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学位論文（　　2021　年度）

論文題名

Automotive-Driven City of Smartness: Study of Compatibility Between Toyota's Woven City and Its Current Business Model.

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（論文題名）

Automotive-Driven City of Smartness: Study of Compatibility Between Toyota's Woven City and Its Current Business Model.

（内容の要旨）

This paper discusses smart city projects driven by Toyota, and its stakeholders by citing typology of smart city, and its application.

To begin with, it explains why the concept of "smart city" is gaining momentum towards global trends by enumerating several factors that back up its popularity. For example, environmental warnings propagated by national to local publicities heighten our literacy about environmental issues that have raised global awareness. Also, incremental world population and its geographic imbalance make life, especially the one in city areas harder to sustain. Moreover, lifted the quality of life including extended life expectancy, and advanced health care services necessitate more optimized lifestyles.

Secondly, to understand what a smart city is, it explores a multitude of definitions, coined by international organizations, and literature reviews. And then it squeezes common factors among them.

Thirdly it introduces specific cases of smart city projects grouped into the following fours; corporate smart city, sponsored smart city, resilient smart city, and commons-based smart city according to a taxonomy of smart city project. Based on the abovementioned taxonomy, the paper then analogizes the strengths and weaknesses of Toyota's in-progress project from several points of view.
Since Woven city does not place local or municipal government those functions as a gateway to public opinion, oftentimes regarded as a significant key for human-centered cities at the center of its project, this formation could lead to negative results.

Finally, it refers to 3 risks of innovation, and applies them to Woven city. Based on the frameworks, the paper concludes that excluding public sectors alleviate co-innovation risks since the number of players in the projects is decreased. Meanwhile doing so obscures the real needs of its residency. Hence, Toyota's case might face less accessibility to public opinions that function as a bridge between businesses and true needs. Plus, this private-driven approach could generate internal conflicts of interests among its stakeholders because there's no coordinator inside.

Contents

1. Introduction

1.1 Purpose of this paper

This study assesses the ongoing smart city projects of Toyota's Woven city, by borrowing frameworks drawn by previous research and literatures, to find potential challenges that Woven City might face in certain phase of its execution. Smart cities tend to be highly praised by media introducing up-to-date technologies when this project is underway. Actually many smart city projects are in general surrounded by myriad of difficulties and uncertainties. As criticized by Gaffney (2016), for instance, problems of the smart city in Rio De Janeiro surfaced at later stages or even after its completion. To prevent these completion from going south, solid perspectives in order to fairly appraise smart cities are needed.

Smart City as academic fields are being immature because it covers complex, interdisciplinary aspects that make it harder to decide what to conduct research . The research paper about this topic tends to be more mono-dimensional, focusing on technology, governance, urban planning etc. Although each research paper contributes to this academic fields, those hardly explain what smart city as a whole is. This research on the other hand, tries to explain about smart cities more wholistically and potentially provide a suitable perspective of how to comprehensively examine smart city projects based on public-private balance, technological controls, end-users' perspectives, rather than adopting technological aspects.

1.2 Background

Internationally, the growing concerns about the planet we live in are gaining momentum, thanks to a multitude of programs by international to local organizations, and passionate

activists like Greta Thunberg, a 19-year-old Swedish leader. One of the most successful campaigns is “Sustainable Development Goals” (SDGs), adopted in 2015, and disseminated by United Nations. This colorful framework (see picture 1) has 17 goals and 169 targets that comprehend ubiquitously social issues, and each goal is expected to be accomplished by 2030, calling for efforts from nation-leveled governments to individuals. The followings are a part of the reasons why human beings necessitate the achievement of sustainability goals. This is also why the smart city is gaining popularity.

Picture 1. UN Sustainable Development Goals. https://www.unicef.org/georgia/sustainable-development-goals

1.2.1 Growing concern for environment

By human activities, we were estimated to let go of 34.81 billion tons of carbon dioxide into the atmosphere in 2020, which was 1.37 times higher than the amounts emitted in 2000, according to Global Carbon Project (see Table 1). These tremendous amounts are owing to burning fossil fuels or decaying vegetation (Greicius 2020). Since the Industrial Revolution dramatically modernized our lifestyles, human beings have begun consuming these materials

and put tons Co2 into the air. The Co2 is said to be a cause of increment temperature, and this phenomenon alters the relationships between biodiversity and ecosystem functioning that we must rely on in order to survive. (Garcia 2018)

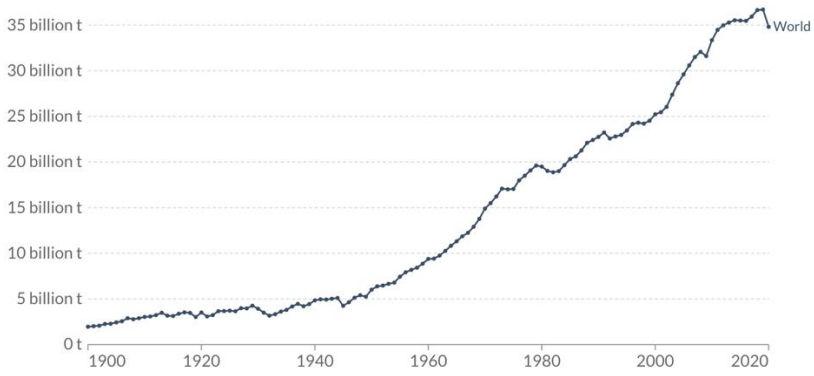


Table 1. Hannah.R, Max.R.CO2 emissions. https://ourworldindata.org/co2-emissions

1.2.2 Population Trajectory in the world

United Nations project that the world population will reach 10.9 billion by 2100, although its annual growth rate has been gradually decelerating (see Table 2). Iinterestingly, the greater number of people are flowing into urban areas. UN World Urbanization Prospects expect that 6.46 billion people will habituate in cities, of the 9.7 billion people in the world around 2050 (see Table 3). Future population sprawling observed in cities will eat up natural resources, causing serious environmental issues, such as water shortage, energy shortage, loss of green and natural spaces, air, traffic, noise, etc. (Ksenija, 2021).

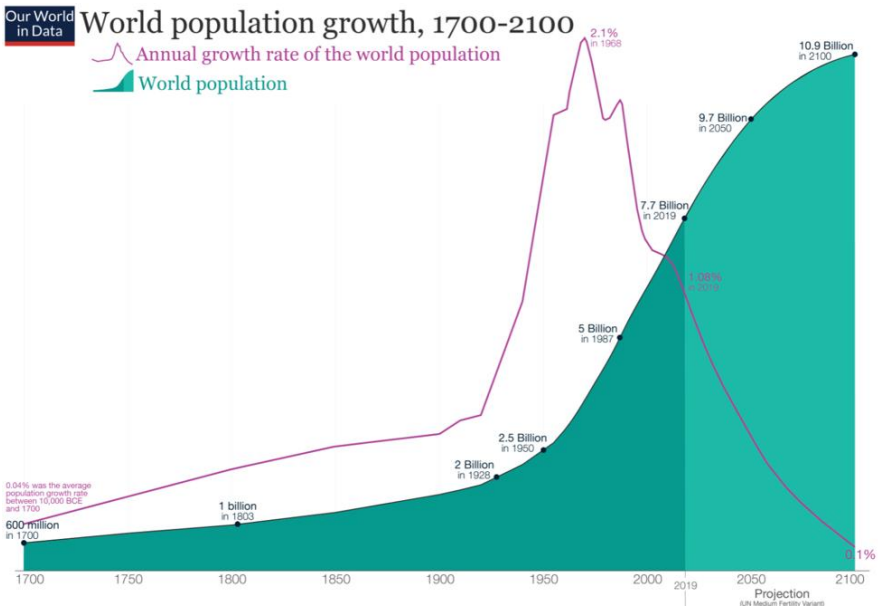


Table 2. Max.R(2019) Future Population Growth. https://ourworldindata.org/future-population-growth

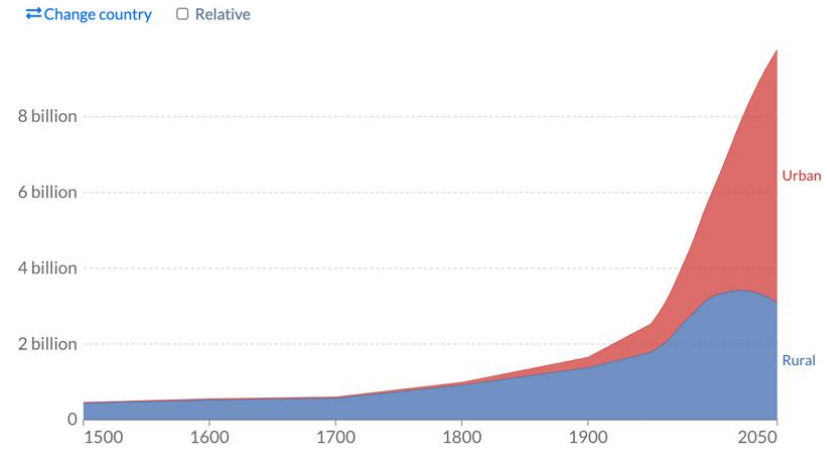


Table 3. UN World Urbanization Prospects (2018) The total urban population https://ourworldindata.org/grapher/urban-and-rural-population-stacked?country=~OWID_WRL

1.2.3 Sustainability of City Operations

1.3 Technology Advancement

To solve the serious issues surrounding us, the futuristic lifestyles have to utilize technologies as their means.

1.3.1 Mobility as a service (MaaS)

In general, Mobility as a Service is an all-in-one service that allows users to plan, book, pay, and evaluate combination of mobility services through software. (Smith, Goran 2019) The concept is often juxtaposed with owning personal cars. According to Deloitte, “The goal of MaaS is to make it convenient for users to get around so that they opt to give up their personal vehicles for city commuting, not because they’re forced to do so, but because the alternative is more appealing.” Transportation, like Netflix that has dramatically changed the way people access media, is at a turning point with mobility as a service.

Historically, the concept of MaaS was at first not called as MaaS, but was introduced as “intelligent information assistant” at a conference, in Innsbruck, Austria, called ENTER in1996 (Wikipedia). Tschanz and Hans-Dieter Zimmermann had already envisioned the platform service that could integrate multiple services covering whole traveling.

In Japan, “MaaS” in the Nihon Keizai newspaper database first appeared on November 20, 2017. The headline was "MaaS, a revolution of transportation services". The number of articles with MaaS since then has increased to 106 by 2019.

Whim, Finnish MaaS organization introduces the beginning of its concept that Sampo Hietanen revised in 2006. He later became a CEO of a non-profit corporate of intelligent traffic and presented his keynote speech at the Science Centre. He finally revealed the concept as MaaS at the Finnish Science Centre Heureka on December 2014 (Intertraffic). Today, rising stars such as BlablaCar, Uber, and UbiGo have emerged and developed the concept of MaaS into our future practice.

Mobility means the freedom to move by means of transportation, and in the world of as-a-service, users don't own the assets, but they are allowed to access the transportation service on demand, which implies using your own car is not necessarily the best choice, but that you can get to your destination faster, cheaper, and safer by combining various modes of transportation (Nakamura et.al, 2019).

1.3.2 Connected, Autonomous, Sharing, Electric (CASE)

CASE is on the other hand, a manufacturer-driven concept coined by Daimler in 2016. C stands for "connecting" cars to the outside world via the Internet. A is automated driving that assist drivers or even dispense manpower. S means a variety of services, especially sharing services of mobility, and E stands for electrics that are transitioned from traditional gas-engine cars. From the standpoint of the personal car, MaaS seeks decrease of private cars to reduce traffic jams, air pollution, and sumptuous energy consumption. The car companies that initiate the technology are thinking of their business of selling private car as its ever-changing core. In this sense, a "car reduction" in MaaS versus a "car promotion" in CASE relation arises.

However, as Nakamura et.al mention that “MAAS is no seekers to eradicate traditional business model of car industry, it is a suggestion that there are more convenient ways to use the car”. On the other hand, CASE creates the world that “unused cars in parking lots can be effectively utilized through sharing, accidents and traffic congestion can be reduced through automated driving, and electric vehicles can reduce carbon emission” Nakamura et.al, (2019). In other words, from the standpoint of "eliminating waste," MaaS

and CASE are looking in the same direction, and the latest technologies of CASE will support MaaS.

2. What is "Smart City"?

Most importantly, smart city has no sole definition since the goals of the cities and input to achieve them are varied. However, smart city is not freely randomized phenomena seen around the world. Here This paper introduces some notable definitions coined by internationally authorized organizations with different levels and academic fields on smart city, and then it summarizes what the smart city is.

2.1. Definition by International Organizations

UNECE (United Nations Economic Commission for Europe) introduces its concept as follows.

> A smart sustainable city is an innovative city that uses ICTs and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects.

On the other hand, Cisco Systems that has taken on many smart city projects as a key technological player, providing comprehensive packages of cutting-edge technologies defined the city as follows.

> A smart city uses digital technology to connect, protect, and enhance the lives of citizens. IoT sensors, video cameras, social media, and other inputs act as a nervous system, providing the city operator and citizens with constant feedback so they can make informed decisions.

As seen above, smart city is smarter compared with traditional cities because of installation of state-of-the-art inputs that help the cities optimize their operations. Not only does they enhance quality of life, smart cities also positively stimulate industries, preserve environments, and cultures. Since smart city covers a wide range of aspects, there's no wonder that the definition tends to be vague and to be dispersed. Regarding the aforementioned concepts, while United Nations focus more on the goals of smart cities, Cisco puts an emphasis on technological efficacy.

2.2. Definition by academia

Although this technologically modern cities cannot finalize a fixed framework due to the reasons mentioned in the previous section, many researchers are tackling the definition problem so that they establish solid basement of this emerging academic field. Here are the couple of definitions and frameworks developed by past research.

Yigitcanlar(2018), by examining literature reviews via an university database, reveals key inputs and outcomes associated with smart city's definition in order to redefine the concept. The author claims that, smart cities emphasize not only technologies, but also communities and policies as equally important drivers, "The inner middle-ring (see picture2) is allocated to the key smart city drivers (process)—i.e., 'community', 'technology', 'policy'. In the inner-ring '(smart) city' is located as the key asset (input) ". The combination between inputs and the city as an asset leads itself to accomplish five ideal goals: productivity, sustainability, accessibility, wellbeing, livability, and governance. These outcomes eventually make huge differences, especially in four domains, economy, society, environment, and governance.

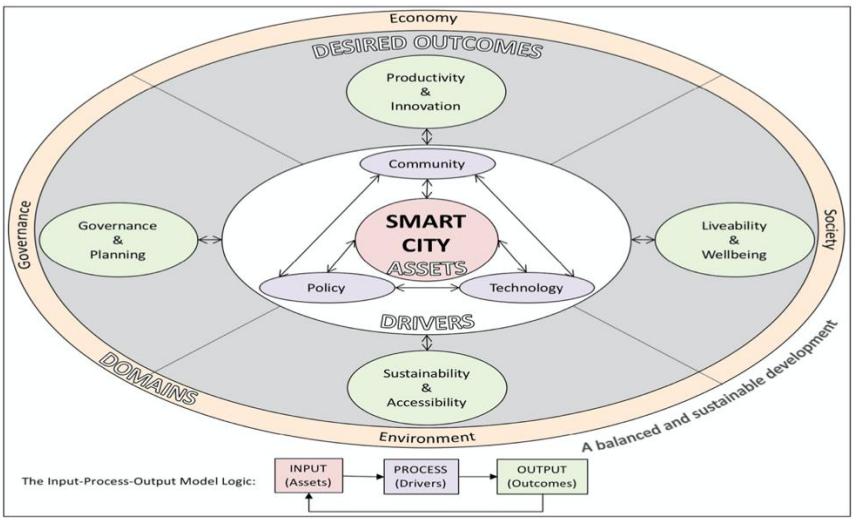


Fig. 1. Multidimensional smart city framework.

Picture 2 Yigitcanlar, T.(2018) Understanding 'smart cities': Intertwining development drivers with desired outcomes in a multidimensional framework

This is such an extraordinary statement in that they warn side effects of delaying complete conceptualization because the complete definition also plays a role in guiding investment to specific fields. For instance, Cisco, as seen previously, underlines the technological aspects whereas the United Nations mildly summarizes technological inputs as ICTs in a single word and keep a room for other means. Hence the blueprints drawn by Cisco, for example, are assumed to be more technocentric than the ones by international organizations.

2.3. Definition by smart city (Morningstar, 2021)

One of the notable definitions by smart cities is the one by Zurich. The followings are what it depicts as an ideal city.

> "Smart" means networking people, organizations, or infastructures so that social, ecological, or economic added value is created. The Smart City Zurich strategy forms a

framework to optimize the opportunities offered by digital transformation. The intelligent networking of data, sensors, and applications new and more efficient solutions for users. The more vital networking promotes contact between the population and the administration. In such a way, the strategy extends the networking of politics, business, science, culture, and society for all. There are the following goals:

- Equal opportunities and high quality of life for everyone. Smart City Zurich actively involves the entire population, including everyone who lives, works, or visits the city of Zurich.
- Conservation of resources and sustainable development: The city of Zurich is using the digital transformation to improve environmental quality and to achieve the 2000 watt society.
- Innovation and an attractive business location: Zurich promotes a modern digital infrastructure and attractive framework conditions for innovative entrepreneurship.

2.4. Common factors of smart city

Based on these varied levels of organizations, smart city is a city of tomorrow fully equipped with latest technologies that optimize decision-making processes through data collection from devices. However, what they see as definition are different for the following reasons. The smart city from the point of technological corporations, is different from traditional cities, in terms of what they have, technologies, whereas, the smart city from the perspective of others are the city that technologies catalyzes traditional inputs, and turn the whole city into a better, new place for people, which is seen as more goal oriented. Hence, what they see is basically identical, but why they tell us differently, comes from positions they are situated.

3. Categorization of smart city project

As mentioned previously, smart city has so many shapes and types that swell the vague definitions that mislead the stakeholders. For this reason, this field needs solid criteria. The wider the framework covers range of smart cities in response to needs of local citizens and to capabilities of participants, the more ambiguous the definitions itself are. One solution here is to categorize smart cities into several types. Since it prevents the swollen concept from explosion, a typology of smart cities could be helpful. This chapter discusses the four types and characteristics of each type.

Niaros (2016) in his paper attended to the processes of smart city project. To be more specific, private sectors that own capability of technological disseminations control information and technologies. Public sectors are concerned about competitiveness of businesses, sustainability of environments, and other interests but they normally do not have competency of digitalizing the city leave the initial stages to private sectors. Then public sectors and their advocates gradually shifted from their allies at earlier stages to leaders of the projects. This pattern is also touched by Gohari. et al (2020).

However, these typical movements are often at the center of criticisms due to monopolistically designing and implementing technology that could fail to meet needs of city-dwellers. This case is a typically applicable to smart city projects led exclusively by private companies. While embracing common goals achievement as a key success factors of smart city, Niaros conceptualized a two-dimension framework (see picture3), called taxonomy of smart city projects. The first axis concerns polarity of centralized or distributed control of the technological infrastructure. In the meantime, the second axis is about orientation towards either “accumulation and circulation of money” or “accumulation or circulation of commons”. The purpose of the money-oriented cities is to maximize its profit, while the one of the latter is to create a better society. According to the author, common goals

for smart city are enhanced performance of city operations such as better energy consumption, waste managements, water consumptions, improvement of citizen mobilities, and crime preventions.

3.1. Corporate smart city

As mentioned above, this smart city is a techno-deterministic approach mostly by private corporates. Governments have been looking into how cities might improve urban economies, quality of life and solve other issues. Normally gigantic IT corporations such as IBM, or Google are key-players, and they design and develop their own products and services for the cities. However, the true intent of these cities is to build a new market and shape it in certain ways. This hits huge criticisms for pushing their own products and services to traditional cities to boost their sales and profits.

The top-down approach may not meet the true needs of the citizens since people do not come first; citizens do not participate both in the designing technologies and in its implementations. Plus “the installation of thousands of sensors and the collection of data generated from the inhabitants may have serious consequences with respect to citizens’ freedom”. (Gohari. et al ,2020).

3.2. Sponsored smart city

According to Niaros (2016), sponsored smart city introduces shared, open-source technologies that have certain transparency to its communities. After the certain corporates have designed products and services, city-dwellers can opt them in and out.

In this sense, this smart city carefully juggles balances between human rights and tech businesses. Nonetheless, collaboration that are required to achieve common goals is hindered because citizens can only join in implementation phase, not in their designing sessions

wherein they can express their needs. Plus implementing sessions require high levels of literacy about technologies. Hence unsolved information asymmetry and digital divide exist without appropriate catchups (Gohari. et al, 2020). Privacy issues also remain unsolved since private sectors dominate data collected by smart products and services.

3.3 **commons-based smart city**

This type is globally most unobserved smart city, which implies the difficulty of scalability. Citizens are expected to get involved in full phase of development of technological infrastructure in order to accomplish common goals. These conditions undoubtedly create circular economies that keep innovating. The goal, borrowing from Niaros's words, is "to expand network of collaboration that is a source of innovations and catalyzes growth of their scales".

While the innovation devised by citizens are similarly as local as the one plucked by Resilient smart city, these creations are up scaled and turn into global movements that changes its shape to adjust to global environment. The issues here is feasibility of creating centralized and simultaneously commons-oriented smart cities for the following reasons. First more centralized and powerful organization are needed to influence and campaign such a large number of people into involvements. Also, unique culture of creativity is a key to success for this type. Niaros summarizes what they need to build ideal atmosphere as follows:

> This smart city suggests that smart cities should follow a more synthetic approach which combines: i) the bottom-up innovation through which citizens seek to create a better life for themselves and their community and ii) the top-down policies and planning that seek to distribute resources fairly so that everyone has the opportunity to innovate successfully.

the next step would be to integrate them into daily social interaction and make all data available to citizens. This could be achieved by building digital platforms to promote open governance through the collaboration between local governments and city-dwellers.

the infrastructure should comply with standards that would be designed to enhance interoperability. These standards should shape technologies that are easily accessible, transparent and open to adaptation to local conditions. At the same time, local authorities could contribute to the adoption of open standards through planning frameworks and procurement practices.

3.4 Resilient smart city

Resilient smart city is regarded as smaller scaled commons-based smart city that allows people to become DIY designers to build up technologies for themselves. This bottom-up approach arises from co-working places wherein diverse individuals from technological experts to students gather and share ideas in constructive ways. They are allowed to devise and try prototypes that could be solutions for mundane issues. These culture of small innovations enables them to create products used for long term, but the collective capabilities of creation tend to be smaller, and these innovations are far from scalable. Nonetheless, all the solutions adopted here meet existing problems and needs, In this point, the value of smart city is certainly high. Niaros said “Cities of this type are becoming laboratories where common value is produced and problems are addressed by citizens who engage in the research, design and testing of solutions.” These smart cities also nurture people’s literacy naturally dealing with issues in private led-cities.

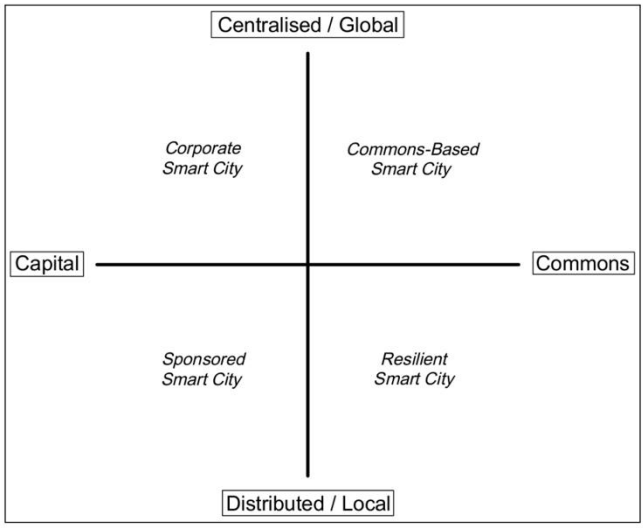


Figure 1: A taxonomy of the smart city

Picture 3. Niaros, V. (2016). Taxonomy of the “Smart City” triple-c.at/index.php/tripleC/article/view/718

4. Woven City Project

According to website of Woven City, A 175-acre land that had been unused became a main basement for a new project. It was first publicly announced at CES, and the urban planning is drawn by Bjarke Ingels Group (Copenhagen and New York based architects, designers, and builders). 3 types of woven streets (see Picture5.) which is why it is called Woven City are interconnected. The first is only for self-driving & ecofriendly vehicles that run at faster pace. The second streets are for mixture of slow-speeded mobilities and pedestrians. The last ones are wider spaces for pedestrian only.

Other than these features, Toyota plans to build up housings made of zero carbon footprints (materials that emit no CO2 from procurements through completions), those housings are equipped with robotics or IoTs that make life better. Toyota’s E-palette is used as public transportation services and as mobile retailers.

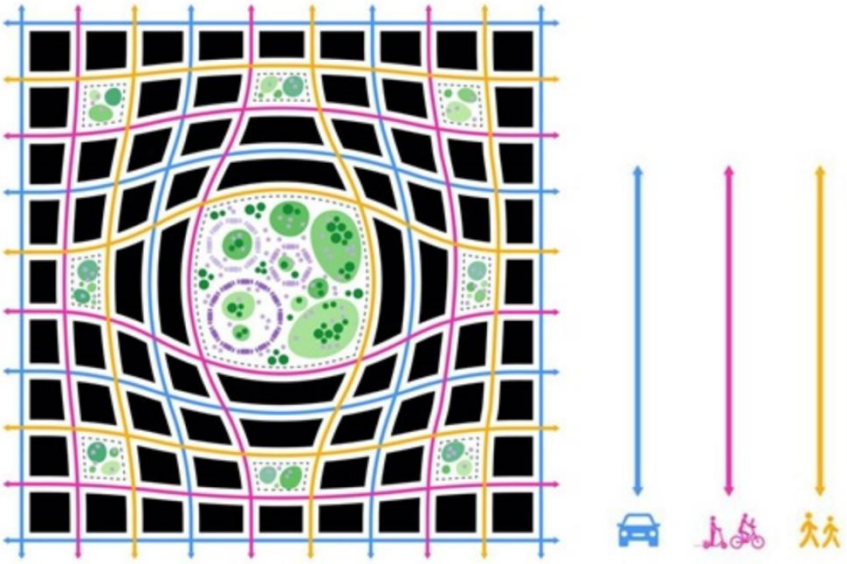
- Woven City is a front-runner that largely transforms lifestyle, workstyle, and mobility. The human-centric city embraces happiness and growth of people living and communities born there.
- The livable proof of concept that develops futuristic technologies through daily life.
- The never-ending city in which perpetuating involvements by residency and partners enable us to grow, to advance, and to create the future.

These three concepts are the main pillars and aimed at proliferation of happiness by providing new values and lifestyles in mobility of human beings, materials, and information. The services the city offers are categorized into 12 types: Mobility, Energy, Logistics, Agriculture Food, IoT, Healthcare, Education, Entertainment, Payment Finance, Safety Security, Smart Home, and Housing Office.

As of January 4th, 2022, Woven City has only revealed two major partnerships: with NTT, and with ENEOS. This raises questions about what the Woven City is. Then President, Akio Toyota, in his interviews, explains that "Woven City is a trial circuit that allow for testing with future products, for this reason I do not think there's no need for open explanations about the city"

In summary, thought as a city level, Toyota's project is grouped as Corporate Smart City. However, rather than getting closer to common-based or resilient city, the smart city works as a huge laboratory in which smaller number of people could live. The top-down approach, framed with taxonomy of smart city could be far from the true needs of the citizens since people do not come first; citizens do not participate neither in the design process of the technological infrastructure nor in its implementation. Residents are merely treated as another source of information according to Niaros (2016).

Picture 4 Woven City Image. https://global.toyota/en/newsroom/corporate/31171023.html



Picture 5. Woven City streets (by BIG) https://big.dk/#projects-twc

5. **Sidewalk Labs by Google (**Cited by Master Innovation and Development plan**)**

One of the most popular projects was Waterfront Toronto, supposed to develop social infrastructures, and digital innovations including mobility services, and sustainable buildings. Although Google gave up on seeking the project further, the sophisticated blueprint deserves referring to. The core concept is transformation of transportation through MaaS (Mobility as

a service). The Master Innovation and Development Plan (MIDP) is a more than 1,500 pages long, which became open to public after Sidewalk Labs won the bid to redevelop the Warfront District in October 2005 to communicate with publics. The report explains the meanings of the project that were expected to bear various benefits including more than 44,000 new direct jobs (93,000 new jobs) by 2040, an annual GDP of C$14.2 billion, an increase in tax revenue of C$4.3 billion, and an 89% reduction in the greenhouse effect (Reuters, 2019).

Hidaka, et al (2020) summarizes that the vision of the Master Plan is to create a transportation system that provides safe, convenient, connected, and affordable options for all modes of travel, reducing the need for private car ownership.

Regarding mobility services, Sidewalk labs was planning to

1) Accelerate the expansion of public transportation through new business methods.
2) Make areas more pedestrian and cyclist friendly.
3) Provide new mobility services to replace the private car so that people can live without owning cars.
4) Improve the efficiency of logistics through a delivery network that makes use of underground properties.
5) Monitoring the flow of people and goods and optimizing transportation through MaaS.
6) To pave human-first streets.

This is a completely new plan for the next generation that is based on the latest technologies. The plan also encompasses everything from population flows to logistics, from hardware to software, and from planning to operation. It is expected that the percentage of people using their own cars will decrease from 27.2 to 10.7%. (p394,398).

The underground delivery systems are expected to reduce the number of logistic vehicles in the IDEA (Innovation Deign Economic Acceleration District.) district by 72%. It is used to refer to the entire waterfront development district, not just the Quayside and Villers West districts. This is a proposal for a human-centered street design that will coexist with varied mobility while envisioning a future automated driving technology. Human-oriented city starts with four types of streets as follows. (Sidewalk labs, 2018, p40)

1) Boulevard (Boulevards)
2) for public transit and vehicle traffic (Transitways that prioritize public transportation)
3) for cycling (Accessways)
4) for pedestrian (Laneways)

Pedestrians and bicyclists are given priority at intersections through signal control, and the roadways and sidewalks are universally designed with no steps. Based on the climatic conditions of Toronto, a system is proposed to prevent freezing in winter by circulating hot water under the sidewalk of sidewalks and driveways, and the circulation of hot water will be activated two to three hours before snow falling.

Also, a hexagonal space is proposed for a flat road surface without curbs. The modules eliminate the traditional lanes, and their usage is flexible time to time, for example, as a temporary stop for driver-less vehicles and ride hailing services to get on and off during the day, and as an open space for stores in the evening. A public transportation priority street is described as a space where light rail, pedestrians, bicycles, and automated vehicle dispatch services are allowed to run. The speed limit on the street is to be 40 kilometers per hour within the Quayside area. In the streets for walkers, juxtaposing open cafes and other dwelling spaces will be secured. The plan was to operate the system at a maximum speed of 8km/h in an 11m wide area where the entry and exit of automated vehicles are controlled.

In conclusion, the massive blueprint envisioned by Sidewalk Labs are like the ongoing Woven City. According to a survey by The Forum Poll, of 38 percent of people in Toronto who knows about the project by Sidewalk Labs, 60 percent of those did not trust its technologies. (*Support for Sidewalk Toronto Mixed*.) As seen as the disadvantages of corporate smart city, data privacy issues are always surrounding this pattern because of the absence of collaborative invention, and information asymmetry. Although Toyota is currently conservative about opening information about the city to public, the expected outcomes of smart city could be analogized with Sidewalk labs.

Picture 5. Sidewalk labs. https://www.sidewalklabs.com/insights/four-principles-for-the-future-of-city-streets

Picture 6. Quayside area. https://www.thestar.com/news/gta/2019/06/24/5-key-take-aways-from-sidewalk-labs-master-plan-for-quayside-and-torontos-waterfront.html

6. Potential Risks

Since the definition of success seems different from the traditional smart cities including the failure case by Sidewalk labs, it is hard to gainsay that Toyota will bloom smart city.

Ander (2012) underscores the important blind spots that innovators tend to miss, referring to Microsoft office 2007 suite as an example. According to his story, Microsoft office released newer version of software that had updated quality overall, and the companies who wanted to replace old version with Office 2007 did not need to pay any premiums. Nonetheless the adoption of Office 2007 was delayed because of a gap to assess “cost” and “benefit”. He describes that while innovators think about benefits as absolute value delivery from products whereas customers think about benefits as value surplus (new value minus value from available alternatives). (see figure 1) Hence, the free of charge does not necessarily mean cost free for users. Adoption won’t happen unless relative benefits exceed total costs.

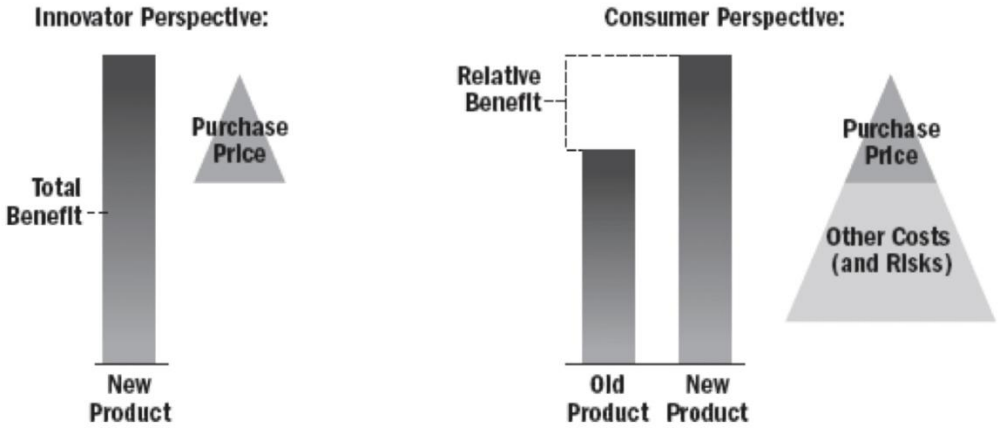


Figure 1. "Innovators and consumers have different views on what constitures "benefits" and "costs." from Adner, R. 2012, *The Wide Lens: What Successful Innovators See That Others Miss,* p57.

Additionally, Ander (2012) introduces two more blind spots people need to pay attention to when it comes to triggering innovations, Co-innovation Risk, and Adoption Chain Risk. These three tools are useful to see smart city projects because smart cities are literally agglomerations of innovations, which means a bunch of innovations must be created simultaneously.

1) Co-Innovation Risk

According to him, co-innovation risk is "the extent to which the success of your innovation depends on the successful commercialization of other innovations." If there are four innovations involved in a single large project, and the probabilities of each innovation are 80%, then the success rate of the projects are 0.8^4 = 40.96% Since smart city projects involve a great deal of stakeholders owning unique strengths, any single players cannot execute them by themselves. Naturally, smart city projects hold a large room for co-innovation risks.

2) Adoption Chain Risk

Adoption chain risk is on the other hand, is the extent to which partners will need to adopt your innovation before end consumers have a chance to assess the full value proposition. This (see Figure 2.) explains the bottom-lines that hinder an innovation from succeeding. If any single players in an adoption chain are unsatisfied, this whole innovation cannot be achieved however much benefits other players receives from this innovation project.

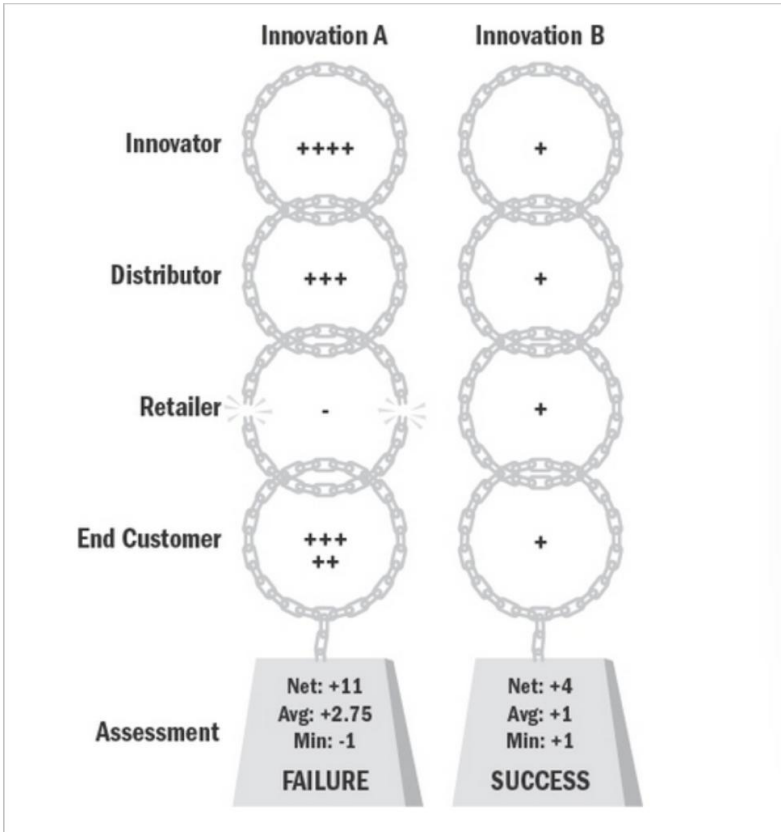


Figure 2. “Surplus along the adoption chain for innovations. Expect failure if any link is negative” from Adner, R. 2012, *The Wide Lens: What Successful Innovators See That Others Miss,* p.63

Based on these frameworks, each player must enhance the probability of success, and at the same times the conflicts of interests must be resolved by either all the key players or major players to surveil activities of each smart city stakeholders. This is the reason why Niraos (2016) positively appreciate human-centric approach that public sectors proactively partake and lead the smart city projects.

6.1 Failure Case of Google

Let's apply this theory to Google's smart city. (see Figure 3) The completion of the project create multiple of benefits for residents, businesses, communities, environment. Unlike traditional corporate smart city, Sidewalk labs pay more attention to public opinions. According to its website, "it invited more than 11,000 people to Sidewalk Lab's workshop and reached more than 21,000 people face to face." Regardless of its tremendous efforts, Torontonians did not appreciate its full values as Google see. The relative benefits (transition from current life to the future) does not exceed the total cost they need to pay. In other words, subtracted attractiveness of futuristic cities with full of technologies could not wipe out skepticisms of privacy issues that raised public concern.

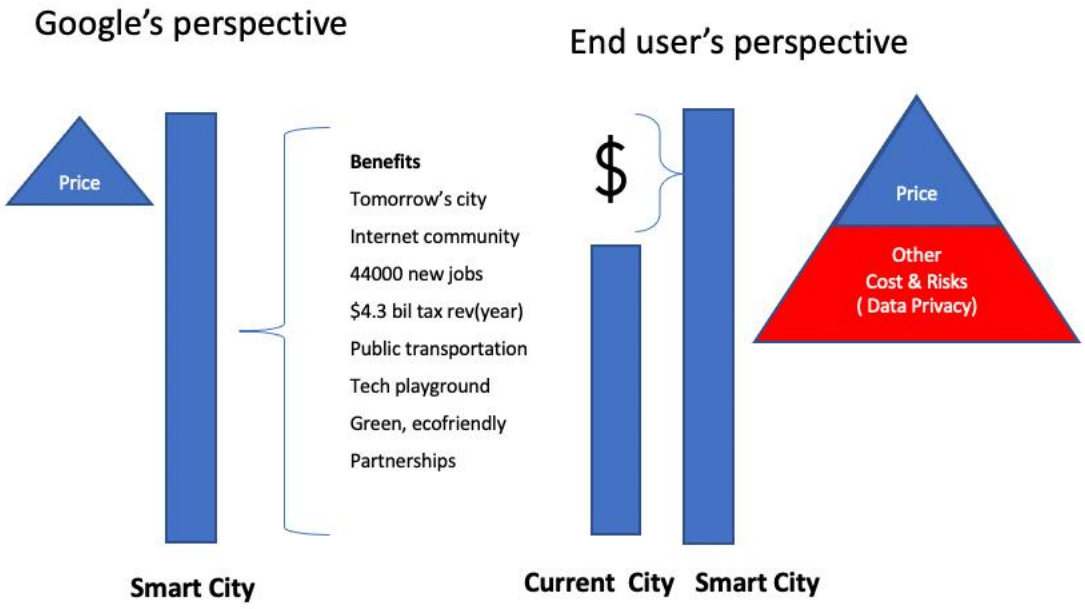


Figure 3. Different views on what constitutes "benefit" and "cost" between Google and its end users, adopted from Adner, R. 2012, *The Wide Lens: What Successful Innovators See That Others Miss,* p.57

6.2 Failure scenario of Toyota

The case of Toyota is similar to the one in google but they have different scenario since the residences will relocate only if they accept its terms and conditions. The similarity is that no matter how different the case is the switching costs from current life matter.

First, without high level of literacy, and technical support, people cannot fully make use of digitalized products and services that they do not design. Depending on one's capability of dealing with technologies, the relative benefits received from digitized life are varied.

Second, people living externally may face inaccessibility to information about "what is in it". Currently, seen from outside, the Woven City is black-boxed. An information session with Susono city for citizens was held October 5, 2021. There, a female attendee also pointed out lack of accessible information about the city.

The difference from Sidewalk Labs is Woven City does not have any inhabitants at an initial phase. The controls of technologies are at its stakeholders' hand, regardless of the fact that the control is centralized or diffused. This could be a precaution for protecting the project from huge criticisms about data privacy. It is obvious that Woven City projects have learned about privacy issue lessons from collapse of sidewalk labs.

On the one hand, those who are interested in the city projects may raise questions about its positive aspects. Because the success for the corporate smart city is to maximize its profit. The city must rely on data sources to optimize systems, however, Woven City is going in the other direction in terms of attracting people, which implies that the project is aimed at product first, not human-first that many smart cities idealize.

From the three blind spots of risks, excluding public sector may work positively, since the smaller number of players (Woven City without government to Woven City with government) are expected to be embroiled in the project, which multiply the probability less times, ending up with higher success rates of innovations. However, Toyota's decision making is risky from adoption chain risks. Each player normally is focusing on their own innovations rather than adjusting other's interests by giving up their own benefits. In the case that Woven City is lucrative for Toyota but not profitable for a certain player, this situation could not be modified unless someone with neutral perspective exists. Therefore, public sectors as a major player are significant as Niaros (2016) asserts. Plus, public sectors play a central role in minimizing the gaps between points of views by sellers and buyers. Hence Toyota's smart cities are great for their own sake but needs to be corrected if it truly like to become human-centered city.

7. Conclusion

As discussed previously, the smart city project by Toyota is categorized as a corporate smart city led by stakeholders of Woven City mostly by Toyota. According to Niaros (2016), This approach taken by Toyota makes it harder to reach the true needs raised by citizens. Toyota's future products and services possibly miss the point of what the residents want, expanding to what people want because of techno-deterministic orientation.

Also, seen from the wide lends, Toyota might find it hard to persuade people into relocation since corporate smart city tends to be product-out approach appealing their own benefits, which might not be as attractive as Toyota expects for end users. If it had a perspective to see the true needs coming from people, it could minimize the gap between two players.

These frameworks introduced in this paper is coherent in terms of importance of human-first approach. These are why human centric approach is appraised by Niaros(2016) as opposed to private-driven projects.

However, in practice there seems a contradiction since private-driven approach is always the majority in the world as Niaros (2016) discussed. Moreover, the result of this paper is drawn from frameworks, not from primary sources, which was hard to accrue since Woven City Project is still underway, and its stakeholders haven't disclosed much information about it. To analyze what the smart city looks like with limited information, the natural choice was to review past research and apply the findings from the reviews to the ongoing projects.

For the future sake, the paper suggests two points to improve this field. First, it is expected to gain more information from Woven City in the future. The analysis of smart city could become easier and more accurate than this research. Hardly does this paper explain the logical reasons why private approach tends to be inferior based on data or primary sources. This point must be modified and improved.

Second, public-led smart cities are appraised more than private-led smart cities in general but to be fair, down-sides of public-driven cases need to be investigated. If it is obviously beneficial to involve public sectors in smart cities, many smart city projects would have done by this approach. Although investigation of public sector could be beyond the scope of smart city projects itself, it is worth assessing socio-politics aspects to draw the more accurate conclusion. Since smart city is interwinding so many academic fields, it is significant to combine those in more comprehensive way, not mono-dimensional approaches.

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