Use cases and related business models for smart cities infrastructures

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***Abstract* — With the advances in information and communication technologies (ICT), physical objects are now augmented with sensing, processing and network capabilities, enabling them not only to intercommunicate with one another, but also to exchange information with people and react to their environment. With such capabilities, these physical objects are referred to as "smart objects". This research is about the identification of areas of application of smart objects in smart cities. Through specific use cases, this research paints a clearer picture of the advantages of integrating smart objects into our everyday lives. A use case is a list of steps defining a system's behaviour as it responds to a series of requests from an actor. For each use case a related business model is described. A business model describes the value proposition, market segment, and cost structure, position in the network of competitors, the competitive advantage and the infrastructure of a business entity. This research started off with a literature review on smart cities that led to the identification of related use cases. The identified smart city environments fall under the categories of smart transport, smart energy, waste disposal, water management and environmental management**

Keywords— business models, use cases, smart cities, smart transport, smart waste disposal, smart water management, smart environmental management, smart public safety and emergency services, smart energy

I. INTRODUCTION

The combination of the internet and emerging technologies such as embedded sensors and locating and networking technologies lets us transform everyday objects into smart objects that can understand and react to their environment. According to (Kortuem, 2010), "smart objects are autonomous physical/digital objects augmented with sensing, processing and network capabilities. They carry chunks of application logic that let them make sense of their local situation and interact with human users. They sense, log and interpret what's occurring within themselves and the world, act on their own, intercommunicate with each other and exchange information with people". (Mattern, 2003) says 'smart objects might be able to not only communicate with people and other smart objects, but also to discover where they are, which other objects are in the vicinity and what has happened to them in the past".

A use case, on the other hand, is a list of steps defining the interaction between an actor (role) and a system to achieve a goal. It describes how a user uses a system to accomplish a particular goal. It describes a system's behaviour as it responds to a series of related requests from an actor. Business model design includes the modeling and description of a company's value propositions, target customer segments, distribution channels, customer relationships, value configurations, capabilities, partner network, cost structure and revenue model (Business model, 2013). This paper is on the marriage between business models and use cases for smart cities.

Section 2 is on the problem statement. Section 3 is on business models. Section 4 is on smart cities. Section 5 is on use cases in smart transport and its business models. Section 6 is on waste disposal and related business models. Section 7 is on use cases in public safety and emergency services in smart cities and related business models. Section 8 is on use cases in water management and business models. Section 9 is on use cases in environmental management and related business models. Section 10 is on use cases in smart energy and related business models. Section 11 is on the conclusion.

II. PROBLEM STATEMENT

At present most cities of the world would do with an enhanced operational efficiency in all its sectors ranging from transport, energy, water, commerce, healthcare, education, environment, to safety and security management. The problem though is that most of the city functionalities are human centred and inadequately supported by technology. It is in the adoption of smart technologies to augment the humans in the city processes that most of the processes can be optimized.

The question that this research is attempting to answer is: "what are the business models that result from processes where cities utilize smart systems technologies in order to improve operational efficiencies and improve service delivery to its citizens".

The objectives of the research are:

1. Conduct a literature survey on smart systems technologies
2. Identify domains where smart systems can be applied in city processes
3. Conduct a literature search to identify various smart systems for each of the domains
4. Analyse these smart systems and come up with use cases

5. Conduct a literature survey on business models
6. Marry the business models to the use cases

III. Business Models

(Timmers, 1998) defines a business model as including an architecture for the product, service and information flows, a description of the benefits for the business actors involved, and a description of the source of revenue. (Rappa, 2003) defines a business model as ‘the method of doing business by which a company can sustain itself” and notes that the business model is clear about how a company generates revenues and where it is positioned in the value chain. Other definitions of business models emphasize the design of the transaction of a firm in creating value (Amit, 2001), the blend of value stream for buyers and partners, the revenue stream, and the logical stream (the design of the supply chain) (Mahadevan, 2000), and the firm’s core logic for creating value (Linder, 2000). (Osterwalder, 2002) propose a framework of four pillars: the products and services a firm offers, the infrastructure and network of partners, the customer relationship capital and financial aspects. (Weill, 2005) defines a business model as consisting of two elements: (a) what the business does, and (b) how the business makes money doing these things. (Faber, 2003) distinguishes common elements of business models as: (1) service design: a description of the value that the value network offers to a specific target group of users, in a particular in terms of a service offering, (2) organization design: a description of the configuration of actors that is needed to deliver a particular service, the roles that each plays, making clear how the network creates value for end-users, (3) technology design: a description of the fundamental organization of a technical system, the technical architecture which is needed by the firms in the value network to deliver the service offering exhibited in the service design, (4) finance design: a description of how a value network intends to capture monetary value from a particular service offering and how risks, investments and revenues are divided over the different actors of a value network. Chesbrough and Rosenbloom identify six components of a business model: (1) value proposition: a description of the customer problem, the product that addresses the problem and the value of the product from the customer’s perspective, (2) market segment: the group of customers to target, (3) value chain structure: the firm’s activities and position in the value chain, (4) revenue generation margins: how revenue is generated, the cost structure and target profit margins, (5) position in value network: identification of competitors, complementors and any network effects that can be utilised to deliver more value to the customer, and (6) competitive strategy: how the company will attempt to develop a sustainable competitive advantage. Examples of business models are bricks and clicks business model, collective business models, cutting out the middleman model, direct sales model, distribution business models, franchise, freemium business models, auction business model, razor and blades business model, subscription business model, all-in-one business model, pyramid scheme business model, loyalty business model, monopolistic business model, online content business model, multi-level marketing business model (Business model, 2013). Rappa categorises business models into brokerage, advertising, infomediary, merchant, manufacturer, affiliate, community, subscription and utility (Business models on the web, 2013). (Alt, 2001) distinguishes six generic elements of a business model: (1) understanding the vision, strategic goals and value proposition, and basic product or service features, (2) the structure which determines which roles and agents constitute a specific business community, (3) processes that show the elements of the value creation process, (4) sources of revenue and investments, (5) legal issues that influence decisions on structures of value creation and (6) technology as an enabler for IT-based business models.

IV. Smart Cities

A city is called ‘smart’ when investments in human and social capital and transport and modern ICT infrastructure fuels sustainable growth and a high quality of life, with a wise management of natural resources through participatory government (Caragliu, 2009). Smart cities, from smart phones, mobile devices, sensors, embedded systems, actuators, smart meters and instrumentation sustaining the intelligence of cities and allowing real-time data to be collected and analysed, will improve the ability to forecast and manage urban flows. The first task that cities must address in becoming smart is to create a rich environment of broadband networks that support digital applications (Schaffers, 2011). This includes: (1) the development of broadband infrastructure combining cable, optical fibre and wireless networks, offering high connectivity and bandwidth to citizens and organisations located in the city, (2) the enrichment of the physical space and infrastructures of cities with embedded systems, smart devices, sensors and actuators, offering real-time data management, alerts and information, and (3) the creation of applications enabling data collection and processing, web-based collaboration and the actualisation of the collective intelligence of citizens. Further, smartness of the city should be measured by its participatory governance, its smart economy, its urban mobility, its smart environmental strategy and management of natural resources and the presence of its self-decisive, independent and aware citizens leading to a high-quality urban life (Roche, 2011).

The application of IT in smart cities can produce various benefits (Harrison, 2011), that is:

- Reducing resource consumption in the form of energy and water, and in the process reduce carbon emissions
- Improving the utilisation of existing infrastructure
- Improving commercial enterprises through access to real-time data on city services
- Smoothing the peak demands for energy, water and transport

The next subsections of the smart city have been subdivided into smart transport, waste disposal, water management, public safety and emergency services, smart energy and environmental management. For the business models we look at the value proposition, market segment, cost structure and revenue generated, value chain structure, position in the network of competitors, technological infrastructure required and the competitive advantage.

V. SMART TRANSPORT

The issue in mobile payment for parking systems is on automating the capturing of meter numbers by the customer, and keeping track of the remaining time before a meter alerts the user of the expiry of the meter. An example of IT-enabled transportation initiatives is the mobile payment program for parking, where drivers pay for parking via SMS. In mobile payment for parking systems, payment is done via a smartphone. The application that runs on the cell phone allows the user to set up an account on the cell phone which links to the parking system's meter and the user bank account. Each meter has a near-field-communication (NFC) sticker which has a unique identifier that tells the application what meter it is. If the user's phone is NFC-enabled it saves the trouble of capturing the meter number manually. Once the meter is detected, the application keeps track of the time remaining before a meter expires and alerts the user. Through a few clicks on the cell phone, the user makes payment. The parking meter is updated once payment has been made. The market for the application is car owners who have smart phones and bank accounts. In a smart city, besides the city council, other competitors offering a similar service would be private companies running the business for the purpose of profits. The competitive advantage is that the technology uses readily available technology such as the cell phone, whose coverage is vast.

The next is a use case on mobile-enabled payment for parking.

Use case:	Mobile payment for parking
Description	An application that runs on the user's smartphone enables the driver to make payment towards a particular meter at the parking bay once an SMS alert has been sent to the driver on the possibility of the expiry of the meter. The application links the user's bank account to the meter identification
Assumption:	The user has the relevant application running on their smartphone and they have registered an account with the parking service provider
Actors	Driver, parking service provider
Steps	1. Download mobile parking software from service provider onto smartphone 2. Set up an account on phone which links to the parking system 3. Click on the smartphone to detect parking meter identifier 4. Driver receives alert on expiry of meter from service provider 5. Driver makes payment 6. The parking meter is updated
Issues	Access to smart phone and bank account is vital. Wireless communication between cell phone and meter is enabled.

To avoid physical toll booths on the highways where each vehicle will stop and pay, which can also worsen congestion problems, e-tolling is used. A road e-tolling system, for example, provides large amounts of 'real-time' information about the movement of vehicles through toll gates. Analysis of historic traffic data can find patterns that can be indicators of the risk of congestion occurring in specific city districts. Such patterns provide a warning period that enables managers to adjust the traffic management systems to prevent such congestion occurring. Radio-frequency identification (RFID) is the technology used to automate toll-taking on the roads. RFID is a technology that uses radio waves to transfer data from an electronic tag, called an RFID tag, attached to an object through a reader for the purpose of identifying and tracking the object. Drivers are given a plastic card with an RFID chip inside allowing them to drive through toll gates without stopping. The plastic card hooks up to the user's account and keeps a set balance. It is almost a prepaid debit card that refills itself based on usage and a low balance level. Toll gates can either be managed by local government authorities or private companies. In certain areas of the City of London, motorists pay more for congestion tax. Cameras take pictures of the number plates and charge against user accounts. The technology that is required is data connections to toll booths, that cars should have tags and that there should be tag readers. Road tolling systems can be run by the local authority, handed over to private companies to run the system on behalf on the local authority or be run as a public-private partnership.

The following is a use case for e-tolling:

Use case:	Road e-tolling
Description	Toll booths on highways automate toll-taking on the roads. RFID cards are placed in cars and are read by card readers that sit on the toll gate. Bills are generated on the information obtained and sent to the car owners at regular intervals. Alternatively the RFID card hooks to a user's account and funds are automatically deducted.
Assumption:	Motorists have RFID tags in their cars, and there are readers on the toll gates. A central server that processes bills runs a software
Actors	Car owner, toll collection company, bank
Steps	1. Card readers detect identity of car as contained in the tag or number plates 2. Information is communicated to a central server at the toll company

	which updates the customer's bill 3. Deductions on the user's bank account occur 4. Monthly statements are generated and sent to the email or SMS of driver 5. Traffic patterns generated for service provider from data collected at the central server
Issues	Decision support system in place, cars fitted with tags and communication between toll gate and central server, communication between central server and bank

VI. WASTE DISPOSAL

It is not cost-effective to dispatch waste collection vehicles where waste has not accumulated enough, or the waste bins are not full to capacity. In Korea, research has been done on smart bins that are equipped with solar panels and batteries. Waste is compressed to a fraction of its original size, which allows the bin to hold a lot more that its usual capacity. As it utilises space more efficiently, a smart bin needs to be emptied less often, which reduces the pollution created by garbage trucks which come to collect it. Each bin can be equipped with a 3G transmitter which provides sanitation workers with real-time alert when it is full through a smart phone application that displays its location (Tebay, 2011). The municipality renders services by law from the tax payer's money. They may subcontract the service to other companies. In Canada, the cost of refuse collection bags has tax built into it for waste collection. Waste is not collected unless it is in such refuse collection bags. In South Africa, residents pay for waste collection services. For technology a WiFi network is required which links the refuse collection bin and the sanitation worker. The market for such a system is the residents and the municipality. Refuse collection can be subcontracted to private companies.

The following is a use case for a bin that alerts the waste collection services when it is full.

Use case:	Alerting waste collection services
Description	A bin is equipped with sensors and transmitters provide real-time alerts to bin collectors when full
Assumption:	Wireless communication and sensor- and GPS-enabled bins in place
Maintenance	Municipality, garbage collectors, network operators
Steps	1. Sensors detect when the bin is full 2. Municipality notified wirelessly via a central control room of GPS location of bin 3. Garbage collector notified via SMS
Issues	Smart bins in place. Position of garbage collectors at any point so that nearest can be contacted to avoid an increase in trips that might increase transport costs

Waste- and storm water pipes overflow, resulting in flooding, when a combination of water released by residents and rain water meet in the limited capacity of the drainage pipes. A combination of highly concentrated domestic waste and a highly concentrated industrial waste results in secondary pollution. In New York City, where sanitary wastewater and storm water share the same pipes, when it rains, the systems overflow. Sensors are installed at the sewer system's overflow location. These sensors function to alert the citizens to the state of the sewer systems. A bulb in the home of a citizen receives a signal from a radio transmitter, and the colour of the bulb changes to signal a problem. This smart drainage system senses the water supply and drainage pipelines and facilities. The drainage condition can be monitored around the clock, while systematic analysis of the overflowing and water-logging process is conducted. Monitoring personnel utilise the analyses to remodel the drainage pipelines and avoid possible flooding. In addition, through real-time monitoring, the system can identify the domestic and industrial waste water and discharge them at different times and phases to avoid secondary pollution. (Internet of things blurs the line between bits and atoms, 2012). The market for this sort of system is the local authority. Income can be generated by small companies from installing the sewer alert systems in the home. Sewer system management is the prerogative of the local authority and it is therefore funded through taxes. The infrastructure is the network of sensors at the sewer system overflow locations, and the communication networks to alert the users.

Use case:	Detecting sewer system overflow
Description	Citizens alerted to state of sewer system through a bulb lighting in their homes so they can control their release of wastewater into the system
Assumption:	Sensors, wireless transmitters, bulb in house that lights up when sewer system overloaded
Actors	Municipality, citizens
Steps	1. Sensors detect state of sewer system 2. Information communicated to citizens' homes 3. Bulb in home lights up to signal overflow 4. Citizen suspends releasing water into the sewer system
Issues	Monitoring should be round the clock. The information generated is used to remodel drainage pipelines

VII. PUBLIC SAFETY AND EMERGENCY SERVICES

Rapid response to an emergency situation can mean a difference between life and death. Unfortunately traffic congestion and other obstructions can delay the arrival of an ambulance at the scene of an emergency. An internet of things (IoT) application can be adapted to search for optimal routes for the ambulance, taking into account the effects of traffic in the ambulance running time. With the help of RFID tags in the ambulance and wireless sensor nodes on the roads, the dispatch control centre in the hospital can collect the real-time traffic conditions where wireless sensor nodes are located. The report messages are sent to a control centre. Based on information from the sensor nodes, the control centre forecasts the optimal path to provide the fastest route for the ambulance. In this decision process, the control centre can ignore some information from the nodes, which have a higher traffic jam that average (Wang, 2011). Ambulances are owned by both private and public health institutions. Payment for these services is by the consumers of the services. Government pays for public institutions while facilities such as medical aid pay for private services. The infrastructure that is required is one that will collect the data and communicate real-time with the ambulance.

The following use case is for the identification of an optimal ambulance dispatch route.

Use case:	Optimal ambulance dispatch route
Description	Searching for optimal routes for the ambulance that takes into account traffic conditions. Traffic information is communicated to the ambulance dispatch centre which has a decision support system that analyses traffic conditions and forecasts optimal path. The information is communicated to ambulance.
Assumption:	Ambulances are tagged for identification, wireless sensor nodes on roads, dispatch control centre in hospital, decision support system at dispatch centre
Actors	Control centre staff, ambulance drivers
Steps	1. Emergency call received by call centre 2. Call location leads to identification of nearest ambulance 3. Optimal route calculation automatically done 4. Information communicated to ambulance via map on dashboard or GPS
Issues	Mode of communication between call centre and ambulance important

Fire, if not contained fast, has a tendency to spread quickly and cause massive destruction. Therefore a rapid response to a fire alert is required. In a fire assistance system, the heat and smoke sensors detect a fire and they communicate the details to a server. The intelligent server functions as a safety monitoring device. It also controls the topological exit route assistance in a building or structure by communicating with the exits to display the exit route via wireless sensor networks. The server automatically sends messages to the relevant parties. At the same time it communicates with the fire brigade. Fire station alerting systems are used to alert personnel who are based at a fixed facility. Personnel alerting systems are used to alert personnel who are away from their stations. The fire truck dispatched is GPS-guided towards the site. Fire-ground systems support communication at the scene. Most networks are designed so that dedicated channels or talk groups are available for fire-ground and tactical communications. The infrastructure that is required are the network of smoke detectors, global positioning systems to locate the fire and fire engines. Fire services are normally the prerogative of the government, hence they are paid for by the taxpayers and a refund obtained from the consumer.

The following is a use case for a fire assistance system.

Use case:	Fire assistance system
Description	Smoke sensors detect a fire and communicate information to the fire station server. Fire staff is alerted via siren or SMS. Fire truck dispatched via GPS
Assumption:	Fire cars fitted with GPS. Communication exists between fire sensors and fire station.
Actors	Fire fighters, fire brigade call centre
Steps	1. Fire detected 2. Fire alarm goes off 3. Exit routes in building automatically highlighted 4. Alerts sent to call centres 5. Call centre alerts fire brigade via SMS 6. Fire machine dispatched guided by GPS location of building
Issues	Mode of communication between driver, call centers and ambulance important

VIII. WATER MANAGEMENT

To conserve unnecessary loss of water, leaks have to be detected quickly and efficiently. Permalog (Permalog, 2012) is an IoT-based system that enables water suppliers to quickly and efficiently locate leaks in a water network by listening for the noise made by water leaking from pipes. These sensors are powered by batteries and their location identified through a global positioning system (GPS). When a leak is detected, an alarm transmitting a radio signal is set on. The information is transmitted to an office computer. The data can be displayed on a map, as a satellite image or terrain as a live on-screen tracking. Such a system removes the need for site visits, increases response time and risk to surrounding buildings. If the water leak is inside one's property, the consumer pays. If the leak is in public space the water-providing company pays.

The next use case is on detecting water leaks.

Use case:	Locating water leaks
Description	By listening to leakage noises using sensors,

	the GPS location of the leak is communicated to the maintenance centre and forwarded to maintenance technicians
Assumption:	Wireless communication and GPS-enabled sensors in place
Actors	Maintenance sensor call centre staff, maintenance technicians
Steps	1. Leak detected via sensors 2. Information on GPS location communicated to call centre 3. Call forwarded to maintenance technicians 4. Cars with GPS location dispatched
Issues	Communication network to be functional

The quality of water is a health barometer in communities. Establishing water risk sources and being able to forecast and give early warnings against pollution incidents is crucial in the maintenance of high-quality water. In the IoT technology water treatment demonstration project in London (Internet of things technology water treatment demonstration project, 2012), the system adopts wireless technology and sets distributed wireless monitoring substations in areas with intensive signal acquisition points of the water plant and electric control equipment to monitor the operation of the equipment in the water plant. The signal of on-site monitoring equipment is collected by a multi-data acquisition collecting system after it passes through the signal conditioning circuit. It is then sent wirelessly to a wireless monitoring station which in turn sends the signal through wireless to an industrial control computer. After information processing according to the signal it receives, and based on the current status of the process, the industrial control computer sends a control command which is then sent by the wireless master station to the substation. By doing so, the wireless controlled sub-station will control the start and stop of the equipment in the water plant to achieve its overall automatic control. Therefore the system is about wireless automatic monitoring of water quality at different sites, establishing water risk source identification and management systems to forecast and give early warnings against pollution incidents. The revenue is generated through distribution of water services to citizens. The competition is among water services providers. The infrastructure consists of sensors that communicate to a central control system. The sensor message triggers an event which makes a decision on action to be taken.

The next use case is on monitoring water quality at various substations of a city's water works.

Use case:	Wireless monitoring of water quality
Description	Automatic wireless monitoring of water quality at various distributed substations to establish sources of water risks, forecasting risks and sending early warning
Assumption:	Wireless communication and sensors in place
Actors	Central node staff, maintenance technicians, water substation
Steps	1. Electronic control equipment monitors water quality and generates signal at a substation of the water plant 2. The signal passes to a multi-data acquisition collecting system 3. The data is forwarded to an industrial control computer at the monitoring station wirelessly 4. The industrial computer processes the information and sends a control command to the substation being monitored 5. The substation will control the start and stop of the equipment automatically
Issues	Wireless communication network to be functional

IX. Environemntal Management

The cleaner the air, the healthier the citizens. It is monitoring and maintaining clean air quality that is the problem. Lessons can be drawn on air quality from the European Union (EU) project, RESCATAME. Pervasive air-quality sensors network for an environmentally friendly urban traffic management (RESCATAME) is an EU-funded project to monitor air quality and urban traffic through a Waspmote sensor board. With data collected from sensors across the city, providing full-time geographic coverage at low-cost, municipalities can efficiently achieve a way of better managing urban traffic in major European cities. The Waspmotes measure parameters such as temperature, relative humidity, carbon monoxide, nitrogen dioxide, noise and particles. If any of the 7 parameters goes above the threshold, the system analyses the information and reacts by sending an alarm to a central node. In order to know where the sensor is located, each Waspmote integrates a GPS that delivers accurate information. It is also possible to transmit data via GPRS, as a secondary radio module for better availability and redundancy in situations when it is critical to ensure the reception of the message, like possible fire alarms. The GPRS module is quad-band (it can operate in 4 different bands, meaning it supports any cellular provider), making it able to work all over the world (RESCATAME, 2011).

The following is a use case for monitoring pollution and noise levels in the city.

Use case:	Monitoring air quality
Description	Sensors measure parameters such as temperature, humidity, carbon monoxide, nitrogen dioxide, noise and particles. If any of the parameters go above the threshold an alarm and the GPS location of the sensor is sent to a

	central node
Assumption:	Wireless communication and GPS-enabled sensors in place. Wireless communication should be able to support all cellular providers for the system to work all over the world
Maintenance	Central node staff, maintenance technicians
Steps	1. Sensors detect various parameters 2. Data is processed against the acceptable pollution norms 3. If data is above threshold for any of the parameters, an alarm and GPS location of the sensor is sent to a central node wirelessly 4. A response team is dispatched
Issues	Will the response be automatic or manual

X. SMART ENERGY

Electricity demand, especially during peak hours has to be put under control somewhat. One way of controlling energy consumption is through giving real-time feedback to the user about their energy consumption and prices to enable them to make instant decisions on controlling at any point in time. This can be made possible through a smart meter. A smart meter is an electric meter that records consumption of electric energy at intervals of an hour or less and communicates that information at least back daily to the utility for monitoring and billing purposes. Two-way communication between the meter and the central system is enabled. Smart meters installed across a wide area result in a smart grid. Consumers receive real-time information about their energy consumption or about pricing of that energy and make decisions about what loads – washing, heating, cooling - to connect. While conventional meters are only able to measure aggregate energy consumption, smart meters have several attractive features that allow them to do significantly more. First, they are able to log, in real time, energy consumption at fine granularities and store the values in digital form. Smart meters have a significant communication component that allows them to report their measurements over a wired or wireless data network. In some cases, smart meters can even communicate with surrounding infrastructure devices, for example, in homes, to send real-time pricing signals to end-consumers. Smart meters can typically measure many additional electric parameters, such as max and min power demand, current, voltage and power factor and can notify the utility about power outages (Agarwal, 2011). The market for a smart meter is every citizen that is connected to an electricity supply network. Income can be generated from the supply and installation of these smart meters and payment for the consumption. Also, it can be generated from management and administration of the billing process. Competition is between these suppliers and installers of these smart meters. The infrastructure that is required is the wired or wireless network through which there is communication between the smart meter and the service provider and the consumer.

The following is an aggregation of the above technologies that utilise the smart meter capabilities to sense energy usage in the home and give feedback to the user for control.

Use case:	Energy sensing and real-time feedback to user
Description :	A smart meter has an energy sensor which gathers data on energy consumption in the home. This data is analysed and communicated to the utility via a cellular network for billing and to the consumer as well.
Assumption:	Energy sensors incorporated at many points in the network
Actors	Energy distributors, network engineer, consumer
Steps	1. Smart meter logs in home energy consumption at regular intervals and stores values in digital form 2. The information is communicated via gateway and over a wireless data network to the utility control system 3. Data is analysed for comparison with other homes and on energy draining devices and pricing and power outages 4. Information is sent from the control centre to the consumer via mobile, email or SMS 5. Users controls their consumption habits, i.e. washing, cooling, heating
Issues	Modes of communication between home, utility control centre and consumer

Controlling energy usage in the home can be done from within the home and from outside the home. The issue is on how to control the energy remotely. With the advent of cellular technology this has been made easy. Using a smart phone one can run an application that can switch home appliances on and off remotely. Cellular networks cover far and wide. The target market is the whole populace as long as they have a cell phone that runs the relevant application. Revenue can be generated from downloading this application onto cell phone, installing the relevant technologies in the home to switch applications on and off. Small and medium enterprises can be roped in to maintain the systems in the homes. The infrastructure that is required is the cellular network for communication.

The next use case supports the concept of home energy control anytime, anywhere using cellular technologies

Use case:	Enabling consumer to control electricity appliances in the home remotely using a smartphone
Description :	Using a smart phone to switch home appliances on and off on the basis of status of applications detected in the home from

	anywhere, from visualisations on the cell phone
Assumption:	Home appliances have sensors, home has network access built into it , user has smart phone and smart meters installed in house
Actors	Home owner, electricity supplier
Steps	1. Home owner visualises on smart phone the on/off status of appliances in the home 2. Owner selects appliances to switch on/off 3. Owner remotely switches off and on appliances in the home at the press of a button on the smartphone
Issues	Wireless mode of communication between home and home owner

XI. CONCLUSION

This paper looks at business models and related use cases in the creation of smart cities. It identifies domains of application of smart cities as transport, waste disposal, water management, environmental management, public safety and emergency services and energy. The business models engulf the value proposition of the smart system infrastructure, the market segment, the financing the smart system, the value chain, the position in the network, the competitive advantage and the infrastructure that supports the smart city system. The research shows that there is room for fully automated systems in the delivery of city services. The paper also creates opportunities for research into the design and development of smart systems to respond to specific problems through identification of various use cases. In the definition of smart cities issues the underlying infrastructure is a broadband network for connectivity between the various smart city devices / systems. The broadband can be both wired and wireless. Sensors are an important component of the physical space, as they detect various parameters and generate data. The next research issue will be on what changes there will be to the social dynamics of the cities were smart systems be introduced to fully automate the smart cities.

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