PURR-E: TOOL FOR A GREEN CITIES DESIGN

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Summary

Changing the paradigm of wastes perception with focus on cognitive aspects of inefficiency is a challenge for a "Wisdom Society" in the urban planning process. Urban or building structures with its material stock can be characterized with a different life span. Based on Service Life Planning, **Reference Service Life** created for each type of materials in building layers can help its users to decide when to exchange or to reshape structural or infill elements, to follow then the next cycle of elements existence. Based on Building Information Modelling, data on **Estimated Service Live** for each component can be collected and managed by Urban Resources Exchange Agency with the focus on historical city centres as well as less valuable urban areas called greyfields. Holistic recognition of existing urban resources reservoirs integrated with new generation GIS programs will organize Long Life Planning system, based on cascade model of use and different resources efficiency means. Creation of dynamic virtual models of urban resources reservoirs as a main framework of PURR-e (digital Planning of Urban Resources Reservoirs) gives opportunity to simulate different End of Life scenarios developed in context of the parallel worlds. PURR-e will help to understand cycles of materials flow, consequences of linear system of goods distribution, will help to rethink the material part of urban structures within buildings and its relations to other people and natural ecosystems.

Keywords: Urban resources, wastes management, life cycle, long life planning, building information modelling, dematerialization.

1 Local wastes problem as local resources advantage

Architects and urban planners have to handle a complex reality of urban structures focusing not only on valuable heritage areas or idyllic, flourishing greenfields but also huge, forgotten, degenerated areas with low quality buildings, no name streets, facing social, economic and environmental problems. Totally, in all mentioned urban structures, large amount of materials are already built-in in the stock, what gives the chance for future generation to use them as Urban Resources Reservoirs, which have to be managed in urban

planning process based on closed-looped economy. The city as an urban machine, with its building sector is responsible for materials flow and resources consumption in local as well as in global scale. The wastes problem is handled by all municipalities in the world. Construction and demolishing activities stimulate a huge amount of wastes both in construction process and occupancy period. All stakeholders of building process are responsible for waste generation in context of Life Cycle Analysis or Environmental Impact Assessment. Therefore involvement of all actors in building process for waste minimization strategy is necessary according to three main aspects of sustainability – harmonized economical, social and ecological development. Integration of urban planning process with waste management defined rather as resources management seems to be obligatory for sustainable development and green cities design.

The preservation act is a matter of responsibility. Without sharing with others the truth we know, our responsibility is annihilated [1]. Up today the most popular waste management practice is a gradation of applied action such as: reduce, reuse, recycle (3xR). Talking about resources efficiency, different rating systems and labeling schemes (LEED, BREEAM, GBC tools) are based on mentioned 3xR formula. But some questions can be raised, is it still effective. Is this approach still enough for sustainable cities with high performance buildings based on existing green buildings tools to face objectives of eco-efficiency, Factor 4 or Factor 10 for example? What mechanisms should be created to improve building process to be less aggressive for our earth environment, how to increase productivity of building sector with focus on Construction and Real Estate Cluster (CREC) as an important part of urban resources reservoir?

Today, in Finland i.e. CREC which covers the whole life of a buildings, infrastructure and other constructed assets is responsible for 60-70 % of the national wealth [2]. Mentioned 3xR formula is focused mainly on material part of resources flow where technical aspects dominate wastes minimization problem. Taking into consideration societal factors, can ordinary people be involved and active in a process of sustainability building and eco-efficiency implementation? We need appropriate, wise tools based on smart software and affordable hardware to involve local societies in effective participation process of green urban regeneration.

Part of **Information Society** is gathering statistical data about different wastes type, its structure or utilization methods. Property management companies handle building related data, they receive and generate data for operation and maintenance. They use different waste indicators, for example use of materials ($kg/m^2/year$), % waste recycled, level of embodied energy or CO_2 emissions equivalent, related to existing building stock. To extract data about urban metabolism and recognize materials flow within the construction sector, national inventories of existing building stock were carried in Denmark, Sweden or Germany. This inventory was an attempt to find out which materials were stocked in buildings and which quantities were annually built in through new building projects, repairs and extensions [3]. Related to the existing urban structures and potential of construction and demolition (C&D) wastes generation more data was collected in Germany. Relations between material intensity and types of land use or building mix were analysed to create important urban planning parameter of resources efficiency.

Coherent interpretation of collected, recorded terabytes of information apply to create a base of **Knowledge Society**, where knowledge for example should execute different methods of waste problem handling or appropriate resources management. The mechanisms that could support the diffusion of know-how should be implemented. Different knowledge models should be shared free through collaboration features or Web

pages generations to increase capacity building at local and regional level. Defining knowledge as important urban resource, disproportion of knowledge transfer streams as well as material flows within the building sector should be a matter of special scenarios. We have to create synergy for minimising construction and demolition wastes and increasing productivity of our building industry by better flow of information among actors and initiated activities in living city machine.

How to apply that knowledge and how to proceed information mess in appropriate way is a challenge for **Wisdom Society**. Inventing, creating and organizing a machinery of knowledge [4] is a challenge of our generation in a global scale.

2 Waste problem perception – a chalenge for green cities

"In industrialized countries, the current resource productivity must be increased by an average of a FACTOR 10 during the next 30 to 50 years. This is technically feasible if we mobilize our know-how to generate new products, services, as well as new methods of manufacturing" [5]. Waste management modernization is not enough; we need radical waste management revolution introduced in soft and smart way. We can conclude, considered aggregated data from national inventories of building stock that large amount of materials with long service life, such as concrete, steel and brick, may be seen as **reservoirs of materials** that could be reused in the future [6]. For its innovative maintenance, cultivation and smart exploitation the **Change Agent** activation is obligatory. From that perspective, transformation from 3xR to **4xR** formula is needed, where the most important "R" is **"Rethink"** then Reduce, Reuse, Recycle [7]. It is necessary to change paradigm in waste problem perception. Rethinking and reflection should be the first step to change throwaway society, it moves us to cognitive aspects of wastes generation problems which have begun at family home.

3 Resources Exchange Agency – sustainable innovation

Urban and building structures, property patterns, infill elements, plumbing, furniture, decorations can be characterized with a different life span. Based on Life Cycle Analysis and Service Life Planning, a kind of Reference Service Life can be created for each type of materials in each building layer. Tenants in an individual or systematic way can decide about period of building elements exchange, reshaping or upgrading and then follow the next cycle of mentioned elements existence. Awareness of that kind of "personal product stewardship" (adopted Extended Producer Responsibility principle) and consciousness of results should stimulate tenants to further activities in that type of building dematerialization.

To organize a framework for urban resources efficiency and to motivate all actors involved in building process from cradle to grave a new systematic approach is necessary. One sustainable innovative solution could be an establishment of **Resources Exchange Agency (REA)** as a new system of building structures and components distribution and management based on Life Cycle "thinking" (**Fig. 1**). That kind of organization with its new services based on Life Cycle Management should enrich offer of property management companies which are mostly focused on building stock administration and "no – action" maintenance as well as Direct Service Organizations (DSO) – responsible for

wastes collection and disposal affected with high level of entropy in traditional system of resources flow.

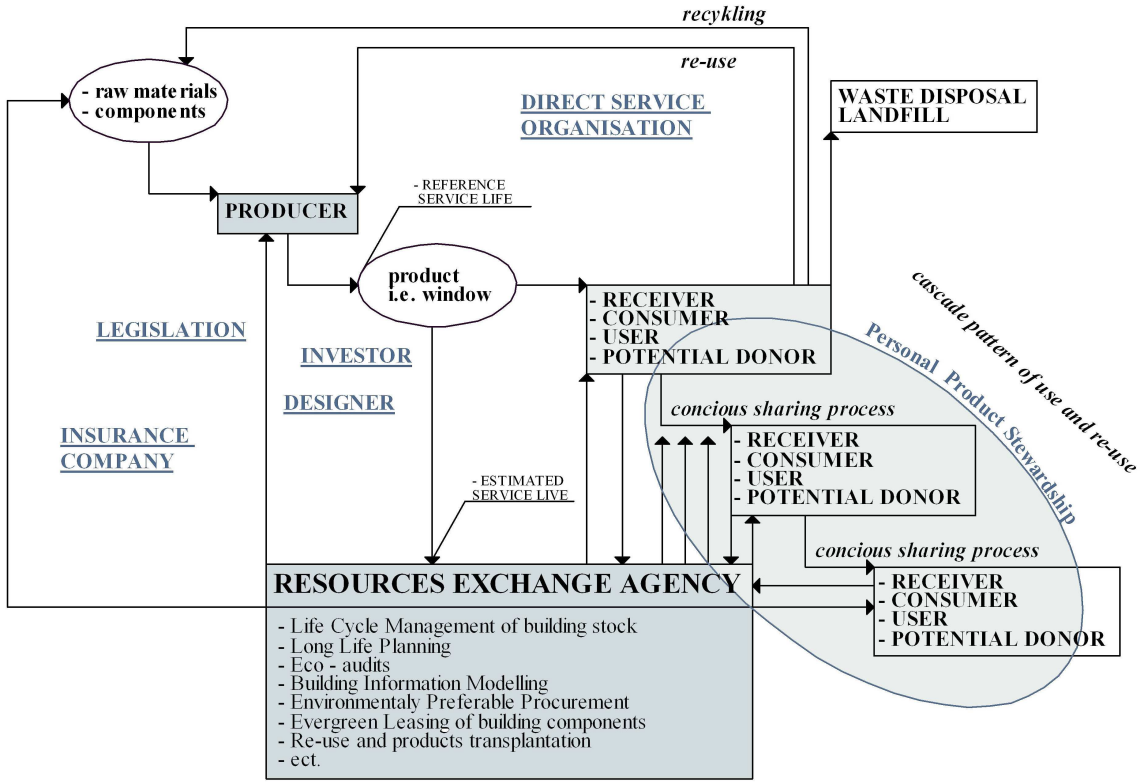

Fig. 1 Location of Resources Exchange Agency and its activities in area of Construction and Real Estate Cluster.

To fulfill social principles of sustainable development, tenants, building users (generally consumers) are important target group for REA activities which seems to be a customer service to guarantee a high level of living in urban structure with respect of environmental performance.

Therefore one of the main strategic targets of REA is urban and building structures dematerialization (new enterprises as well as existed building stock) achieved through increasing construction sector productivity, long life planning, life cycle assessment or life cycle costing as a base of closed – looped economy.

Resources Exchange Agency should be responsible for whole carried urban structure Life Cycle Management, based on Live Cycle Assessment. Main task of LCM is to: identify, inform, assess, implement.

Basic elements of LCA are: initiation, inventory, impact assessment, improvement.

Generation of C&D wastes is related to performance of building as well as the cognitive aspects of users in occupancy stage of building or urban structure life. On level of operation tasks REA should encourage pro-active response from tenants and building users to reduce construction wastes and enhance them to improve building metabolism. Simple measures such as the maintenance survey, building user guide, potential receivers and donors database delivered in appropriate way in building Life Cycle Framework (LCF) can stimulate long life productivity, promote closed-loop organization. REA should be responsible for built – in components and products future repairs, upgrading, dismantling,

removal and reuse. Relevant procedures, checklists, specifications should be implemented, based on alternate end-of-life scenarios.

The Agency should build up and maintain a virtual model based on **Building Information Modeling** (BIM) where data of **Estimated Service Life** for each urban or building component can be collected and managed in comparison with its **Reference Service Life** and other product data delivered by producers according to Extended Producer Responsibility (EPR) principle. Establishment of an effective (digital) system, chain of donors and receivers, is necessary to obtain the longevity of products (by making them durable, timeless, maintainable, repairable, upgradeable, easy to use and reusable). To develop that system the new generation software and databases powering e-retailing and on line 3D objects sharing should be introduced as decision engines located in the World Wide Web.

4 PURR-e and its digital platform of REA agenda

Today most of the new realized urban developments are preceded with virtual model construction in design process, created with Computer Aided Design (CAD) systems as well as with GIS software. Three dimensional models with different data sets should be available for project – based organizations, facilities management companies, property owners and administrators or occupants. Building industry manufacturers provide their products with common 3-dimensional digital models, ready to build into virtual urban or building structure. Many of those models (CAD library files) are offered in the World Wide Web. To facilitate different information streams flow and ensure interoperability between system users a new standard defined as “Industry Foundation Classes” (IFC) was developed by the International Alliance for Interoperability (IAI). The IFC system is data representation standard and file format for defining architectural and constructional CAD graphic data as 3D real-world objects, mainly so that architectural CAD users can transfer design data to and between rival products with no compromises. In addition to physical information about buildings, these classes represent project management information such as estimating and scheduling data. Many core concepts relating to the project management have recently been added to these models. The IAI`s scope is the entire lifecycle of building projects including strategic planning, design and engineering, construction and building operation. The IAI`s goals are to define and promote a specification (IFCs) for sharing data throughout the project lifecycle, globally, across disciplines and technical applications. The IFCs are used to assemble a project model in neutral computer language that describes building project objects and represents information requirements common throughout all industry processes [8].

Numerous database and software tools are available to support the conduction of Life Cycle Management, Life Cycle Assessment or Life Cycle Costing, thereby; ecological assessment can be effectively undertaken during urban structures development and maintenance to increase resources efficiency in context of **digital Planning of Urban Resources Reservoirs (PURR-e)**. Parametric building modeling adds the management of relationships between building components and urban structures [9]. For spatial planning and regional scale the implementation of Service Life Planning (SLP) process on an IFC platform extended with GIS information through IFG (IFC for GIS) brings a new imperative for manufacturing and distribution systems in context of the economics of Resources Management.

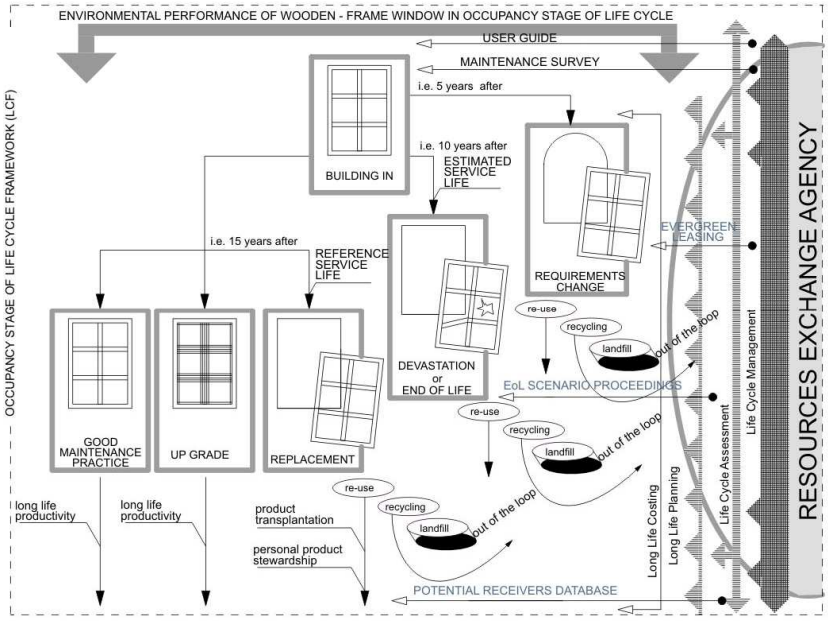

Fig. 2 Influent position of the change agent (REA) in life cycle management of sample built-in window, one of many resources in urban resource reservoir.

In a process of Building Information Modeling, an attachment of appropriate data of **Estimated Service Life** to each urban or building component with comparison to its **Reference Service Life** provided by producer or contractor, creates dynamic system for Long Life Planning. Investing in long-term and cost effective solutions is represented by such services as “evergreen” leasing, customers conscious product sharing or personal stewardship, identified as by-products of Social Life Cycle Impact Assessment [10]. By enhancing leasing business as package of long term maintenance and upgrading service, occupants and residents can enjoy assured quality of service embodied with functions and performance of components for duration of contract [11]. Long Life Planning based on the **cascade model of use** for each building component implemented by REA will create a global network of users, with donor conscious engagement in sharing process in real and virtual space. The mechanism of conscious sharing with building components and “personal stewardship” will help donors to observe cycles of materials flow, to understand consequences of linear system of goods distribution, to rethink their attitude to the material part of their buildings and relations to other people in context of sustainability. Client – driven changes, compatible replacement parts would be available via internet – base communication with equipment manufacturers and suppliers. The information management and transfer of information between different actors especially with regards to requirement management and product service can be provided by better communication tools. The user is given a web based application, where an IFC model from the project can be uploaded. The model is enriched with lifetimes for materials used in building, so adds value in terms of much improved information exchange in the building process [12].

Connecting technologies like online social networks and Web logs, or “blogs” ; wikis – group Web pages that any member may edit, will enrich urban resources management system. The sharing-oriented mindset of the open-source-software community, along with an awareness of the possibilities of the Web, had to penetrate the walls of traditional GIS

companies. Recently, the mapping revolution could change the way we think of the World Wide Web. We've long spoken of the Web as if it were a place – with "sites" that we "go to" – but as places go, it's been a rather abstract, disembodied one. Now that's changing. Geotagging means the Web is slowly being wedded with real space, enhancing physical places with information that can deepen our experiences of them and making computing into a more "continuous" part of our real lives [13]. Lately maps were only created by GIS professionals and cartographers. Today digital maps are transformed to a 'read-write' medium, the information is already flowing both ways: users can upload their own texts, photographs, and other data to the Internet and pin them to specific latitudes and longitudes. The information from the Web that's now being organized geographically, with use of new geospatial applications. We can observe on going capacity building based on the phenomenal success of open-source software, which is created by communities (GoogleEarth or eBay), which also should be a domain of Resources Exchange Agency on its agenda.

Foundation of REA will create new standards and demands for building materials manufacturers and suppliers, contractors and designers. Environmentally Preferable Procurement (EPP) introduction in real estate development and maintenance process will dramatically change existing building materials market and services. On the other hand an obligatory ban on landfill for construction and demolishing waste will push developers to prefer renewable building materials, services and technologies in terms of long life design and zero waste production. That activities should make closed - loop economy competitive to existing markets, being important factor of sustainable development.

5 Conclusions:

The human habitats in the most world urban areas are affected by wastes problem, with specific impact of construction and demolition wastes considered as a part of urban resources reservoir.

Present waste management focused on mostly technical aspect, based on 3xR priority principle is no able to increase resources efficiency to face adequate sustainable indicators.

In context of “Rethinking” as a main priority (4xR) of waste management, the change agent is needed to organize information and knowledge flow, to find wise solutions for resources sustainable economy.

The Resources Exchange Agency (REA) as innovative partner on rising closed-loop market with its interactive tool - digital Planning of Urban Resources Reservoirs (PURR-e) can stimulate actors involved in building life processes, favoring social sphere of urban areas.

Development of digital Building Information Modeling, with use of on the edge open-sources WWW applications, should enhance client-driven maintenance as in virtual reality as in real urban structures, being important part of PURR-e (digital Planning of Urban Resources Reservoirs).

Mass e-communication and easy information flow will facile the Long Life Planning of products or urban structures and productive resources management as in local, closed-loop market, as in global scale by reducing environmental impact.

Organization of REA as a cognitive experiment will need determination and campaign to awake public awareness in field of resources efficiency. But implementation

operational system of Resources Exchange Agency to urban environment will push us on a good path for the future sustainability and green cities design.

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