A mapping towards a unified municipal platform: An investigative case study from a Norwegian municipality

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A R T I C L E   I N F O

A B S T R A C T

Norwegian municipalities set citizens' wellbeing a top priority, through transparent social practices and democratic conduct of public services. In 2015, the United Nations (UN) have set a collection of 17 sustainable development goals (SDGs), which are interlinked towards achieving a sustainable future by 2030. In smart sustainable cities context, a multi-stakeholder, physical and virtual platforms are considered pivotal to achieve the UN SDGs. They are core initiator for transformative actions, endeavoring on public service excellence. This research aims to investigate the digital governance platforms utilized, by a case study Norwegian municipality, to achieve the UN SDGs; towards a smart sustainable city. An empirical systematic approach was followed. The approach commenced by the conduct of a 1) narrative review and synthesis of the literature, and the municipal strategic development documents, 2) collection of a developed semi-structured survey, and 3) interviews with the municipal decision makers (including directors, and departmental professional advisors). As part of the study, broad aspects related to municipal governance and services have been discussed with the interviewees, where effectiveness measures have been identified and prioritized. Further, recommendations for improving the municipal platforms and initiatives were identified and discussed. The municipal investigated platforms and the strategic documents have led to formulating a novel conceptual model for the behavior needed towards making a unified municipal platform. Discussion and recommendations were presented to identify future development prospects, towards achieving a transformative integrated ecosystem. Further, the research presents main concepts, to articulate organizational administrative practices, and to inform municipal stakeholders, decision makers and professionals about the existing digital platforms, while proposing a model for a unified municipal governance transformation.

1 Introduction

In Norway, municipalities derive change towards achieving smart sustainable cities. Their role evolved in importance more than any time ever before. The accelerating emergences, changes in computing power capabilities, advancements in information and communication technologies (ICT), are all considered as drivers that set a demand for investigating the municipal digital platforms utilization. Moreover, the municipal stakeholders' responsibilities have become more challenging, by massive introduction of national investments in smart city initiatives.

As they are challenged to keep an abreast of advanced pace of change, that is in respect to the global moves toward achieving smart sustainable cities [43, 22].

It is deemed pivotal, a need for accelerating the organizational municipal digital transformation. This is through offering utmost quality of public services. Hence, emerged a need for investigating the municipal position of digitalization; to understand its status towards achieving a smarter city [4, 35]. Sustainability of municipalities as governing organizations is prospected to be based on their ability to acquire innovative digital tools and platforms that enhance: *decision making, service*

provision, monitoring and control of regional conditions (from a social, environmental and economic perspectives). Thus, there is also a need to investigate upon the considerations, that municipal policy makers need, to manage their visions. Visions can be realized through the acquirement of adequate strategy-enabling municipal platforms.

In other words, the organizational capability needs to be widened and accelerated. This is to meet the essence of digitalization. As effective digitalization has been always a challenge within a global race for smart sustainable city realization [53]. Therefore, weaknesses in practice should be investigated to eliminate the *diffusion of knowledge*, and to *promote practicality of future works;* as sought after by municipal decision makers (Rosati and Conti, 2016). Further, it is vital to question the level of citizens' involvement in the decision making process. This is to understand the magnitude of citizens' visions and plans of a smart sustainable city; towards achieving an inclusive and impactful democratic *quality of digital transformation* [13].

Norwegian municipalities differ in scales, contexts, and locational environments. There is an investigative necessity upon understanding the concept of smart sustainable city, from a Norwegian municipality perspective. This is with a more focus on investigating the adopted digital tools and platforms; *for being a backbone for a standardized reproduction and unification of municipal products and services*. Thus, A mid-sized Norwegian municipality (around 66,600 inhabitants), that is of United Nations (UN) quality, aspiring to accomplish sustainable development goals through local action, in a holistic manner was selected as a case study for this research.

The case study municipality is the first city in Norway selected for testing and applying the United for Smart Sustainable Cities (U4SSC) key performance indicators (KPIs). The case study municipality merged with other surrounding municipalities to form a new and bigger centralized municipality in 2020. The merge was set to improve their governance and provide high quality of smart services to all inhabitants. The U4SSC initiative was set to test 92 indicators determined by the International Telecommunication Union (ITU) and U4SSC study groups of experts. These indicators are applied to evaluate different cities globally, such as: Riyadh, Moscow, Pully, and Valencia. The list of U4SSC cities has expanded to cover 100 cities in 2019 and more than 200 cities by 2021. The main purpose of the U4SSC indicators is to benchmark between exemplary cities and provide solutions for smart and sustainable development. This is according to a set of requirements formulated by the 14 UN partnering organizations. It also allows sharing the knowledge on transformational experiences and accelerate the change by adopting technological and digital solutions within cities to become smarter and more sustainable [51]. The case study municipality is considered one of the biggest cities in Norway, in terms of population. Being a cluster for innovation, higher education, research, maritime operations and businesses. Thus, this research aims to investigate (a unique case study of municipal digital platforms and proposes a conceptual framework that aids in identifying gaps in practice with relevance to the reviewed literature.

The United Nations have set 17 goals in which among others, the goal number 11 was agreed upon to "*make cities and human settlements inclusive, safe, resilient and sustainable*". The ITU has set a framework for the U4SSC initiative, as more than 200 cities were involved and committed to the initiative afterwards for benchmarking, and identifying best practices. The aim of the initiative is to exchange cities' knowledge internationally. A lab was formed in the case study municipality, serving the national level of Norway, to bring together key stakeholders from the private and public sectors. This is to create, collaborate and innovate on products, initiatives, and solutions towards achieving a state of the art smart and sustainable city transformation scheme of work. The lab is considered as a physical platform for multi-stakeholders' interaction, using KPIs analyses to point out areas of improvement [6]. Thus, the researcher has selected the case study municipality due to its unique standing and position internationally, regionally and locally.

The existing portfolio of digital platforms of the case study municipality is investigated, illustrated and described with recommendations. This is through the identified knowledge from literature and motivated by aspirational perspectives of the author. This research focus on the important aspects required to realize a smart sustainable city transformation. Gaps can be used as inputs for future improvements and investments, whilst matches can be seen as a confirmation of good practice.

2 Background

Urban agglomerations, industrial shifts and innovations are drivers of change in smart cities. According to the UN sustainable development goal number eleven (SDG-11), 70% of global population will be living in cities, being responsible of 80% of the planet's gross domestic product (GDP); thus, a need is set for sustainable development of cities and communities. Sustainable development goals entail a green shift towards realizing a smart sustainable city, by tackling the diversity of a global thriving economy. It is crucial to conduct urban developments with focus on sustaining our planet resources and its people [16, 20]. Several proposed frameworks were developed theoretically. These frameworks follow an inductive positivist approach to realize this prospect. Yet, understanding of the current practices remains a blue space for discovery. Thus, empirical investigations adopting qualitative and quantitative methods are required. This is to unleash the knowledge of relevant best practices and to get-up-and-go for potential innovations sustainably. The current and existing knowledge remains diffused. The gaps in literature motivate the need for extensive investigation. Investigations for building up assemblies of best practices, experiences, and consensus. This is particularly with a focus on municipal products and services for an effective governance (J. H. [29, 14]).

Previous research is focused on the acquisition of urban data, by the use of *software systems, networks of servers and sensors* as a substructure, *infrastructure*, and *user devices*. The use of information and communication technologies (ICT) integrates three main dimensions, namely: *tangible* (physical assets), *non-tangible (systems, services, and non-physical components)*, such as organizational and digital space of an agglomeration and the third dimension is the *human collaborative and cognitive dimension* ([48]; Radovan and Kuchta, 2014). The definition of smart city is broad and changeable, being driven by *technological, environmental, social and cultural* combination of their constructs. A future state of smart cities is described as visions (J. H. [29]). The smart city has been defined by different technology companies as "*an application of compound systems, to integrate the operation of urban infrastructure and services in areas such as buildings, transportation, electrical distribution, water distribution and public safety*" (Radovan and Kuchta, 2014).

The complexity of a smart city sets needs for a new era of design thinking. As, smart cities shall be built upon collaborative knowledge, collected collaboratively across multiple domains of expertise *(e.g. Architects, urban planners, information technologists, systems engineers and public administrators)*. Its interdisciplinarity necessitates a democratic decision making and a stronger emphasis on collaboration, where a city can be viewed as a "*System of Stakeholders*" (Radovan and Kuchta, 2014). The quadruple-helix theory extends this definition to the circulation of knowledge in an ecosystem. In which collective knowledge foster sustainable development through innovation. Innovation can be realized in this theory by collaborative efforts from educational organizations, governmental political organizations, environmental, nature, and public culture interactions. Thus, development of smart sustainable cities should be built on the basis of systematic thinking and alignment of institutional and multi-stakeholders' goals and visions, to foster a well architected knowledge-based evolution (Hämäläinen, 2020; Al-mashat, 2021).

Over history the human-ecosystem relationship has been interactive, and progressive but resources extensive. The primeval era was the longest ever entitled with very low consumption of earth resources. The

daily energy consumption per capita didn't exceed 2000 Kcals. Then, 12,000 years ago the farming phase started where seeding and harvesting techniques changed the use of earth resources than any time ever before. Selective farming and planting, as well as short term vegetation and animal slaughter took place, reaching a daily consumption ranged from 4000 to 12,000 Kcals. Then, 5000 years ago the urban phase started where human settlements became associated with dense and stressed populations. Feeding these populations raised the daily energy consumption per capita to 26,000 Kcal. Then, 200 years ago the urban industrial phase started where cities grew rapidly, with increased use of fossil fuels, the daily energy consumption was raised to 50,000 Kcals per capita. Nowadays, the globalized interdependent phase of our cities set trade exchanges and environmental problems that never existed before, these problems are causing damage to the ecosystem, reaching a daily energy consumption of 300,000 Kcals per capita. This resulted in climate change which necessities sustainable cities based on circular economies. Thus, a sustainable city is "*one in which its people and businesses continuously endeavor to improve their natural, built and cultural environments at neighborhood and regional levels, whilst working in ways which always support the goal of global sustainable development*" (Haughton and Hunter, 2005).

3 Literature review

Several references were synthesized to develop a narrative review of the literature, by critically reading each of the references and synthesizing their abstracts. Different databases and academic search engines were utilized to select and synthesize references. They served to answer the research questions with a comprehensive grasp on smart cities governance. This is by focusing on municipal ecosystems and platforms. Keywords used were "*Municipal Platforms*", "*Municipal Ecosystem*", "*Enterprise*", "*Smart Sustainable City*", "*Databases*", "*Empirical Research*", "*Governance*" and "Knowledge-base". The review findings were themed to discuss lessons learned, perspectives and views on smart cities, centricity of people, empirical investigation as an approach, and investment formats for smart sustainable cities.

3.1 Lessons learned from Seoul and San-Francisco

Lee et al. [29] discussed the development of a conceptual framework based on a taxonomy of smart cities' initiatives. The adopted method investigated different city stakeholders, such as: *government officials,* and *private sector actors*. Lee et al. [29] examined two cases of major cities in the United States and South Korea, which are Seoul and san Francisco. This is to bridge practical gaps in their urban planning. The research identified the role of public and private sectors in their development. A smart city aims to avert challenges in public servicing, such as: *unavailability and shortages of utilities and services, unbalanced land use,* and *inequality*. Thus, to achieve a thriving social, environmental and an efficient economic development, it is required to have a knowledge-base which serves a regulated stream of information. This is to systematically monitor, control and improve its livability. Lee et al. [29] discussed that the availability of open data platforms, in both cases have enabled innovation and raised the level of public participation, while areas of information availability have been identified. Gretzel et al. (2018) discussed that Seoul has been served well, in terms of, *technological affinity and e-governance,* since the 1990s. The city has been named the most wired city; encompassing fastest internet speeds. Seoul has been a knowledge-based development arena, serving efficient provision of value-added services to its stakeholder; systematically. The open data initiative, enabled a freely accessible data that can be used, modified, and shared for any purpose; driving the innovations ecosystem towards growth, through enabling private services exploitation, and aiding actions based on its citizens' engagement. S. Y. Lee et al. (2017) discussed that political reforms in Seoul's strategy, targeted citizens' engagement, as a driving dimension for social innovations. This was formulated by

establishing a public budgeting system, where citizens can review proposals for *financial transparency* and *equitable resource allocation*. Also, by creating an open forum for citizens where they can reflect, listen and adopt opinions. A hub that is established as a mechanism to facilitate a portfolio for consensus-based public-private partnerships.

3.2 Smart cities as enterprises

Smart cities are not just projects, they are an assembly of deliverables emerging from different initiatives. The competitions toward smartness of cities are observed to be evolving in an arbitrary manner. The worldwide classifications aimed to address organizational and technological perspectives for cities maturity. Big data is expected to grow ten times larger by 2025, reaching 175 zettabytes. The big data analytics market is set to reach $103 billion by 2023. Poor data quality costs the united states (US) up to $3.1 trillion yearly. 95% of businesses cite the need to manage unstructured data as a problem for their business. 97.2% of organizations are investing in big data and artificial intelligence (AI) [58]. The international plate of smart cities remains a niche ground to address. Cities can be viewed as state-owned enterprises, or as enterprises which are funded by local governments. Governments and research institutes are building coalitions to examine cases which aim to improve governance practices.

Cities' municipalities as enterprises are considered to be a facilitator, for public services, which traditionally emphasize on areas of economic, social services and environmental development. They possess a potential ground for fostering new markets which support both *local, regional* and *national* growths [5, 41, 25]. The smart city as an enterprise is considered to be an ecosystem of a critical infrastructure which evolves its *administration, transportation, education, healthcare, public safety, properties and real estate, intelligence, assets,* and *utilities*.

Smart cities are multi-layered enterprises, which provide architecture of contextual services driven by enthusiastic *researchers, entrepreneurs* and *professional experts*. They are usually innovators, that are considered pivotal, as stakeholders for its development. Thus, city management institutions should be investigated and evaluated for improving areas of *governance, citizens' engagement*, and simplification *of its systems (operating as lean as possible)*. This is while *increasing the smart cities' public value-adding deliverables* (J. H. [29]). Enterprises are organizations that are structured and formed to conduct specific services through systematic processes. These processes are owed to individuals who are responsible to collaboratively deliver an effective implementation of tasks. These individuals are intended mainly for achieving operationally the organizational goals. They are referred to as knowledge workers, as they use tools to communicate, administer and process knowledge with the organizational customers; internally and externally. The organizational structure serves several dimensions such as: *strategic goals, social aspects*, and *cultural behaviors*. The information technology (IT) in this context tends to unleash organizational complexity by facilitating a structured and automated conduct of high-quality services. Thus, enterprise architectures are utilized to model the various components of organizational levels, as a powerful mechanism that supports a common understanding of its structure and behaviors [24]. Hence, a smart city's municipality must have a *political* and *organizational* hierarchy (*as an enterprise*) which provides a clear semantic and syntactic representations of its parts; along with formal governing guidelines and policies driving its behavior. As in a large organization such municipalities, it is challenging to illustrate how different municipal areas intervene for services provision. This requires a clear demonstration of the cross-functional interaction among areas of governance. To build a municipal organization that is citizen-inclusive and innovative, an integration between its administrative areas must be established. Following a clear leadership system and managerial model that contribute towards finding strong solutions and building a sustainably growing culture. Such culture must work towards common goals, from a holistic perspective [35].

3.3 Smart cities as business models

In 2012, smart cities emerged as dynamic centers for investments. They are accounting for 240 billion US dollars, where solutions, products and expertise are placed and exchanged intra- and inter-changeably [5]. The global smart cities investments exhibited a strong growth over the period from 2015 to 2020. The market is expected to grow more at a compounded annual growth rate (CAGR) around 20% over the period between 2021 and 2026 (*Businesswire*, 2021). Anthopoulos and Fitsilis [5] proposed four business models that are procedural. These models classify the openness of managing a city infrastructure towards smartness, namely:

- *Private* business model of a smart city (where operations and maintenance are managed over a networked infrastructure),
- *Exclusive business model* of a smart city (where management and operations of a private solicitor take responsibility over specific ICT network),
- *Managed business model* of a smart city (where a private organization develops the ICT infrastructure, and then service is agreed upon by several providers), and
- *Open business model* of a smart city (where multiple competent providers establish ICT networks in public areas, where subscribers facilitate its usage, based on their preference).

Barcelona for example have developed lighting poles which are equipped with LED and control sensors; serving an eco-digital smart transition. *Amsterdam* developed a climate street app to transform its streets sustainably into habitable commercial shopping hubs.

Louisville in Kentucky USA for example, gained a status of being one of the worst among cities accommodating people with breathing disorders. Thus, the city formulated a public private partnership (PPP) to fund grants on data analytics. These analytics consist of modules that inform citizens upon the causes of asthma within the city. The partnership was formulated with (local organizations, health organization, institute for healthy air, water and soil, local advocacy groups and healthcare service providers). This module has allowed the city to expand further. The technology used a sensor into asthma inhaler to collect environmental data about air quality, that is transmitted through mobile app to a healthcare provider.

The data collected were related to pollution, inhale counts, time, and location. The data collected allowed the healthcare provider to effectively plan their services and personalize it, for treating its patients. The project resulted in improved use of the inhalers by 82%, which allowed the patients to have a better control on their asthma symptoms. Furtherly, the app data allowed the county to create a map of roads and areas which were polluted, that resulted in increased use of the patients' inhalers. The county then Changed its policies on roads used to reduce CO_2 emissions and divert heavy traffic from its highways and reduce industrial emissions at specific areas.

The data also allowed patients to reduce healthcare costs by being offered the sensor-plugged inhalers for free in partnership with the manufacturer, in its first waves. Then the use of inhalers has been optimized which saved local employers expenses on employees' healthcare due to improved air environmental conditions and optimized use of the inhalers.

Another business case of assets recycling in New York city and Toronto. Where a network of payphones has become obsolete due to the increased use of smart phones. Thus, the cities approached the phone booths as an opportunity for advertisements. They brought around 17 million United States Dollar (USD) in a year. Despite this, the phone booths were blocking pedestrians flow and resembled an outdated service, especially with the advances in communication technologies. Thus, the city of New York partnered with a private organization to replace the kiosks with smart kiosks that deliver free wi-fi to public spaces, digital mapping screens and charging stations for smart devices. This was implemented and operated at no cost on the city, as they project was mainly funded from the advertisements revenues, the plan additionally aimed to generate profits to the city over the first 12 years by 300 million USD.

In Toronto a waterfront land was sold to consortium of private organizations, that generated the city revenues that exceeded 260 million USD, while improving the public spaces offered to its citizens. This value was then planned to be invested on improving public transportation and transits.

In Kansas City, United states of America they have formulated an agreement with a world leading private organization in communications and networking to enhance walkability and reduce vehicles traffic by shifting a 2.1 miles long area through interactive smart kiosks that offered free and public wi-fi; this is in proximity to locations of downtown business headquarters. The kiosks were also equipped with alert systems that enhanced public safety in the area, in case of emergencies. The overall project cost was 16 million$, the city offered an amount of 3.7 million USD for partnership. The model of funding allowed the city to recollect its capital in five years, which afterwards generated revenues worth of 25% shares of the kiosk with the private organizations. The private organizations were allowed to utilize the data collected from the kiosks in exchange to their project investments. The project additionally involved the provision of live maps, maintenance requisition system to city services and collection of infrastructure related data, that improved the city governance by offering better services to its citizens.

The case of Columbus also represents an exemplary case for the application of PPP, where the department of transportation funded a contract of 50 million USD for the city, towards improving its commute to jobs, safety at districts, and reduction of environmental impacts through adopting sustainable development methods on transportation modes and infrastructure, from a holistic perspective. This attracted private organizations to invest around 360 million USD for accelerating its plans. The agreement included that the private organizations would not have direct revenues from the investments in cities but more of a social investment, where the companies aim to thrive the city in order to create a better environment for businesses to grow within. While at the same time transparency of the innovation acquisition processes for these partnership developments as an ecosystem, aims to enhance the city credibility and power. This in a way encourages also other private stakeholders for serving the society for good as a mean of philanthropy (Deloitte, 2018).

Plenty of businesses have emerged in smart cities to evolve its social and technological experiences. Thus, exploring a city platforms as a business facilitator, through cross-functional domains serves to evaluate and focus capitalized investments of assets (J. H. [29]). Further, smart cities as business models can facilitate innovative sub-enterprises. In which these are considered businesses that deliver state of the art services for its citizens, and promote a smart environment; in a sustainable manner [45, 42].

3.4 Smart city platforms

The green initiatives of smart cities are based on a wide infrastructure of networks. These networks utilize web, sensors, communication and mobile devices for data exchange. These data are used to deliver various typology of services through governance platforms. Various range of data ownership forms can take place either by public, private or crowd funded initiatives of services. These initiatives are usually citizen-centric which enable exchange of information in an open eco-system. Data collection formats allow for venture capital investments while increasing a smart sustainable city's social value.

Physical platforms are spaces to meet, present, discuss and collaborate on a knowledge specific topic, between at least two individuals. Digital platforms are online mediums that facilitate beneficial interaction of information between at least two different stakeholders. Examples for a smart city digital platforms can range in services provision,

such as: *transportation, electric vehicles, charging stations*, and *managing clean-tech renewables*. These platforms serve to employ creators, developers toward economic growth and scaling up the business spheres. Urban openness is defined as the "*assessment of smart city services and infrastructure, on whether service design is based on a platform in which people can interact with and participate in to foster civic engagement*" (J. H. [29, 35]).

The following aspects are foundational attributes that aim to evaluate the platforms of a city: *multi-devices consideration* and *data center availability*. There is a balance and limitation between the number of devices available in a city and services offered as platforms. To improve *quality of life* public administration institutions are expected to have the role of coordinating and ensuring a *quality administrative system of services;* to its citizens. The digital solutions' arenas may range and differ, and are not limited to: *welfare, healthcare, transportation, education*, and *safety*. The development of systems and e-services has been extensive by research and in reality demanding collaborative effort from public and private sectors to formulate a joint solution of systems. This sets a requirement for a new, clear, transparent procurement schemes and policies while partnering for sustainability (J. H. [29]).

Further Romualldo-Suzuki and Finkelstein [47], discussed the pervasiveness and fragmentation of cities' data, that collectively piled up over several technological generations. This fragmentation has become a burden for cities to optimize their expenditures. As well as for ensuring their integral capability (pluggability) for addition of new value-added services. Consequently Romualldo-Suzuki and Finkelstein [47], proposed a framework for ensuring a structured availability of several domains that must be considered for smart city infrastructure development, namely:

- *Service domain* (formulation and creation of data that serves specific value for citizens and businesses),
- *Technology domain* (ability for adopting and considering a long-lasting selection of mutually agreed upon infrastructure),
- *Organizational domain* (ability to reserve stakeholders' value as a network of effective collaboration),
- *Value domain* (ability for utilizing the available data and its potential for orchestration and creation of new businesses), and
- *Governance domain* (the umbrella in which management of all domains takes place, while being measured, accelerating city growth).

Chamoso et al. [17] proposed a smart city platforms architecture based on a state-of-the-art literature review. The research study described different city typologies, mainly:

- *Smart city* (a city which performs several functions that aim to serve its citizens, improve their participation based on a connected infrastructure),
- *Digital city* (a city which comprises of open and adaptable complex systems, networks that collects urban information to foster a virtual space) and
- *Intelligent city* (a city based on integrated networks of real time data collectors, using sensors, applications and mobile devices, such data are to be analyzed using digital platforms intelligently with visualization and operational capabilities).

City intelligence is based on three main characteristics: 1) effectiveness of public, and private services, 2) environmental sustainability, 3) Innovative adoption of services and technologies [17, 35].

A city public value can be based on creating an environmental quality of life, while ensuring economic and social values compatibility among different partnering modes of stakeholders. These values can be domain-based such as: 1) *natural resources and energy* (*e.g.* smart grids, smart street lighting, renewable energies, waste and water management, food and agriculture), 2) *transportation and mobility* (*e.g.* city logistics, mobility information, commute modes for citizens, district information

models such as geographical information systems (GIS), Building information modeling (BIM) and systems information models (SIM)), 3) *smart buildings (e.g.* facilities management, construction services and quality housings), 4) *daily living* (*e.g.* entertainment, enhancing hospitality, inclusiveness, air quality monitoring and control, public safety and security, health, welfare and optimal use and management of public spaces), 5) *Governance* (*e.g.* e-government, e-democracy, and authorities transparency), 6) *economy and society* (*e.g.* cultural heritage, innovation, entrepreneurship, e-learning, and human capital development) [17].

Governments tend to adopt different strategies for the acquirement of a smart sustainable city platforms. They can take various roles in formulating the platforms typologies. The government can be the platform builder where it takes the architectural formulation of its components, or an ecosystem builder by formulating a medium for a third party and outsourced platforms, to perform specific services, or as a partner by providing open data to promote the platform economies (Thompson and Venters, 2021).

Gil-García and Pardo (2005) discussed the challenges to e-government initiatives. Information and data, technology, organizational management, legislative and regulatory systems, and the institutional environment, all are challenges identified to e-government applicability. To overcome these challenges the following solutions were identified, namely:

- Adopting a value measuring methodology,
- Utilizing cases on information technology projects and
- Making smart IT choices.

Examples on platformization of the urban space are vast and emerging rapidly. *SmartME* is a platform which combines *projects' management, funding* and *evaluation systems*. The platform bases its process on indicators and goals attainment using qualitative and quantitative logical underpinnings of a project. The platform provides customizable visual platforms to control and improve projects implementation. *Sentilo* is an open source platform which allows collection of real time data, from Barcelona's sensors infrastructure. This data is made available for businesses and administrations who endeavors to process relevant information. The platform allows adoption by other cities to replicate Barcelona's utilization of the platform. *FIWARE* is an open source platform for contextual layer of IoT models for smart cities, the platform enables interoperable and replicable exchange of data in harmonized formats. The platform aims to standardize the definitions of smart city models in order to enable interoperability of services. *CityOS* is an open source city software which provide *application programming interfaces* (*APIs), de-facto standards, data connectors* and *importers, open data exchangers, drivers for IoT devices*, and *more*. Ministry of housing and urban affairs in India created a portal combining more than 100 Indian smart cities open data sets, which enables transparent analyses and adoption of data by third parties. All are examples of the platformization of value adding services to smart cities.

3.5 The human constituent of smart cities

Human-centric models serve to satisfy and correlate a smart city *stakeholders* and *inhabitants*, (*e.g. employees, citizens, visitors*, and *transits*). Such approaches of smart cities serve the highest sustainable goal; placing people on top of the pyramid. Servicing people should follow a participatory role following different approaches, to satisfactorily balance between their *activities* and *management of provided services* (*e.g.* work, play, entertainment, living, health, civic engagement and education). Democratic innovation in smart cities domain has to be driven by the availability and accessibility of open data for its people (J. H. [29]). Novotny and Kuchta (2014) investigated the status of communication platforms for evolving a smart city development, its infrastructure and services. The comprehensive availability of data allowed platform developers and innovators to intervene with technological solutions which

facilitate services for inhabitants based on evidenced data [46]. Pappas et al. [43] investigated the need for digital transformation in Norwegian municipalities and the utilization of Artificial intelligence (AI) for decision making and future aspirations, the research findings have set directions on the importance of deploying intelligent solutions for interactions with citizens (*e.g.* chatbots, use of artificial intelligence and machine learning). There is a clear need to provide innovative solutions, which empower the human component towards achieving a smarter and more sustainable city. Further Van Der Hoogen et al. [54], addressed that cities population are incrementally growing, thus, there is a need to classify inhabitants needs as smart city stakeholders; to facilitate a prioritized implementation upon the most mandated services and initiatives. Yet, trustworthiness of advanced technologies remains a critical question; up to what level the usage of citizens data promotes invasiveness, and contradicts from an ethical perspective with Individuals' privacy.

3.6 Empirical approach to unleash smart cities behavior

Smart cities comprise of different stakeholders. Approaching them is a vital method to unleash the applicable, practical knowledge, gaps, demands and aid the discovery of new innovations. Cases from the literature adopted the empirical approach. Such cases are the City of Tampere in Finland and Trikala in Greece. They utilized *un-structured interviews with directors* where sources of funding were secured for development initiatives. The research of Tampere was based on collation between the *municipality and a university*, this is to aquire the knowledge towards implementing initiatives which enable the sustainable behavior from *organizational perspectives*. Further, private organizations supported both cases with implementation knowledge on realizing a smarter city infrastructure and services. The case study findings identified that this collaboration scheme led to innovational products that support the national umbrella of exports. Moreover, Tampere shared its knowledge with the Finish central government afterwards. While in Greece a coalition between the municipality and the local chamber aimed to convey particular smart city deliverables [5].

3.7 Investments formats for smart cities: public-private partnerships and mono modelled forms

While governments tend to capitalize investments to evolve cities strategically towards a more sustainable economic growth. Services are shifted from public funding to private investments. This is observed from the Chinese state-owned enterprises (SOEs) and the Greek alternatives for energy production and communication throughout their underlying systems life cycles.

The ownership of smart cities systems and development is questioned because of the static traditional methods to keep up with the speed of change; thus, new forms need to be introduced. A gap is identified, where a need to address has been positioned, through the international evolutionary competitiveness, where *private, public,* non-governmental organizations (*NGO), crowd-sourcing* and *municipal agency* formats need to be adopted; serving a trade-of being an international or national competitor [5].

Civic crowdfunding is perceived as a platform which facilitates progressive interaction between governments and citizens. The scheme offers societies an alternate scheme of financing social projects that are ordinarily funded by the government. Civic crowdfunding empowers citizens by enabling them to initiate meaningful developments within their neighborhood, based on their direct choices. They may extend to facilitate citizens involvement in planning and designing development projects (Van Montfort et al., 2020). The European union invested in metropolitan cities with projects that aim to evolute their smartness and approaches for a better livability; an exemplary *regional format of investments*.

The tendency of ownership investigations serves a single perspective

rather than being holistic in literature. Thus, its required to investigate governing bodies of cities, and their approaches of ownership mechanisms. While growing the citizens participatory approach in city development. Partnership formation is defined as "*examination of service diversity or focus, driven either by the city itself or outside providers using open data*". Thus, two factors play a vital role in determining ownership schemes which are: *regulatory capabilities*, and *available sources of funding* (J. H. [29]).

4 Research methodology

This research is based on Oates model for conducting empirical research in information systems (IS) [15]. Oates described that empirical research in digitalization and IT is based on the conduct of specific research strategies, data generation methods, and data analyses. The research is designed to empirically investigate a case study Norwegian municipality, as a research strategy. The areas of investigation cover their use of digital platforms, to strategically manage the shift towards a smarter and more sustainable city. The study emerged from the researcher's motivation to investigate the case study municipality, as an organization which delivers a wide range of services and functions. It was scoped to serve the domain of information systems, where strategic municipal aspects will be linked to the utilization of digital platforms as a technical sphere of systems. The research questions were as follows:

RQ1: *What are the prioritized municipal measures to decide upon smart city platforms investments?*

RQ2: *What platforms do a Norwegian municipality use, for governance (decision making) and strategic development towards achieving a smart sustainable city?*

RQ3: *What improvements can be made to develop an enhanced ecosystem, for the investigated municipal platforms?*

RQ4: *What are the focus areas required to improve municipal performance and services? and which ownership formats are preferred?*

First, a narrative literature review on smart sustainable cities and municipal digital platforms was conducted. Then, a semi structured survey was developed based on active knowledge management procedures [30] and extensive readings of United Nations (UN) sustainability development goals (SDGs). Then, eleven municipal key staff were approached to investigate the municipal digital platforms, identifying best practices, challenges, and gaps. The survey was adopted through the interviews, to solicit their knowledge upon the study areas. Then, the interviews were transcribed and qualitatively reviewed. Then, a set of recommendations are introduced through observations noticed by the author, through the research process.

The research findings are aimed to benefit all municipal decision makers, on understanding the state-of-the-art platforms from literature. While opportunities for development were identified. Several documents provided by the municipality were reviewed to understand its organizational behavior and structure. The municipality has around 6000 employees serving different departments.

Thus, the study aims to focus on specific platforms, that were introduced to the researcher by the municipal professional staff. The staff interviewed are subject matter experts, who serve as decision makers for every municipal area, and have an extensive municipal experience and authority in Norway. *Table 1* illustrates the positions and years of experience of the interviewed professionals.

The survey consisted of several measures to guage the municipal systems effectiveness. A Likert scale ranging from 1 to 5 was adopted. This is to quantitatively measure the interviewees opinion on the effectiveness of the platforms discussed, using agreement terminologies, namely: "*Strongly disagree*", "*Disagree*", "*Neutral*", "*Agree*" and "*Strongly agree*". A relative importance index (Hassanain and Ibrahim, 2020) was calculated to rank the most important areas, and prioritize upon the required focus for future platforms' investments development as follows eqn. (1):

Table 1
Interviewees positions and years of experience.

Interviewees positions and experience			
Municipal (years of experience)	1 – 3 years [a]	5 – 10 years [a]	> 10 years [a]
Municipal department	1 x Technology and Innovation department	1 x Procurement and purchasing department	1 x Human resources, Administration, and communication department
		1 x Documentation center	1 x Culture and citizenship department
		1 x Geographic information (GIS) department	1 x Strategic management department
		1 x Technology and innovation department	2 x Environmental, and urban development department
			1 x Municipal director staff
Total interviewed	1	4	6

[a] Out of 11 respondents.

$$\text{RII} \ = \ \frac{(5X_5 + 4X_4 + 3X_3 + 2X_2 + 1X_1)}{(A * N)} \tag{1}$$

Where x_5 is the Number of responses for "*Strongly agree*", x_4 is the Number of responses for "Agree", x_3 is the Number of responses for "Neutral", x_2 is the Number of responses for "Disagree", x_1 is the Number of responses for "Strongly Disagree", while A: is the highest weight and equals 5, and N is the total number of respondents = 11.

5 Findings

5.1 Municipal governance model, in Norway

Through an extensive review of the municipal organizational documents, and observations at the municipal workplace, it was identified that Norway municipalities, have been working extensively to acquire the best technologies for its knowledge workers, facilitating extensive opportunities for their development. Yet, the plans existed for further development and improvement, but actions were lagged in the making. This is due to a diversified set of visions and strategies in an environment of accelerating and challenging task, required by day-to-day service, from the municipal workers, they needed to keep abreast of smart cities development but there were no specific positions that facilitate improving the municipal strategy towards achieving a smart sustainable city. Many organizations have set visions, that are advanced in their objective such as *Design og Arkitektur Norge* (DOGA) [50]; which placed human first, at the top of its strategic goals. Other, organizations were established such as *Innovasjon Norge* to foster entrepreneurial and innovative solutions for the development of the Norwegian society while increasing its technological and non-oil industries exports [38]. The ministry of modernization has set requirements and developed strategies, as well as other authorities that aimed to develop mega infrastructure projects to achieve better quality of life, yet a unified strategy was lacked in the making, delegating the means of conduct and implementation to organizations, such as the municipalities to take the leap towards achieving the smart cities vision, while guaranteeing a quality level of public service as a guiding requirement. Among other things, the introduction of disruptive technologies has set the challenge on a faster pace; plating for the need for an advanced plan of action to lead the international race. The case study municipality is one of different municipalities that realized the need to centralize and merge with other surrounding municipalities to improve its services while aim for a bigger solution. The governance model of municipalities in Norway is unique

and resembles high level of dedication to societal welfare, by combining healthcare, building, and planning, environmental and urban development, real estate, and property management, and more. The case study Norwegian municipality initiated in collaboration with a national university a set of initiatives to resolve the wicked complexity of smart city transformational efforts. Furtherly, the case study municipality have established a lab in cooperation with the UN namely: *United Future Lab Norway* [52] *which is a part of the united nations (UN)'s smart city program United for Smart Sustainable Cities implementation program (U4SSC)* (ITU, 2020). The lab is located in the heart of the competence cluster, near to the Norwegian University of Science and Technology (NTNU) Campus in city of Ålesund, and the Norwegian Maritime Competence Center (NMK) [37]; targeting partnerships between public and private organizations as well as academia, towards achieving 2030 UN sustainability development goals (SDGs). The Offshore Simulation centre AS (OSC) along with the UN is developing a digital twin solution for politicians, industry, and citizens to better understand the consequences of their decisions, namely: *Augment city* (Augment city, 2020).

5.2.1 Case study municipality

Fig. 1 illustrates the inhabitants-centric model that the case study municipality have adopted towards achieving its aspired organizational goals.

5.2.2 The municipal enterprise

The municipal areas are conveyed through organizational structure that facilitates the realization of the aspired integration. *Fig. 2* illustrates the case study municipality organizational structure.

Norway has a political administrative system that consists of three main levels, namely: national government institutions that are subject specific (19 ministries), regional counties (resembling county governance over several municipalities) and municipal level. The ministries are led by a prime minister whom is responsible of coordinating governmental works, the ministries are [23]:

- Ministry of labor and social affairs (managing labor market, work milieu, pensions and welfare policies).
- Ministry of children and families (managing children welfare services and childhood development, family, religious, living conditions, and consumer affairs).
- Ministry of finance (managing the plan for implementing economic policy and coordinating annual budget).
- Ministry of defense (managing defense policy and its implementation as well as the Norwegian security).
- Ministry of health and care services (managing and ensuring population healthcare services and the underlying legislation, fiscal budget and directs policies through several governmental bodies).
- Ministry of justice and public security (managing the rule of law and preserves its development).
- Ministry of climate and environment (manages cultural heritage, biodiversity and carries out climate and environment policies).
- Ministry of local government and modernization, ministry of regional development and digitalization (both manage building and planning act, geodata and national mapping policies, while ensuring best finances towards an effective local administration, utilization of information and communication technology (ICT), employer policies, and elections).
- Ministry of culture (ensures equality, responsible for discrimination and media, sport and volunteering policies).
- Ministry of research and higher education and research and ministry of education and integration (both manage research, schooling and vocational training, as well as integration and adult learning).
- Ministry of agriculture and food (manages animal husbandry, land use and agriculture as well as their related industries).
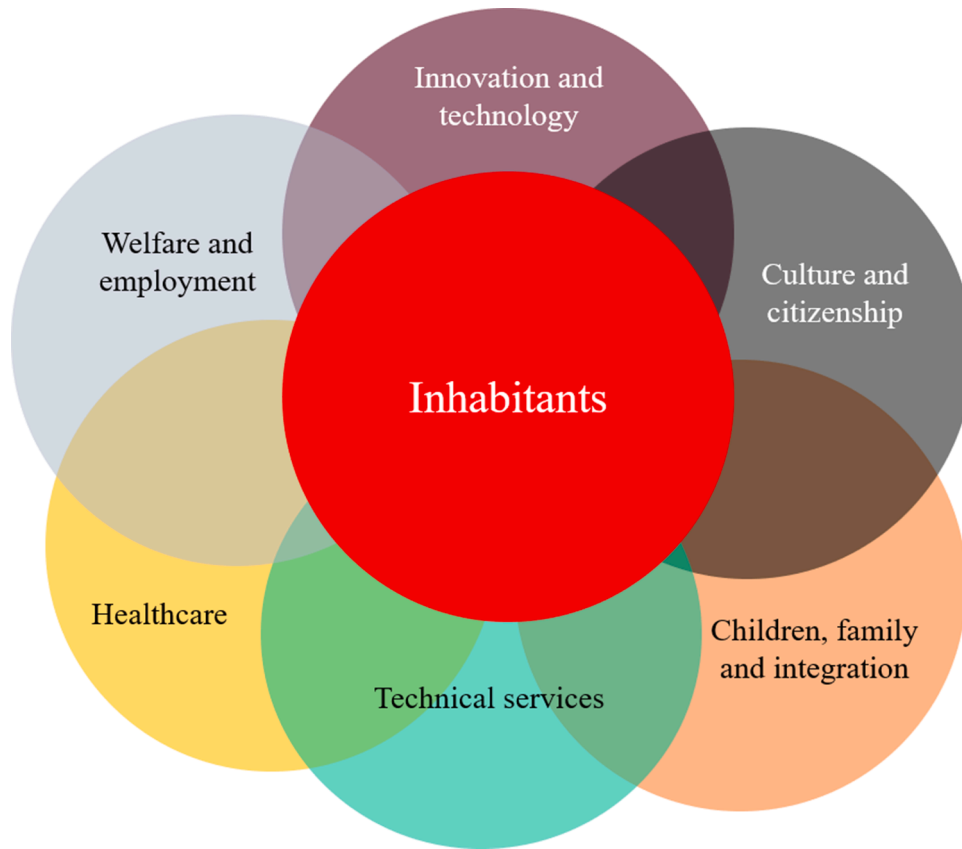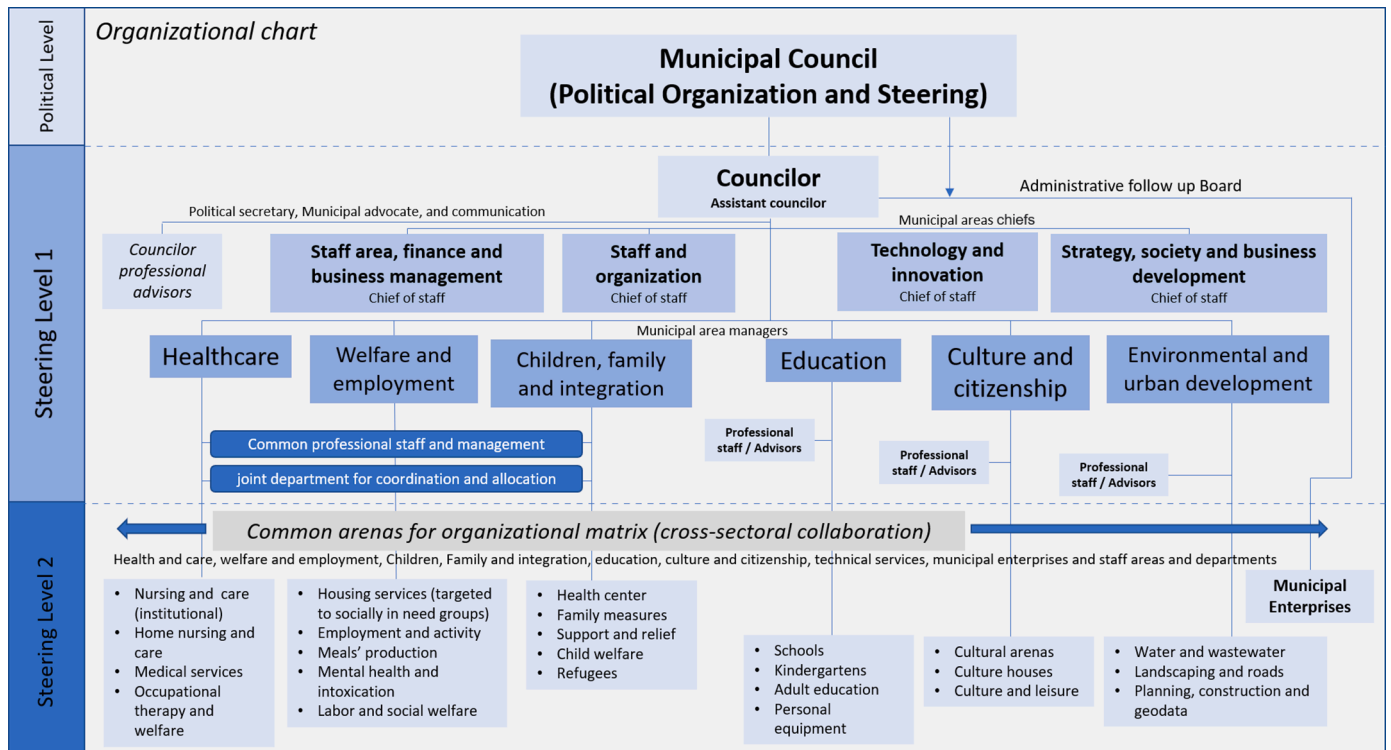
Fig. 1. Municipal areas [28].

Fig. 2. Municipal organization chart [28].

- Ministry of trade industry and ministry of fisheries (manages business and industry, state ownership and international cooperation and exports).
- Ministry of petroleum and energy (manages and coordinates energy policies and ensures an environmentally friendly implementation of policies).
- Ministry of transport (manages postal, civil aviation, public roads, coastal management, marine, environment, ports, sea and rail transports).
- Ministry of foreign affairs and ministry of international development (manages united nations, security, business cooperation, international cultural engagement, peace and reconciliation, European and humanitarian policies).

The county authorities (19 counties) are responsible mainly for regional planning and business development, upper secondary schooling, culture and heritage, environmental issues and county roads and public transports. The local government act describes the plane in which the municipalities and county authorities interact, and rule their relationship, proceedings as organizations; in relevance to the ministries and supervisory state entities [39].

The municipal level as an enterprise consists of three administrative levels, namely: *political level, steering level 1* and *steering level 2*. The political level is responsible for preparing proposals and review cases that are transmitted to the county government, as well as being elected in four years cycles to represent the civic engagement administration of public service provision of the municipality. The council is decisive upon municipal issues, aiming for formulating a planning strategy that can be executed by the leadership of the chief of staff, whom is a mediator between the political level and the steering level 1. The purpose of the municipal planning strategy is to clarify what planning functions the municipality should initiate or continue in order to facilitate the desired development in the municipality, Fig. 3 illustrates the political council strategy and activities to be carried out by the municipality [40].

The *managerial steering level 1* is a management level with a responsibility to follow up municipal activities, through formulating managerial documents, that take into consideration the citizens perspective. Municipal services must ensure equality, in the making, based on the formulated political decisions. It is of utmost priority to use best technological solutions that enhance collaboration across municipal departments. The councilor and power of attorney (*that act on behalf of the councilor)* municipal managers constitute this level. Each municipal manager has a supporting group of professional staff / advisors that have the capacity to coordinate business wide tasks and challenges. Moreover, citizens are prioritized to have digital solutions offered by the municipality for the conduct of its services. Considering citizens co-creation in digital services is a must, for ensuring a participatory rule

when services are established or changed. This is a consideration that is strategically must be taken into at all levels of the organization, to ensure an effective citizens' engagement; a concept referred to as partnership (*between the municipality and citizens as users for the municipal enterprise*). A clear set of responsibilities is set between the staff and their managers while ensuring cooperation across its hierarchy. Each unit has a distinct and clear rule to facilitate each of the areas namely: finance and business management, staff and organization, technology and innovation and strategy, society, and business development. The *managerial steering level 2* structure sub-municipal areas that have specific set of activities to perform. Each department has a set of sections that has work team groups. Where they report to professional staff / advisors in *steering level 1*, who act to report to the municipal area managers. For each area, the municipal staff are assigned to specific positions, with specific codes, which employs a percentage workload based on their participatory tasks of activities over set of sections or departments. The total staff are counted to employ man-years, which is unit of measurement for the amount of work done by each; throughout the entire year. The structure represents leadership behavior and a dynamic role of each actor rather than being solely authoritative or holding a traditional managerial style of works conduct. In other words, this is formulating a top bottom and bottom-up relation that is facilitated by the shown hierarchy in *Fig. 2*. In order to furtherly explain the positions roles, the following definitions are formulated:

- *Municipal area chief of staff (level 1)*: a manager of a municipal area, whom task is to report to the councilor.
- *Municipal area managers (Level 1):* an area manager who reports to the councilor.
- *professional staff / area advisors (Level 1)*: they report to a municipal area manager, who has the role to report to the councilor.
- *Departmental staff (Level 2):* report to middle managers, who report to municipal area managers and chief of staff.
- *Independent departmental staff (Level 2):* report to middle managers, who report to the councilor or his assistant directly.

5.2.3 The municipal business enterprises

The case study municipality as illustrated in Fig. 2, have an administrative board for managing its sub-enterprises, these enterprises facilitate activities such as: *real estate development and operations, fire brigade, waste management, port management, environmental station*, and *parking management* companies. All are interfaced with the environmental and urban development department. These businesses aim to provide innovative solutions while managing their works area with focus of specialty.

5.3 Measures for improving municipal smart platforms

The municipal professional staff were interviewed to investigate the most prior areas for investments, three main focus areas were questioned, namely: digital transformation of (processes, services, coordination, and communication), Citizens' engagement (*for decision making, community collaboration and cultural participation*), and improving the municipal structure (*hierarchy of departmental works and staff*). The survey was used to investigate their opinions on the most challenging areas in municipal governance scheme, where the need for investing on digital transformation was identified quantitatively to be the most critical area that needs improvement. Where the municipal services seemed to be vast and being conducted using manual efforts of the staff rather than having a fluid process between staff and municipal clients for conduct of works. (*6 out of 11*) 55% of the professional staff chosen digital transformation, the documents identified the need for a clear workflow between the different systems that the municipality use for conducting its works, the linkage between a system A to system B should be elaborated and described in detail to automate routine works and eliminate duplicated or overlapping tasks in different departments. The procurement professional staff indicated that there many small systems
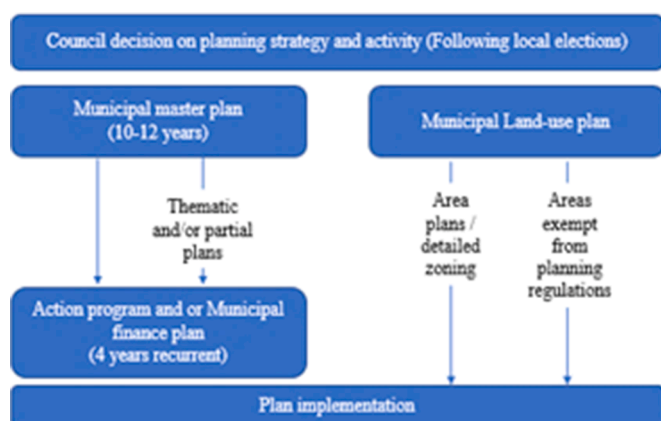

Fig. 3. Municipal planning system as proposed by the planning commission [40].

that the municipality adopts for conducting routine works; a better integration of these systems may lead to a more consistent workflow and reduce financial expenses in a viable magnitude. Furtherly, (3 out of 11) 27% of the interviewed staff indicated that citizens are lacked in the decision-making process, they are usually represented by the political elected personnel but a better engagement, by enrolling the citizens, in the formulation of the municipal new innovative services must be prioritized. Table 2 illustrates main strategic areas that the municipality needs to focus on strategically to improve its service and work platforms.

The interviews were synthesized, based on the analyses of the semi structured survey findings, as illustrated in Table 3. The identified measures aim to set a list of dimensions that should be considered by the municipality strategy, in every initiative. The relative importance index (RII) serves to rank the areas that would lead to a more effective governance performance.

5.3.2 The investigated municipal platforms

Through interviews with the municipality professional staff as illustrated in Table 1, and the review of the municipal strategic documents, an investigative approach has been carried out to understand the municipal platforms functions and uses; illustrated in Table 4. The professionals were questioned about the platforms being used to conduct their works, the following functions and needs were identified:

5.4.1 Strategic planning and management

The platform is developed by a private company, it serves to initiate plans toward achieving sustainability development goals. Through stating different strategic initiatives and plans related but not limited to economic, social, cultural, and environmental development aspects. The platform serves planning and governance tasks, it is web-based and contains different tabs for analyses. The tabs incorporate views for analyses (which shows statistics related to annual initiatives), showing progress charts. Then another tab serves strategies where specific strategies are listed to be achieved over the annual plan. The module is still in pilot phase where it is not fully utilized to its full potential. Some strategies were shown as a list, where each strategy leads to further detailed steps of tasks required to implement the strategy, systematically. each strategy is narrated and linked to a specific UN development goal, where descriptions of actions required with time frame are explained. Usually, the development of each of the strategies incorporate different municipal stakeholders to ensure its comprehensiveness. Other view tabs serve functions such as budgeting, reporting, administration, and political management of each of the strategies. The platform is systematic and analytic, yet it is of basic visual quality. The planning and management system, in the case study municipality, operates by conducting the following consecutive steps, namely: defining municipal challenges, assigning goals, development of strategies (main and sub), identifying measures to evaluate a strategy required actions (includes development of economic plan), assigning tasks to the related departmental stakeholders (through development of business plan), and measuring the performance of actions taken (in means of annual reporting). The developed plan is presented in a plan disk format where it links times with main strategies that should be achieved through the planned year. The platform has the following features and capabilities:

Table 2

Focus areas for improving municipal governance (digital transformation, citizens engagement, improving municipal infrastructure).

SN	Focus area	Count [b]	Percentage
1	Digital transformation	6	55%
2	Citizens' engagement	3	27%
3	Improving Municipal structure	2	18%

[b] Out of 11 respondents.

Table 3

Measures of the municipal system effectiveness (focus areas for improving municipal governance).

Measures of the municipal system effectiveness	Relative importance index (RII)	Rank
Need for introducing new municipal products and services	78%	1
Need to avoid overlapping of smart city and municipal development initiatives	76%	2
Need for a streamlined internal process	75%	3
Need for solutions that anticipate surprises and crises (*e.g. fires, landslides and public safety, pandemics*)	73%	4
Need for enhancing departmental association with international changes of smart cities	73%	4
Need for departmental alignment with smart city initiatives	73%	4
Need for improving new innovative services towards better engagement of citizens	69%	7
Introducing a new scheme, for communication between the municipal departments	69%	7
Need for addressing emerging societal changes (*e.g. aging society, increasing birth rates, expanding welfare technology*)	69%	7
Need to develop new services based on citizens demands	65%	10
Need for identification of new business opportunities to improve the city economy	58%	11
Need for decreasing response times for citizens' complaints about services and requests	53%	12

- Standardize municipal plans and plan content.
- Ensure coherence between plans, goals, strategies, assignments and measures in overall plans.
- Ensure the connection between long-term, overall plans and the financial plan by enabling the financial plan to obtain goals, strategies and measures from overall plans.
- Keep track of how the plans are followed up, including through reporting.
- Make plans digital, ability to publish plans as websites. This increases accessibility and readability for citizens, the general public, politicians and also for their own employees.
- Make the municipality's planning system available by easily publishing a plan overview online.
- Prepare and publish the planning strategy
- Prepare and publish knowledge base, public health overview and long-term operational analysis and local development investment plan (LDIP).
- Facilitate collaboration in the planning work, through simple access control and modern functionality for co-writing and comments.

5.4.2 Geographical information systems

The geographical information mapping system is a web-based platform, that contains two different views, one fitted for computer users and another is set for mobile and tablet users. Both views are considered different solutions that hold the same data. The system had different layer views that serves different categories and functions. Mainly the functions are related to following building permits processing and accessing property related documents that are analyzed by the municipality. The data is linked with the archive system, stored at a local database, and synchronized with the national mapping authority database [12]. The layers view different categories such as: areas which have high risk of landslide, bicycle routes, construction cases, regulatory plans (approved and in progress for development). The base map can be changed based on different periodic aerial plans usually updated every 5 years or else, as arranged by the municipality with the national cadastral authority, a standard graphical and a grayscale map. The mobile/tablet platform allows for taking measurements and marking portions of the viewed map, as well as options for printing, viewing different terrain

Table 4
Investigated municipal platforms (digital).

SN#	Investigated digital municipal platforms			Platform name
	Platform	Functional description [c]	Main users	
1	Strategic planning and management	It provides an annual, and monthly information about the holistic strategy areas of the municipality. It is a clear tool for analysis, planning, budgeting, reporting and business management and political integration for auditing (*Managing the execution of political follow-ups*).	Strategic management department, Municipal area leaders and their professional staff	*Framsikt* and *plandisc* ([9, 44])
2	Geographical information systems	Web-based mapping system with archive, for management of GIS data and other required duties for national services integrations, especially with the cadastral databases. As well as a platform that provides a complete solution for map management and geographical information systems, serving surveying, and planning functions.	Urban development and environment department	*Webinnsyn, Geoinnsyn, Terra Explorer* and *WinMap* ([36], Å. [27, 49])
3	Citizens' engagement, communication, culture and collaboration	Web-based initiative system that is managed by the municipality to organize communal and social activities (either voluntarily or entertainment).	Culture and citizenship department, external organizers	*Friskus* [21]
4	Municipal Archive – Basic case work / (building permits, health, other municipal areas)	A software that provides logging and storage as well as collaboration abilities to document municipal cases, mainly for building permits applications and more. Among other things, used for following up and evaluation (*e.g.* urban development). The frequent uses are: record keeping, archives, case processing meeting treatments and committee maters	Archive section in technology and innovation department, other related departments integration such as GIS, building and planning department, health, and other municipal arenas.	ACOS WebSak [3]
5	Quality insurance and auditing	Web-based repository, for knowledge collaboration and reporting by different municipal stakeholders to establish a data base for the forms and tasks required for municipal tasks processing. Furtherly, a tool for implementing risk assessments over the wide municipal areas.	Urban development and environment department, and almost all departments and municipal areas.	Compilo [19]
6	Knowledge sharing and knowledge workers development	Web-based platform for sharing, educating, standardizing forms and training staff, for the purpose of sharing the knowledge, on municipal works and tasks, among all municipal departments and areas.	Various departments, by Municipal employees	Compilo [19]
7	Human resources management (HRM)	personnel management includes a structured system for handling competence, employee interviews, CVs, handbooks, HSE, sickness, absence follow-up, resource planning, shift planning and payroll. That some of the platforms are integrated with the archive system, while others need to be.	HR Department	[57]GAT-VISMA, VISMA HRM, Web Recruiter – ACOS ([10]c, [11, 8])
8	Crisis management platform	A web-based crisis management system, that carries out risk analyzes, reporting locally, regionally, and nationally, organizing and reporting routine tasks, manages position-based warnings during incidents, for example during floods and natural disasters. Main functions include risk and vulnerability assessment, contingency planning, education and training on response, media handling for informing, evaluation and follow-up of incidents and crises.	Directorate of civil protection and emergency, in all county governance and Norwegian municipalities	DSB-CIM [18]
9	Procurement and purchasing	Various web-based platforms/solutions for tendering, depending on project scale a certain range is handled with invitation to tenderers. Managing vendors, suppliers, public purchases, and tenders in compliance to regulations that is either; local, national, and European regulations. Managing services hourly payments. Ordering and invoicing analyses. Where Doffin is the national public procurement database.	Procurement and purchasing department staff, cross departmental authority for purchases and procurement for approvals	MERCELL, Tendsign, Doffin, VISMA eHandle, VISMA Enterprise), and DVPro ([32, 55]), [1], 2021, [10])
10	Municipal website	Wide range of services, integration with citizens profile and local utilities companies for invoicing. News update and chat bot for collecting and filtering of citizens complains and queries. Information about municipal hierarchy, contacts of departmental staff and a channel for sharing public domain documents and reports by the municipality.	Municipal staff, citizens, communication department, departmental editors' staff in the municipality	Municipal website (Å. [26])
11	Enterprise system	A web-based system that handles, the municipal enterprise economy, HRM, business intelligence, invoicing and interdepartmental agreements and requests.	Varying information and access to different levels of municipal staff	VISMA Enterprise [56]
12	Intranet system	That is the internal web-based platform for sharing information, news within the municipality. Also, for	All staff	Share-point [34]

(continued on next page)

Table 4 (*continued*)

| SN# | Investigated digital municipal platforms | | | Platform name |
	Platform	Functional description [c]	Main users	
		routing to different services and managing employee related information.		
13	Communication and collaboration	Its multifaceted applications, used for email, meetings, automatic forms generation and routing (digitize workflow processes), partial integration with the archive system.	All staff	Office 365, Interact flow ([33, 7])
14	Facilities management platform	Combines several functions that serves municipal assets, facilities, properties, and their hard and soft management services, as well as projects and space management	different levels of municipal staff, real estate enterprise at the municipality	Main manager [2]

[c] Information collected from interviews, platforms providers websites and observation.

profiles in 2D contours and 3D world map explorer (limited to Norwegian data). The levels of details are schematic, an area for improvement could be through the use of drones to make reality mapping and improve the geometrical level of details of city components.

5.4.3 Citizens' engagement, communication, and collaboration

Citizens' platforms lack the holistic perspective, narrowing down to municipal services away from the national governance of services, the municipality website serves to have a profile for each inhabitant where bills from power and water companies are jointed, yet the citizens role in formulating public spaces and services is deemed absent in the making. A voluntarily website that is managed by the municipality is used arrange citizens activities and voluntary initiatives, but no crowdsourcing platform was made available. Where inhabitants would be able to conduct the following activities:

- Invest in innovative services and ideas.
- Participate in the decision making, and strategic formulation.
- Rating the municipal departments and services.
- Collaborating and communicating upon the emerging city development initiatives.
- Evaluate partnerships, suppliers, and vendors within the municipal service provision umbrella.

The municipality have different social media pages at different platforms, yet these pages are observed to be diffusing the knowledge rather than building up a unified platform, as an arena for collective, effective evaluation and feedback by citizens. A case for citizens lack of awareness is a car sharing platform that has been developed in cooperation with local bank and power company, the cars were distributed around specific locations where citizens and municipal staff can use for commutes, yet, the innovative solution was not communicated well to the public that it faced complaints on social media by citizens due to the municipal economic challenges; where the citizens seemed to be against it as it didn't meet their priority choice as a municipal investment.

5.4.5 Archive and building permits

The archive system seemed very promising this observed by fast review of the platform, where municipal cases and building permit orders are documented and followed up in a democratic process. The platform struggles with historical data that needs to be digitized to meet the scheme of the new solution adopted by the municipality after being merged from five municipalities into a new one. Furtherly, the process of the municipal approvals of building permits lacked serious digital transformation, it concludes a systematic process that links different levels in the municipal organization starting by political, through strategic, department heads, staff workers and citizens; yet the use of drones and robotic solutions for inspection and surveying is lacked and requires serious investments for improvement. Master plans of the municipality are based on a combination of digitized data and historical hand drafted

plans, the overlay of these plans should be transformed digitally to improve the unity of the solution. The platform is provided by a national private company that delivers maintenance, but the pace of development does not meet the strategic vision of the municipality of being digitally capable to coordinate and communicate effectively with high level of digital details and attributes. Rooms of improvement can be:

- Developing a unified database and identifying scalable set of attributes by the municipal departments.
- Linking add-ons and modules within a unified solution and interface.
- Improving the interface workflow, while customizing the visual interface for a well-studied hierarchy of municipal departments and their underlying staff.
- Linking the database with GIS capabilities, for effective visualization and collaboration.
- Providing a holistic user interface for time series and statistics upon departments progress and productivity, as well as number of processed tasks.

5.4.5 Quality insurance and auditing

A platform was adopted by a private company to solicit the municipal staff knowledge on performing their work tasks, aiming for a structured development of a quality standard for municipal work. The system has a well-structured hierarchy so that each worker can upload their forms and means of conduct in several areas, such as (not exhaustive): building permits, health, education, and finance. The system has been adopted in 2020 and until the time of this study the pace of contribution seemed to be slow and not encouraged. Thus, its recommended that the municipality establish a reward system for employees who contribute with the most optimal form of data and forms, in order to motivate and accelerate the knowledge base of the workers. This system serves to be of critical importance it is the secret recipe toward an effective and holistic digital transformation. Further, it serves department heads need for quality auditing of their staff output and provides an evident documentation for further development of their work processes.

5.4.6 Knowledge sharing and knowledge workers development

The national collaboration between different municipalities established a learning platform, where employees can develop their knowledge, understanding and skills on performing municipal tasks. The website materials are targeting employed staff in municipalities, volunteers, elected staff, temporary hires, apprentices, newly hired staff, and safety representatives. The themes serve topics of municipal administration, procurement, work environment etiquette and protocols, archive and authorization of works, different type of agreements, management of kindergartens and schools, welfare, property management, human resources management (HRM), purchasing, Innovation, culture, quality, infection control, security, professional certifications, health, languages use, politics, economy and more; being a resource for

individuals development and national unification of municipal learning and collaboration scheme of work processes and individuals personal and professional development. The website follows a roadmap starting from 2021 to first quarter of 2022, where the strategy aims to collect municipalities knowledge toward a single sign on (SSO) based learning scheme, and an application programming interface (API); combining collective municipal knowledge within a singular interface.

5.4.7 Human resources management

The investigated municipality has more than 6000 employees in different organizational functions, that aim to serve the public, and improve its service provision towards achieving smart services and analyses. The municipality has a system for managing employees' payroll, workhours logging and recruitment processes. Yet, there is a need to automate these processes in order to have data analyses that would lead to:

- Better job tasks design through detailed and active monitoring of knowledge workers conducts of work tasks.
- Create a strategic HR tool, that is visual, for employees' development based on detailed departmental needs; to collect data that is not limited to resignation rates, demographic challenges, and improve employees' welfare.
- Digitalizing the municipal structure and work processes, to centralize, integrate and unify the HR data structures and link it to departmental works progression.
- Registering qualifications data over the wide spectrum of municipal departments; this would improve the recruitment and selection processes.

There is also a platform that is web-based for recruitment processes and hiring, unification of these solutions would transform the HR databases and improve their work outputs and processes. There is a need to have a digitalized system for employees' development plan and assessment, especially on the use of existing and future platforms that are procured by different departments. HR data is being registered manually, thus, a SSO service integration would be a good solution for keeping record of employees' competency when joining the municipal organization from other organizations. Further, there is a need to develop specific HR key performance indicators (KPIs), not on the strategic level but in detail with respect to departmental needs), to evaluate and serve among other things, human resources maturity, recruitment demands and productivity.

5.4.8 Crisis management

Through investigation a platform for crisis reporting and management was identified, that is national rather than being acquired, developed by the case study municipality. The platform serves to coordinate operations emerging to fire, police, and health departments in times of catastrophic crises. Further, investigation of this platform is required, as in this study due to time frame set for it, it was a limitation to investigate it and meet its director related staff. Such study would surely provide a more detailed perspective that serves the transition toward a smart city, through integrated governance and digitalization, by integrating crisis management to municipal response in digital means. The platform functions serve carrying out risk analyzes, reporting locally, regionally, and nationally, logging events to ensure an updated situation, escalation of incidents to the right authorities, locally and nationally, automatically generate incident checklists, management of communication and media, and position-based warning during incidents, for example during floods and natural disasters. The case study municipality have had historical occurrences of landslides and fire incidents especially in communal households; an area that requires further research for effective monitoring and development.

5.4.9 Procurement and purchasing

Public procurement makes up about one third of the case study municipality's total budget. To manage the municipal procurement in line with the municipal vision, there must be a transparent means of conduct and information that is clearly conveyed for its citizens; this rises confidence in the municipal decisions and endeavors. It is therefore important that procurement processes and information are transparent and easily accessible. In order to realize this aim, purchase processes should take place digitally; unleashing citizens ability to verify its details. Procurement covers acquisition of goods, services, and projects by national organizations through contracting with public authorities and the private sector. Norway is a member of the European Economic Area (EEA), this membership allows implementation and inclusion by European Union (EU) organizations. Depending on the service value, the treatment and offering of the procurement tenders take place at different platforms. For example, for services that range from 100 K Norwegian Krone (NOK) to 1.3 M NOK does not require a public competitive offering of tenders. While depending on the sector service these ranges differ and may escalate to offering requirement on the European regional level. The platforms used for procurement vary depending on these requirements, where a solution is adopted by a private supplier to manage suppliers and vendors through a systematic procurement process. The platforms allow for contractual and framework agreements that differ in time based on the sector, usually for public sector, it is a four years frame agreements [31]. For general purchases that are lower than 100 K NOK, they are usually handled through regular spread sheets and automated workflow forms creating software, that is provided by both national and international suppliers. Yet, the solutions diffuse the data of projects, which sets a need to research a possible streamlined platform for managing all areas, to facilitate the digitalization of municipal procurements and automate its analyses and processes. The platform used for purchasing does not have a full integration with the archive system, a need addressed towards the unification of data as they are being filed manually into the archive system. Furtherly, the contract administration tool requires the following upgrades:

- Ability to have common frameworks and contracts registers.
- Ability to manage the life cycle of municipal contracts.
- Ability to log events and variations to agreements.
- Ability to categorize historical cost data for future tenders and projects forecasting and estimation.

5.4.10 Municipal website

The municipal website serves a wide range of services, through informing citizens, tourists, and residents with most updated news and holistic information about municipal services and policies. The information provided by the municipal website serves areas for kindergarten and school applications, culture sport and leisure, planning of buildings and property applications, road, water and sewage operations and reporting, healthcare help and emergencies support, taxation and business establishment services, social development, environmental and climate concerns and regulations, information about municipal structure, contact information of staff and policies, and updates about political system steering the municipal development and councils. Furtherly, calendar meetings of director staff for transparent and democratic resolution of communal proceedings. Recently, updates about COVID19 infection controls, rates, testing, and vaccination. The case study municipality is working the development of a data repository for allowing Application Programming Interface (API) integration, with future service providers to ensure a transparent and accurate, informed decision making for planning and strategic steering.

5.5 Norwegian municipalities: investment and development formats

Public-Private Partnerships (PPPs) is observed to be the format which will allow the municipality to procure long-term smart city services,

especially in collaboration with local and international private providers, to outsource and mitigate the risks of developing, financing, and managing infrastructure assets and platforms by themselves. As this would allow a better focus, while improving the economy of the case study municipality. There has to be an alignment between the public and private interests and institutional processes for long term service contracts. It requires hard focus within economic and political contexts to overcome the identified significant governance challenges in the municipality. Thus, the case study municipality created a physical platform for interaction between interested private local and international entities to foster a newer perspective for its future development and investment. Yet, it is evident that there is a lack of a platform for crowdfunding by the citizens, the availability of such platform would enable citizens to critically invest in their prioritized development areas within their community, or municipality. As illustrated in Table 5, 82% (9 out of 11 respondents) agreed on public-private partnerships being the driver for the municipal transformation towards realizing and maturing the smart sustainable city behavior. A respondent stated that "*The public should act private and the private should act public, in means of freeing the behavioral boundaries between both, through ensuring a corporate social responsibility (CSR)*".

The municipality have set goals to achieve better procurement strategy, these goals are:

Goal 1: The municipality shall organize itself, so that the adopted procurement strategy, is anchored within a unified framework for procurement works.

Goal 2: The procurement processes in the municipality must be transparent, digital and must be verifiable.

Goal 3: The procurement to the municipality must cover relevant needs and have the right quality.

Goal 4: The municipality shall contribute to innovation and regional market development.

Goal 5: Procurement for the municipality shall take care of social responsibility.

The municipal vision aims to drive a holistic planning of overall procurement activities, work strategically towards partnerships, strengthen regional development of businesses and innovations, and enlarge its capacity for strategic acquisition of products and services. The purchasing and procurement manager has the authority to set contracts and agreements on behalf of the councilor for all types of municipal procurement. Each municipal area manager has the sole responsibility to ensure a budgeted tendering offering prior for formulating purchasing agreements and contracts. The agreements represent a group of contracts that are provided by the same supplier.

6 Discussion and a proposed unified municipal platform

The case study municipality have been working extensively to adopt various solutions and meet national and international requirements. Furtherly, the joining of the surrounding 5 municipalities have set more challenges, on the municipality as an organization. It is evident that the municipality have made a holistic change management to its processes and departments through the creation of a new bigger municipality. Yet, there is a lot of developments needed on its digital governance, through the use of its existing platforms. There are variety of services that are offered to the public that are very diverse, that cannot be summed in this research, but it is on a continuous growth, but with economic restraints. Thus, there is a need to introduce new services and products, while avoiding overlapping initiatives by streamlining its processes and digital solutions. A joint governance platform would be a viable solution, to make the aspired digital transformation of its governance, increase collaboration and coordination between its departments; while provide a collective intelligence ability for the decision makers to foster strategies based on informed decision. The archive platform for example, lacks integration to old and historical data that is managed and viewed in another different simpler platform, that is in manual format, these

documents need to be digitized and transferred under one archive umbrella that links all departments all together. There is high potential of integrating new services especially in the GIS platform, but as informed that its potential is not fully utilized by other departments, there is a need to dictate each department needs and accustom a linked user interface to fit their requirements. Many systems are procured and have great potential with sophisticated integration, but the data flows need to be well structured, and modeled to increase their output benefits and quality use. This is serving the municipal development of a unified ecosystem for its platforms. There needs to be a link between the *business layer* and *application layer*, for realizing a unified and effective governance platform, while reducing and eliminating the digital divide among these platforms.

Fig. 4 illustrates the change behavior that must be taken by the case study municipality to achieve the unified municipal platform, linking various considerations, stakeholders, and aspects towards a smart sustainable city; by improving its enterprise behavior. The vision of development must start with assessing the "**as-is**" and driving a "**to-be**" state, through linking the municipal areas with a plethora of diffused platforms. The backbone of the behavior is dependent on cultural, social, and environmental aspects linked with technological advancements and solutions, driving a regulatory and legislative changes that should be incorporated in the strategic actions taken by the case study municipality.

The case study municipality is taking progressive steps in a fast pace, towards developing a mixed use of development and investments format. Especially, on the public-private partnerships, but it is evident that there is a lack of a platform for crowdfund investing, where the citizens feel more engaged with municipal development initiative decisions. Yet, the municipality have made different innovation investments to improve areas such as water treatment, and water supply networks monitoring and metering; but there is not yet a platform that is purposefully made available. The case study municipality has to develop a streamlined scheme of work indicators, especially on urban development where most of the data requires digitalization and automation for a seamless workflow. A probable innovative technological shift, in the municipal governance can be realized by adopting the proposed innovative construction of all platforms as illustrated in Fig. 5.

The proposed unified municipal framework comprises of a service layer (three main services, namely infrastructure as a service, open cloud as a service and platform as a service), a data collection layer (which is facilitated to withstand a repository of different spaces, namely: stakeholders space, physical devices space, regulatory and legislative space, micro space representing smaller entities of built assets, community space representing the collective data of a community within the municipality, *meso* space representing built environments that are of mid-scale such as universities, campuses, health hubs and shopping complexes. The data should cover local, national and international schemas; to facilitate APIs for data adoption and requisition. The application layer is represented by the municipal systems, which will represent the diversion of data under specific modules and models. The unified municipal platform shall comprise of a physical facility that enhances visual control and management and collaboration between the different municipal areas, as well as facilitate for different workplace

Table 5

Preferred ownership forms of Municipal investments and developments.

SN#	Focus areas for improving municipal governance		
	Focus area	Count [d]	Percentage
1	Public-private partnerships	9	82%
2	Public projects only	1	9%
3	Crowd-funding	0	0%
4	A good mix of these possibilities	1	9%

[d] Information collected from interviews, platforms providers websites and observation.

typologies and accessibility for different stakeholders other than the municipality. The proposed unified virtual and physical space for the municipality should be transformational in means of being a place for technocratic engagement of citizens and collaboration between departments. The unified platform will have an interface layer which will accommodate intelligent capabilities for decision makers as well as advanced visualization capabilities such as virtual reality to observe simulations and proposals of new development decisions. The interfaces will be accustomed to each departmental function for insights and reporting over three different typologies: strategic, tactical and operational. Each of the typologies will hold accustomed use cases and behaviors that will ease stakeholder accessibility to the same report without the need of rebuilding up the relations and connections of each case. The generated reports will then be standardized for public and political reviews. The system represents a horizontal flow, that allows interoperability between systems, where data will be the basis for the systems, and interfaces rather than having systems in place that require specific attributes of data. The difference is similar to a closed world where specific platforms control the behavior of the municipality, while the proposed unified platform represents an open world of data that fosters engagement from the private sector as well as citizens. The availability of the data repository, will enable innovations and increase transparency. The unified municipal platform is an enabler for

enterprise architects to foster unconventional solutions in less time. Further, the organizational agility will increase on a solid foundational basis, with future precise personalization capabilities. The unified platform approach should be used by different municipal typologies. This is to serve the main goal of unification which is sharing experiences and knowledge between cities. Further, it can be a sustainable facilitator for managing resources, such as assets and budgets among municipalities. As a start bigger municipality must drive the actions for implementation, then to be followed by smaller and less capable municipalities.

7 Conclusion

This research aimed to investigate the current practices on the use of municipal platforms. The case study municipality has novel strategic documentation and experienced professional staff, that are working effectively to transform the municipality services in alignment with the SDGs. Future research must continue to investigate the creation of a unified platform following the municipal hierarchy, and the use of IoT sensors to collect more reliable field data. The research aimed to answer four questions, namely: RQ1) What are the municipal measures to prioritize development investments upon smart city platforms?, RQ2) What platforms do a Norwegian municipality use for decision making
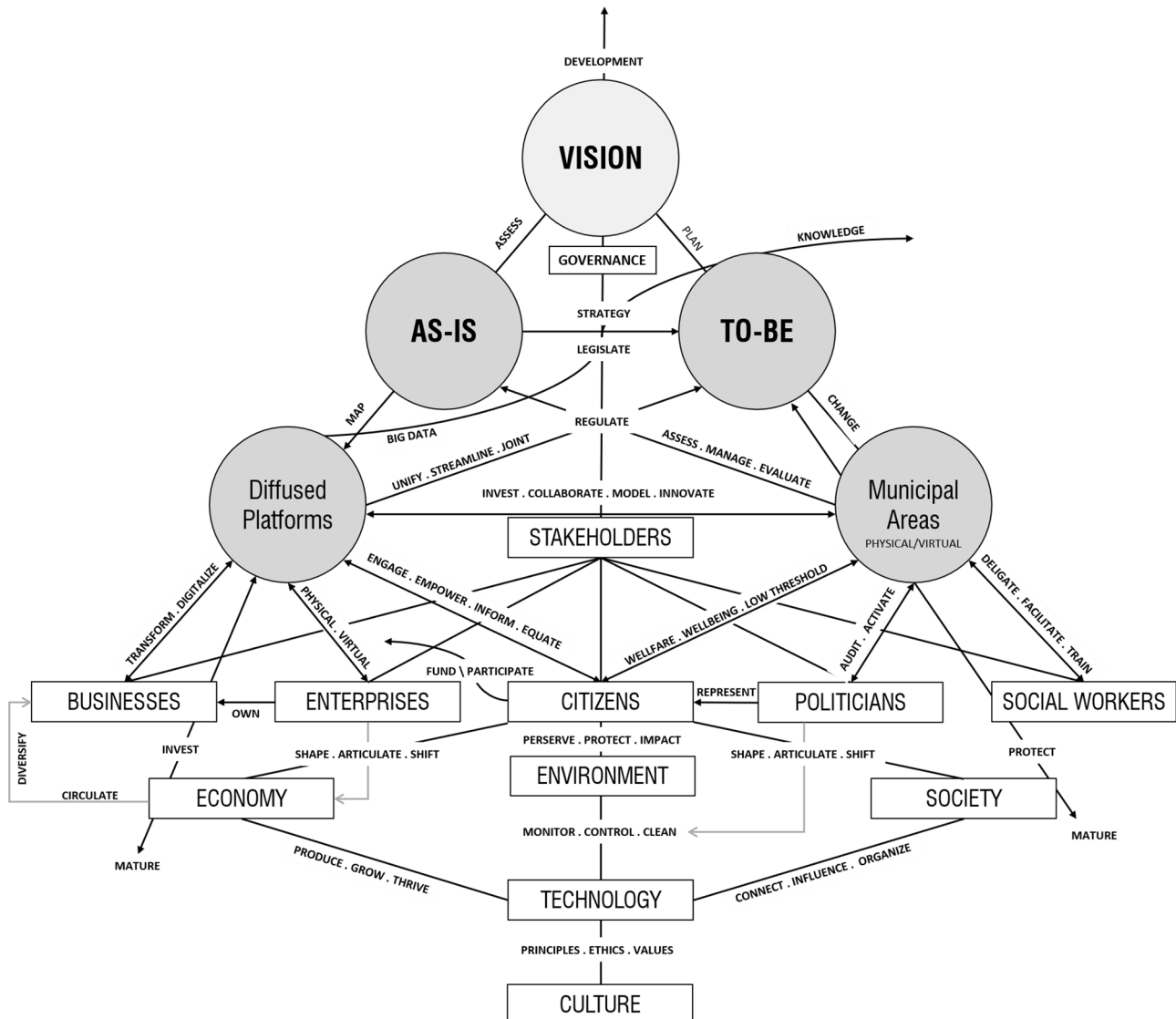

Fig. 4. Mapping the municipal behavior towards achieving a unified municipal platform.

(governance) and strategic development towards achieving a smart sustainable city?, 3) RQ3: What improvements can be made to develop an enhanced ecosystem, for the municipal platforms?, RQ4) What are the focus areas required to improve municipal performance and services? and in which ownership format?

Answering the research questions, the research introduced and discussed the investigated municipal platforms, realizing a behavioral map in formulating a digital transformation, serving a national and local need for a unified municipal platform (not a digital twin but a comprehensive governance solution; they can be integrated). The research study presented a background, a synthesized narrative review of the literature (on smart cities from different perspectives that are found to be aligned with the municipal organizational structure and behavior) and discussed several types of ownership formats. Furthermly, the methodology followed a systematic information system research approach towards investigating the municipal governance, in line with the SDGs perspective. The research incorporated interviews with 11 key stakeholders who are considered as subject matter experts, to investigate the used platforms, identifying a diffused occupation of solutions towards achieving a smart sustainable city. Moreover, the Norwegian model with national and international initiatives were described to ensure the holisticness of the investigation. The proposed mapping of a unified platform behavior aims to propose a solution where the case study municipality is facing economic challenges; this solution can be a cost saving over the long run while optimizing its service provision and maintainability of systems.

Furthermly, measures for improving municipal platforms were investigated quantitatively, to ensure an exploratory investigation of the municipal staff perspectives, further complimentary investigation would be applied on the case study municipality employees, to follow a synchronized *top-bottom* and *bottom-up* approaches. Digital transformation is identified to be the most important aspect towards improving the municipal governance, while a need for eliminating the digital divide in its platforms' adoption is needed (many of the platforms are well integrated already but others are not, thus a holistic remake would unleash a new seamless digital governance over the municipal work). The investigated platforms were discussed and tabulated, to introduce the diffusion in adoption of these systems, while referring to the stakeholders utilizing each. In addition, investment development formats were discussed accordingly to enable the creation of the unified municipal platform, through adopting an alignment between the public and private sectors. The digital transformation should incorporate the collaborative social character of work, empirical research plays a significant role in resonating the organizational settings of work, where developing a system requires a broader understanding of the workplace interactions rather than focusing on technological development solely [48]. Thus, the research findings were discussed and mapped for further future research, promoting the shared concept of municipal work.

Imagine the gains from realization of such unified platform enabling municipalities in Norway, to conduct their workflows and processes seamlessly with highest attention to its social workers' needs (through collaborative, dynamic and unique visualization capabilities), while engaging politicians and citizens towards a social democratic digital governance, formulating coordinated efforts towards an effective informed decision making with greatest attention to the SDGs in the making. A proposed action plan is to formulate a consortium of the platforms' service providers to initiate the realization of this solution. Furthermly, investigating the global applicability to utilize it as Platform as a service for municipalities world-wide through the UN and ITU.

Declaration of Competing Interest

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.
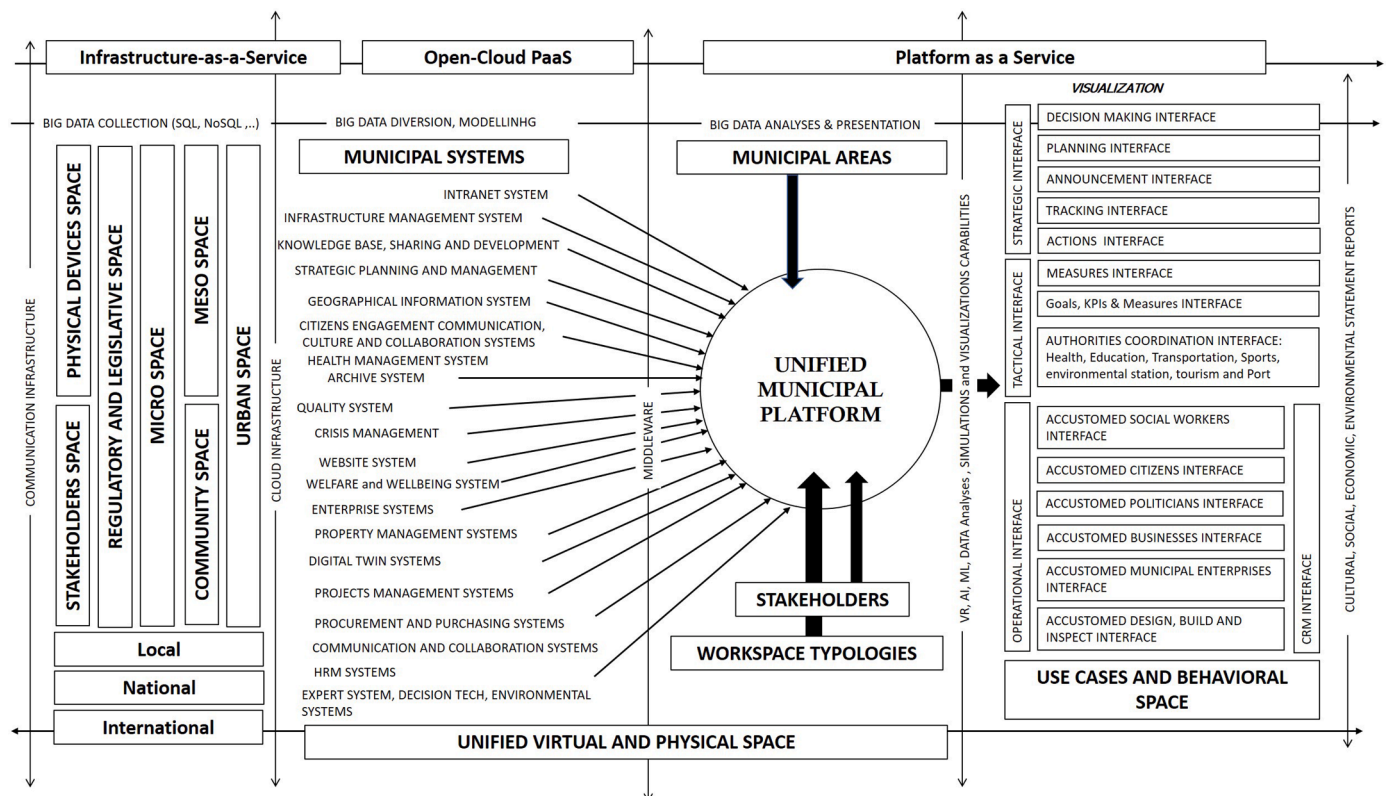

Fig. 5. A proposed unified municipal platform.

Acknowledgments

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