

IRMA: a European project for a sustainable *City Concept*

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Abstract

A project called *Integrated Decontamination and Rehabilitation of Buildings, Structures and Materials in Urban Renewal* (IRMA) is being conducted within the European Commission's Fifth Framework Programme "Energy, Environment and Sustainable Development". This international initiative involves seventeen partners from nine European countries, representing important stakeholders with interests in urban development.

The primary objective of the project is the development and implementation of a general *City Concept* comprising a toolbox of improved technologies and processes, together with decision-making and management tools, for sustainable urban renewal, focusing on contaminated buildings, in order to protect the environment from hazardous compounds and save reusable buildings and materials.

This paper presents the main focal points of the project, including contamination assessment, health and safety of construction and demolition workers, reduction of waste and preservation of buildings and resources. The holistic purpose of the project is to respond to some of the most important challenges of urban development, such as rehabilitation of old buildings, minimisation of waste and recycling of materials.

Within this general context, focus is placed on the main outcome of the project, namely a model for an integrated management system called *City Concept*. The model serves as a management support tool for activities and processes related to the decontamination and rehabilitation of urban structures and buildings, including demolition, cleansing of surfaces and materials and recycling and reuse of recycled materials.

Keywords: demolition, demolition waste, cleansing techniques, cleaner technologies, City Concept, integrated management system, sustainable urban renewal, decision-making tool.



1 Introduction

Most buildings and structures contain substances potentially dangerous for the environment and human health. Some buildings have been constructed with materials containing substances considered harmful today, e.g. asbestos, PCB, heavy metals, certain paints, etc., which can constitute a problem both during the “normal” use and the renewal operations of the buildings.

At the same time, some of the most important challenges of urban development are the rehabilitation of old buildings, minimisation of waste and the recycling of materials. The identification and management of contaminated structures and buildings are thus important prerequisites for an innovative environmentally-oriented approach to urban renewal.

In this context, the development of measures to identify and manage the contamination of buildings and structures, and the integration of rehabilitation, demolition and recycling techniques into a common approach to urban renewal called *City Concept* are the main objectives of a research & development project called IRMA.

IRMA stands for “Integrated Decontamination and Rehabilitation of Buildings, Structures and Materials in urban renewal” and it is a project carried out within the European Commission’s Fifth Framework Programme “Energy, Environment and Sustainable Development”, Key Action 4: City of Tomorrow and Cultural Heritage. The project started in August 2003, and it lasts 48 months, until July 2007.

The project total cost is estimated to be approximately 5 millions Euro, being half of it financed by the European Commission and the other half by the involved organisations.

2 About the IRMA project

2.1 Project objectives

The major problems encountered in the current context of urban renewal are that:

- Very little practical applicable knowledge on the decontamination of buildings and materials is available
- There are no accepted technologies or guidelines for the decontamination of polluted buildings and materials
- There are no standards for the classification of decontaminated buildings and materials as “clean”
- The means of classification of polluted soil cannot be applied to recycled materials
- The health and safety of personnel carrying out work on contaminated buildings is insufficiently regulated

The main objective of the IRMA project is to develop and implement a general *City Concept* comprising a toolbox of improved technologies and processes together with decision-making and management tools for sustainable



urban renewal. This managerial model focuses on contaminated buildings, in order to protect the environment and the people from hazardous compounds and optimise the reusability buildings and materials.

2.2 Project participants

The project consortium consists of sixteen (16) partners from seven (7) European countries. They represent important stakeholders with interests in the decontamination of buildings in urban development: housing and civil contractors, demolition contractors, recycling specialists, consultants, universities, research institutes and municipal administrators.

Table 1 includes the partners participating in the project, the stakeholder group to which they belong and the country they are established at.

Table 1: IRMA project partners.

Partner name	Stakeholder group	Country
NIRAS DEMEX	Consulting engineers	Denmark
Dansk Beton Teknik	Concrete testing and R&D center	Denmark
INTRON	Technical consultancy and laboratory	The Netherlands
Demoliciones Técnicas	Demolition contractor	Spain
Belgian Building Research Institute	Research institute	Belgium
BRANDIS	Demolition contractor	Denmark
Enviro Challenge	Recycling contractor	Belgium
Contento Trade	Research and technology center	Italy
SBS Byfornyelse	Urban renewal and consultancy	Denmark
Hochschule Bremen	University	Germany
Delft University of Technology	University	The Netherlands
Brussels Institute for Management of Environment	Public administration	Belgium
Rotterdam Public Works Engineering	Public administration	The Netherlands
Dr. Tech. Olav Olsen	Consultant engineers	Norway
Meldgaard	Recycling equipment suppliers	Denmark
Federal State of Bremen	Public administration	Germany

2.3 Project contents

The project is organised following a modular scheme, addressing each of the main objectives in separate Work Packages (WP). The contents addressed in each of the work packages are listed below.

WP1. Compilation of data on building contamination and development of database

- Development of a database to be used as information tool
- Compilation of the relevant baseline information



- Description of the state-of the art on decontamination of buildings, structures and materials

WP2. *Assessment of contaminated buildings and structures*

- Identification of existing contamination and assessment of the related risk for human health and environment based on their behaviour with respect to emissions
- Environmental impact and risk assessment of selected urban development scenarios comprising large groups of buildings, including contaminated buildings and structures

WP3. *Development of techniques for the end-of-life phases of buildings and structures*

- Identify research needs and describe existing techniques within all end-of-life phases of buildings and structures
- Implement environmental risk assessment, economical evaluation and human health risk assessment to existing techniques used during all end-of-life phases of buildings and structures

WP4. *Guidelines for design of demolition and application of products from contaminated buildings and structures*

- Prepare procedures and guidelines for
 - Assessment of contaminated buildings
 - Cleansing and demolition structures
 - Production of demolition products
 - Application of demolition products

WP5. *Development of City Concept for decontamination and rehabilitation of buildings, structures and materials*

- Development of a model and a computer program for an integrated management system called City Concept for activities and processes related to decontamination and rehabilitation of urban structures and buildings, including demolition (partial and total), cleansing of surfaces and materials and recycling and reuse of recycled materials

WP6. *Evaluation of City Concept for European cities*

- Feasibility study and evaluation of the City Concept in the following European cities and urban areas: Bremen (Germany), Brussels (Belgium), Copenhagen (Denmark), Aarhus (Denmark), Barcelona (Spain) and Rotterdam (The Netherlands)
- Demonstration of the City Concept during a test project in connection with an actual rehabilitation plan

WP7. *Implementation and exploitation – Reporting, recommendation and guidelines*

- Development of recommendations for cleaner processes for contaminated building structures
- Establishment of procedures for identification of contamination and its removal prior to demolition or refurbishment, for minimum waste production and maximum recovery of the materials
- Development of a structured approach for urban renewal projects including decision making, planning, supervision and administration



WP8. *Project management*

- Project coordination and administration in accordance with the contract requirements and pursuing the highest quality of the project's outcome

Despite of the presented division of work, necessary for the realisation of the project in praxis, the whole project is conceived as a unitary working process aiming at the final objective: the development and evaluation of the *City Concept* to be used for urban renewal processes at European level.

2.4 Project outcomes

The main outputs of the project suitable for exploitation follow the objectives of the individual work packages. The outcome of the project concentrates on the introduction of cleaner processes and maximum waste recycling in the construction and demolition industry focusing on urban rehabilitation and supporting safe and extended lives of buildings.

The results of the project will be materialised in the following deliverables, all pieces of an integrated management system for decontamination and rehabilitation of buildings, structures and materials in urban renewal, i.e. the *City Concept*.

- *Final Report*. Descriptive document about the development and findings of the specific work packages and the project in general.
- *Database*. Database of pollutants appearing in buildings and related materials, their physical-chemical properties and their possible interactions with building materials, preferential disposition sites, methods for their quantification and efficiency of appropriate cleaning techniques among others.
- *Code of Good Practice for Works on Contaminated Structures*. Guideline providing a structured approach for the identification and safe and efficient handling of contaminated structures and leading to maximum recovery of materials and minimum consumption of resources.
- *Dissemination material*. Demonstration material – including video documentation of different activities – for training and further education of engineers and skilled workers in clean construction, refurbishment and demolition procedures.

3 About the *City Concept*

The main objective of the IRMA Project is to develop and implement a general *City Concept*. The *City Concept* comprises a toolbox of improved technologies and processes, focusing on contaminated buildings in order to minimise risk to the environment from hazardous compounds and to save reusable buildings and materials. The Concept consists of decision-making and management tools for sustainable urban renewal, including:

- Minimisation of risk to the occupants of buildings
- Health and safety of construction and demolition workers



- Preservation of buildings and resources
- Reduction of waste

The development of an old urban area - e.g. industrial area or harbour area - towards new purposes - e.g. housing or business - requires firstly, demolition of buildings and clearance of old infrastructure - which are condemnable or not useful for the new purposes - and management of building waste materials with respect to maximum reuse, and secondly, rehabilitation of existing buildings and infrastructure, and reuse of these structures for new purposes. The integration of these processes in a holistic approach constitutes the basis of the *City Concept*, as shown in figure 1.

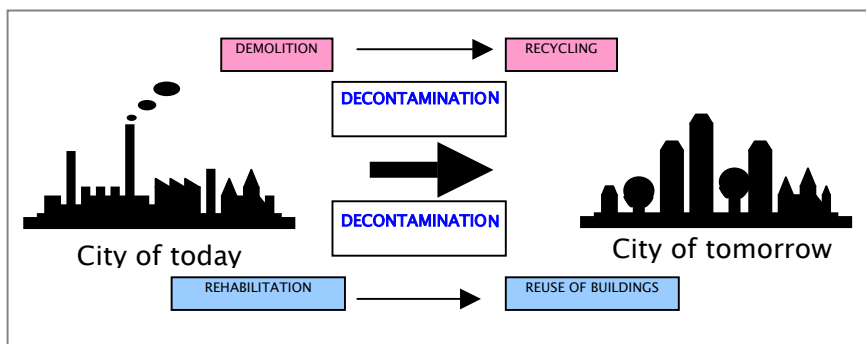


Figure 1: Holistic process of urban renewal according to the *City Concept*.

The technical and scientific objectives of the *City Concept* consist of a sequence of measures to identify and manage contaminated structures and buildings, with the following consequences:

- Hazardous substances in buildings and the industrial pollution of building surfaces and structures are identified and classified
- Toxic emissions are prevented
- The lifetime of a structure can be extended
- Existing polluted building and structures can be rehabilitated and reused
- Volumes of polluted demolition waste materials (primarily concrete and masonry rubble) can be recycled
- The volume of contaminated building waste will be reduced
- Materials can be recovered upon complete or selective demolition to save natural resources and to avoid the need to dispose off waste
- Open spaces at the urban rehabilitation sites are used for the establishment of crushing and sorting machinery in order to allow all recycling to be carried out on site. Only contaminated waste and other non-recyclable materials are to be transported from the site

The aim of the *City Concept* is to optimise the material flow with respect to economy and environment. It means that the amount of generated waste

materials and the consumption of natural materials must be reduced to a minimum, which requires maximum recycling. This is schematically represented in figure 2 below.

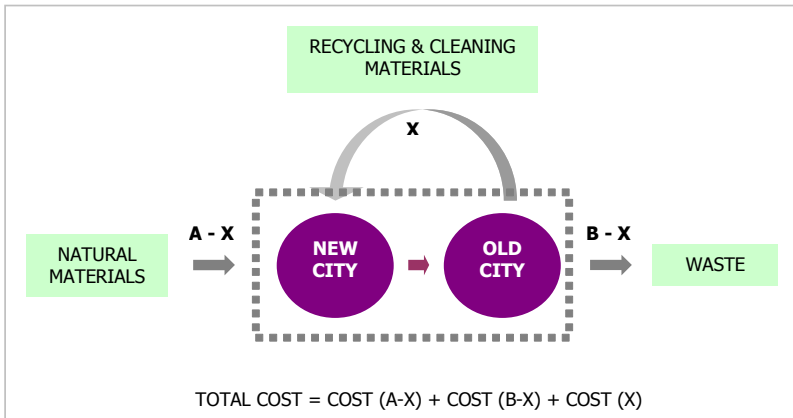


Figure 2: Economic perspective of the *City Concept*.

A crucial barrier to recycling is the contamination of buildings to be demolished or rehabilitated. Hazardous waste is very expensive to dispose off on controlled landfill, to incinerate or to receive special treatment. Therefore, it is necessary to separate the contaminated materials from clean materials, in order to minimise their volume and concentrate the pollution.

The main elements of the *City Concept* are described below. Even though many of the elements and indicators of the *City Concept* are based on national and local regulations, standards and guidelines, the goals and the principles of the *City Concept* are valid for all EU member countries, cities and regions.

3.1 Demolition

Demolition of buildings and structures comprises total demolition and removal of foundations. Demolition work should optimally be performed as selective demolition, which means that demolition waste is sorted on site aiming at the maximum reuse of the different waste fractions.

Selective demolition is usually performed in the following stages:

- Removal of asbestos and other hazardous materials
- Stripping of the structure, including removal of doors, windows, roof and other installations
- Demolition of bearing structures, including beams, walls and plates
- Clearance of the ground area

Asbestos sanitation techniques and demolition processes regarding clean materials are well described. However, in case of contaminated buildings e.g.

surfaces contaminated by heavy metals, PCB, PAH, etc. there is a lack of methods and documentation of the demolition processes.

The key issues with respect to demolition in these cases are:

- To identify and assess the hazardous materials in existing buildings and structures
- To clean surfaces and/or separate hazardous materials from clean materials as a specific step of selective demolition
- To reduce impact on the environment and risk of occupational health problems during demolition of contaminated buildings

3.2 Recycling

Recycling includes recovery of concrete and masonry, and reuse of stony materials and timber. In principle all stones, masonry and concrete could be recycled. However, it must be ensured that the materials are clean and they fulfil the national standards and relevant legislation.

Recycling of clean materials and reuse of clean recycled materials are well-documented processes. There is a lack of documentation and control of recycling processes for contaminated materials and the use of contaminated materials in new structures.

The key issues with respect to recycling in these cases are:

- To control hazardous materials in recycled materials
- To reduce the risk of environmental impact and occupational health problems caused by hazardous materials in the recycled materials, both during the recycling processes and during the lifetime of a structure built with recycled materials

3.3 Decontamination of material

In case of polluted demolition waste materials - e.g. generated by the mixture of clean materials with polluted compounds - it is necessary to clean the materials before recycling, otherwise the materials are rejected for recycling and must be dumped on landfills. In most stationary recycling plants various kinds of facilities for sorting and cleaning crushed rubbles exist. However, there is a lack of facilities and methods for cleaning polluted materials.

The key issues with respect to decontamination are:

- To develop economical feasible methods for cleaning polluted materials
- To establish acceptance criteria for clean recyclable materials

3.4 Rehabilitation

From an environmental point of view, rehabilitation of old buildings and structures should generally be preferred instead of demolition. The choice between rehabilitation and demolition of a given structure depends on various factors. The initial condition of the structure and the degree and type of pollution within the structure are some of these factors.



Rehabilitation of buildings and structures comprises:

- Partial demolition
- Reconstruction of structures
- Repair and/or renewal of doors, windows, roofs and other installations

Rehabilitation and partial demolition of clean structures are well-documented processes; however there is a lack of information on rehabilitation of contaminated structures.

The key issues with respect to the rehabilitation are similar to the key issues of demolition:

- To identify and assess the hazardous materials in existing buildings and structures
- To clean surfaces and/or separate hazardous materials from clean materials
- To reduce the environmental impact and the risk of occupational health problems during rehabilitation of contaminated buildings

However, the principal difference is that in the case of rehabilitation the structure is to be saved and therefore the degree of repair and reconstruction should be minimised.

3.5 Reuse of buildings

During the past decades strong efforts have been deployed in trying to reuse buildings and structures in urban renewal projects. In the development of harbour areas old warehouses are often reused for dwellings or offices. Many examples of converting grain silos into fashionable apartments are seen today in Copenhagen and other European cities.

After partial demolition and cleansing of the building structure, the building is supposed to be free of any substances, which could entail a risk to the environment or the occupational health.

The reuse of clean buildings does not need specific documentation. The reuse of industrial buildings - where hazardous materials have been used or hazardous materials exist in the building - needs documentation.

The key issues with respect to reuse of buildings, like the use of recycled materials in new buildings are:

- To control hazardous materials in the reused structures
- To reduce the risk of impact to the environment and occupational health from hazardous materials in the reused structures, both during the reconstruction processes and during the lifetime of a reused structure

3.6 Decontamination of buildings

Polluted building structures have to be decontaminated in order to save as much of the structure as possible and allow the reuse or refurbishment. The decontamination process comprises:

- Removal of major contaminated structures
- Removal of contaminated surface layers until a certain thickness
- Surface cleansing



- Handling of contaminated materials

The key issues with respect to decontamination are:

- To develop economically feasible methods for cleaning contaminated structures
- To establish acceptance criteria for clean structures

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