Title of the Session

Citizen science involvement and resident-driven impact assessment

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Smart Monitoring for a Smart City. Environmental Monitoring using Internet of Things (IoT) and Blockchain: Key Solutions for an Efficient Work Execution and an Improved Environmental Communication

1. FOREWORD

For the time being, digitalization could ensure a more sustainable development for cities dealing with challenges brought by new urbanization initiatives.

By the same token, the availability of IoT big data will increase Citizens' awareness on urban environmental impacts.

Therefore, identifying solutions to minimize environmental impacts associated with urbanization initiatives while providing real-time information to Citizens on their effectiveness has brought out two strictly connected targets in a Smart City.

The challenge to identify tools during the execution of a Key Urban Planning initiative that can provide real-time data reliable both for Project execution and acknowledged by Local Community still remains.

Thus, involving and guiding Local Community in real-time monitoring of Atmospheric Particulate Matter by using personal smart technology tools represents an interesting development in such direction.

This solution would improve Project Owner's understanding about the sustainability of construction works and, at the same time, would provide nearby Citizens with real-time information about Project's interactions with air quality.

2. ENVIRONMENTAL MONITORING THROUGH CITIZENS' INVOLVEMENT

The lower costs of sensing technologies, combined with an ever-improving quality of connectivity, means that environmental sensors could be installed in every home, and communities of interest could be created around real time air quality monitoring, especially in sensitive areas such as those surrounding building sites.

These communities could bring together citizens, institutions and corporations that would thus share highly pervasive, real time environmental data for improved risk evaluation and faster reactivity.

The blockchain could provide the decentralized data sharing governance layer required in a typically 'trustless' environment. Additionally, the blockchain could provide the means of 'monetizing' environmental data streams, assigning them a value in terms of tokens per time unit, e.g. tokens/hour.

3. SMART MONITORING OPPORTUNITY FOR URBAN DEVELOPMENT PROJECTS

The present paper shows the opportunities to implement Environmental Monitoring through Citizens' Involvement where Project works are executed for a few years (indicatively at least 3 years) in an urban wide area (ideally extended for more than 50 hectares) with significant volume of soils excavated and managed at site.

While such initiatives are used to implement and manage technical solutions to control dust emissions into the atmosphere (e.g. on-site spraying water over interested areas preventing dust from airborne and/or limitation of soil movements when appropriate during the execution of works), there will likely be a remarkable presence of nearby population groups quite sensitive to poor air quality due to the presence of Particulate Matters.

Even if it is predictable during construction the installation of air quality monitoring station(s) for identifying breathable Particulate Matter concentration at site, a Project Owner decision to provide low-cost sensors to the interested Citizens for monitoring PM2.5/PM10 would lead additional advantages.

Involving nearby Citizens would pursue an integration of traditional air quality monitoring station(s) with low cost sensors installed at residents' homes allowing an instant surveillance over the sustainability of the Project and the availability of real time information that will be used in decision making process during the execution of works.

Engaging with the Local Community using a Smart Monitoring approach would mean connecting citizens to the initiative, rewarding them with instant information about air quality, earning the trust of the neighbors even during the execution of the works, increasing the reputation of the Proponent. In effect, improving the environmental communication of the Project to the relevant Stakeholders.

4. MONITORING PM2.5/PM10 BY CITIZENS' SENSORS

Integration between reference measurements and sensors is a key point for the Smart Monitoring implementation.

In addition to the traditional air quality monitoring station(s), predictable at site and the possible presence of a nearby station already operated by the Competent Authority, the Project would increase spatial coverage through the distribution of low-cost sensors showing good agreement with reference systems.

Preliminary calibration of the sensors by co-location with site monitoring station(s) would enable a preventive comparison of sensors' outputs with the regulatory-grade instruments under a range of realistic local environmental conditions. The same collection of an extensive dataset and their use to assess various calibration algorithms should improve the sensors' performance before their delivery to the interested Citizens.

Sensors operating should be representative of the nearby residential areas to the site where construction activities will be carried out (a buffer of 100 mt could be considered as initial reference).

Furthermore, the proposed monitoring network should have a station able to register PM baseline values not influenced by Project activities. Since the main Proponent target is to track any possible significant increase due to construction activities, registering the pre-existing PM level in the surrounding area is strictly necessary.

Smart monitoring can provide key flags about PM increase during the works execution due to Project activities indicating the overall quality trends for PM2.5/PM10.

5. SMART MONITORING KITS

A smart monitoring kit is made of hardware components – i.e. a particulate matter sensor – and software components, i.e. control logic and communication stacks.

During the sensors' selection process, it is necessary to analyse their hardware specifications to assess their overall impact on the project.

Regarding particulate matter sensors, in order to assess data quality, it will be necessary to evaluate Accuracy, Range and Resolution. Similarly, it will be necessary to evaluate the sensors' energy consumption profile and determine a minimum sampling frequency.

Electrical specifications of a sensor allow to calculate the power needed to run the sensor and thus to select the proper power supply equipment – i.e. a 10/20W solar panel, a 10Ah Battery, an MPPT Solar Charger.
The software components, such as the logic needed to integrate with the sensor and the logic implementing communication protocols, allow to extract sampling values from the sensing devices and send them toward the cloud in a push only streaming fashion.

Smart monitoring kits will be made available to citizens willing to actively take part to monitoring activities. The kits will be delivered fully configured and ready to be installed.

6. MANAGEMENT OF MONITORED DATA

The Sensors will send data streams to a Data Broker in the Cloud. Data streams will be sent to the Broker with a 'push' mode.

The Data Broker, based on standard protocols such as MQTT, will have a number of different subscriber applications (i.e. Data Users), for example for risk evaluation, business intelligence, complex event processing & risk alerting etc. These applications might belong to different stakeholders, such as the Building Site Owner, the Project Owner, individual Citizens, consumers association, institutions, universities etc.

Each citizen with a home-based environmental sensor – the Data Owner – will use Smart Contracts in the blockchain to grant and revoke data access to each individual stakeholder looking to access their data streams. Smart Contracts will also set the data streams' value in tokens/hour. Data Owner and Data Users will interact via a cloud-based Data Streams Exchange Hub. This Hub will be managed by the Project Owner, who will invite selected Citizens and Stakeholders to participate.

7. COMMUNICATION FOR SMART MONITORING

For Smart Monitoring implementation a dedicated communication should be set for involving both the Community (Citizens/Institutions) and Stakeholders/Third Companies.

Therefore, narration should be provided through strong contents stressing following key elements: the visibility over air quality data streams generated by particulate matter sensors installed at Citizen's home, the possibility to share such data in a General Data Protection Regulation compliant manner and get rewarded for sharing it.

Disclosing the initiative through direct contacts with Local associations already active in the area, a social network campaign and traditional local media would effectively increase the reputation of the Proponent and of his Project engaging Community and Stakeholders/Third Companies at the Smart Monitoring purpose.

8. REFERENCES

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