UNITED NATIONS UNIVERSITY

UNU-EGOV

Operating Unit on Policy-Driven Electronic Governance

Smart City Applications Catalogue

Checklist and Suggestions

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This document is part of Flavio Yuaca's work plan, under the supervision of Judy Backhouse, during his time as a Visiting Fellow at the United Nations University Operating Unit on Policy-Driven Electronic Governance (UNU-EGOV) in Guimaraes, Portugal, and was written in September 2019.

- Judy Backhouse has experience as both an academic scholar and an information and communications technologies (ICT) practitioner. She is currently a Senior Academic Fellow at UNU-EGOV, after eight years as an Associate Professor at the University of the Witwatersrand in Johannesburg. Her recent research has been into the role of information systems in implementing smart city agendas in the African context. She has researched ICT for development as well as aspects of e-Government. Dr Backhouse has worked in the private and public sectors. In the private sector she worked in technical and management roles over a twelve-year career which began with designing and programming systems and ended with the strategic management of ICT within organisations. She spent two years at the South African Council on Higher Education where she was responsible for monitoring the Higher Education Sector in South Africa and advising the Minister of Higher Education. She also has experience as an entrepreneur, having launched (and closed) a co-working business in Johannesburg.

- Flavio Yuaca is currently a Visiting Fellow at UNU-EGOV. He is a geoprocessing expert (Universidade Federal do Paraná, Brazil, 1996) and has been working with Information and Communications Technology (ICT) for more than 25 years. At Goiania City Government (Brazil), he was the executive coordinator for projects derived from the Inter-American Development Bank's Emerging and Sustainable Cities Initiative, including the Greenhouse Gas Inventory, Results-Based Management and the Integrated Operations and Control Center (IOCC), part of the strategy to introduce Smart City concepts in Goiania. He coordinated the development of SIGGO (Geographic Information System), MUBDG (Digital Map of Goiania) and eDOC (Electronic Documents). He was also a database and data administrator and was responsible for implementing real-time systems at Caixa Economica do Estado de Goias (bank). He was the research and development manager for one of the first AFC (Automated Fare Collection System) for public transportation in Brazil. He also served as a member in editorial boards of Brazilian geographic information and technology magazines such as MundoGEO, infoGEO and Fator GIS and as member of technical committees for events such as MundoGEO Connect, GIS Brasil, and Brazilian Symposium on Geoprocessing, GEOBrasil and GEO Summit Latin America. He was an instructor at GITA (Geospatial Information and Technology Association) and in postgraduate courses in the area of geotechnologies.

16 October 2019

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List of Acronyms

AI	Artificial Intelligence
GDP	Gross Domestic Product
GIS	Geographic Information System
IBM	International Business Machines Corporation
ICT	Information and Communication Technologies
IoT	Internet of Things
ITU	International Telecommunication Union
KPI	Key Performance Indicator
SDG	Sustainable Development Goals
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNU	United Nations University

1. Introduction

1.1 Objective

The purpose of this document is to serve as a checklist for the production of a Smart Cities Applications Catalogue. Each checklist item contained in this document is a suggestion to be considered in the catalogue development. Suggestions were made considering a commonly used catalogue, available online and published through a website. It may also be of use when creating or managing similar online catalogues.

This document attempts to answer the following question: Which are the aspects to consider when creating or managing a Smart Cities Applications Catalogue?

1.2 How is this text organized?

This document is structured in four topics:

- Introduction, which describes the objective, the methodology and contains a brief exposition of concepts and the relevance of a Smart Cities Applications Catalogue.

- Checklist. Suggestions list. Each suggestion refers to one aspect of the Smart Cities Applications Catalogue and contains a brief discussion of the topic. It is organised as follows:

  o Content suggestions

  o Functionality suggestions

  o Context-related suggestions

- Final recommendations

- Annexes

1.3 Warning

Before using this document, keep in mind that:

- Some suggestions are obvious but were kept as a reminder.

- The suitability of incorporating a suggestion should be evaluated in each case.

- Some checklist items may not be viable for your catalogue. Disregard them.

- Some checklist items may have unfavorable cost-benefit for your project. Disregard them.

- The checklist covers a small part of the subject. It was not intended to systematically cover every aspect of a catalogue.

This document contains statements that were not based on documented evidence, but mainly on observation and interpretation. Obtaining evidence and confirming the hypotheses may be subject of further research. Some suggestions are in Annex E.

1.4   How was this text produced?

In short, the process for producing the checklist was as follows:

- A list of websites that could contain a Smart Cities Applications Catalogue was compiled using internet search and referrals. Some websites appear to be generic catalogues, while others appear to be linked to a platform, technology or industry. The websites of the second group were not reviewed. The list of websites that were considered is available in Annex A.

- To better understand how a catalogue works, some projects have been added to an existing Smart Cities Applications Catalogue, as described in Annex B.

- A simplified and informal script was produced to facilitate the analysis of websites and better understand their characteristics. See Annex C.

- A list of suggestions for producing a Smart Cities Applications Catalogue was compiled using prior knowledge and after browsing the websites. See Topic 2 – Suggestions.

- These suggestions were reviewed by experts and their comments were incorporated into the text. See Annex D.

1.5   Relevance of a catalogue

A catalogue of smart applications may be a useful resource when a city is considering an investment in a Smart Cities project. Mayors, legislators, technicians, and other stakeholders can quickly and easily understand basic Smart City concepts by observing smart applications in other cities. Besides, a catalogue:

- can document how a problem was solved, what the cost of the solution was, the results, and the difficulties it faced. A catalogue can simplify and streamline the process of deciding which smart applications will be part of the project.

- can accelerate the process of adopting Smart City concepts by allowing experiences from other cities to be consulted quickly and neatly.

- can also help a city avoid obstacles and find ways to deal with problems that have already been solved by other cities.

- lets suppliers connect with consumers.

- lets users interested in a solution connect with users who have already deployed it.

- also serves as a documentation of the evolution of Smart Cities, allowing future researchers to understand how solutions have developed over time.

Although relevant, a catalogue is only a tool. A Smart City project is not a collection of applications. The applications should be part of a Smart City strategy or a digital transformation strategy for the city.

1.6   Success factors

There are several alternatives to measure the success of a catalogue. This document considers that a successful catalogue is one that has become a reference for the Smart Cities user community and is sustainable in the long term. Becoming a reference means being the industry's most mentioned and most accessed catalogue.

Examples of factors that can influence the success of a catalogue:

- Size of the user community. Although every city is a potential user of the catalogue, the current user community is much smaller. It may be so small that it is not sufficient to even keep the catalogue updated. Even if the users have a high demand for a catalogue, they must be in sufficient number to justify the catalogue.

- Demand from the user community. Even if the user community is big, they may consider it irrelevant to have a catalogue and may not generate sufficient demand to justify a catalogue. Demand is related to long term sustainability of the catalogue.

- Easy to find. The catalogue should be easily found by search engines.

- The number of objects registered in the catalogue. At first glance, this factor might be even more important than quality, which is more difficult to evaluate.

- Data quality. Quality, in this context, refers to relevance and the adherence of data to reality, including whether they are current.

- Functionality. Ease of use. Availability of functions required to consult the catalogue.

- Attractive design.

The checklist contains other factors.

1.7   Basic concepts

Some of the concepts used in this document include:

- Catalogue: a list of objects and functions that act on these objects. Functions can act on the object list, on a specific object, or on different objects that are related.

- Object: a smart application, project, city, user, event, or any other catalogued item. In this document, the word "Object" is also used to mention an instance. For example, cities are an object and a specific city can also be referred to as an object. Objects have attributes that make up their documentation.

- Website: a set of web pages that can contain a variety of Smart City resources, including a catalogue. The website contains the catalogue objects and implements its functionality. This document also mentions websites not related to Smart Cities.

- Catalogue Team: the team responsible for maintaining the catalogue. It may be the department of a development bank or government, a startup or company created for this purpose, a university group, a non-governmental organization or a team hired specifically to maintain the catalogue.

- Smart application: a solution to a problem in a city using Smart City concepts. A set of hardware, software, people, procedures, and communication networks that have been integrated to solve a problem. Not every city that has multiple smart applications is a Smart City. For example, one city has a smart application for traffic signal control and another for emergency vehicles dispatch, but an ambulance cannot prompt the traffic light to stay green for a few more seconds. There are two unrelated smart applications in a context that does not configure a Smart City. Similarly, not every application deployed in a Smart City is a smart application. In this document, the term Smart Application sometimes includes the concept of the Project that implemented it.

- Project: the implementation of a smart application in any city or region. For example, the same smart application may have been deployed in several cities. Each deployment is a project. A single project may have deployed multiple smart applications.

- "A smart sustainable city is an innovative city that uses information and communication technologies (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" (UNECE and ITU, October 2015).

- A smart city is a city where technology is used in a sustainable and ubiquitous way to improve the quality of life of its citizens. In this document, smart city and smart sustainable city are synonyms.

Some of these concepts, such as Smart Applications and Smart Cities, might be the subject of further discussion.

2. Suggestions

2.1 Content suggestions

2.1.1 Catalogue content

In the context of this document, the main contents of the catalogue are the smart applications. Other objects may enrich the catalogue, but they should not overshadow the smart applications repository. Some additional objects that complement the catalogue may include:

- Cities: smart applications already deployed can be associated to a city. The city repository can be associated with indicators to allow a user to identify smart applications in similar cities.

- Countries: cities may be associated to a country.

- Projects: a project consists of activities related to the development and deployment of a smart application in a particular location. For example, an adaptive traffic signal control system (smart application) has been installed in three different cities. Each installation had its own cost, schedule, results, and staff, although the smart application is the same. In this example, the catalogue contains one smart application and three projects. Many smart applications are unique, tailored to each city. In this case, the catalogue team may choose to integrate the documentation of projects and smart applications. If a smart application has been deployed in three different cities, it will be catalogued three times. The alternative of separating the project documentation and the smart application documentation may be better in the long term in a mature industry scenario. The alternative of documenting the project and smart application together may be simpler in the short term.

- Suppliers: smart applications may be associated with one or more suppliers who participated in the project. Suppliers who did not participate directly in any project can also be part of the catalogue.

- Users: members of the Smart Cities user community. Users can describe themselves as experts, consultants, government officials, researchers, teachers, students, contractors or simply someone interested in Smart Cities. User registration can serve as a user resources repository.

- Tenders: list of tenders. An instrument for connecting suppliers and contractors. It would serve as another channel for contractors to publicize their projects in specialized forums. In countries where the legislation requires the publication of tenders in mass-circulation

newspapers, there could be an effort to include the catalogue as an approved alternative. This would make the catalogue official and better known.

- Articles and blogs: opinions, technical or scientific articles that address aspects of Smart Cities, applications and projects, produced by experts, researchers or community members.

- Events: fairs, conferences, exhibitions, courses, workshops, road shows, and other events related to Smart Cities.

- News: news that matters to the Smart Cities community. News is a way of including current information, requiring fewer resources than cataloguing a smart application or project. This is a simple way to signal to the community that the catalogue is active. To keep the focus of the catalogue, consider prioritizing news related to applications or projects already catalogued.

- Tags: There may be several types of tags. For example, tags to identify the stage of a project (planning, specification, deployed, etc.), tags to identify results achieved (cost reduction, time reduction, improvement in the quality of services, etc.). The initial set of tags should be created by the catalogue team. Tags suggested by the user community would only be included after the approval by the catalogue team.

- Comments: Smart applications, projects, cities, events, articles, and other objects may have a comments section where users can publish their opinions.

SMART APPLICATIONS ARE THE MOST IMPORTANT, BUT OTHER OBJECTS ENRICH THE CATALOGUE

2.1.2   **What does the catalogue offer**

It should be clear to the user what the catalogue offers:

- Catalogue contents. Show all objects - not object instances - and their quantities in one place so that the user does not have to navigate to different parts of the catalogue to understand its contents. Make this page easy to access.

- Catalogue functions. Show all available functions in one place so that the user does not have to look at different parts of the catalogue to understand what it offers. Show all things the user can do using the catalogue: queries, selections, maps, triggers, add new smart applications, etc. Make this page easy to access.

All examples should have a hyperlink that takes the user directly to the catalogue page that contains the object or functionality.

CLEARLY SHOW ALL CONTENT AND FUNCTIONALITIES

2.1.3   Quantity of smart applications and other objects

The number of smart applications and other objects registered in the catalogue is very important in making the catalogue remembered, used and recommended. Initially, quantity may play a role as or more important than quality in the promotion of the catalogue, as quantity is easier to measure than quality. The catalogue should publish its main quantities: smart applications, projects, and other objects. Quantities should be emphasized in promotion strategies.

QUANTITY MATTERS

2.1.4   Smart application and project documentation

The catalogue should allow detailed documentation of smart applications and associated projects. To make it easier to understand and compare, at least part of the documentation should be structured. The following lists contain attribute suggestions.

Some – or even most - attributes may be defined as optional, allowing smart applications with incomplete documentation to be published.

Smart applications and projects can be modelled as a single object or separately. For long term goals, a separate approach is suggested.

Examples of attributes that can be part of the documentation for both smart application and project:

- Title;
- Short description;
- Detailed description;
- Participants;
- Comments;

- Links, photos, videos, documentation, graphics, and other media containing more information;

- Sources;

- Keywords;

- History with dates and major milestones.

Examples of attributes that might be part of a smart application's documentation:

- Expected benefits;

- Problems that the smart application wants to solve. Answer to the question: What is the purpose of this smart application?

- Classes. The application can be classified under different classification groups:

  o Class A: Safety, Energy, Transportation, Health, Education, Waste, etc.

  o Class B: Governance, Economy, Mobility, Environment, People, Living, Community, and Infrastructure as it appears in http://icities4greengrowth.in/theme/domain.

  o Class C: Environment, Mobility, Government, Economy, People, Living (Smart Cities Wheel, Cohen 2012).

  o Class D: United Nations (UN) Sustainable Development Goals (SDG) addressed by the application.

  o Class E: other classification criteria for grouping similar applications.

- Architecture and main components;

- The geographical scope of the smart application. Indicates whether the smart application is intended to be deployed in an area that involves multiple cities (district, state, metropolitan region), city, highway or corridor, building, or single residence;

- Key performance indicators (KPI);

- Technologies used: IoT, blockchain, GIS, AI, etc.

Examples of attributes that may be part of project documentation:

- Related smart applications. A project may have deployed more than one smart application;

- Context;

- Funding;

- Costs;

- Current project status;

- Area served. One of the best alternatives for implementing this attribute is through geo-referencing;

- Project results;

- Challenges, obstacles and difficulties;

- Recommendations;

- Key performance indicators (KPI) obtained after deployment.

Several attributes can be modelled as tags. Examples: Benefits, smart application scope, keywords, areas served, situation, United Nations Sustainable Development Goals, etc.

DEFINE THE CONTENTS OF THE SMART APPLICATION DOCUMENTATION

2.1.5   Challenges and difficulties

Difficulties, limitations, problems, mistakes, and challenges faced by a project are seldom disclosed but are very useful especially for those who will start similar projects. Vendors and users generally do not emphasize negative aspects, and it can be difficult to obtain this type of information. The users should be encouraged to report challenges faced by the project and point out causes and suggestions to avoid problems.

ENCOURAGE PUBLICATION OF NEGATIVE ASPECTS

2.1.6   Metadata

Metadata increases the usability of data. Even if a catalogue contains errors, metadata may help the user evaluate if it is suitable. The catalogue should include metadata. Examples:

- When an object was added or updated;

- Who added or updated;

- Completeness of the object documentation;

- How many times the object was queried.

COMPILE AND PUBLISH METADATA

2.1.7   Certification

The certification of objects registered in the catalogue aims to assess whether the data reflects reality. A certification model using a specific team can be viable when the number of objects is small. But for a large number of objects (hundreds or thousands of smart applications, for example) the resources needed to certify can make the process unfeasible.

However, the catalogue may have simplified mechanisms that allow the user community to register their disagreement or approval through endorsements or opinions. This is used on many websites (Uber, Airbnb, and LinkedIn). It does not guarantee the accuracy of the data but may give indications about its quality.

A smart application may be endorsed by the government and vendors who claim to have participated in the project. Consultants, suppliers and even contractors can be endorsed by the user community.

Endorsement of the catalogue itself should be one of the goals: Testimonials from mayors, legislators, universities, and prominent members of the user community can help improve the credibility of the catalogue.

The catalogue should support certification even if, in the beginning, certification proves to be largely unfeasible due to lack of resources or lack of interest.

In a mature catalogue, there may be a demand for formal certification. For example, a vendor may be interested in paying for a consultant to certify its application or project.

Certification adds value to the vendor, to the user community, and to the catalogue itself.

CREATE A CERTIFICATION MECHANISM

2.2   Functionality suggestions

2.2.1   Authentication

Access to the catalogue should be as simple as possible. A user should be able to browse the catalogue with a minimum of effort. The user should be able to query the catalogue without authentication.

Authentication should be designed to control and not necessarily to prevent data update by unauthorized users. Controlling means knowing what data has been updated by a particular user, even if that user is unknown.

AVOID REQUIRING USER AUTHENTICATION

2.2.2   Finding objects

When a catalogue contains few objects - and it is usual for a catalogue to be small at first – selection and search mechanisms may be less relevant. For catalogues with many objects, it is essential to have advanced functions to locate and organise the desired objects.

The following lists show some search scenarios:

What are the smart applications…

… related to public safety

… related to facial recognition

… that were deployed in London (city)

… that were deployed in Germany (country)

… that were deployed within 500 km of Frankfurt (spatial analysis)

… that are in cities with a population and GDP similar to the city of Cairo

… provided by IBM

… in which a particular consultant participated

… that are deployed in more than 10 cities

… that are deployed in more than 5 countries

… that cost less than $ 500,000

… that have been operational for over 3 years

… deployed in 2018

… that use blockchain

… are in the hiring phase

… resulted in reduced service delivery time

… have a tag that indicates PUBLIC TRANSPORTATION

… currently serving over 10,000,000 inhabitants

What are the technical or academic articles…

… related to public safety

… related to facial recognition

… that have more than 5 endorsements

… published between January 2018 and June 2018

Who are the suppliers…

… who deployed smart applications related to public safety

… that have more than 5 endorsements

… who have developed more than 5 smart applications

More examples…

… what are the news reports from this region

… what are the events that will happen in this city

… what are the events in March this year

It should be possible to select or locate any object using any – or most – of its relationships and attributes, including spatial and temporal attributes. For more information about searching with spatial components see the GEO-REFERENCE topic.

The selection engine should be constructed to allow the basic Boolean operators: AND, OR, NOT. One alternative to simplify the use of Boolean operators by non-specialized users is to work with list selection. At the beginning of a selection, the current list contains all objects - all smart applications, for example. After the execution of a selection, the list will contain only objects that meet the established criteria. When executing a selection, the user informs if the selection will be applied only to the elements in the current list (AND), if it will be added to the current list (OR) or if the selection should be applied to all objects (new selection).The list can be inverted. All selected objects become unselected and vice-versa (NOT). This mechanism does not allow all combinations of operators but offers the user the ability to perform complex selections involving multiple criteria while maintaining the simplicity of the interface. Adding new selection criteria has less impact compared to selection forms that try to include multiple criteria at the same time.

This mechanism enables the user to perform relative complex selections:

Which smart applications are related to public security and face recognition, uses blockchain, were deployed in 2018 in the United States in cities with population up to 250.000 and are within 500 km of Chicago, IL.

The initial interface for object selection should be simple. If necessary, the user can enable the advanced selection interface.

INVEST IN SEARCH AND SELECTION FUNCTIONS

2.2.3   Geo-reference

Whenever possible, objects should be associated with a position on a map. Associating an object with a map facilitates searches and enables the use of spatial analysis. Geo-referencing allows the user to search from the map and view search results on the map. Since the catalogue is related to Smart Cities and the primary user is probably someone working in a city, there may be great interest in viewing the spatial distribution of smart applications, consultants, suppliers and other objects.

The geo-reference allows queries such as:

Which smart applications...

... use vehicle license recognition cameras along this highway

... are related to garbage collection within 500 km of Frankfurt

... are in areas with high population density

... are related to traffic signal control systems and are far from smart public transport control applications

Which are the regions with high concentration of...

... smart applications

... smart applications related to public safety

... experts or academics

... suppliers

... Smart Cities

Which experts are close to...

... this city

... my project

... my client

... this university

Typically an object can be geo-referenced to a point, polyline, or polygon on a map. A simpler deployment may include only the option to geo-reference to points.

Geo-referencing is already being used on some websites (hotels.com, kiwi.com).

The user should be able to display the results of any selection involving geo-referenced objects in a map.

USE MAPS

2.2.4   Triggers

The catalogue should allow the user to enable automatic sending of a message whenever a particular event occurs. The message can be sent via email or another low-cost channel. Triggers reduce the user effort to find the desired information in a constantly updated catalogue.

Examples:

- The city mayor wants to be informed when any city with a similar profile deploys any smart application.

- The city mayor wants to be informed of any new smart application in cities within 200 km of his city.

- The municipal traffic agency director wants to be informed whenever a new smart application related to traffic signal control is included in the catalogue.

- The consultant wants to be informed whenever someone consults his data.

- The consultant wants to be informed whenever a project related to street lighting is included.

- The supplier wants to be informed when a new consultant with expertise in IoT is included in the catalogue.

- The smart parking provider wants to be informed when a similar project is included in the catalogue.

- The researcher wants to be informed when new conferences in their country are registered.

- The researcher wants to be informed whenever a new application using blockchain comes up.

A set of special triggers should support the users that include projects. Unless the user opts out, the catalogue will inform periodically which data is missing. If the user reported that the project will be fully operational in 6 months, the catalogue will remind the user to complete the documentation with results, lessons learned and other implementation data that were not available when the project was initially included.

ALLOW TRIGGERS

2.2.5   Ranking

List of objects sorted by some criteria, creating a ranking, are naturally attractive.

The catalogue can publish rankings:

- The cities with the highest number of smart applications
- The cities that invested the most in smart applications
- The countries with the highest number of Smart Cities events
- The countries with the highest number of Smart Cities
- The suppliers with most cities served
- The suppliers with the highest number of smart applications developed
- Cities with older smart applications
- The consultants who participated most in projects
- The most consulted smart applications by the user community

Rankings built from smart applications and other objects voluntarily added without certification may contain major distortions. For example, a city with many smart applications does not appear in the ranking because no one was interested in including its projects. Rankings are at least meant to show the reality of the catalogue, even if they don't show the reality of the world.

Rankings can become a powerful tool for implementing a catalogue policy. For example, if the catalogue team wants to increase supplier certification, a ranking showing this could encourage suppliers to seek certification.

Rankings can encourage vendors and cities to register their smart applications.

Rankings can encourage mayors to research more about smart applications.

PUBLISH RANKINGS

2.2.6   Contact us

The user should have a way to contact the catalogue team to suggest, criticize, complain or request more information.

The catalogue team should be able to provide some sort of response in a short time, even if the answer is automatically generated.

INCLUDE A CONTACT US

2.2.7   Newsletter

Even if a newsletter is desired by only by a few users, the catalogue should have an option to keep users informed.

There should be an effort to verify if the user that requested the newsletter wants to continue to receive it. This can be achieved by asking for confirmation once in a while. The newsletter can include the request for confirmation. The number of confirmations may indicate whether or not an investment in a newsletter should continue.

A very basic newsletter can be automatically generated - thus not consuming too many resources - and may include new smart applications and objects, quantities, trends, ranking changes, statistics, upcoming events, etc. This low cost newsletter may be viable even for few users.

NEWSLETTERS: USE WITH CAUTION

2.2.8   Help

The catalogue should contain instructions for the various operations, in particular for locating smart applications and adding new objects.

Help can be passive - the user goes to the help when need some information - or active - the catalogue informs the user when an operation appears to be incorrect. Active help can be used, for example, to avoid the same application to be included twice, to avoid using inappropriate words or to suggest how to make the content more relevant. Active help can also be used to guide the user through a sequence of steps to perform a more complex task.

BUILD AN ACTIVE HELP

2.2.9 Presentation in lists

There are some presentation alternatives to show the selected objects:

A. The user provides the search criteria, and the catalogue returns the smart applications that meet the criteria. The catalogue only displays smart applications if the user asks.

B. The catalogue shows the complete list of smart applications. When the user provides the search criteria, the list is filtered to keep only smart applications that meet the criteria.

In the first alternative, the catalogue shows no objects until the user asks for more objects. In the second alternative, the catalogue shows all objects until the user asks for fewer objects. The second alternative seems to be more suitable for a general public. It allows even users who are unfamiliar with the website to have easy access to the content. There is no need to specify selection criteria to see the complete list of objects.

Lists can be long and, as is common on many websites, may be shown in groups (a certain amount of objects per page, for example). The initial classification may be in descending order of the date they were included. This causes the list to return the newest cases first. The frequent user may see a different list every time he or she checks the catalogue. The catalogue must provide the functionality of sorting the resulting list.

Once the user sees the list, the catalogue allows him or her to perform operations on any object of the list. For example, ask for the object's documentation.

Lists:

- Objects should be presented in a list.
- The initial list presented to the user should contain all objects.
- The objects in the list can be selected using criteria specified by the user.
- The list can be sorted.

- The list can take many forms depending on the interface design and user-entered parameters: lines, text, icons, boxes, tiling, etc.

- The basic functionality of the list does not depend on the type of object it contains. Being able to sort, export, get details and print, for example, is independent of whether the list contains smart applications, projects, users or events.

- The user can execute functions on the whole list (print details of each object of the list, for example) and on each element of the list (show the documentation of a specific object of the list, for example).

- Each type of object accepts a particular set of functions. The functions that can be performed on a smart application may differ from the functions that can be performed on an event.

PRESENT OBJECTS IN LISTS

2.2.10   Presentation of derived data

The presentation of an object may contain data and statistics derived from attributes, relationships and other objects.

Examples:

The presentation of a city can show the total amount invested in smart applications, obtained from the sum of the costs of all projects that took place in the city.

The presentation of a smart application can show an estimate of the potentially affected population, obtained from the sum of the population of all cities where the smart application was deployed.

SHOW DERIVED DATA

2.2.11   Presentation of related objects

When presenting the documentation of an object, it is important to decide which other associated objects will be shown.

Examples:

- The presentation of a smart application can contain the cities where the smart application was deployed and the list of vendors involved. A hyperlink lets you navigate to the presentation of each of the associated cities and vendors.

- A city presentation can show the smart applications that have been deployed in that city. A hyperlink lets you navigate to the presentation of each smart application.

Note that these examples do not depend on whether the smart application and project documentation were done separately or jointly.

Even when the part of the data that describes the object is shown without the need to navigate through a hyperlink, the hyperlink should be present, allowing the user to navigate to the object and get all the details.

Whenever an object contained in the catalogue is mentioned, there should be a hyperlink to it.

CONNECT OBJECTS

2.2.12   Internal architecture

This document does not address the internal architecture of the catalogue.

However, considering that the internal architecture can impact the usability of the catalogue, here are some observations:

A simplified data model that shows how objects are related can be derived from the contents of the FINDING OBJECTS topic.

Adopting a superclass (supertype) that includes all objects contained in the catalogue may produce a simpler system and even a clearer interface, as sometimes the interface reflects the internal architecture. This superclass would include smart applications, cities, vendors, experts, events, and even news. Attributes of this superclass can include its primary key, name or description, spatial and temporal location if relevant, and at least one n-n self-relationship that has the relationship type as its attribute. This self-relationship allows many semantically different relationships to be registered in one place, in a single structure that demands a single set of algorithms:

- which vendors participated in a smart application

- which experts endorsed a smart application

- which users endorsed an expert

- who are the authors of an article

- any other relationship involving any two objects instances. Although it supports only two object instances in a single relationship instance, 1-n, n-1, 1-1 and n-n relationships can be implemented using this approach.

The superclass can relate to generic entities such as those that record metadata, historical data, and even certification data. In this architecture, any object - even those yet to be implemented – has a minimal functionality, which can be enabled or not.

If the catalogue is deployed without the geo-reference part (see the GEO-REFERENCE topic) the self-relationship can also be used to register:

- in which cities a smart application has been deployed or which are all smart applications in a city - both are derived from the same self-relationship;

- where an event will occur;

- who are the specialists living in the city where I want to start a project;

Adopting this superclass can greatly simplify the effort to develop the catalogue and especially the inclusion of new types of objects. This superclass allows the algorithm used to locate and display all experts who worked on a smart application to be the same to identify the smart applications in a city (assuming no geo-reference) or who endorsed a supplier. Semantically different relationships using the same structure.

USE SUPERCLASSES

2.3   Context-related suggestions

These are suggestions not related to content nor to functionality.

2.3.1   Target user

Catalogues can be built to suit various user groups. However, it is important to identify who the primary target user is. The catalogue must address the needs of this user group. A secondary target user can also be defined, but the priority should be clear. Solutions that are good to the secondary target user but are negative to the primary target user should be carefully evaluated.

The primary target user needs to realize with a minimum of effort that the catalogue has been built for him or her. It should be possible to identify the primary target user after briefly browsing the website or even by the content of the homepage.

Users of the catalogue can be many: a vendor who wants to show its products and services, a university researcher looking for evidence, a mayor, legislator or a government employee who wants to know Smart Cities better.

Primary user target

The suggestion is that the primary target user of the catalogue should be the person with the decision-making power to invest or recommend a Smart Cities project and seeks data to support his decision. In many cases, this person works for the government and is interested in knowing the benefits of smart applications being deployed in other cities. The primary target user is someone who may not have an ICT background, does not know the concepts of Smart Cities in detail but possibly knows the problems of the city and is looking for solutions. The primary target user may be involved in defining the public policies that will be adopted by the city. This profile fits in a mayor, a legislator, a president of a government agency or a government technician. It may be, for example, a mayor who attended a Smart Cities conference and wants to understand better the benefits and the solutions. Or can be the president of a public company that visited another city that has deployed smart applications and wants to assess whether it is worth investing in similar applications.

Secondary Target User

A catalogue popular with investment decision-makers will likely attract suppliers. Suppliers make up a group that may have details of the solutions, ability, resources and interest to keep the catalogue up to date. Suppliers, therefore, are important to the sustainability of the catalogue. Consultants, experts and other users selling Smart City related services and products are also part of this group.

Other users

Other user groups that can be served by the catalogue include researchers, development banks and the average citizen.

ADDRESS THE NEEDS OF THE PRIMARY TARGET USER

2.3.2   Motivation to use the catalogue

When designing a catalogue, it is important to consider why each of the target user groups would participate. The following discussion assumes that the user has been able to locate the catalogue, knows its contents, and can use the interface.

Primary target user: the person with the decision-making power to invest in or recommend a Smart Cities project uses the catalogue because of the benefits it brings: ideas for solving the city's problems, data regarding costs, schedule, errors, benefits, contact with suppliers and with other users who have already deployed similar solutions.

For the primary target user, the quantity, quality, and reliability of the information are essential, as well as the catalogue functionality and ease of use. Because this type of user may not return often, the ease in which the catalogue is located by search engines and the frequency that it is recommended by other users is of great importance.

Secondary target user: vendors, consultants, and others who sell Smart Cities-related services and products are looking for a channel where they can present their products and services. For the secondary target user, the motivation to invest resources in updating the catalogue is the possibility of becoming visible to the primary target users.

The interest of the primary target user depends on the maintenance of the catalogue done by the secondary target user, and the interest of the secondary target user depends on the acceptance and use of the catalogue by the primary target users. There may be no primary target users because there are no secondary target users and no secondary target users because there are no primary target users.

The success of the catalogue depends in part on getting secondary target users to work even before the catalogue is adopted by the primary target users. One alternative is to have sufficient resources to build and maintain the catalogue without the participation of the secondary target users until it is adopted by the primary target user.

DEFINE AN INCENTIVE MODEL

2.3.3   Search engine

The user has to find the catalogue. It is of great importance that search engines locate the catalogue from keywords such as

- smart cities (or smart city)
- smart cities applications
- smart cities solutions
- smart cities catalogue
- smart cities providers
- smart cities cases
- smart cities user cases
- smart cities projects

Preferably the catalogue should appear in the first page of search results for the most commonly used search engines such as Google, Bing and Yahoo!.

See http://gs.statcounter.com/search-engine-market-share to check search engines market share.

THE CATALOGUE MUST BE FOUND

2.3.4   Marketing

Even if a catalogue has the most complete content and the best functionality it is important to have a marketing strategy to reduce the time to be adopted by the user community. Announcements in Smart City's publications, exhibitions and conferences may be part of the advertising strategy. Specialists, consultants, suppliers, teachers, and even students of Smart Cities-related courses may receive promotion kits. The catalogue must be remembered and recommended, especially by the community of experts, suppliers, and consultants.

The outcome of advertising strategies should be tracked through access statistics that may indicate which are most effective and which should be discontinued.

ADVERTISE

2.3.5   Catalogue monitoring and evaluation

The monitoring and evaluation of catalogue using access statistics should be done periodically:

- The number of hits per day, month, year etc.;
- The number of returning users;
- Average access time per user;
- Dates of increased access;
- Trends in the number of accesses;
- Geographic related statistics and trends;
- etc.

Statistics can be used to measure the effectiveness of strategies to make the catalogue better known. For example, the number of hits after the participation of the catalogue team in an event or after an ad was posted in a magazine should be monitored.

Statistics can be used to identify events. For example, increased access from a certain region or city may indicate that something is happening at that location. Heat maps that show the origin of the access can be made public as another feature available to the user.

Above all, statistics help in decision making, including deciding if the catalogue is feasible and should continue to exist. Indicators and goals can be part of the decision support system.

ANALYSE STATISTICS

2.3.6 Data update model

There are some basic models for maintaining data in a catalogue.

- Content is maintained only by a team created specifically for this purpose.
- Content is maintained primarily by the catalogue team assisted by volunteers from the user community. Data are only published after approval by the catalogue team.
- Content is maintained primarily by volunteers from the user community. The catalogue team provides support and complements the content.

Websites such as Wikipedia and Tripadvisor have shown that it is possible to collaboratively and voluntarily generate useful content from the efforts of the user community.

Projects involving smart applications are being developed in different parts of the world, and the process is just beginning. Maintaining a catalogue for a long time and addressing a large number of smart applications require considerable effort. Obtaining details of a project or smart application can be a complex task even for the team that was directly involved.

For these and other reasons, the alternative of allowing collaborative and voluntary content generation by the user community seems to be the most viable option. In practice, this means that almost anyone interested can include catalogue data.

Even if the update is open to everyone, a dedicated team is essential to maintain the catalogue. Some of the responsibilities of this team may be:

- Maintenance of the environment (website).
- User support.
- Adding data in the catalogue, especially those of great relevance that the community has not voluntarily added.
- Minimal update to indicate to the community that the catalogue is still active, especially over long periods when no voluntary updates occur.
- The initial inclusion of data in the catalogue, enabling its release.

- Dispute mediation: when there is a dispute between two users. Example: Two vendors claim to be the project leader or a user complained that another user included wrong information.

- Stimulate users and cities to publish their smart city strategy, projects and applications.

- Implementation of new functionality.

- Create the catalogue advertisement strategy.

To keep the staff workload down, it is important to encourage the community to take on most of the work. See the MOTIVATION TO USE THE CATALOGUE topic.

THE CATALOGUE DATA SHOULD BE MAINTAINED BY THE USER

2.3.7   Stakeholders

One of the aspects that might interfere with the reliability of a catalogue is related to the stakeholders. It is important to make clear who the catalogue stakeholders are. When the stakeholder is also the provider of smart applications, the catalogue is not expected to be unbiased. The catalogue is not expected to mention smart applications from competitors. Similarly, if the stakeholder is an integrator, it is not expected to announce successful projects from other integrators. If the stakeholders are clear, it is easier for the user to better assess any bias the catalogue may contain.

Some examples of potential catalogue stakeholders:

- Non-governmental organizations

- Governments

- Universities

- Private companies created to manage the catalogue

- Development bank

- Product and service provider

- Association of providers of products and services

- Association of cities

In the collaborative model where any user can register smart applications, bias is likely to exist, even if the catalogue stakeholders are unbiased. The city government staff may not mention the mistakes they made. A vendor may emphasize the strengths of their solution over the shortcomings. A catalogue with bias can still be useful.

CATALOGUE STAKEHOLDERS SHOULD BE CLEAR

2.3.8   Design

The catalogue project should include investments in graphic design, branding, logo, and other aspects that helps the user remember, identify and have a more positive experience with the catalogue. At first, the graphic design of the catalogue may be as or more important than its content, which is unknown by the user.

INVEST IN DESIGN

2.3.9   Social networks

The catalogue should be integrated with social networks such as Facebook, LinkedIn, Twitter and Instagram. This may help the operation and in making the catalogue better known.

INTEGRATE THE CATALOGUE WITH SOCIAL NETWORKS

2.3.10   Compatibility

The catalogue should be compatible with leading browsers in desktop (Chrome, Firefox, Safari, IE, Edge) and mobile (Chrome, Safari, UC Browser, Samsung Internet, Opera, Android, KaiOS, Firefox and QQ Browser).

See http://gs.statcounter.com/search-engine-market-share to check browsers market share.

THE CATALOGUE MUST BE COMPATIBLE WITH BROWSERS

2.3.11   Performance

The catalogue should allow browsing and provide answers in a short time (5 seconds or less, for example).

CARE FOR PERFORMANCE

2.3.12   Language

A general-purpose Smart Cities Applications Catalogue should use English.

Having a second language version of the catalogue can signal to the user that the catalogue may have a bias towards countries that use that language, and also increases operating costs.

Automatic translation of the catalogue to the language chosen by the user may be an alternative even if the translation is not perfect.

USE AUTOMATIC TRANSLATIONS

2.3.13   Funding model

The catalogue will need resources to be constructed, disseminated and maintained.

Catalogues made for specific situations such as supporting a government's policies can be funded with the resources of the project to which it is connected. Development banks or the government itself may fund the initiative.

However, long-term financing models are essential for catalogues made for general use with no set date to be deactivated.

Even if the funding to create and publish the catalogue comes from an investor (startup), government funds or some project, it will be necessary to have a funding model for the long-term operating costs.

If the catalogue becomes a reference with a significant number of suppliers, experts, consultants, tenders, and governments, it may be feasible to sell services:

- Advertisement

- Sponsored content

- Supplier and consultant certification

- Smart application certification

Even with the sale of services, for the long-term catalogue survival, it should be considered that the catalogue will continue to depend partly on grants and help from those interested in institutionally promoting Smart City concepts.

HAVE A LONG-TERM FUNDING MODEL

3. Final recommendations

3.1 Existing catalogues

For the primary target user, it is preferable to have few catalogues with many objects than many catalogues with few objects.

Before proposing a new catalogue, it is important to verify if it is viable to associate with an existing catalogue. The analysis of stakeholders, objectives, content, funding model, catalogue team can help with this assessment.

CONSIDER ASSOCIATING WITH AN EXISTING CATALOGUE

3.2 Smart City strategy

One of the mistakes in Smart City projects is to focus on specific applications rather than discussing applications as part of a Smart City strategy. The catalogue should emphasize the importance for a city to have a digital transformation strategy before identifying eligible applications for their smart city project. Defining a vision, objectives and actions needed to reach them are important. A Smart Cities Applications Catalogue should include an Introduction to Smart Cities Projects that may contain:

- Main concepts, including the concept of what is a smart city;
- Concepts and importance of eGovernance;
- Main elements of a smart city project;
- Best practices;
- Smart city project framework;
- Main success and failure factors;
- The importance of a strong leadership in the success of the project;
- The importance of identifying and involving the stakeholders from the beginning;
- Other.

A SMART CITY IS MORE THAN A COLLECTION OF SMART APPLICATIONS

4. Annexes

4.1   Annex A: Existing catalogues and websites

The following websites have been identified. A small text taken from the website gives you an idea of its purpose.

icities4greengrowth.in

"The Indian Cities for Green Growth is a Smart Cities Knowledge Portal about smart cities, smart solutions, case studies and other resources."

amsterdamsmartcity.com

"Amsterdam Smart City consists of a public-private partnership and an international community. By sharing knowledge and by collaborating we come up with innovative solutions for metropolitan issues of a social, economic and ecological nature. This way we ensure that the Amsterdam Metropolitan Area remains liveable, now and in the years to come."

www.beesmart.city

"bee smart city is the leading global smart city solutions network and community with currently about 12,700 members from 170 countries, featuring 630+ smart city solutions implemented in over 970 municipalities."

smartcitiescouncil.com

"We envision a world where digital technology and intelligent design have been harnessed to create smart, sustainable cities with high-quality living and high-quality jobs. To tap into the transformative power of smart technologies, cities need a trusted, neutral advisor. The Smart Cities Council provides that help. We are a network of leading companies advised by top universities, laboratories and standards bodies."

we-gov.org

"The World Smart Sustainable Cities Organization (WeGO), established by 50 founding members in 2010, is an international association of city and other local governments, smart tech solution providers, and national and regional institutions committed to the transformation of cities into smart sustainable cities."

The following websites have been identified but not used in this document.

www.fiware.org/success_stories/

"Firmware is a curated framework of open source platform components to accelerate the development of smart solutions."

aws.amazon.com/pt/mp/gctc/

"We have organized the solutions available in the AWS Marketplace, so you can easily understand, test and adopt technologies that will transform your city."

www.ssatp.org/sites/ssatp/files/publications/Toolkits/ITS%20Toolkit%20content/case-studies/default.htm

"A set of Case Studies has been prepared to illustrate how ITS is used in practice. The sites have been selected to provide diversity in environment, operator type, scale, ITS implemented, and degree of experience with ITS."

https://stateofgreen.com/en/partners/state-of-green/news/10-examples-of-smart-city-solutions/

"We have gathered 10 examples of smart city solutions to illustrate how taking a smart approach to urban development creates liveable, sustainable and prosperous societies globally."

4.2   Annex B: Adding user cases to a catalogue

To better understand how a catalogue works, three smart applications have been added and published to the portal icities4greengrowth.in, with invaluable support from Louise Thomasen (louise@cothomasen.dk).The following smart applications projects, identified on the portal as User Cases, were registered and associated to the city of Goiania, Brazil.

- CCO - Operations Control Centre (Goiania Metropolitan Area - Brazil) - http://icities4greengrowth.in/casestudy/cco-operations-control-centre-goiania-metropolitan-area-brazil

- IOCC - Integrated Operations and Control Centre (Goiania - Brazil) - http://icities4greengrowth.in/casestudy/iocc-integrated-operations-and-control-centre-goiania-brazil

- CIICC – Integrated Centre for Intelligence, Command and Control (State of Goias – Brazil) - http://icities4greengrowth.in/casestudy/ciicc-integrated-centre-intelligence-command-and-control-state-goias-brazil

4.3   Annex C: Guidelines to review online catalogues

A simplified and informal script has been produced to facilitate the analysis of websites and better understand their characteristics. The script has 3 parts:

Part 1, to know the contents of the catalogue:

- What are the contents of the catalogue? Is it easy to know what the catalogue contains?
- How many objects does the catalogue contain?
- Is it clear when the objects were added or when the documented facts occurred?
- What is the documentation structure of a smart application and other objects? What does the documentation contain?
- Does the catalogue have a sitemap?
- Does the catalogue contain rankings?

Part 2, to know the functionality of the catalogue:

- What is the functionality of the catalogue? Is it easy to know what operations the catalogue performs?
- Who can update the catalogue?
- Who can consult the catalogue? Is authentication required?
- Does the catalogue allow users to endorse a smart application, vendors or other objects?
- How is the selection tool?
- How the catalogue shows the smart applications that have been selected?
- Is it possible to import or export catalogue data?
- Is it possible to compare the cities?
- Does the catalogue show usage statistics?
- Does the catalogue show how to contact a supplier?
- Are smart applications and other objects geo-referenced?
- Is it possible to contact the catalogue team?
- Is there a way to subscribe to receive updates?

Part 3, to know the context of the catalogue:

- Is it clear who the target users are?

- How are the design and the user interface?

- Is it easy to locate the catalogue using internet search engines?

- Is the catalogue being updated?

- In which languages is the catalogue available?

- Is there any incentive for each type of user to participate?

- Is there an object certification process? Is there a moderator?

- Is it clear who the stakeholders are?

- Does the catalogue have institutional support from any company, government, development bank, etc.?

- Are there agreements or partnerships to publicize the catalogue?

- Is the catalogue publicized on social networks?

- How is the performance?

- Is the catalogue compatible with most commonly used browsers?

- Can the catalogue be accessed by smart phone?

- What is the funding model for the catalogue?

4.4   Annex D: Revision

The suggestions were reviewed by the experts identified below. Comments generated by the review were incorporated into the document. There was an attempt to include in the review group at least one representative of the primary target user.

- Paulo Roberto Miranda was a Government Fellow at UNU-EGOV (2019). He is also the President of the Information and Communications Technology Services Company of the Municipality of Porto Alegre – PROCEMPA (licensed). Prior to this position, he was the Secretary for Information and Technology of the city of Curitiba, state of Paraná, Brazil. Previously, he was CEO at CELEPAR – State of Paraná (PR) ICT Services Company, Technical Director at PROCERGS State of Rio Grande do Sul (RS) ICT Services Company, and Regional Director at SERPRO (Brazilian Federal ICT Services) in the states of Rio Grande do Sul and São Paulo. He also served as Executive Secretary of the ICT Board of the states of RS and PR. He was elected three times President of ABEP, the Brazilian Association of ICT Public Companies. He was the founder and director of the International Centre for Software Technology – CITS (Paraná/BR) and vice president of ABNT's Software Subcommittee (Brazilian ISO branch). He was Consulting Director at BRISA – Society for the Development of Information Technology. Paulo has over 40 years of experience in Information and Communication Technology, Strategic Planning and Technology Management, both in government and in the private sector. He holds a Master's Degree in Management, Information Systems and is Civil Engineer, both diplomas from the Federal University of Rio Grande do Sul (UFRGS), Brazil. He is also the author of two chapters in books: "eParticipation in Smart Cities of Developing Countries: Research-Based Practical Recommendations" and "Porto Alegre, Brazil: the smart health case of Gerint".

- Judy Backhouse has experience as both an academic scholar and an information and communications technologies (ICT) practitioner. She is currently a Senior Academic Fellow at UNU-EGOV, after eight years as an Associate professor at the University of the Witwatersrand in Johannesburg. Her recent research has been into the role of information systems in implementing smart city agendas in the African context. She has researched ICT for development as well as aspects of e-Government. Dr Backhouse has worked in the private and public sectors. In the private sector she worked in technical and management roles over a twelve-year career which began with designing and programming systems and ended with the strategic management of ICT within organisations. She spent two years at the South African Council on Higher Education where she was responsible for monitoring the Higher Education Sector in South Africa and advising the Minister of Higher Education. She also has experience as an entrepreneur, having launched (and closed) a co-working business in Johannesburg.

4.5 Annex E: Research or discussion opportunities

This document contains statements that were not based on documented evidence, but on opinion, observation, and interpretation. Obtaining evidence and confirming hypotheses and axioms may be the subject of further research and discussion.

This appendix contains some suggestions.

- Identify the criteria that indicate the success of a Smart Applications Catalogue for Smart Cities. How to get answers to the criteria? Given the criteria, which are the most successful catalogues?

- Confirm if each suggestion in the checklist has a positive impact on the catalogue success or it is irrelevant. Determine the degree of relevance of the suggestion.

- Despite the potential usefulness of a catalogue, is there sufficient demand from the user community to justify the production of a Smart Cities Applications Catalogue? Is it sufficient to ensure the sustainability of the project?

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