



A systematic approach to connected services in the urban environment¹

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Abstract

As the global trend of people moving into cities grows, local governments are evermore pressured to keep improving their services while serving a rising number of customers. The quality of life perceived by city dwellers, however, is influenced by a composition of all services they use, regardless of their public or private nature. Alternatively, residents judge cities based on a comprehensive experience. As such, private and public entities are jointly motivated to improve on this to retain and grow their customer base. Providing these services under a unified platform, moreover, may result in a consolidated cost of provision as well as higher revenue potential via cross- and upselling offers on personalised terms. Further on, it may enable cities to link discounted access to generally demanded or popular services to the utilisation of or preference for services with positive externalities for the public, in line with the city's strategy. In this article, the economic benefits of such a tight, so-called 'City as a Service' level of integration will be examined.

Keywords

Smart city, Public services, Service integration, City as a Service, Urban efficiency.

1. Introduction

Most services related to urban life have a high overlap in their customer base. In recent times, citizens could witness increased collaboration between providers, resulting in the integration of numerous such services. The basis of all this is that they know their users' habits and patterns of using their service and they are accounted for in data-based systems. Of course, this primarily requires users (residents) to opt into data sharing, but in most cases this is a prerequisite of service provision or taking advantage of benefits originating from higher levels of service integration.

¹ This work was published with the contribution of the National Data Economy Knowledge Centre. The research was funded and supported by Neumann Nonprofit Ltd. – National Data Economy Knowledge Centre.

This way, public utilities can be integrated with mobility services. Healthcare services can also be combined with sports services, or leisure services can form a unified service with programmes provided by public institutions. In this article, we cannot review all urban services for all potential integrations, but at the same time we would like to show how we can use interconnected services in a more customer-friendly and integrated way.

All this is increasingly desired by citizens who use the city's public services, as they also experience a high level of integration and better user experience of other, non-public, services, such as Uber² or N26³ and Lime. As such, urban service providers need to meet this emerging need.

Meanwhile, there is a globally trending concept commonly referred to as a smart city. It's a collective term for data collecting and processing solutions enabling data-based – sometimes in real/near time – decision making/support in an urban environment. In addition, due to rising living standards, an ever-greater number of people choose to drive, thus consuming more energy. As a result, a growing demand for services that reduce congestion and waiting times in both transport and municipal administration, as well as public healthcare is expected. Due to the overlap of beneficiaries of these services, their combined improvement may bring about efficiency gains on the provider side, while introducing otherwise non-feasible added value offerings for citizens. Therefore, the positive cross-sectoral externalities underline the importance of an ecosystem model.

The article is arranged as follows. After the introduction, the literature is presented in Chapter 2, followed by a description of the methodology in Chapter 3, in which we can also learn about the services. Chapter 4 shows the application of the methodology through a case study, leading up to Chapter 5, where the conclusions are drawn.

2. Literature review

Based on the criteria described, the design and implementation of the smart city concept has already started in many places. Major cities in developed regions have concluded that smart cities are the key to further development, while cities in developing regions considered smart cities as a chance to leap forward. In both cases this is urged by congestion, the general drive for sustainability and need to mitigate various economic and social problems. Evaluating and analysing the quality of services is a well-researched field of science in many cities and articles.

The concept of smart cities in practice focuses on urban transformation based on sustainability. Sustainability itself has been researched in many places, based on environmental (Goodland, 1995; Jacyna et al., 2015; Jacyna & Merkisz, 2015; Veleva et al., 2003), social (Olakitan, 2019; Rafiaani et al., 2018) and economic (Dabbous & Tarhini, 2019; Goerner et al., 2009) factors. Because every country and city can be described by their institutional as well as the respective dimensions above, smart cities need to consider and adhere to sustainability considerations.

Although quality has been defined in many ways over the years, it supplements sustainability with another layer of assessment of services in smart cities. Consequently, several studies have analysed them from a quality perspective. Their approach applied TCQSM (de Oña & de Oña, 2015), TQM, Lean, and Six Sigma (Näslund, 2008) to classify the characteristics of urban

² Lime And Uber Partnership Expands Into Europe. <https://www.li.me/blog/lime-uber-partnership-expands-in-to-europe>

³ Lime and N26 Partnership Encourages Riders To Move Freely, With Two Free Months of Lime Prime. <https://www.li.me/en-po/blog/lime-and-n26-continue-partnership>

services. Systems formalised by quality control concepts can also eliminate functional barriers and increase cross-functional processes.

If cross-sectoral projects and services are considered, integrated infrastructure management is justified not only by a general desire, but also by the scarcity of resources. (Scott & Pasqualetti, 2010). Efficiency is a fundamental interest and, in many cases, an elementary necessity. Water and electricity supply can also be made more efficient, which is not the main consideration in a non-environmentally conscious city. In addition to the scarce availability of resources, the rising cost of energy is a more important driver for more efficient operations. It has been shown in many European urban studies (Barraqué et al., 2011; Hillenbrand et al., 2008; Moss, 2008) that a decrease in the level of consumption also endangers the maintenance and modernisation of networks built in the 80-90s. The entire network was built due to the apparently ever-increasing demand induced by urbanisation. As a result, there have often been excessive developments. Nowadays, changing patterns and dispersing and atomising overall demand therefore require not only new technical solutions but also results in economic weakening.

Consequently, cross-sectoral projects and interactions should be sought not only because of the scarcity of resources and international trends, but mainly because of changes in the pattern of supply and demand. More research has been done on this and it is related to the ideas developed for rethinking urban infrastructure (Schöneich, 2012; Rutherford, 2014).

3. Methodology

3.1. Types of urban services

The range of urban services is wide, and these may be handled differently in different countries and cities. Often, a task considered to be of great public interest is not done by city or state-owned companies but by NGOs or other charitable organisations.

Therefore, this article is limited to services that appear on a daily or at most annual basis. These sectors can be distinguished between public services: (Table 1.)

- Utility services
- Transport services
- Support services and public healthcare
- Public institutions
- Sport and leisure services

Utility services:

Utility services include electricity, natural gas, district heating, district cooling, drinking water, wastewater, refuse collection and chimney sweeping. These are the most basic services that create and serve daily housing. Without the above, urban life could not be sustained.

Mobility services:

It is also essential to provide transport services to connect the labour force with employers via the most efficient commute possible for car owners and public transport users alike. It manifests in a wide variety of ways, ranging from the traditional trains, subways, trams and buses, all the way to new micro and shared mobility services, such as public bicycle systems e-scooters, e-bikes and e-mopeds. In addition, there are services for motorists, such as car-sharing, road maintenance and parking services.

Support and healthcare services:

This sector includes services that provide a healthy urban environment while also preventing potential public health emergencies. The following important services can be distinguished: mental health services, funeral service, emergency response, forest management, public building facility protection, Street cleansing and gas furnace maintenance.

Public institutions:

Public institutions host government services, libraries, museums, church services, cinemas, theatres, opera houses and public safety services.

Sport and leisure services:

It is necessary for the city to provide services not only for work, housing, transport and public affairs, but also for leisure and recreation purposes. The following services can be considered in this category: baths & spas swimming and sport facilities as well as cultural services, and public parks.

Table 1. Services and service sectors

Utility services	Mobility services	Support and healthcare services	Public institutions	Sport and leisure services
Electricity	Bus services	Public and mental health services	Government services	Baths, spas, swimming pools
Natural gas	Tram services	Funeral service	Library, museums, churches	Sport fields, sport tracks
District heating	Subway services	Emergency management	Cinema, theatre, opera	Public parks, recreation
District cooling	Train services	Forest protection	Public safety	
Drinking water	Ancillary mobility services (e.g., funicular, ships)	Public building, facility protection		
Waste collection	Public bike system	Street cleansing, maintenance		
Chimney sweeping	E-micromobility (e.g., e-scooter, e-bike, e-moped)			
	Car sharing			
	Taxi			
	Parking			

3.2. Integration of service providers

Although the services provided are in most cases separated to different legal entities provided backed by different service providers, sometimes they are very separate, but many times they are organized under a common group, in a holding company.

It can be said that the development of various smart cities is based on progress in the following important areas:

- Water
- Energy
- Waste
- Mobility
- Healthcare
- Economic Development and Housing
- Security
- Government
- Engagement and Community

Not only progress is important, but also the development of individual services and the creation of integration and service offer packages between companies.

Exploiting operational synergies between companies is very much needed, because exploiting the coordinated central coordination and internal service roles (logistics, finance, planning, HR, law, regulation, procurement, facility operation) and the additional benefits of economies of scale are basic interests. The synergies could give much more opportunity to companies which are operating separately and related only to the residents as the users. The sectoral division of the service is shown in Table 2.

Table 2. Service providers

Utility companies	Mobility companies	Support and Healthcare c.	Public institution c.	Leisure companies
Waste management c.	Bus service provider	Stormwater management c.	Municipalities, civil administration	Baths, spas maintainer c.
Electricity producer and supplier c.	Tram service provider	Disaster management c.	Entertainment facilities	Sport facility maintainer c.
Gas supplier	Subway service provider	Animal control service	Police	Leisure centres
Water treatment and distribution c.	Train service provider	Hospitals, health care facilities	Fire service	Urban gardener public c.
District heating supplier	Other service provider	Ambulance		Public area maintainer c.
District cooling supplier	Micro mobility provider	Burial office c.		
Sewerage c.	Car sharing c.	Forestry		
Chimney sweeping c.	Petrol station c.	Public cleanliness c.		
	Charging station c.	Road maintainer c.		
	Parking inspection c.			
	Road maintainer c.			

Searching synergies, several levels can be distinguished considering integration and cooperation. For simplicity, there are 3 levels:

0, None: Non-integrated, non-cooperating urban service providers.

1, Low: Some collaboration can be observed, but only based on individual interests, not providers operating in a united system.

2, Medium: Service providers appearing in a city service holding company in a common system, seeking cooperation in several projects, searching for common interests.

3, High: An urban service provider as part of a holding company, in which the divisions and sub-areas work closely together and also provide packages to citizens of different profiles.

Integration has not only a development trend, but also a sequence. Integration takes place within the different sectors (Utility, Mobility, Support and Healthcare) and then between the sectors. The greatest integration usually starts with the utility holding company. The largest and one of the most important integrations is when the utility provider merges with the urban transport management centre, including parking and all public transport actors, such as car sharing or micro mobility. (“c.” is an abbreviation of company)

3.3. User profiles

The services are used by a wide variety of people. For this reason, different companies distinguish customer personas and create customer profiles accordingly. This study acknowledges this differentiation and goes one step further, taking social status besides purchasing power into account, as it has a big impact on habits. To illustrate this, 12 examples of such personae have been created, however, this is not to claim that it is they are representative of any particular society. Nonetheless, the 12 example profiles below can show the different set of people with potentially different habits to be served by the same provider on a par when it comes to service level. These consumers are included in Table 3. With regard to annual income, London annual earnings data for 2020 were taken into account.

Table 3. Introduction of personae

Persona	No.	Name	Gender	Age	Profession	Marital status	Income per year	Children
Child	1	Sara	female	14	Student	Single	0	0
Student	2	John	male	21	Student	Single	0	0
Analyst	4	Dave	male	24	Data analyst	Single	25000	0
Designer	5	Selina	female	27	Graphic designer	Single	30000	0
Housewife	3	Maggie	female	37	Housewife	Married	10000	3
Manager	6	Mary	female	38	Manager accountant	Married	35000	1
Director	7	Brian	male	43	Marketing director	Single	80000	0
Banker	8	Justin	male	45	Businessman - finance	Divorced	70000	2
Bookkeeper	9	Teresa	female	57	Bookkeeper	Married	18000	4
Lawyer	10	Richard	male	65	Attorney	Married	100000	3
Pensioner - poor	11	Elisabeth	female	76	Retired administrator	Widowed	5000	3
Pensioner - rich	12	Charles	male	87	Retired salesman	Married	40000	2

There are big differences between different user profiles. The most basic reason for the differentiation is the age of the users, but there is a difference in the users' finances, namely their

monthly / annual income in GBP. Another important difference is their occupation, which also has a big impact on their incomes and opportunities. The number of children is also an important metric because it is projected onto people’s habits and opportunities. For example, a mother with small children cannot move and access services so easily, while a man who does not raise children can use more services. In this sense, even a person’s gender is an important datum, as along with their marital status and presence and age of children.

If the profiles are examined from an international point of view, there can certainly be profile shifts and changes between the users in different societies. Different social classes are likely to look different in other countries. Nevertheless, this article wants to point out how much correlation there can be between different unconnected services.

Considering the very important factors that change the habits, the services used were evaluated, which is shown in detail in the Table 4.

Table 4. Users and used services

Used services		Sara	John	Dave	Selina	Maggie	Mary	Brian	Justin	Teresa	Richard	Elisa	Charles
Utility companies	Water & energy supplier	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Water treatment and distribution c.	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	District heating/cooling supplier	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Waste management c.	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Chimney sweeping c.	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mobility companies	Public transport company (bus, tram, subway, train, other)	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No
	Micro mobility provider	Likely	Yes	Yes	Yes	No	No	Yes	No	No	No	No	No
	Car sharing c.	No	Yes	Yes	Yes	No	Yes	No	Yes	No	No	No	Yes
	Parking/road inspection c.	No	No	No	No	No	No	Yes	No	No	Yes	No	No
	Petrol/charging station c.	No	No	No	No	No	No	Yes	No	No	Yes	No	No
Support and Healthcare c.	Vis major management	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely
	Hospitals, health care facilities	Yes	Yes	Likely	Likely	Yes	Yes	Likely	No	Likely	No	Yes	Yes
	Animal control service	Likely	Likely	No	Yes	No	Likely	No	No	Yes	No	No	No
	Public/road/forest/air cleanliness c.	No	Yes	No	No	Likely	Likely	Yes	Likely	Yes	Yes	No	No
	Burial office c.	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No
Public institution c.	Municipalities, civil administration	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Entertainment facilities	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	No	No
	Emergency services (police, fire department)	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely
Leisure companies	Leisure centres	Yes	Yes	No	Yes	No	No	Yes	Yes	No	Likely	No	No
	Sport facility and spa/bath maintainer c.	Yes	Yes	No	No	No	No	Yes	No	No	No	No	No
	Urban garden and public area maintainer c.	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	No	No	Yes

Searching for positive effects among services

It is exactly known what kind of services different people use. Hence, it can be inferred what services people with a given user profile use on a regular basis. For this reason, different sectors interacting with each other can have a positive externality on each other's operation and service expansion, as well as on the development of services consumed by users.

The search for these potential positive cross effects and opportunities for cross-sectoral co-operation have also been carried out, which is shown in Table 5.

Table 5. Comparison of different services interacting with each other

Synergies /cross-sectoral utility		Utility companies	Mobility companies	Support and Healthcare c.	Public institution c.	Leisure companies
Utility companies	Water & energy supplier	Yes	Yes	No	Yes	Possible
	Water treatment and distribution c.	Yes	No	Possible	Yes	Possible
	District heating/cooling supplier	Yes	No	Possible	Yes	No
	Waste management c.	Yes	Possible	No	Yes	Possible
	Chimney sweeping c.	Possible	No	No	No	No
Mobility companies	Public transport company (bus, tram, subway, train, other)	Yes	Yes	Possible	Yes	Yes
	Micro mobility provider	Yes	Yes	Possible	Yes	Yes
	Car sharing c.	Yes	Yes	Possible	Yes	Yes
	Parking/road inspection c.	Possible	Yes	Yes	Yes	Yes
	Petrol/charging station c.	Yes	Yes	Possible	Yes	Yes
Support and Healthcare c.	Vis major management	Yes	Yes	Yes	Yes	Possible
	Hospitals, health care facilities	Yes	Yes	Yes	Possible	Possible
	Animal control service	No	Possible	Possible	Possible	Possible
	Public/road/forest/air cleanliness c.	Yes	Yes	Yes	No	Possible
	Burial office c.	No	Possible	Yes	Possible	Possible
Public institution c.	Municipalities, civil administration	Yes	Yes	Yes	Yes	Yes
	Entertainment facilities	Yes	No	Yes	Yes	Possible
	Emergency services (police, fire department)	Possible	Yes	Yes	Yes	Yes
Leisure companies	Leisure centres	Yes	Yes	Yes	Yes	Yes
	Sport facility and spa/bath maintainer c.	Yes	Possible	Yes	Yes	Yes
	Urban garden and public area maintainer c.	Yes	Possible	Yes	Possible	Possible

Positive incentives to counteract negative externalities

Many incentives and measures can be used to encourage people to change their habits towards an economically, socially and environmentally sustainable alternative. In the case of public utilities, the transition from natural gas to electricity can be encouraged, which can make our environment more sustainable in the long run, if we generate electricity from clean energies.

In the case of transport, support measures could be directed towards micro mobility. Although this isn't an alternative for everyone, using micro mobility services can speed up the daily commute for many people. This requires, however, to make micro mobility much cheaper and more accessible. Good practice for such an approach has been implemented in combination with public transport in Helsinki, Antwerp, Vienna and Munich. (e.g., Whim, Moovster applications)

Though not eliminating all cars from the streets, the number of parking spaces can be greatly reduced, especially in the densest part of the city centre, which can be transformed into a park or a smaller green area.

Personalised service packages.

There may be different examples on how to set up different service packages for people with different profiles.

Nowadays, car sharing services by energy service providers, fuel companies and car manufacturers are the most common, which is not just a simple service, but can be supplemented with discounts on energy/fuel consumption for the first two.

In the field of smart mobility, the definition and application of individual zones for monthly passes can be a solution (Szilassy et al., 2022), which was examined in an earlier study.

Considering public healthcare, the automatic and cloud storage of personal data and medical records can be a great option, but individual packages can also be created for sports and entertainment passes.

Result and discussion

Based on the above, there is great interoperability and common project opportunities between different public service sectors. Taking advantage of these is in the best interests of the various public service firms, because if they cannot do it then market players may come and do it for them. It may not be necessary for public utilities and the city government to implement every service in an integrated way, but there is a great opportunity for a city to embark on such a project and make the city more liveable, smarter and more integrated.

However, different personalities require different services, for which different packages can be put together. Compiling such packages is the responsibility of the service providers, which vary from country to country, from city to city.

Public utilities and transport, on the other hand, are permanent services that can be found in many cities and are mostly among the tasks of the city. The process of integration of these has already begun in many places.

In Copenhagen is called the integrative organisation as the Greater Copenhagen Utility. There is a Paris Board of Public Utilities in Paris, but most notably in the German-speaking area, the Stadtwerke (Municipal Utilities) system is widespread, with integrated utilities but, in many cases, urban mobility also. Such a system exists in Berlin, Munich and Vienna.

The Vienna example (Wiener Stadtwerke) is very progressive as it integrates the public utility system through energy, water supply to waste and district heating systems and network operators. Furthermore, the entire transport network and the parking system are integrated together also in the public space as well as car parking facilities. In addition, burial and maintenance of cemeteries as well as the entire IT infrastructure are included.

In total, there are several such forward-looking systems, which Budapest and Prague are trying to establish and introduce. Progress in service integration will be needed to provide an integrated service to cities.

Conclusion

In summary, finding and developing links and synergies between service integration and services is very important and inevitable. The basis of the future development is to identify the service

sectors, the clientele and, the level of integration. Furthermore, it is essential to see what kinds of people, citizens with a personal profile, use the services, and which services these people use and how often.

In addition to these, by finding synergies and benefits between sectors, packages can be put together in which city services can be used for everyone.

The research is recommended to everyone who wants to understand that many more services can be integrated, sold, and used, packaged with public services. They can be useful for city leaders, managers, and decision-makers of public utility service providers and urban transport companies.

In the future, the model can be further developed, many new areas can be included in addition to the above. Integration is a major step forward in most areas and can take place through the use of new technologies, e.g., in field of micro mobility, or even in the monitoring of the road network with sensors.

The hardest part of the whole integration is realizing what can be brought together and how the lives of individuals can be made more efficient and simpler in practice with these integrated services. In this sense, this article wanted to provide guidance for service integrators.

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