed to allow maximum compatibility, integration, and customization for future use cases.

Implementing agile processes to discover risks

Transparency of risks and short-comings is critical for handling the complexity of design and implementation and preventing or minimizing delays. The agile approach has proved to be superior to revealing risks early on, especially in implementation areas with more uncertainty.

Validating innovative technologies through proof of concept / minimum viable products

A sandbox environment for immature technologies with expected high potential value was provided for The Red Sea Project. Also, multiple PoCs with IoT platforms and weather station connection, digital wallet, and seamless internet technology for zone-wide internet access were conducted. This was necessary to implement key learnings into the process.

From vision to implementation, The Red Sea Project has been driven by key learnings from smart cities worldwide. For its conceptualization, a portfolio of dozens of smart services ranging across mobility, utilities, environment, logistics, healthcare, education, security, buildings, public realm, administration, and more was defined. A smart destination platform to integrate and provide central data management services is at its core. In the end, the ticket to success so far has been exceptional planning, continuous learning throughout the project, and stakeholder involvement – from internal departments of the development company to government agencies, vendors, industry experts, and specialist consultancies.

The first phase of The Red Sea Project is on track for completion by the end of 2023. Across five of our islands and two inland sites, 16 hotels with a total of 3,000 rooms will be able to accommodate up to 300,000 visitors per year. The declared sustainability and environmental goals are 100% renewable energy, 75% LEED Building Accreditation, and a 30% net positive conservation benefit over the next two decades.

These greenfield projects under development by TRSDC are already setting new standards in sustainable development as the organization works toward achieving these goals. The destinations will offer a seamless, highly personalized guest experience, a positive impact on the sensitive environmental ecosystem, and the highest living standards based on state-of-the-art technology infrastructure.

5 KEY RECOMMENDATIONS: HOW TO REALIZE YOUR SMART CITY

Smart cities will play an essential role for future generations. A smart city project must adapt to the specific reality of each city by considering the differentiating elements. Initiatives should be aligned with a city's size, potential, and primary interests. This renders smart city initiatives highly complex to implement, maintain, and improve successfully. A holistic concept is a prerequisite for successfully embarking on the brilliant city journey. Based on our experience, we have identified some guiding principles to follow.

First, a **holistic smart city vision and strategy** has to be the starting point. Do not start by discussing the product or solution but define the objectives and image of the smart city first! After doing so, you can thoroughly design the strategy and roadmap that best fit your goals to identify the right solutions for your individual needs.

Before the implementation phase, **prioritize innovative initiatives and assess their value creation potential,** both in quantitative and qualitative terms, to optimize the use of scarce resources. To further unlock the full potential of digitalization across the city, integrate your smart initiatives across domains of life. **Monitor operations in real time** through a central command and control center with specialized teams and custom dashboards.

Always phase the ramp-up of initiatives: **Start with a PoC/PoV** to prove the value of the initiative, optimize it, and prepare for the full-scale rollout. To gain buy-in to development, testing, and usage, continually engage end users such as residents, the private sector, and technical institutes and incorporate their requirements into the initiative.

Define clear measures of success for each initiative, and constantly monitor those KPIs to identify issues, derive learnings, and optimize the different initiatives and the overall city performance.

Finally, **establish an ecosystem of committed and collaborative partners** with the expertise and resources needed to deliver on budget and in time. A strong technology partner to accompany you on this journey will transform a smart city into a success.

ABOUT SIEMENS ADVANTA

Siemens AG (Berlin and Munich) is a global technology powerhouse that has stood for engineering excellence, innovation, quality, reliability and internationality for more than 170 years. Active around the world, the company focuses on intelligent infrastructure for buildings and distributed energy systems, and on automation and digitalization in the process and manufacturing industries.

Siemens founded the new business unit Siemens Advanta on April 1, 2019 with its headquarters in Munich, Germany. It has been designed to unlock the digital future of its clients by offering end-to-end support on their unique digitalization journey. Siemens Advanta is a strategic advisor and a trusted implementation partner in digital transformation and industrial IoT with a global network of more than 9,000 employees in 19 countries and 89 offices. Highly skilled and experienced experts offer services which range from consulting to design & prototyping to solution & implementation and operation – everything out of one hand.

Further information is available on the internet at
www.siemens-advanta.com

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THANK YOU

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