The Synergetic Smart City Framework — From Idea to Reality

BY VIKTOR WEBER

Underlying goal of this article is to highlight issues in current smart city approaches, find common success factors of established projects and to create a framework based on these findings, which should lay ground for future smart city concepts and research.

There are 31,700,000 results on Google if one searches for the keyword pair 'smart city' and our basic sentiment analysis indicates that the term has a positive connotation.[1, 2] This assumption can be fortified by analyzing a sample of 677 tweets, which had an aggregated reach of 2,868,453 and a 99.1 percent non-negative sentiment, consisting of 37.1 percent positive and 62.0 percent neutral sentiment.[3]

It seems that social media has this topic on its agenda, which is proven by 58,087 tweets using the hashtag #smartcity during a 30-day timespan. Compared to 1,322,482 tweets using #justinbieber in the same period of time, it becomes obvious that the smart city is still a niche topic.[4] Academia's interest is attested by more than 30,000 publications, which have the term 'smart city' in their title.[5]

There are numerous smart city projects around the globe and even large scale initiatives, such as the Smart City Challenge from the Indian government or developments from scratch like Songdo City in South Korea.[6, 7] Similarly, the European Union is subsidizing smart city projects with its own initiatives.[8] The absolute number of projects is growing and the global smart city market size is predicted to reach $88.7 billion by 2025, yet there are still few holistic approaches.[9]

So, why is it our envisioned smart city is drastically differing from the projects we have today, and that there is still not a common understanding of a smart city?[10]

WHAT IS A SMART CITY?

There are multiple approaches for the conceptualization regarding smart cities as well as the definition of such a city or even of smart systems. In order to omit further confusion and to lay ground for a future homogenous approach, it is deemed reasonable to use a definition aggregating the input of 116 varying definitions.[11]

> "A smart sustainable city is an innovative city that uses information and communication technologies and other means to improve quality of life, efficiency of urban operation and services with respect to economic, social, environmental and cultural aspects."[12]

Crucial components of this definition are information and improvement, which can be translated into learning. Unfortunately, smart is often a buzzword, which is used to advertise lighting systems, dash buttons or heat control systems among other similar applications. But in the wake of artificial intelligence, or, more precisely, supervised machine learning models, we have to think about learning when talking about smart. It should not be a static input-output function, but a dynamic, iterating and learning feedback system, which would be truly smart.[13]

Current applications often struggle to fulfill this criterion. Due to this fact, it is necessary to work out common issues in the creation as well as implementation of smart city projects.[14]

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Viktor Weber *is a pioneering expert and thought leader in technology induced real estate innovation. He is the founder and director of the Future Real Estate Institute, which researches about the impact of technologies such as artificial intelligence, blockchain, robotics and 3-D printing on the built environment and its business processes. He consults corporations regarding innovation strategies, implementation and innovation- & change management. Adding to this, Viktor Weber frequently publishes in international professional publications and is a conference speaker. Currently, among other things, Viktor Weber works on the usage of machine learning for commercial valuation. He is also co-founder of Lean Consultancy, which is specialized in Digital Transformation and Software Development. As Global Shaper of the World Economic Forum Global Shapers Munich he fights for education and integration.*

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SMART CITY CHALLENGES & ISSUES

Projects like Masdar City or Songdo City have been developed in a top-down approach which led to acceptance issues.[15] These acceptance issues could be traced back to a lack of transparency, communication and singular control by one entity.[16]

Another challenge for a smart city concept is the adequate usage of data.[17] Due to the massive amount of theoretically available data, its diversity and constant creation within a city, the criteria for big data are often fulfilled, which adds complexity.[18,19] Hence, there are multiple issues related to data, which consist of security, data quality, quantity and scalable processing or the creation of learning systems.[20] Privacy is an issue which severely impacts the acceptance and perception of citizens regarding a smart city project, which makes it a critical balancing act.[21]

The complexity is ever more increased by the financial costs, cross-department communication within cities, the creation of flat hierarchies, technological understanding, measurability of key performance indicators and the need for viable business models underlying each project.[22]

Thus, the following core issues for a smart city project were identified:

- (Big-) Data
- Top-Down Approach
- Focus on Technology
- High Up-Front Investment
- Lack of Citizen Engagement
- Lack of Benefit Measurability

In order to improve future smart city projects, it was deemed reasonable to conceptualise a framework with transparent steps that can counter some of the addressed problems and could potentially lead to more citizen engagement as well as a higher acceptance rate.

THE SYNERGETIC SMART CITY FRAMEWORK

Based on findings from academic as well as practical literature, the Future Real Estate Institute has conceptualized a preliminary framework for the planning as well as implementation of a smart city concept for already existing cities, which shall pose as a basis for discussion and future research.

The framework was broken down into ideation, research, planning, implementation and measuring (see Figure 1). Adding to this, a dynamic communication — feedback — loop was included in every phase, which should increase citizen engagement, transparency, understanding and long-term acceptance.[23]

The Synergetic Smart City Framework is inspired by the theories of design thinking and the lean startup, which translates into an extended pre-implementation phase and the continuous incorporation of feedback.[24, 25, 26]

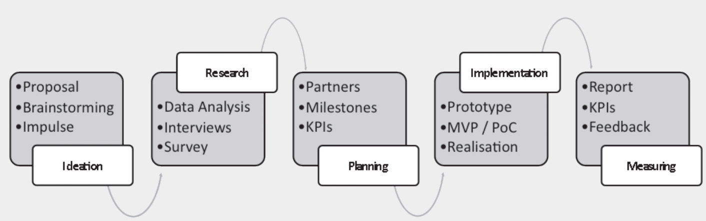
PHASE 1 — IDEATION

The ideation phase is initiating a smart city project and is the only part of the Synergetic Smart City Framework that is not fully transparent, since the communication — feedback — loop is restricted to impulse — provider and governmental entity.

Step 1 — Impulse

The first step of the Synergetic Smart City Framework

Figure 1
Figure 1: Synergetic Smart City Framework –
From Idea to Reality (Source: Own)



Source: Own

is the impulse, which has to come either from a governmental entity or an external impulse-provider, such as academia, a startup, a corporation, the civic society or an individual.

Step 2 — Brainstorming

Similar to a design thinking process, it is advised that the impulse-provider brainstorms together with governmental decision makers about the potential outlines, goals, resources and already existing projects, which would impact the smart city project.[27, 28] Already existing ideas from the impulse-provider should be presented and analyzed according to feasibility and practicability.

In this step, current problems and future challenges have to be assessed provisorily, in order to formulate an adequate proposal.

Step 3 — Proposal

Depending on the legislation, a smart city project has to be tendered or funding has to be secured, which makes an initial proposal necessary.[29] The city's government has to make this step on its own and lay ground for a smart city project by asking for funding or directly issuing a call for proposals.

It should be communicated that any partner has to act according to the Synergetic Smart City Framework, which could ensure transparency and citizen engagement.

After the tender, one individual (entity) should take the lead for the next phase 'Research & Analysis.'

PHASE 2 — RESEARCH & ANALYSIS

In order to increase granularity, a mixed-method approach is recommended, which can help understand already identified issues, reveal upcoming challenges, stakeholder sentiment and foster ideas for a holistic concept.[30] Preliminary research objectives should be defined, which would translate into the research's scale. Among the research objectives should be to understand what the current 'pains' of the inhabitants are, how they perceive their city, what they understand of a smart city and what they wish for their city's future.

The entire raw data, as well as findings, should be made accessible in an open data platform, which could positively affect acceptance and increase transparency, while providing researchers or interested individuals with appropriate data-sets for their own research.[31]

Step 4 — Data Analysis

Before commencing the first interviews, a systematic literature review of academic as well as practical publications should be conducted in order to inform the question guide for the interview and the survey.[32, 33] The acquisition of large amounts of relevant textual data could be enhanced by the usage of a web scraping tool, working through relevant databases.[34]

In order to accelerate the process and increase granularity, it might be advised, dependent on the research goals and resources, to automate text analytics, using natural language processing artificial intelligence.[35]

Step 5 — Interviews

As part of a qualitative, grounded theory approach it is advised to conduct semi-structured, one-to-one, indepth expert informant interviews.[36]

The interviews should be conducted with samples of all city stakeholders, which we divide into permanent inhabitants, temporarily inhabitants (commuters, tourists, refugees), employees of the city administration and public utilities, academia, corporations, startup entrepreneurs, politicians and non-governmental organizations. Yet, the sample size and level of saturation is dependent on the scale of the project.

Step 6 — Survey & Report

Based on the findings from data analysis, as well as interviews, a survey should be designed. Depending on the project's scale and previous findings, it could be adequate to use Likert scales as well as open-ended questions.[37] The survey should be conducted online as well as offline with a similarly distributed sample as in Step 5, yet with a larger sample size.

The findings should be aggregated and presented in a report and the raw data shared in an open access database similar to databases of New York City or Chicago.[38, 39]

PHASE 3 — PLANNING

Based on the research, objectives should be formulated and transparently communicated. We propose an open approach, which would share the planning process in real time with the city's inhabitants via the city's website and/or app, which should also aggregate all other services in one application. Using such a transparent approach, citizens could directly comment on the planning process or vote for/down certain proposals, which could accelerate the process, foster engagement, reduce resentments and increase understanding.[40]

Step 7 — Key Performance Indicators (KPIs)

KPIs have to be set according to the varying objectives, yet could also be adopted from standards such as ISO 37120:2014 or based on the Gross Social Feel-Good index as proposed by Hara et al (2016).[41, 42] Adding to result oriented KPIs, as with the previously mentioned metrics, it is important to measure the interest, engagement, sentiment and acceptance during the entire ideation, planning and implementation process, which requires a different, individual set of KPIs.

Step 8 — Milestones

Each objective has to be broken down into feasible milestones, which can be measured and calculated. The sentiment measurements during the planning process indicate how to break down the long-term objective. Thereby, the project would not overwhelm the city's stakeholders, but allow time for adaptation, trials and constructive feedback.

Step 9 — Partnerships

Concomitant, it is vital to build strong partnerships between the city's stakeholders and to find suitable external partners that are capable of realizing the project's milestones.[43] Depending on the legislation, calls for offers and a bid process could be required, similar to Step 3.

PHASE 4 — IMPLEMENTATION

The first significant milestone should be the creation of a centralized communication tool about the smart city project. This should be a website, which includes the city's previous web-services, an open innovation tool where citizen can post their ideas and vote, an open data library and our proposed open planning tool.[44]

Step 10 — Prototyping

Since one critical issue of smart city projects is cost, it is recommended to include a prototyping stage into the implementation phase.[45] A prototype could be digital mock-up, a presentation, demo-video or a virtual reality experience, which would foster feedback, test for feasibility and create a first proof of concept.

Depending on virtual reality solutions availability, adequate data, intelligent simulation models and budget, the various milestones of the holistic concept could be tested within a virtual reality environment.[46]

Step 11 — Minimum Viable Product & Proof of Concept

A minimum viable product (MVP) could be the basic implementation of a first milestone for a partial plan that should produce real-life data on usage, interaction and create a proof of concept.[47]

In case of the smart city project website, the MVP could be the open planning tool, which could be added to the regular website with basic functionalities and advertised in the local media in order to measure interest and engagement.

Test results should be measured and shared with the public, which would enhance the learning curve of other smart city projects as well as the quality of academic research.[48]

Step 12 — Realization & Scaling

If the proof of concept was positive and the generated feedback analyzed, the scaling stage within the implementation phase should commence. Scaling should be based on inhabitants' preferences, which could be expressed in a voting process. This would increase acceptance, since it is evident that large parts of society do not have a clear vision regarding a smart city and see technological penetration in a city skeptically.[49]

The realization of milestones is always dependent on generated data and feedback, which might make it necessary to go back to previous phases/steps of the Synergetic Smart City Framework.

PHASE 5 — MEASUREMENT

Measurement should include e-service analytics, sensory data from connected devices, analysis of feedback, relevant city data from the socio–and eco-sphere as well as economic data. [50, 51, 52] It is vital to measure sentiment of the city's inhabitants in order to see if there are issues arising which could then be addressed.[53]

Due to the fact, that the communication — feedback — loop is part of every step, measurement in Phase 5 rather describes the final results after a long period of iteration and multiple learning cycles.

Step 13 — Key Performance Indicators

Measurability of key performance indicators and comparability against other projects are an important aspect of constructive feedback and learning, which is why it is advised to incorporate a standardized documentation, tracking and measuring system. Adding to individually designed metrics, it seems reasonable to use the standardized 'Indicators for City Services and Quality of Life' — ISO 37120:2014, which enhances comparability between cities and smart city projects.[54] These ISO standards help to quantify, in a standardized manner, parameters addressing the economy, education, telecommunication and governance as well as other major components influencing the quality of life and sustainability in a city. Step 13 can be seen as a more diligent, in-depth analysis, compared to the constant measurements as described in Step 7.

Step 14 — Feedback

Even though the Synergetic Smart City Framework uses feedback at every step, a concluding feedback phase should be included in order to aggregate and analyze the entire project laying ground for future projects and knowledge-creation.

Step 15 — Report

Crucial for the process is to summarize the data, findings, feedback and results, which should be communicated in an understandable report. The city's stakeholder should be able to comprehend what the project has done for them by elaborating the cost vs. profit structure as well as non-monetary benefits.

Each report should be written as a case study in order to enhance learning for future smart city projects.

CONCLUSION & RECOMMENDATION

Cities are complex systems, which make an implementation process of a new concept highly complicated and its success likelihood dependent on multiple parameters, which are not fully understood.[55, 56] Yet there are certain known covariates such as stakeholder involvement, resource availability, implementation in a holistic approach, transparency, usage of data and strong partners, which is why the Synergetic Smart City Framework has aimed to incorporate each known success factor into the concept.[57, 58]

By including a large scale research phase with input from all stakeholders, the framework helps to avoid a mere focus on technology, since the ideas, wishes and thoughts of all stakeholders are heard, which will help to increase the acceptance of the project.

Issues such as low citizen involvement and low acceptance could be avoided by extensive feedback from city stakeholders at every step of the Synergetic Smart City Framework.

The reporting phase, combined with the aggregated data from each feedback step, lays ground for data mining, which can help to create inferences for future models and smart city concepts.

One limitation of the model is that the issue regarding adequate investment has to be treated as an external factor, which is still decided in a top-down approach, depending on the city's government, except a smart city project is crowdfunded, which might be an option in the future.

In order to avoid transparency issues, data security breaches and more intense governmental control based on personal data, the Future Real Estate Institute proposes that the entire data flow and analytics be anonymized, encrypted and stored within a distributed database/blockchain.[59] This anonymous 'citizen-print' could be stored using the Ethereum blockchain, which was analyzed in a study regarding the storage of electronic health records.[60]

By pursuing the Synergetic Smart City Framework, with its intrinsic openness, transparency, engagement and data anonymity, it is aimed for an enhanced innovation adaptation, increased learning, fewer resentments and the creation of synergies between all stakeholders.

This approach has to be tested in an implementation process, which would be a goal for future research. Furthermore, it is deemed necessary to collect more standardized data about currently existing smart city projects, including their citizen feedback, which could be used to find more issues as well as success factors. Adding to this, it might be possible to create weights for each success-predictor, quantifying a smart city framework in future research. ■

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