

Developing Open Data Competencies: A Training Kit Approach for Smart City Workforce Readiness

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Abstract

With the rise of data-driven solutions, cities increasingly depend on open data to optimize services and drive innovation. However, there is a significant gap in workforce readiness, highlighting the need for enhanced competencies among smart city personnel to effectively manage and utilize open data. This study focuses on creating a training kit designed to equip smart city officers with essential open data skills by following an approach that emphasizes flexible learning opportunities. The research employs a structured design methodology to create the training kit, focusing on real-world applications and competency-building. The training kit significantly enhances participant skills in open data management, leading to improved urban services and decision-making. This initiative underscores the importance of workforce development in realizing the potential of open data. By investing in skill-building, cities can achieve more efficient and sustainable urban environments, driving future urban innovation.

Keywords: Smart cities, Open Data, Data Competencies, Public Data Sharing

1. Introduction

A "smart city" is an urban environment designed to enhance citizens' quality of life, promote sustainability, and improve city operations through the integration of data and technology. Rapid urbanization and advancements in technology are central to this concept, driving the need for responsive solutions to complex urban challenges, such as traffic congestion, pollution, and resource management. According to Sta (2017), smart cities rely on information and communication technologies (ICT) to optimize urban services and interactions between citizens and governments, leveraging real-time data from autonomous sources to address inefficiencies and enhance livability (Sta, 2017). As cities pursue sustainability goals, data analytics play a crucial role in monitoring environmental metrics, optimizing energy use, and implementing conservation strategies, underscoring the transformative potential of data in urban governance (Kawashita et al., 2022). Studies on data governance highlight how transparent, data-centric approaches can support sustainable development, ensuring the effective alignment of resources to enhance citizens' quality of life (Guimarães et al., 2020).

Open data is a cornerstone of smart city development, providing a foundation for innovation and improved urban management. By making data accessible and usable, cities can enhance transparency and foster citizen engagement. This accessibility facilitates collaboration between government agencies, private enterprises, and the public, driving economic growth and improving the quality of life for residents. As a result, open data initiatives are essential for developing data-driven solutions that address urban challenges. The benefits of open data in smart cities are multifaceted, significantly enhancing urban services and transparency (Nikiforova, 2021). They allow cities to optimize services such as public transportation and emergency response by analyzing data patterns to improve efficiency and reduce costs. Additionally, it promotes transparency by providing citizens with access to government information, fostering trust and encouraging civic participation. These advantages make open data a powerful tool for improving urban management and fostering innovation.

Despite its advantages, open data presents several challenges that must be addressed to realize its full potential. Ensuring data privacy and security is a significant concern, requiring robust protection measures to safeguard sensitive information. Furthermore, the effectiveness of open data initiatives depends on the quality and consistency of the data, necessitating standards for data collection and management. Addressing these challenges is crucial for the successful implementation of open data initiatives in smart cities.

The transition to smart cities has created a demand for a skilled workforce proficient in handling data-intensive tasks supporting urban management and innovation. As smart cities rely heavily on open data for decision-making, resource optimization, and citizen engagement, city personnel require a range of technical and interpersonal competencies (Neves et al., 2020). These skills include data literacy, analytical thinking, interdisciplinary knowledge, and familiarity with emerging technologies like artificial intelligence (AI), the Internet of Things (IoT), and big data analytics (Hashem et al., 2016, Panagiotakopoulos et al., 2023).

The need for these competencies is further amplified by the use of new technologies as they transform urban management practices. Automation technologies are increasingly integrated into city operations, and employees must be equipped to oversee, troubleshoot, and interpret automated systems effectively, including managing the open data generated and utilized by these systems to ensure transparency, accuracy, and informed decision-making. Skills in data monitoring, diagnostics, and real-time system adjustments are crucial to maximizing the potential of automation and mitigating risks linked to smart infrastructure (Ang et al., 2022; Jiang et al., 2020). The role of open data in urban governance extends beyond accessibility; it demands a culture of data literacy and the integration of open data management into governance processes. International initiatives recognize that merely providing access to open data does not resolve the complex information challenges faced by city departments. A vocational approach to urban data initiatives is emerging, focusing on culture change and embedding data literacy training across diverse urban governance roles (Neves, 2020; Ruijter, 2020). To overcome barriers and fully harness the potential of open data, it is essential to prioritize education and training in data management. Developing a workforce proficient in both smart city management and open data capabilities ensures that cities can navigate the complexities of data-driven governance, enhance urban innovation, and create more sustainable and responsive environments for their citizens.

However, despite the extensive research on smart cities and open data, a critical gap exists regarding the availability of specialized training programs designed to equip city personnel with the competencies necessary for managing data-centric urban environments. While much of the current literature focuses on the technical infrastructure and data capabilities required for smart cities, limited research addresses the specific training needs for municipal staff. This gap is particularly pressing, as effective smart city initiatives depend not only on technological infrastructure but also on a workforce capable of leveraging these tools to meet urban goals (Neves et al., 2020; Belizario & Beradi, 2019). By investing in workforce development, cities can enhance their capacity to leverage open data, leading to more efficient, transparent, and innovative urban environments.

This research aims to address the gap in training programs for equipping city personnel with open data competencies critical for managing smart cities, enabling them to leverage open data for innovative, efficient, and transparent urban governance, thereby addressing the complexities of smart city initiatives. Using the ADDIE model, the study develops a structured training program through five phases namely Analysis of requirements, Design and Development of educational material, Implementation -delivery of the program, and Evaluation of it to ensure continuous improvement through feedback. Specifically, this research is designed to address the two key questions:

RQ1: What are the objectives for teaching open data competencies to smart city Key stakeholders?

RQ2: What learning outcomes are essential to ensure smart city stakeholders develop the necessary open data competencies?

The rest of this document is structured as follows: Section 2 provides an overview of the foundational concepts and background essential to understanding the open data in smart cities, Section 3 presents the methodology for developing the training kit, Section 4 outlines the learning outcomes integrated into each module of units within the curriculum, while Section 5 concludes with findings and suggests directions for future research.

2. Literature Review Smart Cities and Open Data

2.1 Open Data in the Context of Smart Cities

Data serves as the backbone of smart city initiatives, empowering city governments to make informed, proactive decisions. Today's cities generate vast data from sensors, mobile devices, and municipal databases, analyzed in real-time to optimize service delivery, predict trends, and manage resources effectively. A smart city leverages data as a core resource, integrating ICT and analytics to foster an efficient, sustainable, and community-focused urban environment. This data-centric approach not only enhances cities' operational and economic resilience but also bolsters civic engagement and improves overall citizen well-being.

Open data has emerged as a foundational component of smart cities facilitating transparency, citizen engagement, sustainability, innovation and economic growth. Defined as data that is freely accessible, reusable, and shareable, open data serves as a public resource that cities use to improve services and foster community involvement (Janssen et al., 2012). By making urban data available on open platforms, cities enable diverse stakeholders—including governments, businesses, researchers, and citizens—to leverage data to enhance urban functionality and drive data-driven decision-making (Neves et al., 2020). This approach is critical to achieving the adaptive and sustainable goals of smart cities, which depend on real-time data to meet urban challenges efficiently (Belizario & Beradi, 2019). Open data initiatives in cities like Barcelona and Helsinki exemplify this by supporting the development of applications that aid residents in navigating traffic and selecting efficient transit routes (Jaakola et al., 2015), (Chan, 2013).

Public access to data enhances transparency in governance, allowing citizens to stay informed about municipal operations and actively participate in public discourse, thereby strengthening civic trust and accountability (Chan, 2013). Open data initiatives not only support transparency but also foster community engagement. By providing citizens with access to valuable information, these initiatives empower them to actively participate in urban decision-making processes while they enhance operational efficiency and facilitate civic involvement. For instance, research indicates that these initiatives have been pivotal in promoting citizen-centric governance, allowing local communities to influence policy and contribute to sustainable urban solutions (Ojo et al., 2015). Additionally, research on open data-driven participatory models underscores how these platforms facilitate resource allocation in governance, such as through participatory budgeting, enhancing civic empowerment and improving trust in public institutions (Skouloudakis & Christopoulou, 2021).

Environmental sustainability is another significant benefit of open data in smart cities. Through open access to environmental data, cities can promote eco-friendly practices and involve citizens in sustainability initiatives. Data on air quality, water usage, and energy consumption allows city officials and residents to collaboratively address environmental concerns. Studies reveal that cities using open data platforms enhance public engagement by empowering residents to participate in urban initiatives, such as environmental monitoring, fostering a data-literate public that actively engages in civic matters (Pereira et al., 2017). For instance, open data platforms has contributed to improved urban planning and resource management by providing real-time environmental data to monitor pollution levels and implement conservation measures (Kawashita et al., 2022). Similarly, the integration of open data with IoT platforms has helped cities optimize energy use and reduce their ecological footprint while promoting economic and social sustainability (Bibri, 2018).

Open data in smart cities also support economic growth. Economic benefits include creating new opportunities for businesses and startups that leverage public data to develop services, often through innovative applications. They enable innovation, supporting sectors like real estate, energy, and transportation with evidence-based insights that boost market competitiveness and resource efficiency (Corrales-Garay et al., 2020). By using data to optimize

resources, smart cities can meet the demands of growing populations sustainably, supporting economic resilience and social engagement in their communities.

2.2 Challenges in Open Data Utilization and Governance

Despite its benefits, implementing open data systems in smart cities presents several challenges. Privacy concerns are a significant barrier, as open data often includes sensitive or personal information. Balancing privacy with accessibility requires robust data governance frameworks, especially with emerging technologies like AI and IoT, which increase data collection's complexity and scale (Braun et al., 2018). Protecting personal data demands advanced anonymization techniques and strict adherence to data protection regulations to mitigate risks associated with data misuse (Janssen et al., 2012).

Interoperability also poses a critical challenge. Smart cities collect data from various sources, including transportation networks, healthcare systems, and energy grids, each using different data formats and standards. This diversity complicates integration and limits data usability, emphasizing the need for interoperability frameworks that allow seamless data exchange and analysis across urban systems (Ahlgren et al., 2016). To enable cohesive urban management, cities must invest in technical infrastructure and standardized protocols that facilitate cross-sector data utilization (Hernández et al., 2019).

Data quality is another critical issue. For open data to support effective decision-making, it must be accurate, timely, and reliable. Poor data quality can erode public trust and reduce the effectiveness of data-driven solutions, underscoring the need for continuous data monitoring and validation (Barnaghi et al., 2015). Inaccurate or outdated data can lead to ineffective outcomes in applications relying on real-time information, ultimately impeding open data initiatives (Kawashita et al., 2022).

2.3 Essential Competencies for Smart City Personnel

A robust competencies set is essential for individuals involved in smart city initiatives to effectively leverage the opportunities presented by open data and to address the associated challenges. These competencies enable evidence-based governance, enhancing service delivery and citizen engagement (Kawashita et al., 2022). For example, analytical thinking is a critical component, allowing personnel to derive actionable insights from complex datasets, which inform urban solutions across transportation, public health, and environmental sustainability (Chan, 2013). Additionally, Interdisciplinary knowledge and collaborative skills are also crucial. Smart cities integrate technology with governance, requiring employees to collaborate across departments and work with diverse stakeholders, including public agencies, private companies, and citizen groups. This interdisciplinary approach fosters innovative solutions to urban challenges as personnel blend technical expertise with an understanding of social and regulatory contexts (Ojo et al., 2015). Furthermore, competencies such as communication, negotiation, and teamwork are vital in a such environment for smart city workforce (Panagiotakopoulos et al., 2023). These skills enable effective collaboration and ensure that diverse teams can address complex urban challenges in a effective manner. These competencies form a foundation for building and developing smart cities that are efficient, sustainable, and inclusive.

However, a significant gap exists between the current workforce capabilities and those needed by smart cities workforce, especially in the domain of open data-driven smart city projects. Many city governments face a shortage of personnel trained in data analysis, visualization, and data governance; skills critical for handling open data effectively. Studies indicate that traditional roles within city governments often lack the data-centric skills required for managing and leveraging open data, which hampers the potential of data-driven initiatives (Janssen et al., 2012). For instance, while open data projects necessitate the use of specialized data visualization and analytics software, many city personnel are unfamiliar with such tools, limiting their ability to apply data insights in practical, impactful ways (Belizario & Beradi, 2019).

Moreover, integrating open data across different municipal departments and systems requires knowledge of data interoperability standards and security protocols. However, many city employees lack training in these technical areas, making it challenging to create cohesive data ecosystems that support cross-functional projects (Gupta et al., 2020). This gap highlights the need for robust training programs that cover technical and governance-related skills to enable open data projects to realize their full potential (Toze et al., 2021).

2.4 Developing a Competent Workforce for Smart Cities

An Effective education program for smart city roles must cover technical expertise in data science and digital governance while also equipping personnel to address regulatory and ethical challenges unique to smart cities (Belizario & Beradi, 2019). Researchers highlight that smart education frameworks, including IoT-integrated platforms, are pivotal in enhancing data literacy and real-time decision-making skills critical for smart city management (Chawla et al., 2021). In addition, studies propose that training curricula should also incorporate soft skills such as communication and negotiation which are essential for successful cross-sector collaboration (Gkamas & Rigou, 2023). This comprehensive approach is crucial for enabling city personnel to meet the complex demands of smart city projects and to design integrated solutions that benefit diverse urban communities.

Current educational programs for smart cities vary in scope and depth, ranging from university degree programs focusing on urban informatics and data science to specialized workshops and MOOCs aimed at upskilling public sector employees. Many universities offer courses in urban informatics, smart city management, and public policy, emphasizing essential skills such as data literacy, GIS (Geographic Information Systems) analysis, and environmental management (Shah, 2021). However, these programs often lack interdisciplinary approaches, especially in integrating technical data skills with an understanding of policy, governance, and citizen engagement.

On the other hand, professional workshops and online courses have become popular means of acquiring targeted skills especially by public sector employees. These programs typically focus on specific technical competencies like data analysis, cybersecurity, and data visualization tools (Chan, 2013). Some cities have collaborated with academic institutions and private organizations to create custom training solutions, such as Barcelona's partnerships for data governance and real-time analytics training (Jaakola et al., 2015). While effective in some cases, these ad-hoc workshops are often narrow in scope, lacking a comprehensive approach to the diverse skill sets required to manage open data initiatives effectively (McKenna, 2021).

2.4.3

Current research tends to emphasize technical skills, such as data analytics, cybersecurity, and IoT integration, without fully exploring how these skills intersect with policy-making expertise, ethical governance, and citizen-centered engagement—competencies essential for holistic smart city management (Jaakola et al., 2015; Kawashita et al., 2022). The literature lacks a comprehensive framework for training programs that combine technical and policy-oriented skills, leaving city personnel underprepared to navigate the complexities of data-driven governance effectively (Gupta et al., 2020).

One prominent gap is the absence of actionable frameworks that guide city personnel in implementing data governance practices within the municipal context. While studies underscore the importance of privacy, security, and transparency in managing urban data, few offer specific guidelines for training programs that prepare personnel to balance open data accessibility with privacy protections. The development of structured training curricula that address these considerations could significantly improve municipal capacity for responsible data use (Gupta et al., 2019; Barnaghi et al., 2015;). Additionally, literature on citizen engagement often overlooks the role of workforce training in fostering public trust in open data initiatives. In contexts where citizens may have low trust in governmental data management, trained personnel with data literacy, ethical sensitivity, and communication skills

are essential for bridging the gap between technological capabilities and community needs. Existing studies seldom focus on training models that cultivate these interdisciplinary skills, which are vital for empowering city employees to engage citizens effectively in co-creating sustainable urban solutions (Ojo et al., 2015; Chan, 2013).

A lack of hands-on, experiential learning also hinders the effectiveness of current training approaches. Personnel trained in theoretical concepts without practical application may struggle to implement data-driven solutions effectively. Training models that incorporate real-world scenarios, simulations, and case studies would bridge this gap, providing professionals with the applied skills needed to respond to the complex, evolving challenges in smart city environments (Iatrellis et al., 2020).

To address these gaps, research should prioritize the development of interdisciplinary training models that go beyond technical skills to include data ethics, policy integration, and public communication. Such models would better align city personnel competencies with the demands of open data governance and citizen engagement, fostering a more inclusive and sustainable approach to smart city projects (de Magalhães & Madaleno, 2023).

3. Methodological Approach for Training Kit Development

3.1 Instructional Design Model

The research methodology for this study is centered around the development and implementation of a training program about open data for smart city officers, utilizing the ADDIE model as the instructional design framework. The ADDIE model, a well-established component of Instructional System Design (ISD), comprises five phases: Analysis, Design, Development, Implementation, and Evaluation (Molenda, 2003). The ADDIE model is well-suited for professional development training focused on specific, skills-based learning and development goals. This model was selected due to its structured yet adaptable approach, which can be tailored to meet the unique needs of smart city officers and the evolving demands of urban data management.

This instructional design framework is carefully chosen to directly address the research questions:

RQ1: What are the objectives for teaching open data competencies to smart city Key stakeholders?

RQ2: What learning outcomes are essential to ensure smart city stakeholders develop the necessary open data competencies?

The ADDIE model adoption, provides a structured and systematic approach to designing a training curriculum that ensures the accurate identification of competency requirements, an effective development of a training kit, and ongoing improvement and alignment with the goal of preparing personnel for the unique challenges of managing open data in smart city environments. Each model phase includes the following processes:

Phase 1 - Analysis: This phase focuses on identifying the specific needs and objectives of the learners. It ensures the training program aligns with the unique challenges faced by smart city personnel. It involves understanding of the required competencies, knowledge gaps, and desired outcomes of the training program. To achieve this, a comprehensive literature review was undertaken to identify global trends and best practices in open data management and smart city governance. Additionally, smart city stakeholders were engaged such as municipal officers and smart city open data project leaders, to gain insights into their roles and challenges. The findings from this phase revealed key competency gaps, such as limited proficiency in open data utilization, insufficient interdisciplinary collaboration, and a lack of familiarity with emerging technologies. These findings form the basis of the definition of specific training objectives, aiming to enhancing data literacy, promoting ethical governance, and fostering cross-sector collaboration.

Phase 2 - Design: This phase builds on the results of the Analysis phase and translates them into a structured training plan. The goal of creating a dynamic and engaging learning program was the main objective of this phase. It defines clear learning objectives, instructional strategies, content organization, and evaluation methods. Objectives were prioritized to address critical skill gaps, such as open data management, regulatory compliance, and citizen-centered engagement. Instructional strategies included a blend of theoretical and practical approaches, ensuring that participants could understand and apply the concepts in their professional roles. Key design elements included content structure, instructional strategies and assessment methods. By integrating these elements, the design phase ensured the program was comprehensive, relevant, and tailored to the diverse needs of smart city personnel.

Phase 3 – Development: In this phase, the training materials—such as presentations, manuals, videos, and interactive exercises—are created. These resources are customized to address the identified needs and are designed to engage participants while building their expertise in managing open data. The developed material included both core modules on open data principles, ethical governance, and interdisciplinary collaboration but also and specific modules focused on practical applications of open data, such as improving urban services in areas like transportation, energy efficiency, and public safety. The training kit included material in form of presentations and manuals, videos, interactive exercises, activities, group projects and case studies offering theoretical and hands-on learning experiences. The development of material aimed to address different learning styles and ensure active participants' engagement.

Phase 4 – Implementation: The Implementation phase included the pilot delivery of the training program to a group of participants, mainly from municipal domain. This phase was critical for ensuring the effective design and implementation of the training kit. The training program was delivered through multiple formats, including virtual sessions, and hybrid approaches, to ensuring accessibility and engagement. Interactive elements, such as live discussions and group exercises, were integrated to foster engagement and collaboration among participants. Real-world scenarios were simulated to allow participants to apply their learning in practical contexts. This included exercises in analyzing open data sets, designing data-driven solutions, and collaborating across departments to address urban challenges. These activities helped participants gain confidence in their ability to implement open data initiatives in their roles.

Phase 5 – Evaluation: This phase focused on assessing the program's effectiveness and collecting feedback to ensure continuous improvement. Feedback obtained through participant evaluations and expert reviews. Also, performance metrics were used to measure program outcomes against the initial objectives. Feedback was systematically collected and analyzed to identify areas for enhancement, ensuring the program's ongoing relevance and impact.

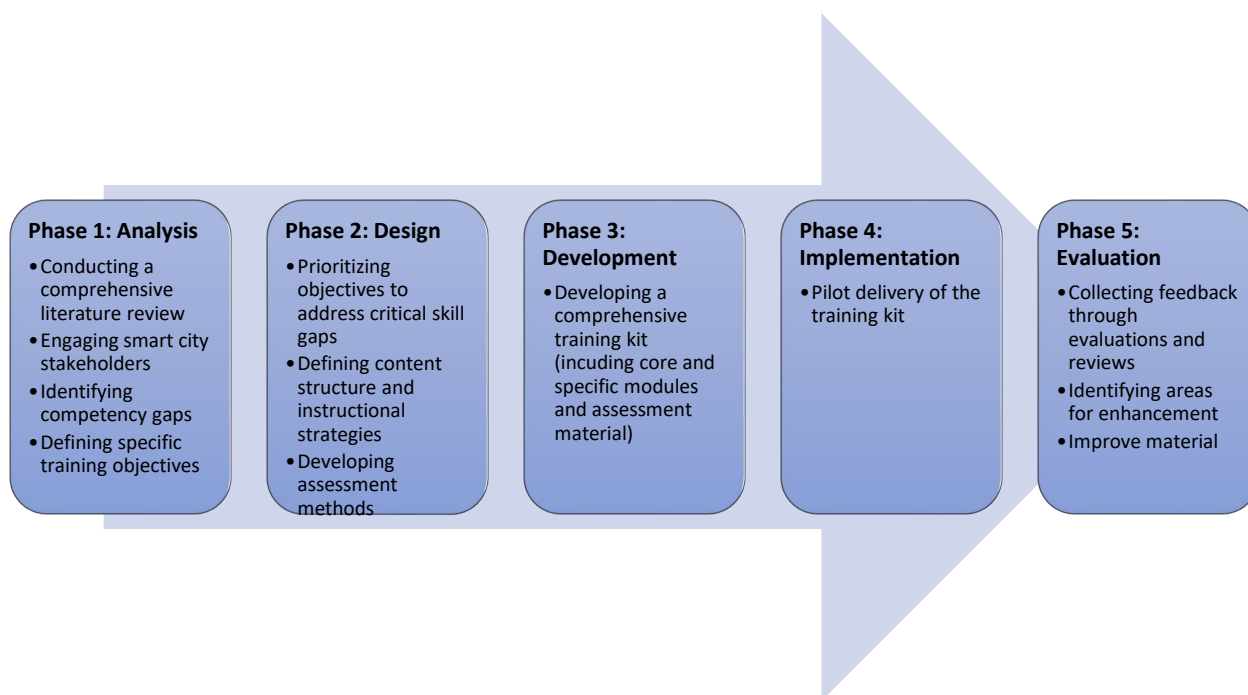


Figure 1 Training kit design

4. Developing the Training Kit to Build Open Data Competencies for Smart City Key Actors

4.1 Integrating a VET and Problem-Centered Approach

In the development of the training kit for open data competencies within smart cities, a Vocational Education Training (VET) and problem-centered approach was employed to create a powerful and engaging learning environment. Research by Biemans (2013), de Bruijn (2011), and Placklé (2014, 2018, 2020) has highlighted key features of effective VET environments, such as reflective, constructive, and authentic learning and teaching. We proposed a curriculum that aims to integrate both theoretical knowledge and practical skills, recognizing that each plays a crucial role in preparing learners for future professions. By combining these elements, the curriculum is designed to equip individuals with a well foundation, making them ready to successfully undertake their future open data projects. These principles were foundational in structuring the curriculum and implementing the training kit to meet the specific educational needs and knowledge requirements of smart city officers.

A problem-centered curriculum is particularly effective in contextualizing learning within real-world issues. By emphasizing current and pressing urban challenges, the training engages learners actively, requiring them to analyze, evaluate, and devise practical solutions. This methodology transcends traditional educational models that compartmentalize subjects, instead fostering an integrated understanding that connects academic concepts with practical applications. It promotes critical thinking, problem-solving skills, and the ability to apply knowledge in real-life scenarios, making learning relevant and meaningful. Empirical evidence supports the efficacy of this approach, showing that participants in problem-centered learning environments often exhibit higher achievement levels, deeper understanding, and greater intrinsic motivation (Hall, 2002; Dewi, 2023). This engagement is driven by framing education around genuine urban challenges, allowing trainees to appreciate the real-world value of their studies. The training kit sets forth a dynamic framework for instruction, learning, and assessment processes, encouraging active learning and preparing participants not only for academic success but also for lifelong adaptability in an evolving world.

The integration of VET characteristics with a problem-centered approach offers a robust framework for preparing smart city officers by equipping them with necessary knowledge and practical skills to address specific challenges related to open data. The training kit is designed to bridge gaps in knowledge and experience, effectively combining theoretical understanding with hands-on applications to enhance the competencies required for success in smart city environments. Moreover, the training kit's inclusion of open educational resources (OERs) offers support to learners through free and adaptable materials. OERs, which can be copied, printed, altered, and shared with minimal expenses, provide indefinite access and updates. The digital nature of many OERs also presents advantages similar to e-texts. Hilton (2016) found that both students and teachers generally view OERs as comparable to, or better than, traditional textbooks. By integrating these resources, the training kit offers a flexible and cost-effective approach to developing essential open data competencies for smart city stakeholders.

4.2 Structuring the Training Modules

The training kit is organized into modules, each targeting specific competencies essential for smart city stakeholders. These modules are further divided into units that contain various learning objects. This modular approach is crucial for accommodating diverse learning paths and requires a standardized method for designating modules across different curricular pathways. To ensure consistency, detailed specification tables were developed. These tables maintain metadata for the modules, units, and educational materials, thus guiding the systematic development and organization of each module. They provide crucial information such as module objectives, keywords, required workload, educational strategies, and resources, enabling the linkage of learning objects to their intended outcomes seamlessly.

The structuring of these training modules was aimed at offering a comprehensive, step-by-step breakdown of learning components. Each unit is meticulously aligned with the overarching objectives of the training program. The detailed analysis of required competencies underpins the design of each module, ensuring they build relevant skills and knowledge areas in a progressive manner. The process involves:

- Defining learning objectives and organizing content: Each module starts with clear learning objectives that align with the competencies identified in the analysis phase. These objectives guide the development of content and activities.
- Organizing content and incorporating diverse learning methods: The content is organized into logical units that build upon each other. This ensures a coherent flow of information and allows participants to gradually develop their skills. To cater to different learning preferences, the modules include a mix of instructional methods such as lectures, interactive workshops, and online modules. This variety helps engage participants and reinforces learning.
- Integrating practical applications: Hands-on activities and case studies are embedded within the modules to provide real-world context. These practical applications enable participants to apply theoretical knowledge to urban data management scenarios.
- Developing assessment tools: Each module includes assessment tools to evaluate participant progress and understanding. These tools help ensure that learning objectives are met and provide feedback for continuous improvement.

4.3 Identifying Learning Outcomes for each training module

A total of 20 modules have been crafted to deliver a specific set of learning outcomes, each tailored to address the multifaceted challenges and opportunities associated with open data in smart city contexts. These outcomes are designed to build a versatile skill set, enabling participants to effectively harness the power of open data to drive

innovation and enhance urban living. Through these 20 modules, learners will develop a deep understanding of critical aspects such as stakeholder management, service design, and business model innovation, alongside technical skills in programming and data analytics. They will explore the legal, ethical, and strategic dimensions of open data, gaining insights into governance, security, and quality standards. Through practical applications and strategic planning exercises, participants will learn to visualize, share, and distribute data, promoting transparency and informed decision-making. By achieving these outcomes, learners are empowered to foster sustainable, data-driven urban transformation, positioning themselves as leaders in the advancement of smart cities.

The endpoint of this process is described below for each competency, where all the corresponding module's learning outcomes are systematically delineated, providing a structured framework for smart city personnel training and professional development in open data management.

01: Stakeholder Management

In the realm of smart cities, stakeholder management is a crucial element. This module helps learners understand the dynamics of various stakeholders, including government officials, private sector entities, citizens, and nonprofit organizations, all of which play pivotal roles in urban data ecosystems. Learners begin by defining the factors that determine stakeholder relevance to open data initiatives and identifying those whose engagement significantly impacts the progression of smart city projects. The module delves into the benefits and challenges of open data within this context, providing learners with analytical tools to evaluate these dynamics. Learners will apply open data practices, adapting them to address specific urban challenges and opportunities within smart cities. They will explore and develop multi-stakeholder approaches, emphasizing collaborative strategies that integrate diverse stakeholder perspectives and needs. This includes creating robust engagement strategies aimed at fostering stakeholder buy-in, ensuring data provision, and facilitating the effective implementation of smart city services. As a result, learners will acquire the ability to cultivate strong, effective partnerships among varied entities, understand and mitigate potential conflicts, and maximize the potential of open data through collaborative urban solutions. By the end of this module, participants will have a comprehensive understanding of how to leverage stakeholder relationships to drive innovation and enhance service delivery within smart cities, positioning themselves as effective intermediaries in the complex landscape of urban governance.

02: Services and Service Structures

As digital transformation sweeps through urban environments, designing and optimizing service structures for smart cities becomes a linchpin for contemporary urban development. This module offers a comprehensive exploration of the integral services that compose the smart city ecosystem, including transportation, energy, healthcare, waste management, governance, and more. Participants will begin by defining the key services and service domains, identifying suitable delivery models that consider scalability, resource optimization, and user experience. They will learn to articulate the principles and components that underpin smart city services, comparing interdisciplinary approaches to designing and implementing these services effectively. The module places significant emphasis on the use of advanced technologies and data-driven insights, teaching participants to leverage data analytics tools, Internet of Things (IoT) integration, and predictive modeling to inform and optimize service design. Learners will explore how to implement innovative, user-centric service structures that improve efficiency, promote sustainability, and enhance the quality of life for city residents. By adapting these service structures based on real-world scenarios and case studies, participants gain a nuanced understanding of the implications of different strategies across diverse urban contexts. As they progress, learners develop the skills necessary to orchestrate seamless service delivery that aligns with the holistic vision of a thriving smart city, equipping them to anticipate and address emerging challenges while fostering community engagement and collaboration for sustainable urban evolution.

03: Smart City Business Models

In the era of digital and urban transformation, innovative business models are instrumental for the success of smart city projects. This module guides learners through the intricacies of business models tailored for smart cities, emphasizing the effective use of open data to drive innovation and address urban challenges. Learners will begin by describing the concept of a business model and defining the various patterns used to classify them. They will explore the nine building blocks of the Business Model Canvas, a strategic management tool that enables a better understanding and visualization of business models. Through this exploration, learners will recognize the ongoing discourse surrounding smart, sustainable, and innovative cities leveraging open data, identifying conceptual models that offer promising frameworks. The module further challenges learners to identify essential connections between urban innovation, open data, enterprise initiatives, and smart city business models. As they progress, learners will explore six specific challenges related to these models, gaining the skills to strategize and overcome potential obstacles effectively. By explaining the integral role of Information Communication Technology (ICT), data, and urban analytics, learners will understand how these components can collaboratively address and mitigate key urban challenges. They will tactically apply frameworks to select appropriate smart city business models that align with global standards and local needs. Upon completion, learners will be adept at developing business strategies that leverage open data, driving economic growth, and fostering sustainable urban ecosystems, thereby enhancing their proficiency in creating impactful business solutions for modern urban environments.

04: Smart City Service Co-design and Generation of New Revenue

Service co-design is a collaborative process that empowers smart cities to innovate and generate new revenue streams by creating services deeply aligned with citizen needs. This module provides an in-depth understanding of the service co-design process and its significant advantages, focusing on the synergy between innovation and user-centric solutions within smart cities. Learners will start by defining the principles of service co-design and understanding its application in the development of smart city initiatives. They'll recognize the vital roles and contributions of key stakeholders, understanding the importance of each in shaping successful service outcomes. The module emphasizes the exploration and application of co-design approaches that ensure citizen preferences are central to service design, leading to more relevant and effective solutions. Learners will be introduced to various co-design methodologies and tools that facilitate effective collaboration and ideation. By engaging with these strategies, learners will gain the capability to create actionable service prototypes and implementation plans, translating co-designed ideas into practical, well-defined smart city projects. Moreover, the module delves into monetization potential within smart city environments, equipping learners to identify and capitalize on new revenue opportunities. Through case studies and practical examples, learners will discover how smart city services can be designed not only to meet public needs but also to generate substantial financial returns, thus contributing to the sustainable economic growth of urban landscapes. By the end of the module, participants will be prepared to engage in and lead co-design processes, driving both social innovation and economic value within the smart city framework.

05: Open Data Legal Framework, Privacy, and Ethics

As cities evolve into interconnected networks driven by open data, understanding the legal, privacy, and ethical dimensions is crucial. This module offers a comprehensive exploration of these aspects, providing learners with the tools needed to navigate and implement open data initiatives effectively. Starting with real-world scenarios, learners will analyze and determine appropriate legal and ethical strategies for open data usage, ensuring that they can effectively address complex challenges in diverse contexts while safeguarding personal and corporate privacy. This includes applying knowledge of data protection regulations to assess compliance within open data initiatives, thus identifying areas of risk and ensuring adherence to legal standards. Learners are further tasked with drafting recommendations for managing intellectual property issues that arise in collaborative projects, balancing the need

for innovation with necessary protections of intellectual rights. Additionally, the module encourages learners to critique the effectiveness of existing legal frameworks and licenses, evaluating their suitability for various applications and understanding their impact on data sharing and accessibility. Lastly, learners will evaluate both the ethical and commercial consequences of open data decisions within city environments, assessing the impact of regulations and proposing improvements when necessary to enhance ethical standards and commercial viability. As a result, learners will be well-equipped to make informed, strategic decisions that uphold high ethical standards while fostering innovation and growth in smart cities through open data initiatives.

06: Open Data Vision, Strategy, Planning, and Communication

Creating a strategic vision for open data is critical to the success of smart city initiatives. This module equips learners with the essential skills and knowledge needed to lead these endeavors. Learners will explore the components of project budgeting and timeline management specific to open data initiatives, gaining the ability to explain these elements and describe key components of long-term strategic planning for data management and use. The module goes beyond logistics, diving into the principles of decision theory and the role of transparency in innovation and stakeholder collaboration. Learners will interpret these principles in the context of open data projects, learning how to effectively collaborate with diverse groups to drive project success. The module further emphasizes how to formulate and implement robust long-term plans for data management and develop strategies and timelines for open data initiatives through informed project management skills. Learners will engage in strategic thinking to create comprehensive data management plans, utilizing decision-making techniques to address specific challenges within open data contexts. Finally, the module encourages an evaluation of data dissemination approaches and communication strategies, pushing learners to design innovative campaigns that promote open data usage and engagement. As a result, learners will develop the capacity to critically assess transparency initiatives and enhance communication strategies, ensuring inclusive, accountable, and impactful stakeholder engagement in advancing open data understanding and community adoption.

07: Smart City Infrastructure as a Supplier of Open Data

Smart city infrastructure serves as a critical backbone for generating and supplying open data, vital for fostering innovation and optimizing public sector performance. This module delves into the essential elements that contribute to this infrastructure, providing learners with a robust understanding of how open data originates and is utilized within urban environments. Learners will recall and describe the core elements of smart city infrastructure that drive open data production and the interplay between these infrastructures and data initiatives. Learners will explore the cost management factors influencing open data implementation, summarizing principles and identifying areas for cost reduction. Through this, they will interpret how open data can inspire user-driven public sector innovations, proposing and developing innovative solutions for challenges faced in these sectors. The module further focuses on employing cost management strategies that prioritize technical infrastructure, ensuring data security and optimal human resources for project success. Learners will analyze the impact of smart city infrastructure on open data availability and quality, assessing cost management effectiveness in controlling expenses related to open data programs. By examining the alignment of open data initiatives with smart city infrastructures' goals, learners will learn to critique and evaluate the efficiency and effectiveness of open data in driving public sector innovation. This comprehensive examination equips learners with the skills necessary to sustainably implement and manage open data programs that align with and foster the strategic aims of smart city developments.

08: Programming

This module introduces the fundamentals of programming through Python, an approachable and powerful language widely used for data analysis and automation. Designed for beginners, it establishes the foundational skills needed

to write and understand basic programs. Learners start by defining Python’s core concepts, such as variables, data types, and control structures, establishing a solid footing in programming. They explore the significance of Python in data tasks, recognizing the role of programming in automating complex processes and enhancing analysis capabilities. The module progresses to cover conditional statements and loops, equipping learners with tools to implement decision-making and repetitive tasks efficiently. By utilizing functions and Python libraries, learners gain proficiency in leveraging built-in tools, enhancing their coding efficiency and problem-solving abilities. Practical exercises demonstrate how these concepts support real-world applications, specifically through open data analysis. Learners will also apply Python libraries to explore and transform open data into actionable insights, showcasing their capability to address practical data challenges. By the end of the module, learners will possess the skills to write, execute, and optimize Python code, paving the way for further exploration into data-driven solutions and reinforcing their role in enhancing smart city functions through robust programming practices.

09: Big Data Analytics and Tools

Big data analytics is at the heart of revolutionizing urban management and enhancing smart city operations. This module provides an extensive overview of how these methodologies are applied to open data within smart city environments. Learners are introduced to fundamental data analytics techniques, learning how to employ them in analyzing extensive datasets typical of urban data ecosystems. With emphasis on real-world application, learners will explore big data tools and visualization techniques that facilitate the interpretation and presentation of data-driven insights. The module discusses the role of outlier detection algorithms, essential for identifying and managing anomalies within urban data sets—skills critical for addressing exceptions and ensuring reliable data analytics outcomes. Furthermore, learners will engage with big data processing frameworks, such as Spark, demonstrating their capability to handle large-scale data scenarios effectively. This practical engagement extends to employing visualization techniques that communicate complex data insights, supporting decision-makers in urban planning and enhancing strategy development. Through comprehensive exercises and case studies, learners will develop a nuanced understanding of how big data tools enhance the efficiency, sustainability, and resiliency of smart cities, ensuring they are equipped with the competencies necessary to optimize city services and anticipate future urban challenges effectively.

10: Artificial Intelligence and Open Data

Artificial Intelligence (AI) is rapidly transforming how cities operate, providing the tools needed to analyze open data, uncover patterns, and make informed predictions. This module explores the intersection of AI and open data within smart city contexts, offering learners a thorough understanding of AI’s applications in urban environments. Learners begin by describing different AI methods and machine learning techniques, equipping them with the knowledge needed to integrate AI into municipal data processes. The module delves into basic learning methods such as classification, regression, and clustering, demonstrating their application to smart city-related problems. Learners will discuss and implement recommendation algorithms tailored to urban data challenges, enhancing their problem-solving abilities and enabling personalized solutions for city services. Additionally, learners will apply machine learning techniques to real-world classification and regression problems, showcasing how these approaches can address diverse data challenges across city ecosystems. The module concludes by exploring advanced forecasting and clustering methods, empowering learners with the skills to predict urban trends and segment data effectively. With hands-on exercises and case study analysis, learners will see the transformative power of AI in driving smarter cities, encouraging them to utilize open data for innovative solutions that address both current challenges and future urban demands.

11: Open Data Governance

Data governance within smart cities is a cornerstone of transparent, secure, and effective data management. This module provides learners with a comprehensive understanding of data governance frameworks, including their functionality, processes, and controls. Learners will explore the principles and responsibilities that stakeholders must adhere to ensure robust data stewardship. Through an examination of privacy concerns and the FAIR principles guiding data management, learners gain insights into the necessary trade-offs involved in designing governance frameworks for urban environments. They will learn to navigate the complexities of data privacy and security, understanding the impact of these factors on governance systems. The module highlights the characteristics and functionality of powerful data governance tools designed for smart city applications, offering practical guidance on implementing these solutions. Learners will engage with case studies and real-world examples, exploring how effective governance frameworks enhance data quality, compliance, and usage within urban settings. By mastering the concepts and applications of data governance, learners are empowered to apply structured, ethical, and accountable data management practices, essential for fostering innovation and ensuring cities' long-term resilience and sustainability in an increasingly data-driven world.

12: Open Data Security

As smart cities become more data-driven, securing sensitive information is paramount. This module focuses on the strategies required to safeguard open data, ensuring its integrity, confidentiality, and availability. Learners will engage with best practices for implementing access controls, including data encryption techniques and secure Application Programming Interfaces (APIs), to protect against unauthorized access and breaches. The importance of network security and user awareness is underscored, equipping learners with the knowledge to create secure data environments. As part of their learning journey, learners will develop incident response plans and explore regular backup strategies to maintain data safety. Emphasis is placed on understanding compliance with data protection regulations to achieve regulatory adherence. Learners also receive guidelines on monitoring activities, enhancing user accountability, and enforcing policies that safeguard data across platforms. By the end of this module, learners will be adept at designing and implementing comprehensive security frameworks that protect open data within smart cities. These essential skills ensure data resilience and foster trust and reliability in smart city initiatives, empowering learners to contribute to secure and transparent urban ecosystems.

13: Open Data Standards

Standardization is essential for ensuring efficient data interchange and collaboration both within and among smart cities. This module delves into open data standards, providing learners with an understanding of their importance in urban data management. Learners will be introduced to the concept and benefits of standards, focusing on those specifically related to open data. The module explores the challenges associated with implementing these standards and emphasizes their role in enhancing data interoperability and exchange. Learners will review key standards currently in use across smart cities, linking them to urban activities and services, and investigate how these standards contribute to transparency, productivity, and collaboration across city agencies. The importance of best practices in the implementation of open data standards will be highlighted, showcasing their impact on smart city governance and service delivery. Through case studies and discussions on future trends, learners will gain insights into the evolving landscape of standardization, preparing them to effectively implement and benefit from standardized data protocols. By mastering these concepts, learners enhance their ability to manage and utilize open data effectively, unlocking new possibilities for innovation and integration within smart city frameworks.

14: Open Data Quality

Data quality is vital for ensuring that smart cities function effectively and derive valuable insights from their data. This module underscores the importance of maintaining high standards of data quality in smart city environments.

Learners will learn about various data quality dimensions and their impact, which measure the effectiveness of data to serve its intended purpose. By exploring methods for measuring and enhancing data quality, learners gain skills to identify and rectify errors, ensuring that data is accurate and reliable for smart city applications. The module covers data quality management processes, including best practices for metadata management and data storage. Learners will examine open data portals' functionality, exploring examples from leading cities to understand how these systems support high-quality data dissemination. The concept of data virtualization is also discussed, presenting it as a method for integrating data across disparate systems into a coherent, agile framework. Finally, the module introduces powerful platforms for open data management, equipping learners to implement effective data quality strategies that enhance performance and foster smart city growth. By the end of this module, learners will be equipped with the necessary tools and understanding to ensure data in smart cities is consistent, reliable, and actionable, driving informed decision-making and strategic urban planning.

15: Open Data Visualization, Sharing, and Distribution

Effectively visualizing, sharing, and distributing data can dramatically enhance a smart city's decision-making capabilities. This module introduces diverse techniques for visualizing complex datasets, enabling learners to highlight important patterns, relationships, and insights with clarity and precision. Learners will explore methods for sharing and distributing data, ensuring it reaches relevant stakeholders effectively and promotes collaborative data use. The course emphasizes storytelling through data, teaching learners how to construct compelling narratives that integrate quantitative findings with strategic communication methods. By engaging with visualization techniques—such as charts, graphs, and interactive dashboards—learners enhance their ability to convert raw data into easy-to-interpret formats. They'll analyze real-world examples from leading European projects, gaining an understanding of innovative data visualization applications. Moreover, learners will address challenges linked to data distribution in cities, employing best practices for safeguarding data accuracy and ensuring timely dissemination. Through hands-on exercises and case study analysis, learners will build competencies vital for advancing urban analysis and policy development. Ultimately, this module equips learners with the confidence and expertise needed to transform complex datasets into actionable insights that guide smart city strategy and support dynamic urban evolution.

16: Open Data Literacy

Enhancing open data literacy is critical to leveraging data effectively in smart city contexts. This module explores the skills needed for interpreting and utilizing datasets to drive insight and innovation. Learners begin by examining the areas strengthened by open data literacy, including community engagement, informed policymaking, and enhanced public service delivery. The module identifies the specific competencies required to navigate and harness datasets effectively, emphasizing critical thinking, data interpretation, and analytical skills. Throughout the course, learners engage with exercises designed to build their data literacy, equipping them to handle complex data environments and challenges. They discover how to transform raw data into meaningful insights that inform decision-making and foster tangible community benefits. By understanding how to communicate data-driven insights clearly and concisely, learners will gain practical skills they can apply to various urban contexts, ultimately supporting more effective solutions and policies. By the end of the module, learners will possess a comprehensive understanding of open data literacy's role in championing civic engagement and driving data-smart urban strategies to push the boundaries of modern city development.

17: Open Data Marketplaces (Open Data Platforms) and Business Models

Open data marketplaces and platforms offer municipalities new ways to generate revenue while democratizing data access. This module introduces learners to the concept of open data marketplaces and their integration into urban business models. Learners will explore the architecture of open data platforms, understanding how they facilitate

data sharing, collaboration, and service innovation. They'll examine the role these platforms play in creating economic opportunities, including how they can drive public-private partnerships and foster entrepreneurship within the urban ecosystem. Through detailed case studies, learners will analyze successful implementations of open data marketplaces and derive insights into their strategic design and operation. The module further encourages learners to consider the scalability and sustainability of these platforms, pointing out how cities can ensure ongoing value creation and financial return. By investigating the relationship between data accessibility and civic innovation, learners will glean strategies for maximizing the potential of open data in generating economic development and facilitating smart city growth. Armed with this knowledge, they will be ready to devise innovative business models that leverage open data platforms to enhance urban resilience and competitiveness.

18: Open Data for the City's Education and Health

This module examines the transformative potential of open data in the education and health sectors of smart cities. Learners explore how open data can enhance public service delivery in these domains, fostering improved educational outcomes and health services through evidence-based strategies. Learners begin by reviewing the roles and responsibilities of education and health sectors within smart city contexts, understanding the unique challenges and opportunities within each. The module presents collected data typically used in education and health, detailing how it is analyzed to derive valuable insights. Through the lens of case studies, learners will assess best practices and real-world applications of open data that demonstrate measurable benefits. They will identify potential issues, such as data privacy and ethical considerations, learning how to address these effectively. The module culminates in an exploration of the pathways through which open data initiatives can be tailored to meet the specific needs of educational and healthcare landscapes, with particular focus on policy implications and community engagement. By the end of the module, learners will be equipped with the skills and insights to contribute to and lead the development of open data-driven strategies that support dynamic, data-informed growth in education and public health sectors.

19: Open Data for the City's Mobility/Logistics/Economy

Mobility, logistics, and economy are pivotal domains in the urban landscape, and this module explores how open data can enhance these areas within smart cities. Learners begin by investigating the roles of each domain, identifying their interdependencies and how they collectively contribute to city functionality and growth. Learners review data typically collected in these fields, understanding how it is analyzed to optimize urban mobility, streamline logistics, and bolster economic activities. Through a series of case studies, the module demonstrates open data's capacity to drive efficient infrastructure, devise innovative solutions, and address sector-specific challenges. Learners will identify opportunities enabled by open data, such as improved traffic management, efficient supply chains, and robust economic development strategies, reinforcing city resilience and adaptability. They will also consider potential issues, including data privacy and security, ensuring that these are appropriately managed. By developing an appreciation for open data's value, learners will acquire the skills to employ and promote open data initiatives within mobility, logistics, and economic contexts. By conclusion, learners are prepared to engage with intelligent data-driven solutions that optimize city performance and support sustainable urban growth.

20: Open Data for City's Environmental Issues

Environmental challenges represent critical considerations for smart cities, and open data plays a vital role in addressing them. This module explores how cities can harness open data to tackle environmental issues, promote sustainability, and enhance urban resilience. Learners begin by examining the significance of open data in environmental applications, identifying opportunities for data-driven interventions and policies. Focusing on successful case studies, the module unpacks how open data has underpinned significant environmental impacts,

from climate change mitigation to resource management and pollution control. Learners will evaluate the diverse strategies municipalities have employed to leverage open data, understanding the barriers and enablers within this context. The module also stresses the importance of stakeholder collaboration, guiding participants on how to effectively involve relevant parties in designing and implementing data-driven environmental initiatives. By the end of the module, learners will be prepared to transform environmental data into actionable insights that guide urban sustainability efforts, supporting the development of eco-friendly policies and a greener, more resilient city infrastructure. Equipped with this knowledge, learners are positioned to take an active role in crafting environmental solutions that incorporate open data, driving forward-thinking policies that prioritize ecological health and urban vitality.

5. Conclusions and Future Directions

The creation of a specialized training program on open data management for smart city personnel, is a significant advancement in developing sustainable, transparent, and innovative urban environments. This research highlights the necessity of such a program, as current educational frameworks fail to meet the specific demands of this domain. By blending theoretical knowledge with practical applications, the program prepares municipal personnel to tackle challenges associated with open data use and management while supporting smart city development objectives.

The training program curriculum was meticulously developed using a structured methodology, the ADDIE model. The process began with a detailed needs assessment to identify skill gaps and identify the objectives that are aligned with the strategic goals of smart city open data management. The educational program followed a multidisciplinary approach, combining technical knowledge in data management with essential skills in regulatory compliance, citizen engagement, and ethical governance to ensure that it reflects the most current and relevant competencies needed.

The design phase translated these needs into a coherent and dynamic curriculum, including modules that address both foundational and advanced aspects of open data management. These modules cover areas such as data governance, urban analytics, and the integration of emerging technologies. The curriculum is structured to include theoretical components complemented by practical, real-world applications, such as case studies, simulations, and project-based learning. These elements ensure that participants can directly apply their skills to the challenges they face in their roles.

The development of training materials further enhanced the program's emphasis on practical learning. A diverse set of learning materials such as presentations, videos, exercises and case studies were created to address diverse learning preferences. Real-world scenarios, based on best practices implemented from smart cities like Helsinki and Singapore, were integrated into the program to offer participants actionable insights and strategies. By that way critical thinking and problem-solving skills is fostering, enabling learners to address complex urban challenges effectively.

The pilot implementation and consequent evaluation provided valuable feedback, leading to refinement that enhanced the program's relevance and impact. Adjustments were made to enhance the relevance and accessibility of the program, ensuring that it meets the diverse needs of learners.

This research beyond its main goal to equip smart city personnel with the necessary competencies to deal with open data in smart cities to enhance transparency, innovation and efficiency, has a broader impact as providing a comprehensive guide for developing specialized training programs for smart city personell. The integration of emerging technologies, urban analytics, and ethical considerations ensures that participants in a such program are equipped to navigate the complexities of modern urban environments. Moreover, the program's modular design and flexible delivery options make it accessible and adaptable to diverse urban contexts.

In conclusion, the proposed training kit for open data management is a vital contribution to the professional development of smart city officials. By addressing skill gaps, fostering interdisciplinary learning, and emphasizing practical applications, it supports the advancement of data-driven urban governance.

Future research should explore the long-term impact of such training programs on smart city projects, assessing their role in shaping sustainable and resilient urban environments. Expanding the curriculum to include emerging technologies and methodologies, such as artificial intelligence and advanced urban analytics, will ensure its continued relevance.

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Track Name: DATA2025

Paper ID: 13

Paper Title: Developing Open Data Competencies: A Training Kit Approach for Smart City Workforce Readiness

Abstract:

With the rise of data-driven solutions, cities increasingly depend on open data to optimize services and drive innovation. However, there is a significant gap in workforce readiness, highlighting the need for enhanced competencies among smart city personnel to effectively manage and utilize open data. This study focuses on creating a training kit designed to equip smart city officers with essential open data skills by following an approach that emphasizes flexible learning opportunities. The research employs a structured design methodology to create the training kit, focusing on real-world applications and competency-building. The training kit significantly enhances participant skills in open data management, leading to improved urban services and decision-making. This initiative underscores the importance of workforce development in realizing the potential of open data. By investing in skill-building, cities can achieve more efficient and sustainable urban environments, driving future urban innovation.

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Primary Subject Area: Digital Energy Technology and Smart Grid

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Submission Files:

TK_OpenData v1.0.pdf (611 Kb, Sun, 24 Nov 2024 21:36:20 GMT)

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