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To cite this article: Laila A. Elsawaf and Ayman A. E. Othman 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **974** 012022

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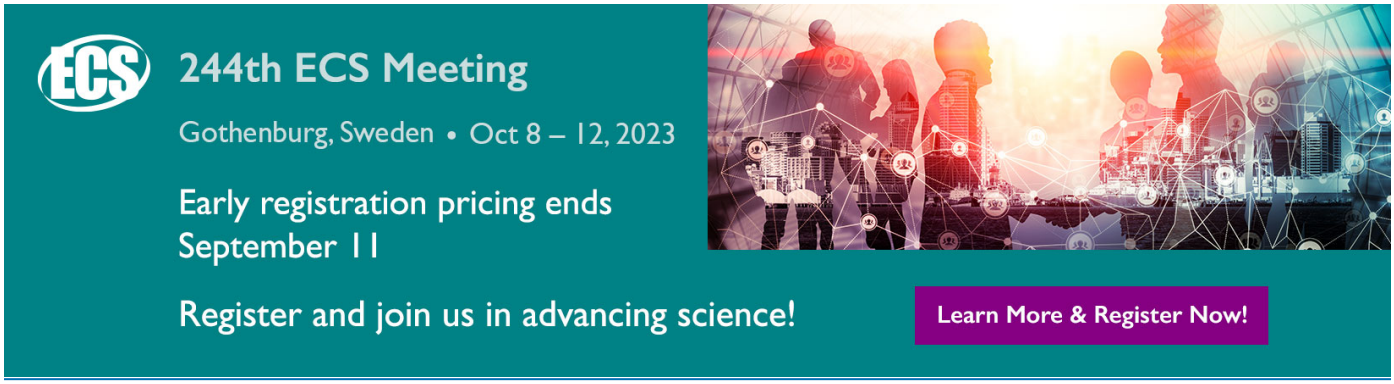

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Design out waste as an approach for achieving sustainability in Egyptian housing projects

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Abstract:Housing projects have been increasing rapidly during the previous years to fulfil community needs and achieve the national and international sustainable development objectives. Due to their nature, housing projects generate a significant amount of waste that accounts for approximately 40% of the solid waste that the construction industry generates annually. Many of these wastes are a result of inappropriate decisions adopted during the design process such as using non-sustainable materials and inefficient use of natural recourses. Meanwhile, research has revealed that achieving sustainability within housing projects is a crucial challenge, yet an essential one. This called to think differently and adopting creative strategies for reducing construction waste during the design process. Therefore, this research aims to develop a matrix that correlates the aspects of sustainability with design out waste strategy as an approach within RIBA design phases for achieving sustainability in Egyptian public housing projects. A research methodologyconsists of literature review and case study was designed to achieve a working matrix by accomplishing three objectives. Firstly, literature review was used to investigate the topics of sustainability, design out waste strategy and housing projects. Secondly, a case study collected by literature presentedand analysedto identify the design out waste strategy for reducing waste as an approach to achieve sustainability. Finally, developing a matrix that correlates sustainability and design out waste strategy within RIBA design phases.

Keywords: Waste Reduction, Design out waste strategy, Sustainability, housing projects, Waste, RIBA design phases.

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1. Introduction

Waste is one of the most devastating global dilemmas generated from the construction industry, particularly from housing projects.smith, [1] stated that the U.S. alone generates roughly 251 million tons of solid waste annually, of which 40% is produced from construction projects alone. According to the World Bank[2] only 4% of the waste generated from low-income countries is recycled and one third of the high-income countries. Due to the negative impact of waste economically, socially and environmentally, the construction industry aims to reduce this percentage down to 30% approximately by 2020[3]. Whilst, it may seem to be a low percentage, yet it is not assured to be done. The majority of waste and unusable materials as solid waste are generated from the construction industry. Which leads to the question of how we can minimize waste generated from construction projects? A plausible solution would be considering the utilization of the design out waste strategy within architectural design firms to reduce the waste from the early stages of the design of housing projects as an approach to achieve sustainability. Waste in the construction industry usually results from inefficient or limited guidelines that aid with resources[4]. Particularly, that generated from housing projects, which mainly begins to appear from the earliest stage of the design process[5]. Whereas, the decisions taken during the design phase have proven to decrease the overall waste generated from the housing projects[6]. Waste management is one of the main aspects that controls and regulates the avoidance of waste in housing projects. Nevertheless, architects responsible for the design of housing projects should take into consideration the types of wastes that are primarily a result of decision made during the design process. However, these wastes should be decreased by considering the multiple design out waste techniques for further sustainable development. Therefore, the issue is based on exploring the impacts of waste on construction and contributing causes which will help the practitioners to formulate ways of avoiding or reducing waste. It also highlights the sustainable approach in design out waste management as a strategy. Therefore, design out waste strategies would minimize the causes and effects of waste on environment, economics, and social impact. According to Wrap [7], design out waste is a principle of building using resources in an efficient manner. Usually, it is first introduced within the design stage, which in turn helps with reducing the amount of resources that are consumed throughout the project. On the other hand, it could also be considered a strategy that increases the overall quality of the project.However, with focusing on the resources not only human resources but energy consumption, water, health, education and environment as a whole leads to Egypt 2030 aspiration for developing sustainability. As well as, to keep the country participators in developments challenges facing it keeps initiative plans to determine these areas.

2. Methodology

The methodology adopted throughout the research for the purpose of attaining its aim and objectives. A research methodology consists of literature review and case study was designed to achieve a working matrix by accomplishing the objectives. However, the matrix developed will be in form of a checklist for easy use as it's the first of its kind as a model collaborating design out waste strategy , RIBA design phases and sustainability.

Aim

- The research aims to develop a matrix that correlates the aspects of sustainability with design out waste strategy as an approach within RIBA design phases for achieving sustainability in Egyptian public housing projects.

Objectives

To achieve the mentioned aim, a number of objectives have to be accomplished.

1. Investigating the waste in public housing projects in Egypt, design out waste strategy and sustainability listed in literature review.

2. Acase study collected by literature presented and analysed to identify the design out waste strategy for reducing waste as an approach to achieve sustainability.

3. Developing design matrix to assist ADFs with achieving sustainability through implementing the design out waste strategy within collaboration to RIBA design phases.

2.2 Research Methodology

The research methodology is based on data collection and the action demanded to achieve the proposed aim to develop a design matrix for achieving sustainability within Egyptian public housing projects through the implementation of design out waste strategy as an approach.

- **Data collection and gathered information:**

  Literature review which is based on the literature review that investigate the waste in public housing projects in Egypt, DOW strategy and sustainability.

  Case studyis researched to achieve objective two that uses design out waste strategy to reduce project waste within the construction projects and achieve sustainability.

- **Required Course of Action:**

  Based on the results of the previous objectives analysed developing a design matrix to achieve objective three to develop the proposed matrix and research conclusions for achieving sustainability in housing projects and meet with Egypt 2030 vision.

3. Literature Review

2.1 Waste in housing project in Egypt

The construction industry specially housing projects is one of the biggest industries worldwide. It is one of the essential sector for the development in countries worldwide. Moreover, the housing projects plays a significant role in increasing Gross Domestic Product (GDP), economic growth and urbanization development improvement of countries. In Egypt, the construction industry employs about 11% of the total population which contributes towards increasing[8] GDP by 5% through 2009/2010-2013/2014. However, the construction industry through housing projects provides a contribution toward meeting society needs and requirements. Furthermore, the housing project is a complex business in the construction industry. It is a risky business that is affected by some internal and external factors which impacts its performance.Housing projects are subject to a number of problems including low productivity, time and cost overrun, poor safety, lack of quality and lack of working conditions. Durgekar[9]stated that Egypt has increased its solid waste in housing projects by 36% since 2000. Globally, producing construction materials are using about 40% of the global economy. The 60% is about accountable construction sector of natural materials resources from nature, 23% of air pollution and 50% of water pollution, 50% of water and energy consumption and 50% of total generated waste which is a huge percentage. However, the problem has been released throughthe lack of direct guideline and effective legislations. According to Durgekar,[9] housing projects in Egypt waste has been generated among each structure participant working separately, that also lacks the vision of planning and collaboration in each construction phase. Furthermore, the limited reliable services providing cost-efficiently and funds provided by municipal authorities.As well as there is a lack in public awareness and citizen behavior. Those unconsidered lacks generates the waste in housing projects. A result of the dismiss performance of waste in Egypt during the last decades, the pollution and its impact has been highly increased [9,19]. The fishbone diagram shows different types of construction waste through the construction project, see figure (1). Development of construction wastes can becaused by various factors. It is very important to identify andunderstand those causes for controlling waste generation atsource. However, this diagram below explains the causes and effects

ofconstruction waste. Identification ofthe different factors can help in increasing awareness ofconstruction practicing to control construction waste.

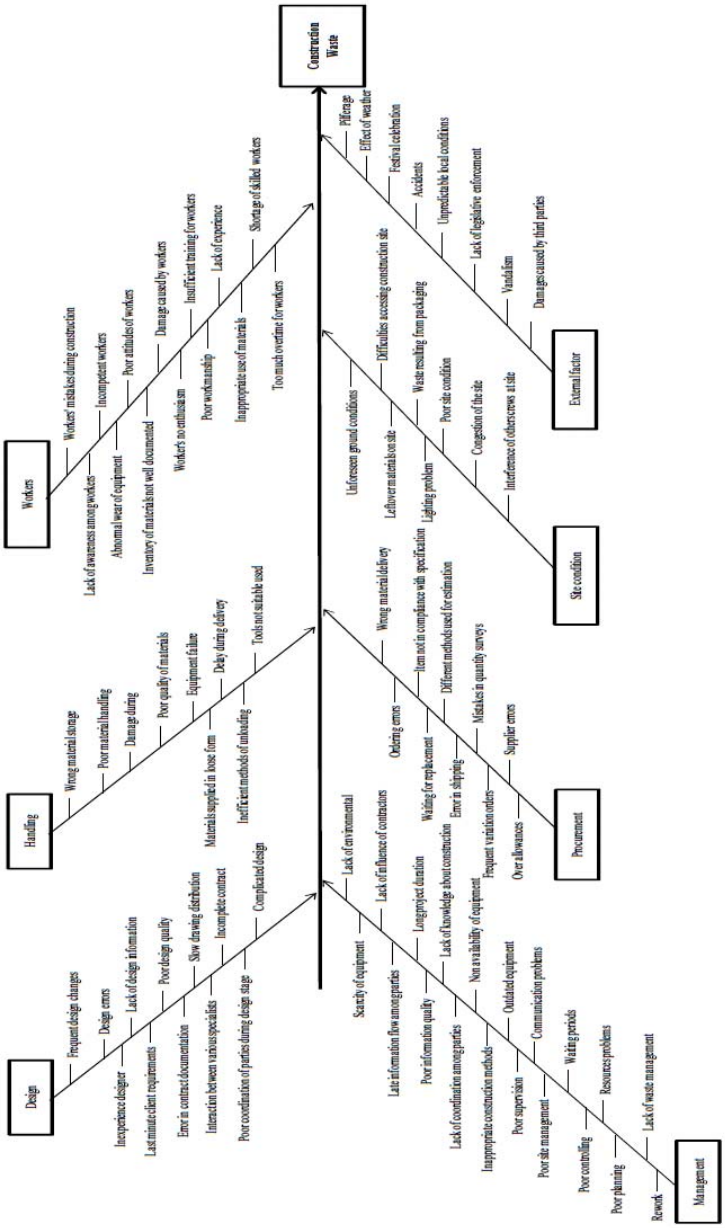


Figure (1) construction waste fishbone [9].

2.1.1 Types of waste

Construction waste is one of the most recycled materials and recovered waste according to its diversity in types and quality[10]. Construction waste generated from housing projects includes a wide variety of materials. Some of those materials may be recycled considered as hazards materials while other materials could not be recycled that considered asnon-hazardous in nature. For managing the construction waste effectively, should classify the type of waste to work with it as a recycled material or to used it carefully without generating any waste, see table(1). As for example, concrete separated means the separation of concrete from steel or other materials in the components [10].

Table (1) types of wasted materials [10] (developed by the author)

Materials	Hazards (could be recycled)	Non- hazardous (couldn't be recycled)
category 1	Concrete separated	Concrete
	Ceramic separated	Ceramic
	Bricks separated	Bricks
	Tiles separated	Tiles
Category 2	Wood	Treated wood
	glass	Gypsum
	plastic	paint
	Paint cans	
Category 3	Fibre glass	insulation
Category 4	Steel	Metallic cables containing oil
	Copper	

Construction waste also is divided into two groups including physical and non-physical waste as shown in figure (2). The physical waste represents the materials loss, while the non-physical waste represents waste in time and cost.

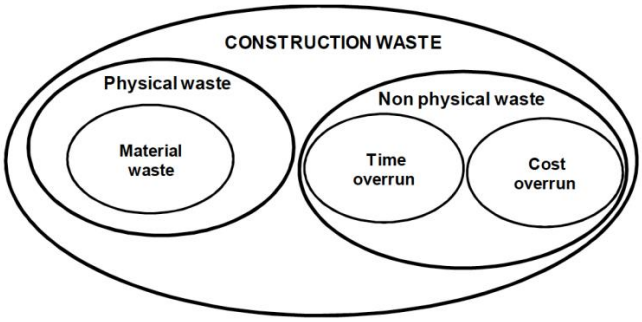


Figure (2) the waste occurs in the form of material, time and cost losses [9].

2.1.2. Waste Different impact of the housing project

2.1.2.1. social impact of the housing project

Dispute economic and environmental impacts, social impact is the least in the "triple bottom line" the principles of sustainability developing. However, it's an impact of housing construction projects in Egypt that refers to certain social aspects to human populations of housing projects as the change of the way people work, relate to one another live, to meet people needs and overall organize how to cope as members of the society. In construction housing projects the development may lead to positive or negative social impact and maybe both, resettlement of nearby resident provides a negative impact on society. Furthermore, land acquisition, disposals and resources depletion effects on a negative way to the surrounding settlements and residents. Social impacts of the construction waste under certain conditions could lead to social risks and evolves a conflicts if different stallholders didn't dealt with the waste problem carefully and properly. While society couldn't cope with the current situation for long period of the housing project lifecycle.

2.1.2.2. Environmental impact of the housing project

The successful construction projects should recognize that not only cost is the effective method but also environmental methods should be respected. The Environment is affected by the unethical activities that cause problems generated from the housing waste.The waste contributes environmentally disposal to pollution globally within the wrong deposit activity of physical wastes. However, the waste impact on the public generally and to the whole environment around the world.

Construction waste has an effect that requires an immediate attention to protect the environment globally. According to Nagapan[11]Studies shows that the adverse wasted materials of housing projects has significant highly impact on the environment.Compromising the Egyptian natural resources improper disposal of housing projects waste like waterways that contaminate the water supplies[9]. This contributions and current lack causing serious environmental impact. Various countries are blown down by neglecting the concept of waste impact on environment and its very important to understand the current situation to discover the solution.

2.1.2.3. Economic impact of the housing project
Construction housing projects waste increases the project cost above the budget of the project[11]. However, the cost overrun by different aspects as the transportation, the surplus materials and the repairing damages. The materials wasted in housing projects generated from the construction activities in different identifications as concrete leftovers, steel scrap and demolished debris [11].

2.2. Achieving Sustainability In Housing project

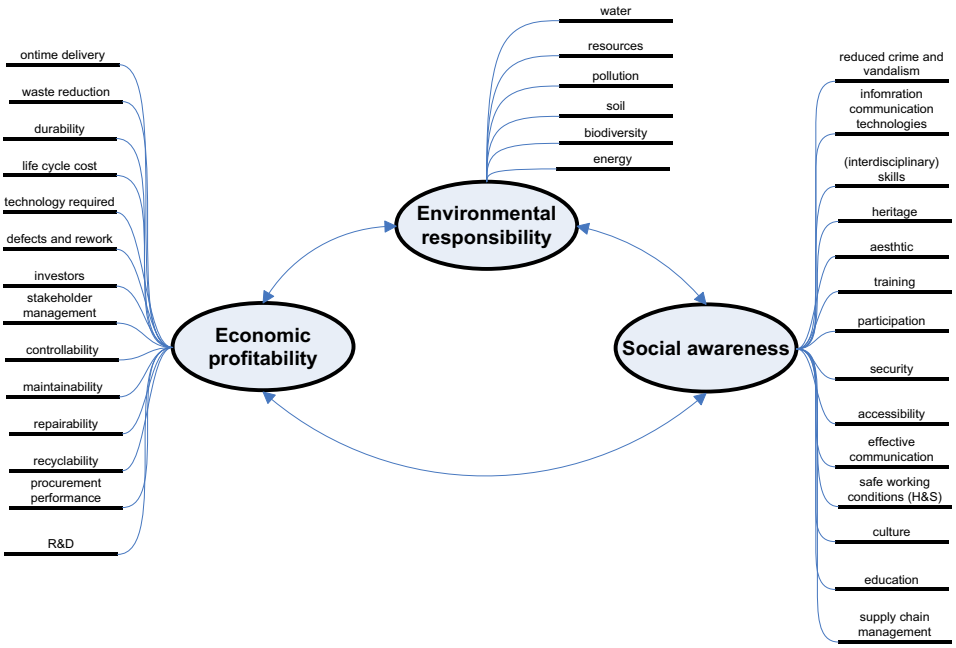
2.2.1. Definition of sustainability
Sustainability means the capacity to sustain, the current need and future generations for well and survival being depending on natural environment, either directly or indirectly way [12]. Furthermore, sustainability aims to consent humans within nature in present and future by creating and maintaining the environment, social and economic aspects. Sustainability is becoming a great variety term that can empiric to almost every aspect of life on earth, ambulatory from local to globally scale and over diversity of time period[13], see figure (3).

2.2.2 Aspects and dimensions of sustainability
Environmental, social and economic those are the main three pillars of sustainability. However, combining between those three pillars generate three new pillars, namely: Social Environmental, Environmental-Economic and Economic-Social[14],see figure 3.

2.2.2.1 environmental aspect
The environmental pillar of sustainability concern to use the natural resources in an efficient way within reducing the waste, effluent, pollution and emissions generation to the environment. Moreover, it aims to protect human health from the negative impact reduced, while exterminate the toxic substances and encouraging the use of renewable raw materials[13].

2.2.2.2 social aspect
The social pillar of sustainability is a fair and achievable society fairness and justice when conveying its resources within itself. According to BenzuJK,[13]the society would not demanding in the rights of each and every individual based on sequences of their age, sex, religious, ethnicity and social background. The rights to have sustainable is living in a good quality life, right to housing, right to social security, freedom of speech and right to facilitate property ownswith sustainable aspect according to[13,15].

2.2.2.3 economical aspect
An economical pillar means the self-sustaining society which it using the available resources provided in efficient way according to its individuals with its needs without help from the neighbouring countries. according to Othman et al.,[13]to develop an economically sustainable society, increasing productivity, adding value and minimizing waste is by creating new market share, reducing cost, energy through improving efferently and using raw material.



Figure(3) Qualitative data - the construction industry sustainability tri-polar[13].

2.2.3 Dimensions of Sustainability

Sustainability is a long period structure strategy for environment , economic and social system, which aims to minimize the burden on natural resources. However, balancing these three pillar is the aim for developing sustainability for long term. Otherwise, neglecting one of the three pillar will impact potentially danger on developing the whole process.

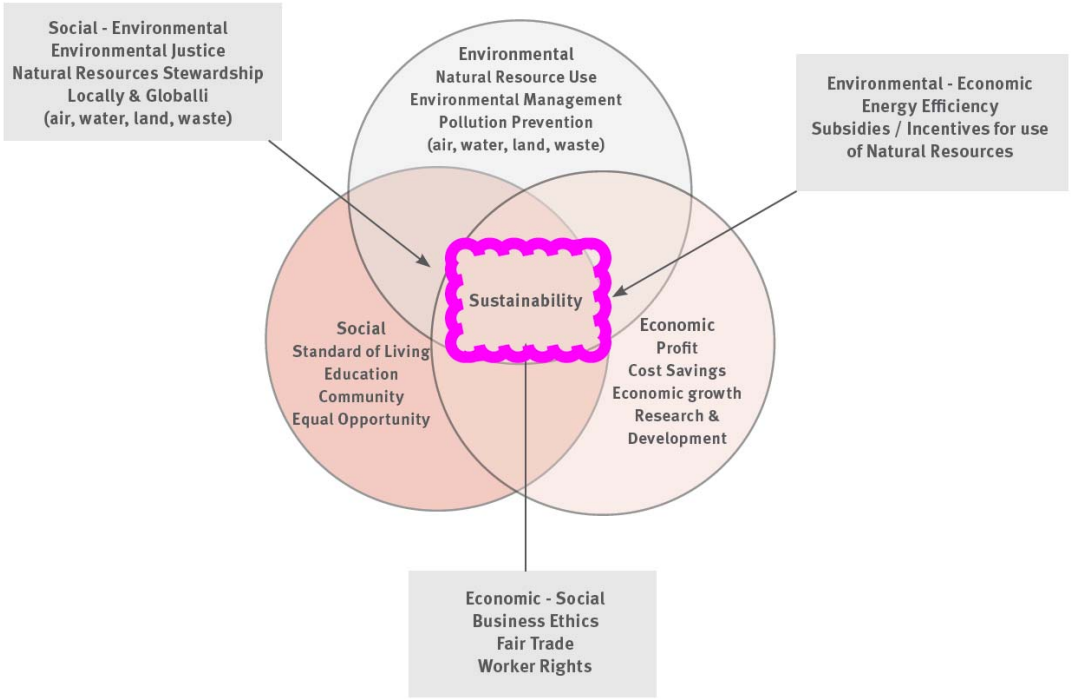


Figure (4) sustainability dimensions [15].

4. Design Out Waste Strategy for achieving sustainability in Egypt

3.1 Definition of design out waste

Design out waste (DOW) defined as building principles within using resources efficiently during design process of construction projects[16]. The concept of this strategy to design the use of each material with no value intrinsic, or inherent value discarding. Design out waste strategy can be integrated into a process matrix to evaluate the waste generated and identify how to be reduced within a buildability ,cost less, high quality and less time. It aims to plan the minimization of resources within use of available resources and materials efficiently as possible as can. Design out waste circular economy depending on pollution and optimizing usage of natural resources. The UK waste and resources action program (WRAP) designed this strategy to reduce waste during design process has provide five main principles[16], as follows the processes production serve several principles:

- Design for Waste Efficient Procurement
- Design for Materials Optimization
- Design for Off-Site Construction
- Design for Reuse and Recycling
- Design for Deconstruction

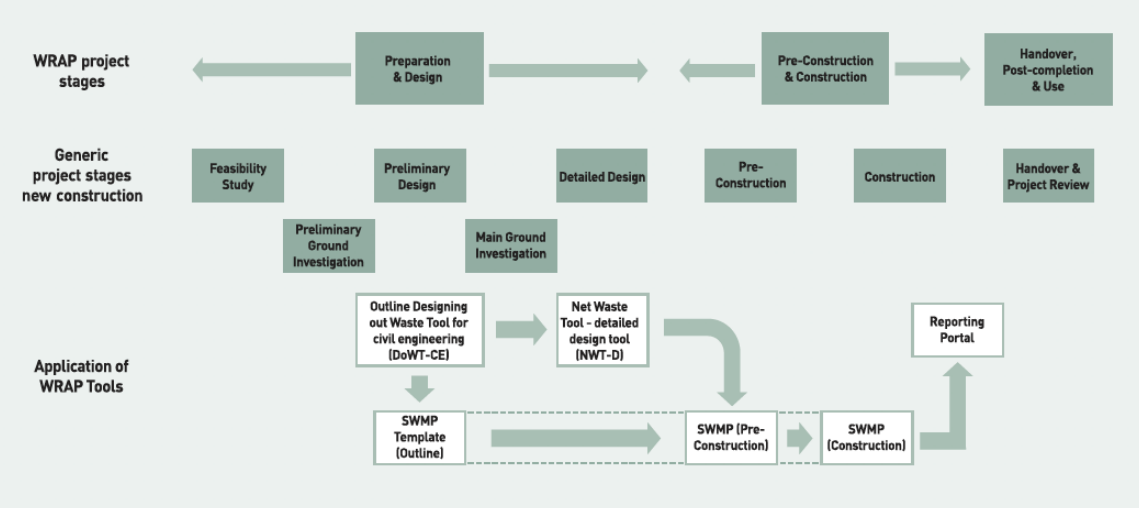


Figure (5) WRAP project stages [16].

3.2 Principles Of Design Out Waste

3.2.1. Design for reuse and recovery [16].

- This principle focuses on recycling used material (ex. reclaims products or crushed demolition materials) throughout project whole life cycle.
- Reuse demolition materials and building components.
- Reuse existing site buildings.

3.2.2. Design for offsite construction[16].

- Through early phase in construction project contractors should specify a concept of using prefabrication to improve the supply chain.
- Use modular volumetric construction.
- Use of-site prefabrication of structure elements.
- Use of-site prefabricated pods, bathrooms.

- Use of-site prefabricated and pre-cut building elements.

3.2.3. Design for material optimization[16].

- Focusing on the design process with an approach towards "good practice" that allows designers to consider materials usage to be more efficient, which will further reduce the overall waste in construction, by minimizing excavation and material.
- Facilitate the building layout, form and elements.
- Design within standard room sizes, ceiling high stand material sizes.
- Reduce number of material used using local material standard.
- Specify recycled content.
- Consider the services, maintenance and replacement required of each component for the long run life time.

3.2.4. Design for waste efficient procurement[16].

- Allows the designer to be involved within both the design and construction process, which aids with the considerations that dictate workflows.
- Use documents for setting the waste performance requirements.
- Supply chain collaboration.
- Identify the source responsible of recycled content and materials.
- Reduce the required packaging in using materials procurement.
- Prepare plans within contractors waste minimization and site waste management plan (SWMP).
- Consider logistics material and in time delivery.

3.2.5. Design for deconstruction and flexibility[16].

- The concept of deconstruction and flexibility is principle that on climate adaptation throughout the whole life cycle of the building, which is linked to the reuse and recovery material principle.
- Use precast steel frame.
- To simplify the future reuse of bricks use lime mortar.
- To change of use enabling method use flexible construction.
- Facilitate the design life time potentials once the project is done.

3.3. Benefits and Methods of Design Out Waste Strategy

Benefits of the design out waste strategy in projects, that it can be applied in any constructionphase throughout the project, while its effective action done mostly during the structure of the project as approached by[16]. Previous research found that poor design planning followed with failure, according to WRAP, [16]33%of all on-site waste is due to a failure to implement waste reduce on measured ways during the early design stages.However, to minimize waste through the initial design planning phase are the best opportunities using (DOW) in it.

3.3.2 Role Of Design Out Waste Towards Achieve Sustainability

If the ideas and principles of designing out waste strategy are to be successfully applied to any project, The effective impact is achieving sustainability across the project is absolutely vital. Every team member or stakeholder involved in the design, construction and ongoing management of the project should result a building to be engaged a with design out waste as early as possible[7]. This will ensure that the importance, benefits and implications of designing out waste are fully effective to achieve sustainable housing project. While, technical team members such as contractors, construction engineers and facilities management teams can all bring extremely valuable insight on the practical implications of the delivery of sustainability[17]. All team members and stakeholders should be encouraged to apply the strategy for achieving sustainability. It is also important to engage as early as

possible with the relevant planning, building regulation and other statutory compliance authorities. Communication with these bodies should include discussion of the planned designing out waste strategy and measures of sustainability meet together. This means they can be addressed and resolved before causing disruptions of work environment to reach the effective implementation of sustainability during housing projects plan.

3.4. Sustainable development in Egypt 2030

Egypt 2030 vision is known with sustainable development strategy, set a goal to be initiative with creating productive, modern, striving, happy society in addition to that is to be economically, environmentally and politically stable[18]. Maximizing the domestic resources is a need for developing the energy sector and the construction industry to accomplish an effective accommodation. Additionally, urban development is another Egyptian 2030 vision issue that admired of multiplying the current urban spaces within relocating both projects and citizens for introducing more effective use of numerous lands and resources. The key for developing urban spaces include creating developed 7.5 million housing units within finding kind of a solution for slums in Egypt. As the housing project is the main source of comfort and save accommodations[18]. This leads to the next level of initiative future plan, which is the consequently quality of life overall improvement. The construction industry combine both economic and environment for developing a sustainability approach, while balancing between both to of them adhesive the economical level in advance way that do not effect on the environment in negative way[18]. To be par with the environmental standard internationally, Egypt should follow this strategy to be on track, as well as establishing consumptions practice, sustainable approach and significant waste management methods. However, design out waste is a successful and efficient method for delivering sustainability of construction projects in Egypt, as it followed by the three pillar of sustainability environmental, economic and social to meet with Egypt 2030 futuristic vision.

4. Case-Study: Model D house

4.1 Background Information

Figure (6)Model D house [16].

- Location : Pitmanchie near Insch, Aberdeen
- Source : (zero waste Scotland, 2011)
- Architects : GokayDeveci ARB RIBA FRIAS
- Project Type : Residential
- Date Completed : October 2011

- Gross Internal Floor Area : 155 sqm

Case study objective: This case study uses Model D house located at Pitmanchie near Insch, Aberdeen as an example to investigate the compatibility of new uses design out waste strategy. The case study also takes into consideration several indicators such as architectural integrity, building form, building function and sustainability (considered as sustainable building values listed previously in the literature review) . This case study aims to identify qualitative issues and to understand the new features to provide a guidelines for using it during the investigation of waste that generated from housing projects and reduce it, based on the analysis.

Introduction: The Model D house was designed for Zero Waste Scotland at 2011 is an innovative project designed and managed as part of resources efficient for Scotland by GokayDeveci ARB RIBA FRIAS[16]. The house was opened in October 2011 is now a new feature and visitor attraction at it's a new iconic in the city. It shows how several of the ideas of designing out waste can be successfully incorporated in a building to have high potentials to be cost-effective

4.2 Project Brief

The house is located near Insch in Aberdeenshire, and is designed to determine the different alternatives of unaffordable products that offered by high developers. The design aims to offer a new approach of design that consist of large scale and related to the surrounded context rather than kit-built homes that are expensive.

Figure (7) model D house [16].

4.3 Case Study Target

Additional to that, the clients were focusing on to develop an alternative design to be providing an affordable, high quality within low-energy dwelling that adopts home-grown timber. The design main target is to stimulate a transformation in our old version of current thinking about architectural design and house design[16]. Here in, it focuses on the ecological awareness increasing and the concentrating on environmental and friendly designs and the use of local materials.

4.4 Case Study Process

4.4.1 Orientation

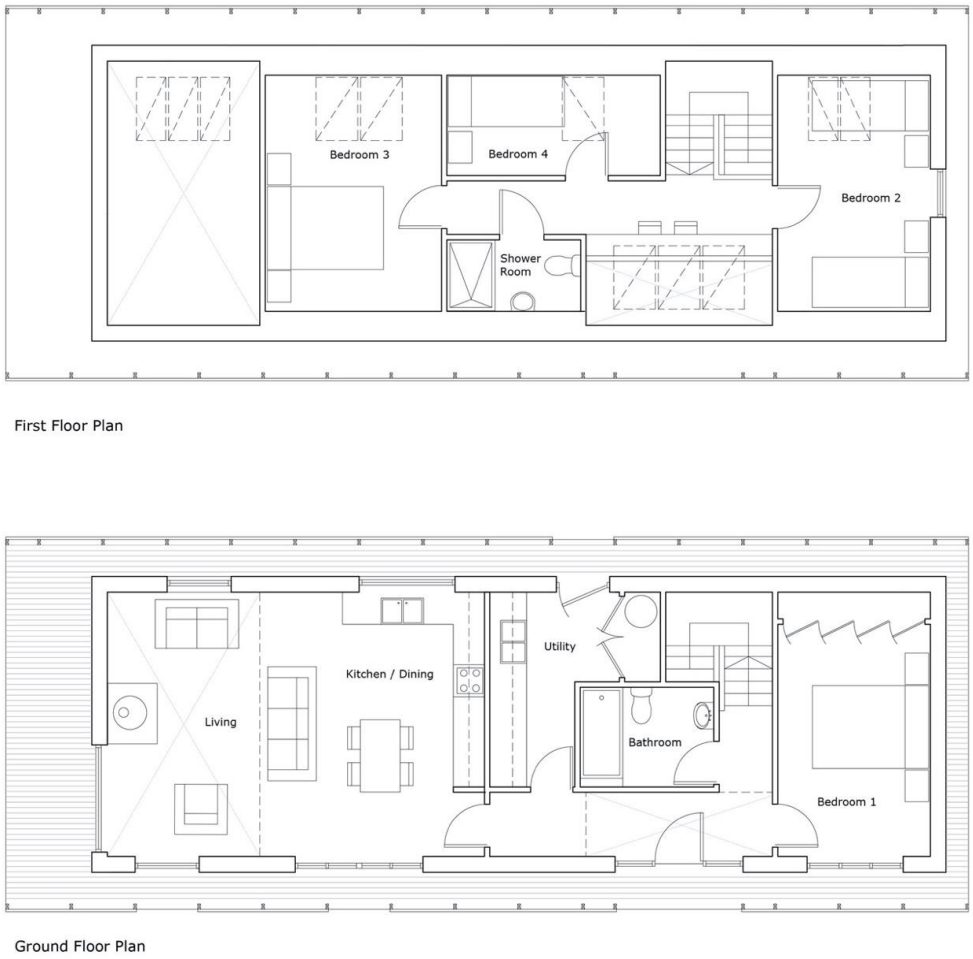


Figure (8) model D house plans [16].

The orientation of the building was to develop a flexible approach for the living space that proposed in summer. As shown in figure (8) the design of the house is designed within a very simple design within rectangular long plan, building including an open living, dining room, kitchen space and one double bedroom on the ground floor. There is a separated utility room that used as a recycling storage room and also a bathroom on the ground floor plan. On the first floor plan there is a two double bedrooms, an additional shower room is in the attic story and an extra open gallery space[16]. The bedroom that located over the living space (bedroom 3) can be used as an open studio or office space only by removing the alternatively wall. There is a main circulation space within the living space both designed double height space to give the sense of lighting and space in the interior[16]. The design incorporate a terrace in the house that offers a buffer space, protected within timber screen. Taking advantages of the solar heat gain by using large south facing floor-ceiling openings, while it also maximize the views.

Figure (9) model D house screens [16].

The large widows openings of the building is in the south façade that takes the desired solar gain and maximize the views. Durability and homogeneous appearance is provided by the meticulously detailed external rain screen which provides shading and privacy where required.

4.4.2 Materiality

Due to the smaller parts of timber panels sections of the wood used in the building is manufactured on site, as well the superstructure of Scottish timber was delivered on site in open panels[16]. The use of standardized timber kit construction was adopted to provide the required U-values and air tightness. The wall construction became two leaf's of 95x45mm C16 timber frame panels, with a layer of OSB sheathing between to accommodate the air-tight membrane, Similar to the roof arrangement [16]. As shown the materials and setting of the dwelling through the process that followed by the design out waste strategy application.

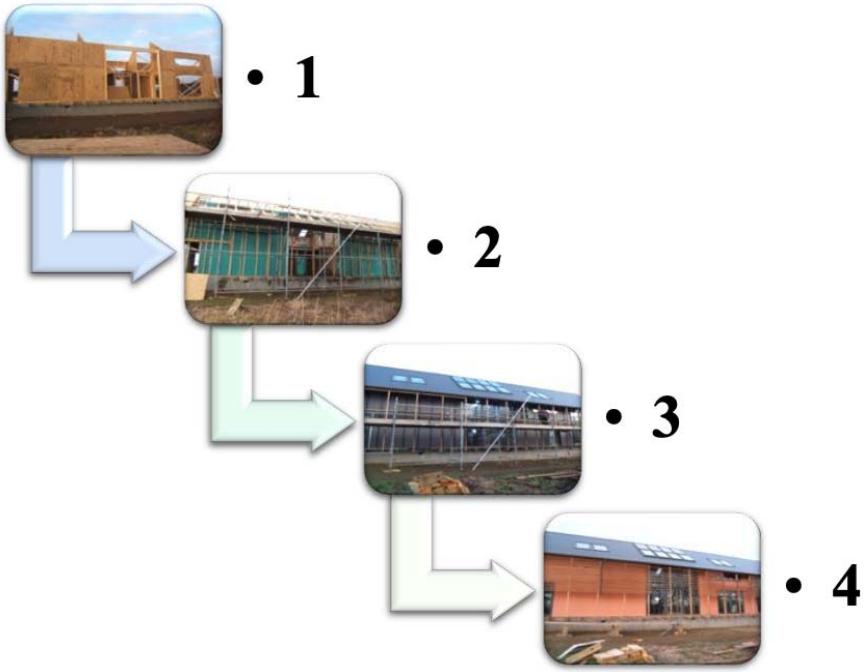


Figure (10)model D house building process[16].

4.4.3 Energy Efficiency

The dwelling was designed to meet the German passive house standard, where it strict that the houses should build with high thermal performance to minimize heating demand. The U-Values achieved throughout the House include:
Walls 0.15 W/m2/degC
Air tightness 0.6 m3/(h.m2) @ 50Pa

4.5Response achievement to sustainability

According to the stages of design out waste highlights the key points in that process where clear and unambiguous communications between the architect/design team, the client and other project team members are crucial. It provides a guide maps that would be recommended measures, interventions andconsiderations of designing out waste to the Working stages, see Figure (11).

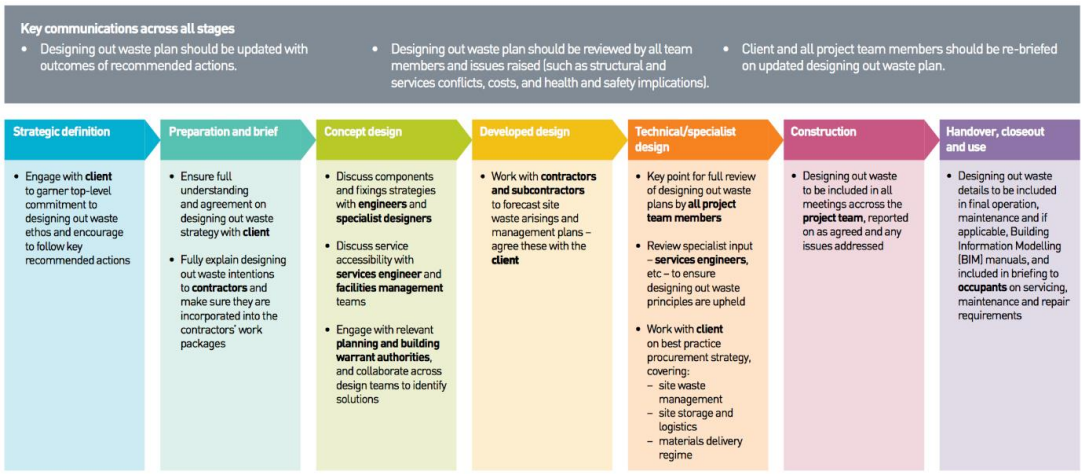


Figure (11) key communication points [17].

4.6Challenges with the implementation

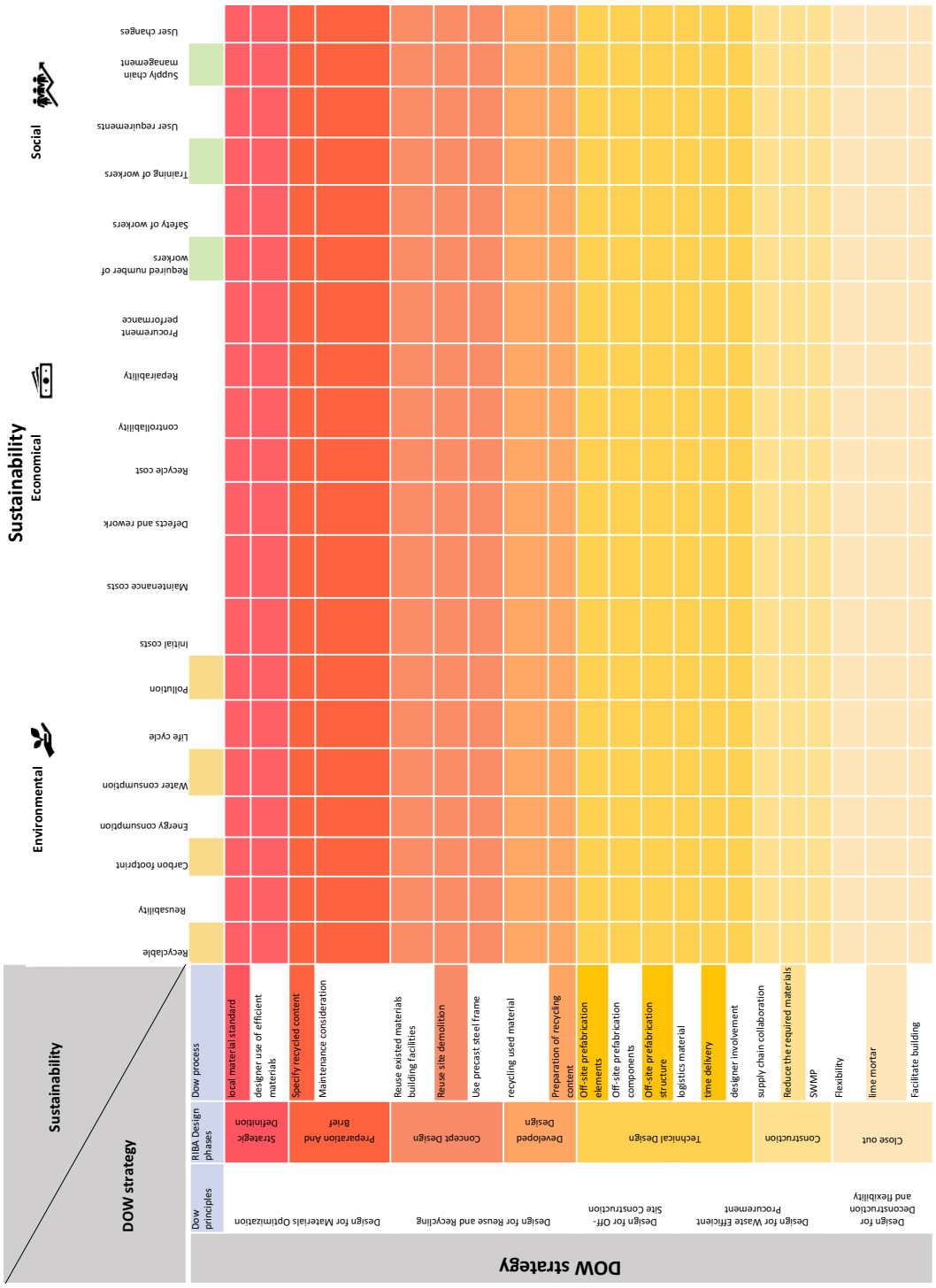
Establishing targets and reporting structures needs to be supported and complemented bysuitable additions or alterations to standard procurement templates in respect of the clientorganization's engagement with others involved participant in the project. In large organizations, this canbe complicated by the fact that different departments or individuals are responsible for differentcontractual arrangements, so a concerted effort to integrate the subject is required.In construction projects, it can be useful to ensure the information is contained within thedocuments issued and that a separate briefing exercise, perhaps as part of the tenderingprocess, is undertaken to highlight and explain the aspirations of the client. Taking this approach gives a legal standing to the targets and will create a binding keyperformance indicator that gives the client recourse about overall the process to be aware of the entire success.

5. Discussion

A brief overview of the paper was introduced in the first part explaining research background stating the problem tackled and why it is important to solve and addressing its causes as well. The second part presented a thorough overview of the research pillars, concluding with the criteria will be illustrated in form of matrix. Developing a matrix that corelates sustainability and design out waste strategy to be applied on housing projects in Egypt in order to achieve the 2030 Egypt sustainability vision. However, the impact of current state working technique gives an impact on the environmental, social and economic aspects. Furthermore, analysing this impacts give opportunity to choose the will established strategy for applying it. While, Design out waste can achieve sustainability in public housing projects in Egypt. As mentioned before housing projects applied using the DOW strategy has

achieved critical point that meets sustainability approach. The matrix on table (2) shows the criteria that will be used to analyse buildings according to it as a checklist. However, The matrix developed within the correlation of RIBA design, design out waste strategy and sustainability. This matrix will also help in extracting some guidelines and recommendations for future studies to follow those successful steps for a beneficial outcome.

Table (2) DOW and sustainability matrix (developed by the author)



Design out waste strategy matrix application

Design out waste strategy matrix explanation of each principle as follows:

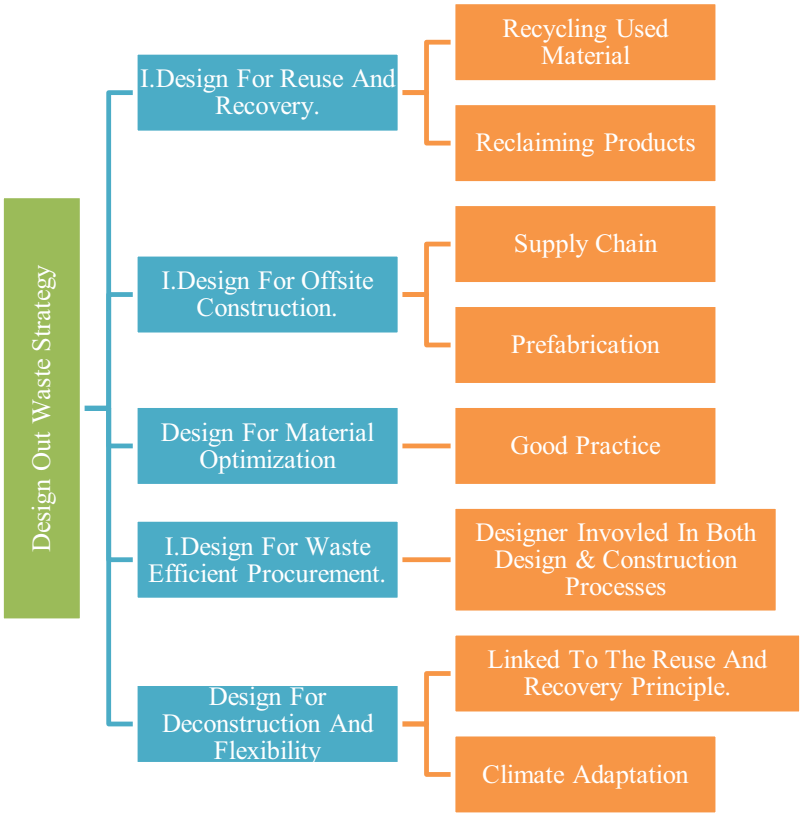


Figure (12) design out waste matrix application

Design For Reuse And Recovery.

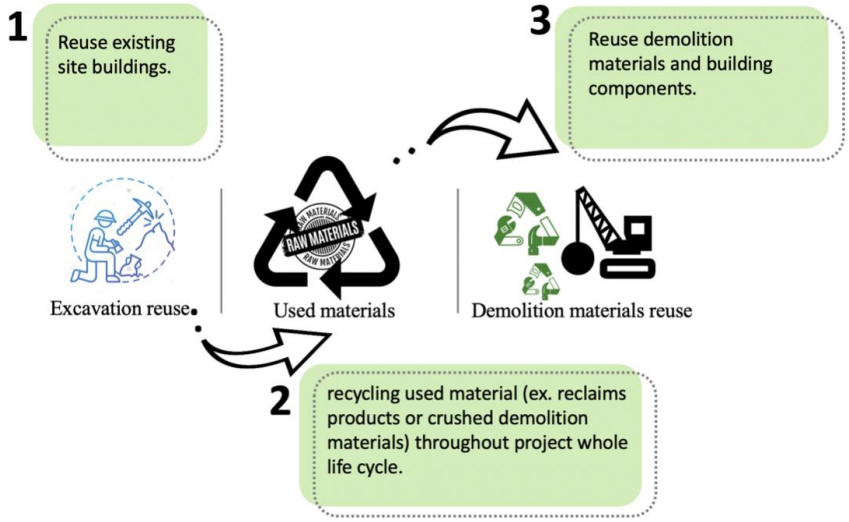


Figure (13) design out waste Design For Reuse And Recovery matrix explanation

Design for Deconstruction and Flexibility

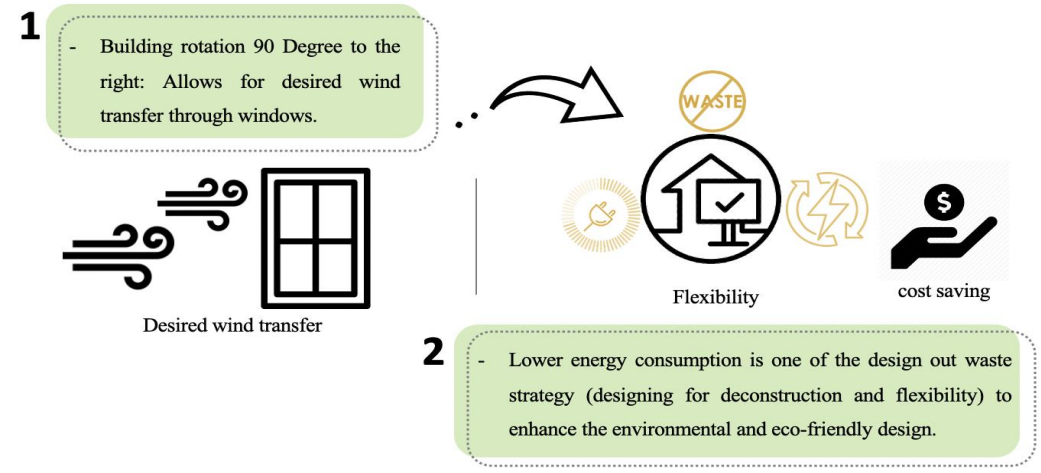


Figure (14) design out waste Design For deconstruction and flexibility

Design for Waste Efficient Procurement

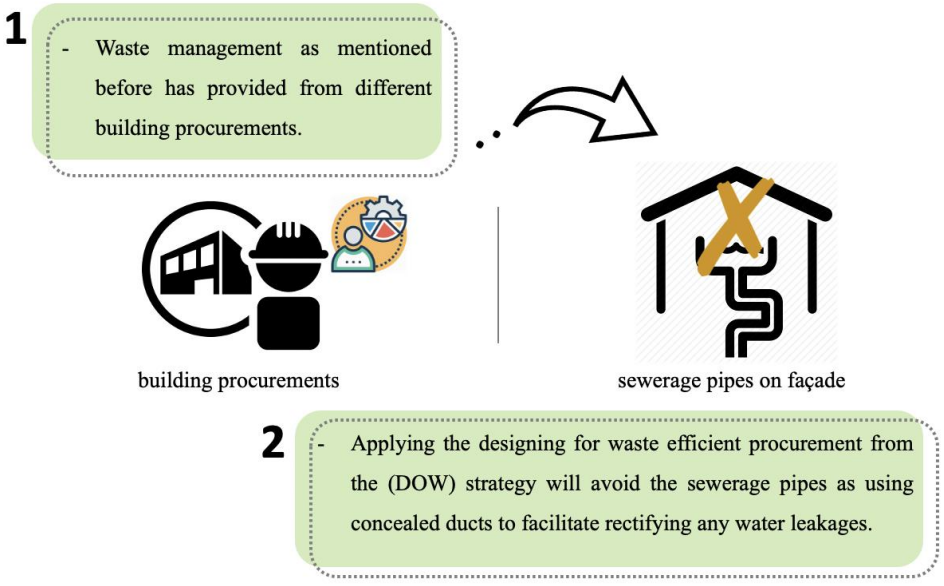


Figure (15) design out waste Design For waste efficient procurement

Design for Material Optimization

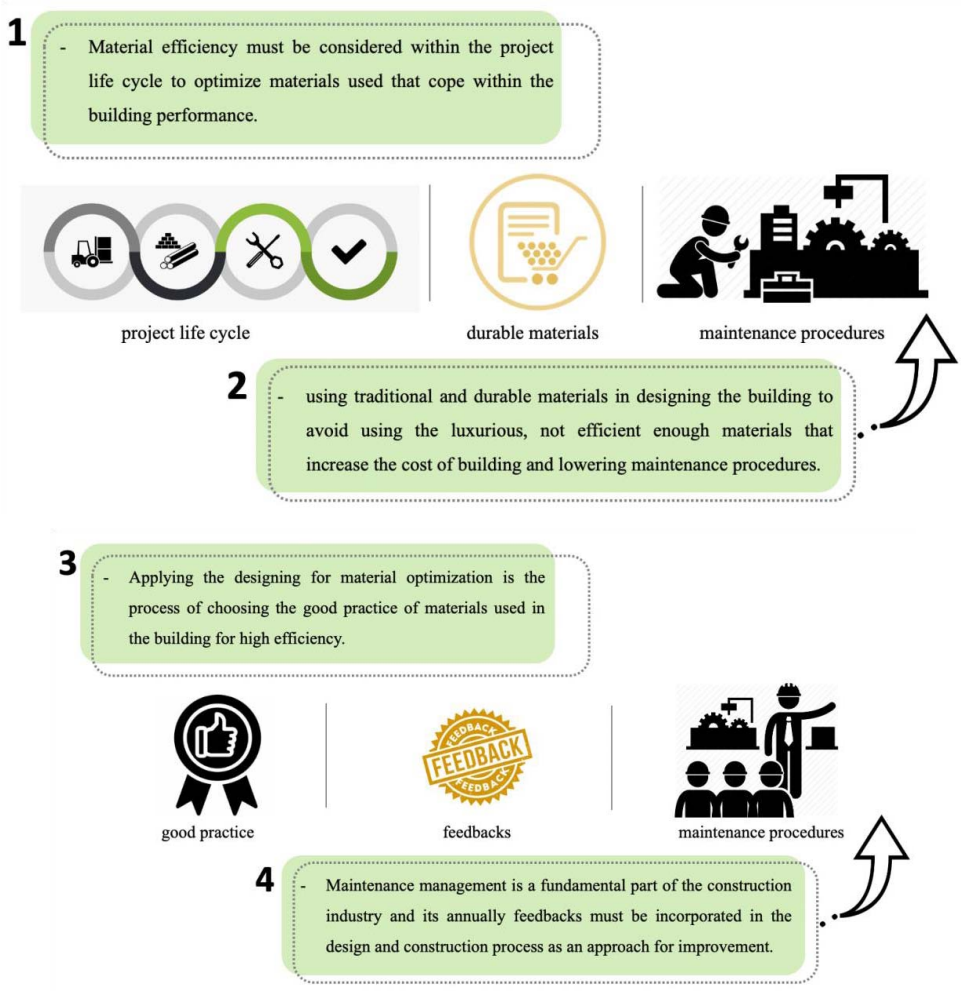


Figure (16) design out waste Design For material optimization

6. Conclusion

In conclusion, the literature review along within the case-study proposed have highlighted the need of a collaborative integration of management within design a housing project for avoiding waste through construction project. It emphasized the prominence of waste integrationin construction site through design process changes resilient design standards to promote sustainable development. Design out waste was introduced as a strategy where the matrix would properly position the role of architecture throughout the cycle towards waste prevention, while bridging the gap between the rest of the disciplines involved. The case study was predominately related to the waste reduction through implementing DOW strategy, which included a multitude of essential attributes to be present for each state, the sound practices prove that waste reduction could be achieved at any stage if the capability of compliance is available, as some practices have shown prominent success at the early stages. Finally, managing the project phases is to eliminate the consequences of the waste production, giving flash to the idea of design out waste strategy. While, existence of relative applicable resilient design standards could lead to a more waste reduction and achieving sustainability to meet with Egypt sustainable vision 2030. The collection of model D house is based off real-life case study which further support the value of the research and its aim to develop a design matrix for housing projects as an approach for achieving sustainability through implementing design out waste to meet with the Egypt sustainable development strategy vision of 2030.

7. Recommendation

The need to Adopt a DOW strategy in housing projects to enhance the architect's ability to develop more resilient solutions by implementing resilient design standards within everyday practice, in addition to integrating DOW strategies within their firms with resiliency as a key indicator for sustainable development. Moreover, raising awareness and communication through education and introducing the ideologies within architectural education and lastly, linking the resources with other disciplines.

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