Reuse of Industrial Materials in Buildings To activate their application in Egypt

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ABSTRACT: Increasingly stringent rules and regulations on construction and demolition waste, diminishing landfill space and depletion of natural resources are all reasons for the push for industrial byproduct materials recovery. In Egypt, Industrial byproduct materials are generated in large volumes every day that are potentially usable materials, and must be disposed of. The main goal of this paper is to change the way Egyptians' think about waste—to see the value of a used material as a product or commodity, not as a waste, and encourage the use and recycling of these rich, largely untapped resources. Positive economic rewards and environmental results are moving our partners toward more waste reduction and materials management. This paper summarizes the proposed Egyptian industrial materials waste management guidelines to reuse in building ,which cover: (1) Identify the parties involved and the distribution of responsibilities; (2) Complementarily of roles of parties(owner, engineer, designer, and contractor) involved in the process of re-use to remove the causes that hinder the management of such material in Egypt ; and (3) Participation of the Parties to the proposed project to achieve sustainable development fields at the actual application of the project.

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KEYWORD: reuse –industrial byproduct materials, waste management, sustainability, Egypt.

INTRODUCTION

The world is becoming increasingly conscious of the environmental implications not only of production processes but also of products discarded after use. The recycling of waste materials as a means of tackling the solid waste problem is attracting growing interest.

This is the problem of solid waste currently producing and increase with increasing Almttrd Census world population of the most serious problems and will remain polluted environment for long periods of up to thousands of years which cause environmental damage and health problems.

In Egypt, the traditional method to get rid of Industrial wastes is send to landfill as waste. Industrial wastes are more damaging to environment, and public health, In addition, Construction and demolition (C&D) materials led to urban pollution image around, as well as the economic burden and the cost of waste transportation.

In pursuit of sustainable development principles, which aims to rely on recycling waste came importance of research on alternatives, Salvaging materials for reuse can be both an economical and environmentally sound alternate to waste stream disposal, and it also saves energy and environmental impacts of producing new products from virgin materials that help communities be sustainable in infrastructure renovation, construction, and maintenance.

With the pursuit of Egypt now to the sustainable development of areas and provide jobs for young graduates, In urgent need for alternative construction materials with rising cost of wood universal waste and demolition and construction that represent a high proportion of solid waste, Find the possibility of reuse industrial materials in building that Re-cycling building materials is an essential part of ecological sustainability.

And therefore need to find research benefit from industrial materials in the possibility of exploitation as an economic environment friendly housing in Egypt organization management process participation and funding for projects on physical development, to activate application construction for environmental development, economic, social and physical in areas

Despite the government attempts to impose penalties or fines or recourse to academic studies and research centers to develop solutions for waste management but it is still a deficiency in complete control of the problem in Egypt.

Research aims to propose a comprehensive and integrated approach to establishing industrial materials and its activation in Egypt by identifying the parties involved and their respective roles for the protection of areas affected by the effects of disposal opening alternatives to creating markets for reuse industrial materials in physical development, and to conserve energy and preserve natural resources.

The main objective of research can be achieved through several sub-objectives, namely: monitor problems resulting from industrial materials pollution in Egypt, current status assessment and

study of causes that hinder the proper management of residues in Egypt, finance and operations planning part of the parties involved to upgrade the project such areas, Identify the areas of development environmental, economic, social, physical and role of parties involved in achieving these areas

1- Sustainable

Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs. Basically, it's another term for "green" or "environmentally friendly".

Implementing sustainable projects means achieving an ecologically, socially and economically acceptable future[1].

By taking into consideration all economical aspects and the effects on people, and the environment during the planning and development phases, minimize the use of energy and resources to protect the environment, and increase the efficiency of all projects[2].

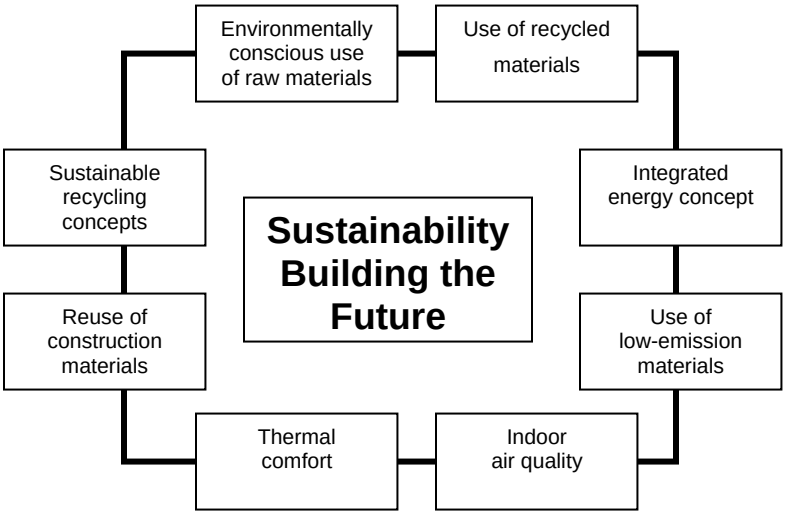

Fig. (1) Aspects of the Sustainability

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1-1 Choosing sustainable materials

It can be difficult to assess exactly how sustainable a product is and which materials are preferable to others[3]. There are some tools that can help you to choose the building materials, table (1).

There are many considerations that should be taken into account when choosing building materials. Since many different definitions exist concerning what constitutes an environmentally friendly or green material, this study use the following set of terms as factors in determining environmentally preferred materials and products[4].

By-product

Unused or waste material from one manufacturing or energy-producing process that can be used in another manufacturing or energy-producing process [5]

- *Agricultural by-product:* Unused or waste material from farming operations, several of which can be used in building products such as strawboard panels, etc.
- *Industrial by-product:* Unused or waste material from power plants or manufacturing operations, several of which can be used in building products, e.g. fly ash concrete, etc.

Table (1): Evaluation tools to choose the building materials

Evaluation tools	**Life-cycle assessment**	This means considering the impact during the extraction of the raw materials, manufacture, transport, handling, installation, the lifetime of its use, recycling and disposal.
	Embodied energy	The total amount of energy that is needed to produce, transport it to site and install it. For building products, it is commonly measured in Mega Joules (MJ) per unit of product.
	Renewable resources	These are resources that will be replenished with time; they include plant and animal products such as timber, paper, cork, wool and leather.
	Sustainable resources	Sustainable resources are the products of cyclic closed systems that do not require outside inputs, and do not generate waste.
	Local resources	Locally sourced products need less energy for transport and they support your local economy.
	Toxicity	Some materials are relatively harmless for humans, but their production might cause habitat destruction or release toxins into the environment. Toxic materials can also be a problem for installers or when they are disposed of at the end of their life cycle.
	Quality	The expected lifetime of the building is short; it makes little sense to use very durable materials.
	Re-use and recycling	Using second-hand or recycled materials is another option for reducing resource use.
	Uncertainty	Materials that have been tested for a long time in your local conditions are a safer choice than new materials or those which have not been proven locally.

2- Industrial materials

Industrial materials recycling, referred to as beneficial use, means reusing or recycling byproduct materials generated from industrial processes. These materials can be used as substitutions for raw materials in the manufacture of consumer products, roads, bridges, buildings, and other construction projects. Thousands of manufacturing and industrial processes and electric utility generators create hundreds of millions of tons of nonhazardous industrial materials that are often wasted[6].

2-1 Examples of practical recycling applications

Nonhazardous industrial materials, such as coal ash, foundry sand, construction and demolition materials are valuable products of industrial processes. Each material may be recycled in a variety of diverse applications, table (2). These materials have many of the same chemical and physical properties as the virgin materials they replace - they can even improve the quality of a product[7].

Table (2): The properties of industrial materials and recycling applications in building

industrial materials	The properties and the problem	recycling applications in building
Cement dust produced during the cement industry	Produced from the burning and grinding of raw materials used in the manufacture of cement, contains a high proportion of the components of the cement but in different proportions, and fails to plant one of the factories of the Egyptian cement per day at least 300 tons in the Mediterranean.	It has been used in many engineering applications, including: Partially replace cement in some industries of construction materials such as bricks, tiles, the cement industry, glass, rubber, sewage treatment, the foundation layer for roads.
Steel slag	It is a byproduct of iron and steel industry and contains a high proportion of the components of the cement, but in different proportions. The amount of (steel slag)	It is used in many engineering applications, including: as heap in concrete works of traditional and light production, types of cement

	from iron and steel sector about a million tons annually, which is a national problem as well as emissions generated from the accumulation of slag	(Ferro-cement - high iron slag - high resistance to sulfate).
Foundry Sands	It is sand that is used to make molds and cores in the metal casting process. Although generally recycled many times internally by the foundries, about 3-4 million tons of foundry sand is discarded each year. The recycling of nonhazardous, spent foundry sand can save energy, reduce the need to mine virgin materials, and may reduce costs for both producers and end users.	the spent foundry sands is used As partial replacement for fine aggregate in asphalt mixtures; in Portland cement concrete; As source material for the manufacture of Portland cement; and As a sand used in masonry mortar mixes, And in the other applications
Coal combustion products	CCPs include the following materials: Fly Ash; Ash; Boiler; Flue Gas Desulphurization Material (FGD); and Other types of material such as fluidized bed combustion ash, and scrubber residues The characteristics and physical properties of CCPs vary. In general, the size, shape, and chemical composition of these materials determines their beneficial reuse as a component of building materials or as a replacement to other virgin materials such as sand, gravel, or gypsum.	Fly ash can be used as a replacement for the Portland cement that binds traditional concrete mixes. The manufacture of Portland cement requires large inputs of energy, and it is estimated that its manufacture constitutes about 8% of all carbon dioxide emissions from human sources. Approximately 75% of the fly ash produced annually is disposed of in landfills, which makes incorporating it into concrete a resource-efficient alternative.
Pulp and paper byproducts	Two significant byproducts from the paper industry are WWTP residuals and boiler ash	There are numerous examples of other uses Building board/fixture, Brick or concrete additive, Glass or lightweight aggregate
Construction and demolition (C&D) materials[8]	It consists of the debris generated during the construction, renovation, and demolition of buildings, roads, and bridges. C&D materials often contain bulky, heavy materials, such as concrete, wood, metals, glass, and salvaged building components[9]. In Egypt, the daily quantity of construction and demolition (C&D) waste has been estimated as 10,000 tones. That is equivalent to one third of the total daily municipal solid wastes generated per day in Egypt[10].	It can make a number of products (solid cement bricks, hollow bricks, paving blocks) using the broken bricks and broken ceramics. As possible, get a light concrete using broken bricks as an alternative partial or total ruins of the great used in industry. You can also use the surplus concrete and rubble after rounding heap for the production of concrete suitable for the various structural elements.

3- Advantages and disadvantages of the process of recycling waste

The process of recycling has some of the advantages and disadvantages[11], Table (3).

4- Building Applications for Industrial Materials

The beneficial use of industrial materials that were previously considered wastes has been expanding with a number of applications gaining market and regulator acceptance. Environmental and economic benefits derived from the recycling and beneficial use of industrial materials are becoming more evident:

- Conserving energy and reducing greenhouse gas emissions by decreasing the demand for products made from energy-intensive manufacturing processes;

- Preserving natural resources by decreasing the demand for virgin materials - recycled materials have many of the same properties as the virgin material they replace, and may improve the quality of the products in which they are used;
- Decreasing the economic and environmental burdens of disposal, as well as reducing the cost of material for end users.

Table (3) Advantages and disadvantages of the process of recycling waste

disadvantages of recycling waste	**Advantages of recycling waste**
- Some materials are generally more difficult to recycle - other materials are dangerous or require more energy inputs to be recycled - The durability of some materials can be extended if they properly protected and maintained while in use - Environmentally preferable materials may be more expensive or difficult to locate - Determining a product's environmental preferability can be a complex process for which no tools exist - Prepare the materials may need more time - Need efficient labors	- Conserves energy and reduces greenhouse gas emissions by decreasing the demand for products made from energy intensive manufacturing processes - reduce the volume of materials which are sent to landfill as waste to achieve the continued development - save the embodied energy content - Preserves our natural resources by decreasing the demand for virgin materials - Saves money by decreasing disposal costs for the generator and decreasing materials costs for end users. - Local employment creation - Reuse of old buildings and use of recycled materials.

This diagram illustrates a variety of common building applications for industrial materials. Note that the availability of specific industrial materials can vary regionally, fig. (2)[12].

Fig. (2) Building Applications for Industrial Materials

Fig. (2) Building Applications for Industrial Materials

Table (4) a variety of common building applications for industrial materials

(a,b) Green Roofs & Landscaping	Green roofs are roofs covered with plants; they reduce storm runoff and provide insulation. Scrap tires can be used to make rubber tile for walkways. Bottom ash can be used as bedding material. Clean wood, recycled gypsum wallboard, and cardboard can be ground and used as soil amendments in both green roofs and landscaping applications.
(c) Landscape Furniture	Benches can be made with plastic lumber containing fly ash or with recycled C&D wood.
(d) Building Facing Material	Manufactured stone, which is concrete mixed with aggregates, is commonly used as building facing materials. fly ash can be used in the production of manufactured stone
(e) Sidewalks	Industrial materials can be used to make concrete sidewalks, and used tires can be recycled to create rubberized sidewalks. Asphalt concrete sidewalks can be made with recycled asphalt pavement and recycled asphalt shingles.
(f) Ceiling Tile	Ceiling tile can contain flue gas desulfurization (FGD) gypsum (a material resulting from burning coal to produce electricity), fly ash, recycled gypsum wallboard, or air-cooled blast furnace slag.
(g) Flooring	Industrial materials can be used in various flooring applications. (h) Carpet backing: Used tires, fly ash, or recycled carpet. (i) Wood flooring: Salvaged lumber or recycled wood. (j) Flooring tile: Fly ash, blast furnace slag. (k) Tile underpayment: Fly ash.
(l) Backfill (Foundation Support)	Backfill surrounds the building foundation, supporting it and providing drainage. Scrap tires provide superior drainage, insulation, and wall pressure relief. Blast furnace slag and recycled concrete also can be used for drainage.
(m) Foundation Structural Fill	Structural fill is an engineered fill that is constructed in layers and compacted to a desired density. Coal fly ash, bottom ash, slag, and spent foundry sand can all be used as structural fill. Concrete can be crushed and used onsite as structural fill.
(n) Poured Concrete Foundation	Concrete, which is composed of cement, aggregate, and water, is used in a wide array of building applications. Industrial materials can be recycled in cement and concrete in many ways. Here are a few examples: • Fly ash and ground granulated blast furnace slag can be used as partial cement replacements. Using these materials can produce stronger, longer-lasting concrete. • Portland cement itself can be made with fly ash, FGD gypsum, foundry sand, recycled gypsum wallboard, blast furnace, and steel slag. • Concrete aggregates can include bottom ash, foundry sand, crushed concrete, and blast furnace slag.
(o) Insulation	Air-cooled blast furnace slag can be used to produce mineral or rock wool insulation (also known as slag wool insulation).
(p)Drywall/Wallboard	FGD gypsum and recycled gypsum wall board can be used to manufacture drywall.
(q) Mortars, Grouts, Stucco	Mortars, grouts, and stucco contain aggregate (sand), binder, and water. Fly ash, foundry sand, silica fume, and slag cement can all be used as partial cement replacements.
(r) Masonry Blocks	Masonry blocks are made from cement and aggregate. Slag cement, fly ash, or silica fume can substitute partially for cement. Bottom ash, blast furnace slag, and recycled concrete aggregate can substitute for newly mined materials.
(s) Base Material	Spent foundry sand can be used in place of natural soil as base material for the building site. Recycled concrete is also commonly used as base material.

5-Case study

Home of the experiences of the World created by using industrial materials reused, table (5)

Case study	Location & Building Specs	Design	Materials Reused or Recycled	Positive Community Impacts
The Lazarus Building[13] is one of the most significant green rehabilitation projects in Columbus.  *Lazarus Before Redevelopment*  *Lazarus After Redevelopment*	Renovation of a 600,000 square foot commercial building in downtown Columbus, Ohio.  	-Reducing, reusing, and recycling materials during renovation and construction -Using recycled-content products and materials in construction -Cost savings and environmental benefits -Environmental awards and recognition -Local community revitalization	Developers retained over 75 percent of the original structure, significantly reducing the amount of materials needed for the project. The renovation employed -Coal fly ash in concrete; -Recycled glass and tile flooring containing up to 100% recycled materials; -Carpets containing recycled nylon; -Restroom partitions containing 100% post-consumer recycled plastic; -Drywall containing at least 96 percent recycled materials, including flue gas desulphurization gypsum; and -Building siding containing 60 percent recycled metal.	-cost savings and avoided local community impacts from trucks hauling debris away. - The project created local jobs, improving the local economy. -a showcase of innovative ways to reduce waste.
EPA's new building[14]  **Architectural Scale Model**  **The exterior environment**  **The interior environment**	200,000 square foot EPA Regional Headquarters office building in downtown Kansas City, Kansas.  	-Many building features contribute to exceptional energy efficiency - The building's operations and maintenance environmentally friendly. -building products and materials are more environmentally sensitive, or "greener"	-Utilizing Fly Ash in concrete design -The aluminum mullions and trim on the windows, sheer wall, sunscreens, cable trays and skylight are all constructed from recycled aluminum. -In restrooms, the floors and walls were constructed with ceramic tile made from over 70% post-industrial recycled waste glass. -The Shaw carpet is made of 25% recycled material - The wood wall base in the atrium is 100% recyclable. - The ceiling tile is made from 93%-recycled slag and the grid system from light gauge steel made from 67% recycled material.	-the reduction of smog was considered when selecting building materials. In order to help reduce the contribution of VOCs into the atmosphere. -a showcase of innovative ways to reduce waste.

6- Waste Management in Egypt

Waste Management is a component of sustainable development, which seeks to reduce the impact of human activities on public health and the environment and development.

The industrial development in Egypt is the main engine of economic growth, where is the advantage of good Waste and exhaust for different industries, one of indicators of progress in the United.

Industrial waste are serious environmental problem and that the lack of local industries based on Exploitation of the waste in other industries, making it a burden and a waste of environmental resources used In production processes, fig. (3). In fact, it can be exploited to become the waste materials with high economic value.

To sustainable improve waste and materials management in Egypt[15] will focus on the active involvement of industrial waste generators in the reduction of waste volumes at source, and will also encourage private sector participation in solid waste management services, particularly collection and recycling.

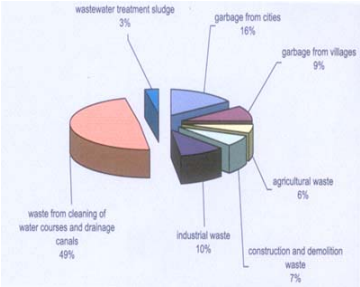

Fig. (3) The proportion of solid waste in Egypt

6-1 About a method to organize and manage the re-use of industrial materials in construction in Egypt:

This part comes to address the negative aspects which appear in the overlapping of roles and responsibilities of the parties involved in the project and overcome the causes that impede the management of re-use of industrial materials in Egypt to achieve urban development[16].

6-1-1 Identify the parties involved and the distribution of responsibilities

Parties to the proposed approach are different bodies responsible for policy development re-use of industrial materials in construction.

They are the government, institutions of technical advisory, executive agencies (investors and a group of capital and local governance), popular participation (beneficiaries), research centers, contractors and specialists (architects). In order to integrate the curriculum leading to activation of the application re-use of industrial materials in construction in Egypt should be considered interested parties and their respective roles to achieve the restructuring of the curriculum by ideal integration of limbs.

(I) the role of government

The success of the reuse industrial materials in building depends heavily on local government engagement and action. Their role is large and vital[17].

- Coordinate and facilitate partnerships to implement the reuse materials action plan.
- Lead by example in government
- Provide incentives that encourage green design, construction, and deconstruction and begin removing disincentives
- Expand capacity and markets for reusing and recycling construction and demolition materials.
- Increase awareness, knowledge, and access to reuse industrial materials
- Encourage innovative product design
- to encourage beneficiaries to participate in these projects beneficial to the environment
- amend laws and existing environmental legislation

(Ii) The role of NGOs non-governmental organizations:

- Implementation of development projects in the environment and recycling waste.
- Training of local technical staff
- Coordination between the professional societies and funding for the implementation of various development programs.

- Galvanize the efforts of various parties (government, individuals, and investors) with the coordination between them.
- Support salvaged materials collection centers.
- Subsidize warehouse space to support the collection and distribution of salvaged materials.
- Create incentives for deconstruction, recycling, and the use of salvaged or recycled materials into construction procurement contracts.

(III) The role of professional engineers[18]

Specialists are planners, architects, economists, social, the most significant roles played by professionals in the following:

- Create new buildings that save energy and water, use fewer material resources, and create less waste.
- The design appropriate to the building to suit the Egyptian environment, according to the needs of the population and location
- Created propose a method suitable for the Egyptian environment and the work of drawings.
- Technical guidance and training courses for users and individuals to create technical staff can participate in all phases of the project.
- building designers have a responsibility to specify preferred materials and methods of construction which are suited to recycling

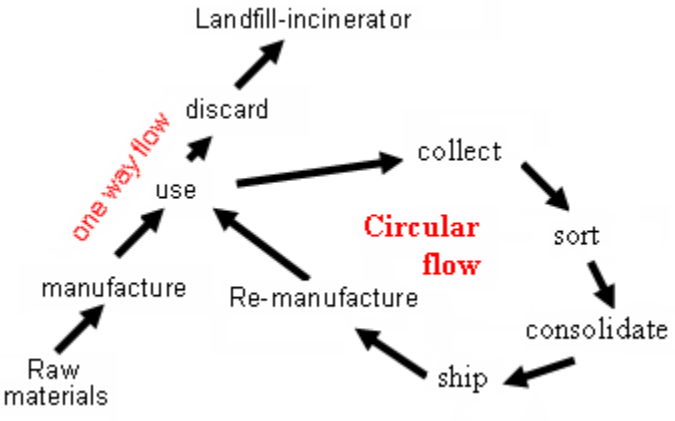

Fig.(4): Circular and linear flows of materials

(IV) Contractor` Role

- Design and plan to Prevent Waste, and develop a Construction Waste Management Plan
- Survey the Site Before Demolition or Deconstruction, Plan for Recyclable Materials
- Identify Reusable or Salvageable Items, all materials should be examined using a precautionary approach to eliminate possible toxicity or future regulatory constraints to their use and disposition.
- Select Salvage Removal Alternatives
- Estimate the Costs and Savings
- Prevent Contamination
- Separating the components will facilitate adaptation and reduce the complexity of deconstruction
- Building contractors need to exercise care during demolition, and should be prepared to re-use suitable materials on projects.


Fig. (5) Reuse –recycle can occur onsite and offsite [19]

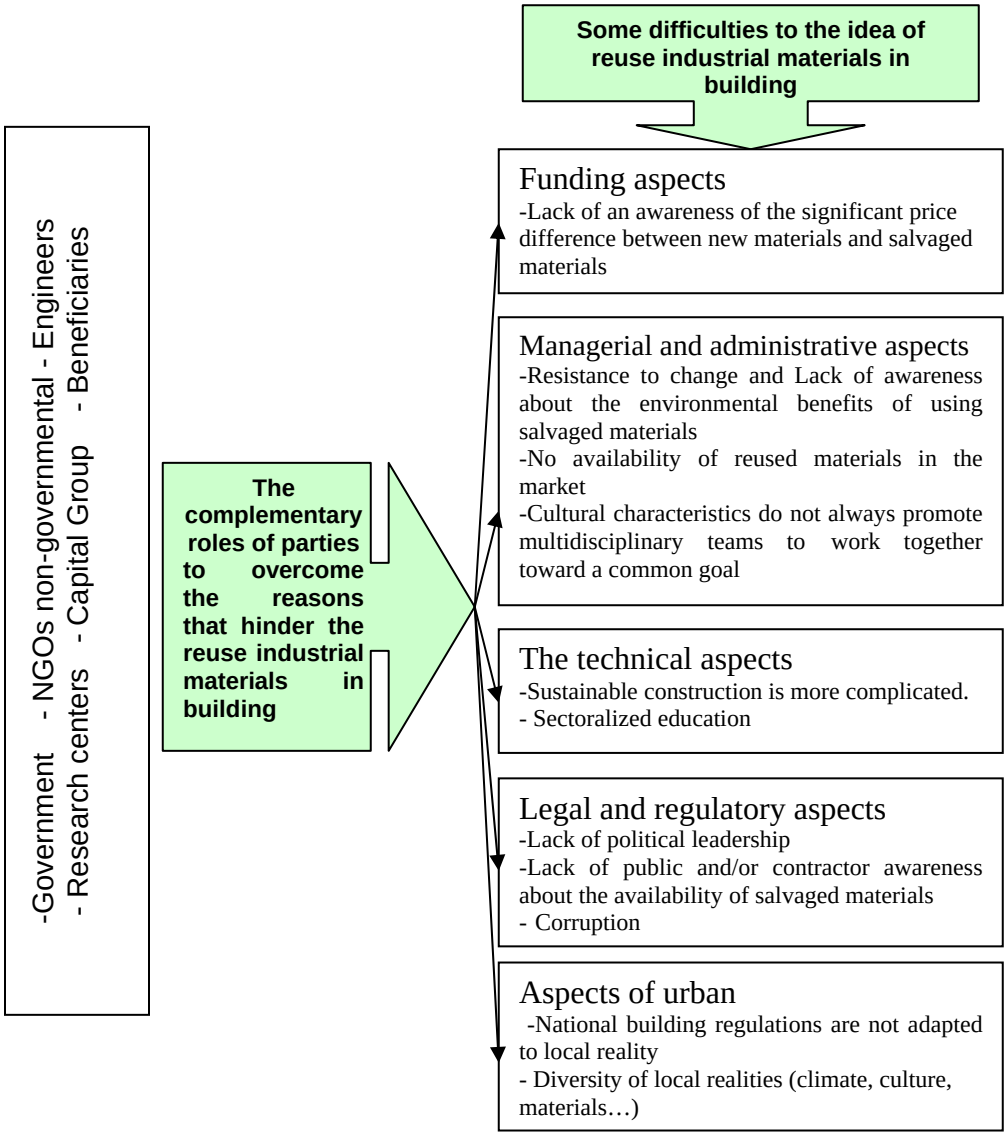

Fig (6) overcome the reasons that hinder the reuse industrial materials in building in Egypt

(V) The role of research centers

- Examine the adequacy of recycled materials used with the Egyptian environment.
- Insurance system building against fire, moisture and insects, and the work of all the tests required, and improve the implementation of this new technology.
- Study ways to improve the properties of the construction of the building using this new technology.
- Employment training to create this type of installations.
- the use of certain programs to achieve energy efficiency within enterprises, and may remove energy consumption to the minimum (Zero Energy)
- Monitoring of constraints and variables that occur in the region and draw conclusions to contribute to approve the project with the environment and the needs of the user, the study of the potential physical and technical implementation, and improve the economic viability of the project.

(Vi) The role of Group Capital (investors and businessmen, banks, real estate specialist)

- Develop and/or fund training programs. Subsidize training costs for participants.

- receipt of the site, and provide the necessary potential for re-use of building materials to be used
- coordination between manufacturers and specialists to bring in industrial materials and re-use in construction
- Follow-up after implementation of changes in operations and maintenance

(Vii) The role of beneficiaries / individuals

the user is the basis of urban development which is capable of maintaining the physical output, and can be user participation in several areas.

- participate in the implementation of self-help
- participate in the maintenance and improve the local environment
- Participating home improvement loans to upgrade facilities and infrastructure and public services.
- Owners should insist on the use of recycled materials… in the interest of ecologically sustainable development.

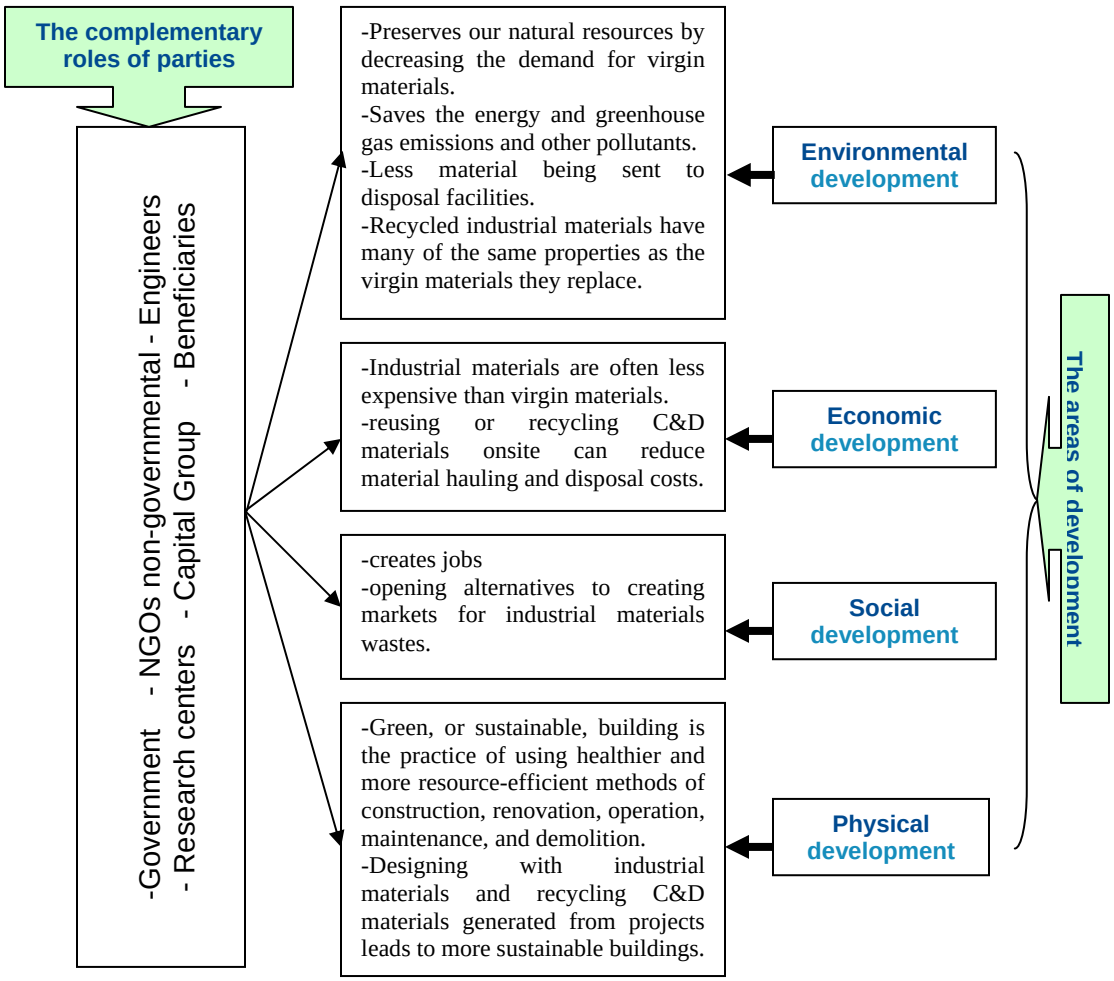

Fig (7) increase the effectiveness of the parties involved in the process of reuse industrial materials in building in various facets of development (environmental, economic, social and physical) for sustainable development

6-1-2 Complementarily of roles of parties involved in the process of re-use to remove the causes that hinder the management of such material in Egypt, figure (6).

(a) between industry and regulators to increase the understanding of the beneficial use of industrial materials and regulatory programs; (b) among state regulators to share information and experiences on beneficial use regulations

and determination processes; (c) among industries to share experiences on successful reuse and recycling, and to assess the potential to utilize each others' materials, and (d) among researchers, nonprofit representatives, industry, and regulators to share information and concerns regarding risk assessment, beneficial use determinations, environmental safety, and new research.

6-1-3 Participation of the Parties to the proposed project to achieve sustainable development fields at the actual application of the project.

Integration of the roles of the participants in the process of re-use of industrial materials in construction is conducive to the development of environmental, economic, physical and social**,** figure(7).

7- CONCLUSIONS

Based on the data collected from the literature survey, it is revealed that the production of industrial materials waste is escalating both on the international and national scales. Furthermore, environmental, safety, visual and technical related problems generated from these wastes has severely added to the long-term negative impacts of these wastes on the surrounding environment.

The essence of the recommended guidelines in this paper is to offer systematic procedures that could help in minimizing the magnitude of the industrial materials waste problem in Egypt. Therefore the disposal option can be avoided by the implementation of reuse them in building.

Waste reduction opportunities begin with the earliest choices made in the building process, including architectural design and material selection. Effectively balancing resource-efficient design concepts requires the attention of skilled and environmentally conscious building professionals. These concepts include waste prevention, durability, and recyclables.

And has been monitoring some of the negatives facing the potential to activate the application of construction materials industry and are summarized as follows:

1. Limited NGO non-governmental organizations concerned with the field of urban development in general and re-use of industrial materials in particular.
2. Does not represent low-income housing a sufficient degree of urbanization, culture and enable them to participate in such environmental projects in an effective manner.
3. Difficulty of maintaining such environmental projects for low-income.
4. Building design re-use of industrial materials zero energy consumption in Egypt still needs some time.
5. Non-participation of specialists sometimes leads to delays in implementation and increase the cost and other obstacles that may face the project when actual implementation.

8- RECOMMENDATIONS

(1) Increased awareness, acceptance and proactive government policies are critical in order to continue the upward trend of recycling and reusing materials whenever possible

(2) More political support is required to enforce the implementation of waste management scheme in the construction/building field, collect industrial material wastes under the direct supervision of authorities. Imposing a special tax levied on wastes when exceeding a certain level determined by the government.

(3) It is also recommended to extend research on the area of recycling and reusing techniques of industrial materials in building to induct feasibility studies, including cost/benefit and payback period analysis for each technique. The research should survey the Egyptian market and seek the potential possibility of using waste as raw materials in factories. This research should integrate both the construction industry and the manufacturing industry to bridge the gap between the two disciplines.

(4) Overcoming these challenges may require advocacy work to strengthen policies and incentives to reduce construction and demolition waste, intensive education and marketing to expand the demand for reused building materials, as well as smart partnerships and inventory management to keep the right mix of reused materials in stock to meet local demand.

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