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Developing and Evaluating Training Programs on Energy Efficient Building Design: The IUG Experience, Palestine

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Abstract—nowadays, great research efforts are devoted to investigate energy efficiency practices in buildings as a response to the rapid consumption of the depleting fuels and the associated environmental challenges. This paper presents a systematic approach that was implemented in the Islamic University of Gaza (IUG), Palestine to develop and evaluate a training program on energy efficiency in buildings. The aim of the training program was to bring together engineers and architects from a variety of governmental, non-governmental, and international organizations to learn and discuss energy efficiency practices in buildings considering the local conditions of the Gaza Strip. This study reports the methods used to design, implement, and assess the program including a questionnaire, focus group, and reflection workshop. The study concluded that there is a great need in the Gaza Strip for such training courses. There is also a need to expand the scope of the training to cover further categories of people involved in the construction sector, and to use additional training formats such as on-job, and over-distance training.

Index Terms—Energy, Efficiency, Buildings, Training, Gaza

I Introduction

Human current dependence on the rapidly depleting fossil fuels forms a great challenge that directly affects security of the planet. From the perspective of sustainable development, two actions are required: to rationalise this consumption, and to exploit the available renewable energy resources. The greatest potential for realising this change lies in the buildings sector, which is a main source of the global CO_2 emissions [1]. The role of energy efficient building design strategies is significant here to protect the environment, rationalize resources consumption, and allow for financial savings by implementing energy-efficiency practices. This paper aims to present a systematic mixed qualitative and quantitative approach that was implemented in the Islamic University of Gaza (IUG) to design, implement, and assess a training program on energy efficient building design.

This training program is part of PEEB project, which is an Austrian-funded project through APPEAR. This project is carried out through a two-year partnership between IUG and TU Wien, and aims to provide a structured program of activities to promote energy efficient building design practices in the Gaza Strip. The project activities included developing an academic course that was delivered to the architecture students at IUG [2], organizing an international conference on energy efficiency [3], establishing a computer lab equipped with simulation tools and environmental performance measurement devices, and carrying out a training program for local engineers and architects. The latter activity in terms of its implementation and evaluation is the main focus of this paper, which is discussed in the following sections.

II Energy Situation in Gaza

The Gaza Strip has been suffering from a lack of energy, especially electricity, for many years. It is estimated that the shortage of electricity is about 40-50% of the actual needs of the people in the Gaza Strip [4]. As a result, electricity supply is cut off for about 8-12 hours a day. This has led over the previous years to a sever deterioration in most aspects of life. This deficiency between supply and demand is attributed to many reasons including the unstable political situation, the hard economic conditions, the deteriorated distribution grids and the limited available sources of electricity [4]. Thus, saving energy in buildings and utilizing available renewable energy resources is required as an immediate action to tackle this problem. This gains further importance in view of the fact that more than 70% of the supplied electricity is consumed by residential buildings, and the abundance of solar energy in the Gaza Strip all year-round [5].

Producing energy efficient buildings is a well-recognized approach of building design and construction to respond to the energy challenges in most countries of the world. Applying this approach in the Gaza Strip is expected to reduce the dependence on the depleting conventional energy resources, limit the environmental adverse impacts of burning fossil fuels and create more sustainable and environmentally-friendly built environment. Energy efficiency refers to using less energy to produce the same output [6]. In general, energy efficient buildings are characterized by the use of efficient energy systems that ensures high energy performance in all building operation aspects (e.g. lighting) [7]. However, as indicated in Figure 1, energy should also be conserved in

the construction stage through the use of low embodied energy materials at all building life cycle stages. In addition, building design should include on-site renewable energy technologies to reduce building reliance on electricity and other non-renewable energy sources. The use of PV and solar thermal systems is a common practice in this regard.

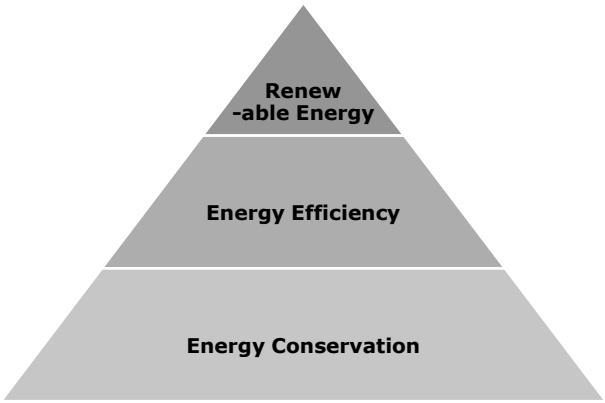

Figure 1
The Concept of Energy Efficiency in Buildings [6, adapted]

IV The Role of Training in the Field of Energy Efficiency

Energy efficiency in buildings design, construction and operation is not a new issue in the construction sector. It has been discussed in several world congresses in the last decades as a main part of the broader context of sustainability [8]. However, this may not be the case in the developing countries, where the inefficient old practices still have their impact and legitimacy. This includes the Gaza Strip, Palestine. Despite some preliminary efforts in this regard [9, 10], great efforts are required to improve public awareness about the importance of energy efficiency in buildings. The role of universities is essential here. University courses offer engineering students the opportunity to learn the basic required skills to design and erect energy efficient buildings. It is very common now that universities offer comprehensive post-graduate programs in this regard. In these programs, issues such as sustainability, energy efficiency and carbon pricing are discussed [11].

At IUG, Department of Architecture at Faculty of Engineering has developed a specified course for undergraduate students in this regard. This course incorporates both theoretical and practical parts. The theoretical part includes the concepts of sustainability and energy, renewable energy technologies, heat transfer basics, thermal comfort, thermal properties of building materials, thermal insulation, passive cooling and heating, and energy efficiency assessment. The practical part includes computerized simulation tutorials on building environmental performance to practice thermal design of buildings [2].

However, what about those who have already graduated without studying such courses? The role of training is essential in such cases. A range of training options on energy efficiency in buildings is possible. This includes structured classroom training courses, which offer the opportunity for engineers and the construction sector stakeholders to learn how to implement energy efficiency strategies in buildings. These courses are effective to provide the required knowledge using the traditional means such as black/whiteboard or the relatively new ones such as PowerPoint presentations and video training. It is very useful in this training format to deliver the training in an interactive mode using discussions, quizzes, and brainstorming in order to keep the trainees engaged. The most important idea here is that training is not an ordinary lecture. It should include a variety of techniques that make training an enjoyable experience and in the same time develop the required skills [12].

Also, work-based training is essential in this regard since it facilitates delivering the training in a practical and technical-oriented mode. This could be conducted through an organised effort of experts who can team up to conduct on-site visits to explain energy efficiency strategies in buildings design, construction, and retrofit. This could be done in partnership with the government or the concerned organisations such as universities and engineering syndicates. Training on energy efficiency may also be provided over distance. A forum or website may also be established to provide a source of continuous self-training through the provision of information on energy efficiency in buildings. This method of training is becoming more common due to the fact that the internet is becoming more accessible. However, it limit's the potential of exchanging experience between trainees. Although this paper is concerned with training on energy efficient building design, the broader context should cover buildings operation as well. Several skills are needed in this respect in order to identify and measure energy consumption, and recommend improvement strategies in this regard. These skills include energy usage audit, improving energy usage, and reduce the associated risks [13].

V The Implemented Training Program

A Needs Assessment Stage

Prior to conducting the training program, the project team carried out a needs assessment in Gaza to question feasibility of the proposed program. The idea was based on an international report [14] that investigated the potential of sustainable construction and green jobs in the Gaza Strip. The report recommended that a great capacity building effort is required in this field. This was followed by a focus workshop that was held in Dec. 2015 and gathered about 30 concerned stakeholders from the Palestinian ministries, municipalities, local consultants, international organizations, NGOs, and the private sector to discuss the potential of this training. The workshop discussed the local energy situation

in Gaza and diagnosed the opportunities and challenges that exist in the field of promoting energy efficient buildings.

According to these two activities it was concluded that the proposed training is feasible, and will contribute to alleviate the energy crisis in Gaza and improve the local sustainable development practices. It was also believed that this course will contribute to raise awareness of the importance of energy efficiency in buildings among the different sectors of the society. In addition, the proposed training is consistent with the Palestinian strategy to achieve sustainable energy development, and ease the local energy shortage [14]. Moreover, the gathered researchers and experts stressed the need to stimulate and activate the role of official institutions to adopt this approach and work on the development of new laws and regulations to ensure its application.

B Implementation Stage

Two main activities were carried out here: preparation of the training content, and delivering the training program. Based on several brainstorming sessions that were conducted by the project team members in Gaza and Vienna, several topics were selected for the training considering the training program limitations. These topics are as follows:

1. Introduction to the energy efficient design. This included the following topics: sustainability and architecture, energy and its resources, energy efficiency concept, design principles for energy efficiency, and assessment of energy efficiency.
2. Sustainable urban planning. This included the following topics: historical background, environmental aspects, socio-economic aspects, energy consumption control through urban planning, and case studies.
3. Solar design. This included the following topics: solar geometry, thermal comfort, passive cooling, passive heating, and case studies.
4. Building materials and thermal insulation. this included the following topics: thermal properties of materials, thermal insulation concept, thermal insulators, building envelope insulation strategies, and case studies
5. Renewable energy. This included the following topics: global overview, wind energy, solar energy, geothermal energy, and case studies.
6. PV design and installation. This included the following topics: PV cells, PV types, stand-alone and grid-connected systems, PV sizing, PV performance optimization, and case studies.
7. Thermal modeling and its applications (two meetings). This included: basic principles, modeling engines and their limitations, output analysis, conceptual strategies for energy efficiency, and practical examples.

In the stage of delivering the training, the concerned organizations were contacted to nominate their training candidates. Nominees included engineers and architects who work in the Palestinian ministries, international organizations, NGOs, universities, and the private sector. The training program was held at the IUG Community Service and Continuing Education Deanship (CSCED), in addition to the Architecture Department computer lab. The training program included eight three-hour meetings delivered through two weeks. Training materials were supplied to the trainees in the form of PowerPoint slides. Training classes were managed in a way that facilitates group discussions of the training topics, which provides an opportunity to draw on the trainees' ideas and experiences. Five professors from IUG have prepared and delivered the training topics. In addition to the training material given to the trainees, there was a practice in the lab to explore energy simulation tools, and a field visit to see some practical examples especially on thermal insulation and solar PV systems.

C Assessment Stage

The program's organizing team asked the participants to evaluate the program using a questionnaire form. The form included four fields and 14 questions as follows:

1. General acquired knowledge. This field included two questions as follows:
   - Q1.1: I became able to discuss the general principles of energy efficient building design.
   - Q1.2: The course strengthened my belief that it is crucial to protect the environment and natural resources through implementing environmentally friendly design methods.
2. Detailed training content. This field included five questions as follows:
   - Q2.1: Training period was appropriate.
   - Q2.2: Lectures were adequately divided and distributed over the week.
   - Q2.3: The theoretical background offered in the course was appropriate and consistent with the course aim.
   - Q2.4: The practical part of the course was sufficient to gain new basic skills in the field.
   - Q2.5: Course time and venue were appropriate.
3. Developed skills. This field included four questions as follows:
   - Q3.1: I gained good skills in the field of estimating building material thermal properties.
   - Q3.2: I became able to properly select the appropriate building material for energy saving based on its thermal specifications.
   - Q3.3: I am now capable to develop my skills in using simulation programs for thermal design based on the basic skills I gained in the course.
   - Q3.4: I am now capable to propose some ideas in the field of energy efficient buildings design, and integrate them into the building in order to promote energy savings.
4. Future career development. This field included three questions as follows:
   - Q4.1: I will keep working in the future to develop my knowledge and skills in the design and construction of energy efficient buildings.

- Q4.2: I believe that implementing the main principles of energy efficient design would improve the local architecture and the local engineering practice.
- Q4.3: If I were appointed in a decision making position, I will be keen to make it obligatory to implement energy efficiency principles in buildings design.

Study population was 20 trainees affiliated to a variety of organizations as mentioned above, which also represents the study sample. Thus, a total of 20 questionnaire forms were fully completed. The questions were answered using a five-point Likert scale. Table 1 shows the obtained results. It is clear that the respondents are generally satisfied with the idea of the course. There is a consensus that the course strengthened the participants' awareness about the topic importance, and improved their ability to discuss the general principles of energy efficient building design. As for the training content and structure (Q2.2 and 2.3), the trainees were generally satisfied. As for the training period (Q2.1), 45% of the respondents were not sure that the training period was sufficient. This is expressed clearly in the practical part case (Q2.4), 40% of the respondents were not sure that it was long enough, and 15% of them think that it should be longer. The respondents in general believe that the course improved their skills in the field of energy efficient building design. They believe that they became able to:

- Estimate building material thermal properties (65% of the respondents).
- Select the appropriate building material for energy savings (95% of the respondents).
- Develop their skills in using thermal simulation programs (50% of the respondents).
- Propose and implement design ideas in the field of energy efficient buildings (100% of the respondents).

Table 1

Training Assessment Questionnaire Results

Field	Question	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Total (%)
Acquired Knowledge	Q1.1	0	0	0	75	25	100
	Q1.2	0	0	0	30	70	100
Training Content	Q2.1	0	5	45	40	10	100
	Q2.2	0	0	5	70	25	100
	Q2.3	0	5	5	70	20	100
	Q2.4	0	15	40	45	0	100
	Q2.5	0	5	0	85	10	100
Developed Skills	Q3.1	0	0	35	65	0	100
	Q3.2	0	0	5	75	20	100
	Q3.3	0	0	50	35	15	100
	Q3.4	0	0	0	80	20	100
Future Career	Q4.1	0	0	5	55	40	100
	Q4.2	0	0	5	60	35	100
	Q4.3	0	0	0	30	70	100
1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree							

Finally, the respondents presented an agreement that the training course would have a sustainable impact on their future career. This because they will keep developing their capacity in this field, implement what they have learned to improve the local architecture, and, wherever possible, support decisions that enforce the implantation of energy efficiency measures in buildings.

In addition to the questionnaire, the project team organised a reflection workshop following the completion of the training course to discuss the course impact and the possible improvements. The trainees expressed the following notions:

- It is essential to develop longer training programs specialized in the field of energy-efficient buildings.
- The practical aspects need more attention including lab practices, field visits, case studies, and construction of real models.
- It is essential to develop a system (code) for the design and construction of energy-efficient buildings.
- The issue of buildings retrofit may also be discussed.
- Effective involvement of the private sector is required in order to promote the principles of energy efficient buildings.
- The training may be expanded to target the contractors and other stakeholders in the construction sector.

VI CONCLUSION

Promotion of energy efficiency in buildings design requires multi-dimensional strategy that is based on collective and well-organised activities. This strategy aims to preserve the resources, protect the environment, and reduce both the running and initial costs of buildings. The role of training is essential here to encourage the concerned stakeholders to implement this strategy. In this context, IUG has designed, implemented, and assessed a training program on energy efficient building design. The trainees' feedback showed that such training programs are relevant in Palestine, and are extremely needed in Gaza. However, the assessment stage revealed some recommended developments for the course. This includes developing longer and more detailed training programs, increasing training hours allocated for the practical part of the program including lab practices, field visits, case studies, and construction of real models, and finally considering the issue of buildings retrofit as a main activity in the construction market.

In this regard, there is a great responsibility on universities to develop and deliver the required training. However, other institutions may also get involved such as the concerned professional syndicates. The role of the official institutions is essential too in order to adopt this approach and work on the development of new laws and regulations to give the training outputs more value. In addition to the classroom-based training, the authors recommend that the delivered training course may be adapted and simplified, and then posted online as a free on-line training course in Arabic.

This could be an interactive course supported by multi-media means and self-learning strategies. An online forum may also be established to provide updated knowledge and exchange experiences and incentives. It may also be useful to produce a further shorter version in the form of leaflets and booklets that target the different stakeholders involved in the construction sector to make them aware of the very basic principles of energy efficient construction techniques. From our experience following the implemented training program in Gaza, the issue of thermal insulation may be on the top of the agenda in this regard.

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