

Intruding Thermal Insulation And Teaching By Hand Concepts In Engineering Program Of Jordanian Universities

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Abstract: The engineering programs in most of the Jordanian Universities don't include the essential basic background to use the thermal insulation in the building and the philosophy of teaching by hand. Additionally, the private construction sector in Jordan doesn't have the vital information or the experience of using the thermal insulation concept in their constructions. This study aims to establish a roadmap for developing the engineering program in Jordanian Universities to intrude the concept of thermal insulation and teaching by hand philosophy. This will enhance the higher education institutions in the field of thermal insulation for engineering constructions in Jordan. The study will focus on establishing laboratories to receive the necessary equipment to improve the teaching by hands and modernising at least four courses mainly in the construction material and the heat transfer topics. These courses will be introduced in the civil engineering and the mechanical engineering curricula and built based on the Engineering courses. The study will, therefore, contribute to improve the quality of higher education and enhancing its relevance for the labor market and society. It will also initiate the awareness of thermal insulation into the Jordanian governmental and private construction sectors.

Index Terms: Construction material, Engineering program, Insulation, heat transfer, teaching by hand

1. INTRODUCTION

WITH what is going on in the Middle East region, Jordan is facing its own similar challenges. Jordan will soon be, if not already in progress, in an economic crisis due to many factors, such as; the refugee emergency, low water supply, and rising unemployment in the country [1]. As these factors may take a while to fix, there is an approach to unravel the economic crisis and that is finding a new way to solve reserve the energy situation in Jordan. The energy situation in Jordan has two main obstacles: the growing energy demand as well as the very limited domestic resources to fulfill the demand. In 2012, Jordan's own production of energy was 272 ktoe, which is made up of natural gas, crude oil, and renewable energy. It only meets around 5% of the country's demand. This leads Jordan to become one of the highest countries in the world depending on foreign energy sources, especially from the neighboring Middle Eastern countries. The reliance on energy imports consumes around 17% of the country's GDP, leading Jordan to plan \$15 million investment in renewable and nuclear energy [2]. The Jordan Times has stated that in between 2014 and 2017, 44% of the total energy consumptions lies in households, which includes heating systems [3]. Other than the economic crisis, the energy catastrophe in Jordan isn't giving its people the quality of life they hoped. Whenever the winter comes around, many houses are still left cold without the right way to heat and shelter the families. Many families rely on kerosene and wood which puts them in danger. People living in rural places can barely afford such dangerous tools to keep their houses safe [4]. As for the summer with the increase of climate change, there have been rising heat waves as well as more people dying of heat strokes in the past couple of years. Alongside the low supply of water, dehydration is more evident during the summer, even when people are inside buildings.

As stated before, people don't have a financial basis to keep their houses comfortable in the summer [5]. This is why there needs to be a new efficient solution that helps families to stay safe, to keep the right microenvironment in their building, as well as try to resolve the economic crisis in the country by reducing the money spent on the energy demand. There needs to be a new effective and efficient way in order to achieve the goal as well as not to spend as much money as possible. Therefore, the approach starts with buildings heat loss and gain. Thermal insulation in buildings is an important factor in achieving thermal comfort for its occupants. Insulation reduces unwanted heat loss or gain and can decrease the energy demand for heating and cooling systems [6]. It just refers to the insulation materials used in order to slow heat loss, such as: cellulose, glass wool, rock wool, polystyrene, urethane foam, vermiculite...etc [7]. An approach that is so convenient and efficient with the least cost as possible, there would be nothing going against it [8 and 9]. Insulation of roof and walls have been shown to increase energy savings by 77% [10]. Jaber [11] studied the evaluation of best direction of the building, its windows size and insulation thickness from energetic, economic and environmental point of view. He showed that about 28 % of annual energy consumption can be saved and the Life Cycle Cost (LCC) is reduced by 12 %. Unfortunately, there are many obstacles facing the goal that include universities and the private construction sector in Jordan. The Engineering curriculums in most of the Jordanian Universities, including Mu'tah University, don't include the essential basic background to use the thermal insulation in the building. Moreover, many universities don't have the philosophy of teaching by hand or hands-on learning for such subjects. Additionally, the private construction sector in Jordan doesn't have the vital information or the experience of using the thermal insulation concept in their constructions. It was declared in Final Version of the 2nd International Conference of Engineering Education for Sustainable Development [12], October 2004 that "Engineering education, with the support of the university community as well as the wider engineering and science and community must: Have an integrated approach to knowledge, attitudes, skills and values in teaching, Incorporate disciplines

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of the social sciences and humanities,
 Promote multidisciplinary team work,
 Stimulate creativity and critical thinking,
 Foster reflection and self – learning,
 Strengthen systematic thinking and holistic approach,
 Train people who are motivated to participate and who are able to take responsible decisions, and
 Raise awareness for the challenges posed by globalization”.

The above statement delivered to the researchers an excellent guide to develop and modify the engineering program to pass some of the accreditation criteria such as ABET. The above pillars have to be considered in developing engineering program even though such developing started long time ago [13]. Also, every five years, most of the engineering colleges revise their program and curricula to equip their graduate students with the required skills for the job market. This research aims to establish a road map for developing the engineering program in Jordanian Universities to intrude the concept of thermal insulation and teaching by hand philosophy and taking Mutah University as a case study. This will enhance the higher education institutions in the field of thermal insulation for engineering constructions in Jordan. Numerous courses will be introduced in the civil engineering and the mechanical engineering curricula of the targeted departments. The study will, therefore, contribute to improve the quality of higher education and enhancing its relevance for the labor market and society. The graduate engineers from Jordanian Universities, who might work at the Ministry of Work and Housing, will realize the vital of isolation Jordanian building and their collective efforts will result in amending some of the regulations and rules addressed by the Ministry and related to the construction sector. The target groups to be reached are the teachers, the students and the technicians. Since there will be new courses and labs to be offered in addition to new equipment to be delivered, the mentioned groups need to be trained very well. The teachers are required to deliver the new courses properly with the proposed concepts. In addition to the teachers, the technicians require to be trained on the new equipment in order to be able to operate them in an appropriate way. The students also require to be engaged in the training as they are the main target for this study. So this study is intended to result in that new graduates will be more demanded in the labor market and can use project work skills gained in university. According to the main goal of the project, the first target group is students. This study also can meet the Jordanian priorities in many aspects such as developing new curriculum in Engineering and introducing method of Education (i.e. hands on). The following aspects can be achieved by adapting insulation in Architecture and construction namely; reduction the adverse effect of climate change, lower fuel consumption and emissions by clean Environment, welfare and good health to Jordanian people, creating more jobs, and making business by trading and manufacturing the insulation material.

2 OBJECTIVES

The main goal of the study is to commence the awareness of thermal insulation into the Jordanian governmental and private construction sectors by intruding the thermal insulation concept into the curriculum in Jordanian Universities. Specific objectives of this study can be achieved also such as modernizing at least 2 courses in thermal insulation into the Engineering curriculum and innovating teaching by hand

concept in Jordanian Universities. Also several training courses for the Universities staff and private and public sectors can be conducted. This can be done by establishing an appropriate thermal insulation Hands-on laboratories in Universities. This part will also bring the student to practical experience and will engage faculty in the development of interactive instruction techniques for lectures and laboratory courses. Additionally, extend services and training in collaboration with the national industry and community. It is envisaged that these specific objectives will contribute to a sustainable outcome that will promote curriculum reform in engineering education and leave a longer-term legacy for Jordanian universities. By achieving the objectives of the study, the concept of thermal insulation will be introduced to the Jordanian universities. Also, teaching by hand which is new teaching method in Jordanian universities, will be introduced. The private and governmental sectors will be awarded with this concept. This will have an influence on the methodology used to construct new building in Jordan as well as refurbishing the awareness of the thermal insulation.

3. METHODOLOGY

3.1 Study Framework

The Faculty of Engineering in Jordanian Universities considered one of the largest faculties. In each University more than 100 staff members and more than 3000 students enrolled. It offers B.Sc and M.Sc. programs at several fields of Engineering. The faculty of engineering always organized many international conferences and workshops. Also, the energy center established the global network of researchers, engineers, economists and decision makers interested in the renewable energy in desert areas. On the other hand, Ministry of Public and Work Housing where some of the graduate students will work, is the most powerful institution in Jordan that has the main rule in constructing building in Jordan. It is responsible of developing the construction sector by using and implementing the best practices and modern techniques that keep pace with the international developments. In particular, Faculty of School of Engineering in Mutah University was established in 1984. The faculty offers Bachelor Degree in Science (B.Sc.) in Electrical, Mechanical, Civil, Chemical, Computer and Industrial Systems Engineering with the completion of 163 credit hours of multidisciplinary subjects, and eight weeks of field training. In addition, the faculty offers Master's Degree (MSc) in five programs: MSc in Engineering Management, MSc in Telecommunications Engineering, MSc in Renewable Energy, MSc in Mechanical Engineering, MSc in Water and Environmental Engineering and smart management system. Additionally, the faculty provides short courses, workshops, and consulting services in different fields of engineering through the University Southern Center for Studies and Continuing Education to extend its services to the community by participating in meetings, councils, committees, and conferences in both public and private sectors. The development of the engineering program at Jordanian Universities must support the overall institutional goals. Perhaps the most strongly felt of those goals is the institution's efforts to develop a relationship with local community and try to enhance the rules instructed by Governmental entities based on scientific principles. Institutions should develop programs that produce graduates who understand the engineering concepts taught domestically and abroad, but the

focus should be on domestic teaching. Insulation concepts intruded in engineering curriculum will enhance the graduates understanding of constructing and updating the current rules of buildings. One of the main priorities of Higher Education in Jordan is to develop and innovate a new courses and methodologies in undergraduate programs. This project is directing to that end for engineering program. The new developed courses focusing on insulation along with new equipment will improve the learning outcomes of engineering program in Jordan.

The following steps are essential to be included in the adopted work and intended tasks within the frames of the project are:

- 1) Establishment of laboratories in Jordanian universities by allocating and preparing space in the selected institutions to receive the necessary equipment provided as assigned in this study. This is to improve the teaching by hands in Jordanian universities in order to increase the chance of fresh graduate to find jobs.
- 2) Modernise at least 2 courses in each university mainly in the construction material and the heat transfer topics. The concept of thermal insulation will be introduced. These courses will be built based on the Engineering courses.
- 3) Establishing two main labs in the University (construction material lab and heat transfer lab). One special laboratory will be intruded in thermal insulation into Civil Engineering curriculum, Mechanical Engineering and electrical Engineering. These laboratories will be taught based on the teaching by hands.
- 4) The Target Group of this study are the under graduate students and Engineers from industry. The total number of students is 500 per year. Work will be carried out on the development of methodological base of courses taking into account the peculiarities of the Target Group.
- 5) Trainings to the staff and teachers will be organized on following areas:
 - a. Training on how to reach zero energy building (this course is selected based on the EU experience). Most of the Jordanian people ignore thermal insulation in building and they have no awareness of the significant of this during construction or how to use insulation effectively.
 - b. Courses in economic effect of thermal insulation through (software, and computer simulations). Today a large number of small companies in need for workers who have the ability to employ the isolation concept.
 - c. Courses on organization and building energy management skills are important to reduce unemployment. This concept can create more jobs in construction sector.
 - d. Special training to the staff to the method of teaching by hand because this new technical method in Jordanian universities
 - e- Train trainees how to develop their own in house engineering software programs such as Matlab, SciLab or similar. By forming their own software trainees would better understand the concept of thermal insulation and they could be more creative in the future in introducing bio and nano materials for producing of thermal insulation.
 - f- Training on skills for materials developing on the basis of locally available raw materials and residues (e.g. ashes) in the logics of circular economy. Furthermore, in collaboration with CertiMaC, thermo-physical properties, measurement and related experimental and numerical

equipment will be presented. Finally, visits on local industries working in the field of thermal insulation

6) Network form stakeholder will be established relying on the private companies, engineering institute, and related governmental sector in building insulations. The established network will promote the concept of thermal insulation among the construction sector and between the partners

7) The methodology of using such materials in construction in Jordan will be presented in the workshops. This will enhance the trading with Jordanian construction companies.

3.2. Development Program

Development the engineering program and curricula can be implemented through the following:

- Preparation and start-up: This can be implemented by integration of previous experiences of successful studies in developing the engineering programs and creating essential data in addition to organizing workshops and seminars to exchange information and knowledge. The networking can be achieved by subscribing a special e-form on the University website and defining the list of network members. Several activities can be accomplished upon creation of the network that includes market study survey, up-to-date information, networking activities such as conferences and staff exchange. It is recommended also to enhance the awareness and commitment of the public administrations, ministries, research centres, companies and employment agencies in the aim of the study. This will be finalized with a Networking and list of Stakeholder Members.
- Scoping and Market Needs Analysis and Scoping and Academic Needs Analysis: This activity of the study is to design, deliver, accredit and adapt 2 state-of-theoretical courses and 2 teaching by hand laboratories that will add value to the existing program in the targeted University. And to have technological and economic impact on the thermal insulation in Jordan. The study will begin in a scoping and needs analysis exercise to investigate the current status of theoretical and practical teaching in general and compare between two methods which the thermal insulation will be considered as a model for Jordanian higher education. This can be done by:
 - 1) Survey and interviews (Questionnaire) with appropriate stakeholder, including enterprises and governmental bodies as well as international projects and initiatives, focusing on all academic programs being in offer in Jordan in the field of thermal insulation issues, current market demands, people need, trends and needs as well as government policies and regulations.
 - 2) Survey on teaching method in Jordan and management facilities and on the structure of the partner universities to make sure that the project training content can be carried out successfully.
 - 3) Integration of the first and second survey analysis results about the training needs and partner management facilities with the standard methodology and experience and then drafting a final report about the methodology. This is a crucial document to elaborate the didactic content and select race.
- Development of Study Plan and Curricula by Selection of Pilot Courses and Labs equipment, Workshop on Curricula Updating, Detailed Design of Pilot Courses,

Accreditation of New Curricula, Implementation stage of developed courses, Establishment of thermal insulation laboratories and Monitoring and Feedback Methodology and Reports. This is the most important task to be done by the University. It aims to update and improve the content of state-of-the-art for developed courses (2 theoretical and 2 teaching by hand lab). Then deliver, accredit and adapt to add value to the existing program and have technological and economic impact on the thermal insulation sector in Jordan. The 2 theoretical courses will build a good knowledge with student and then will practice what they learn in the lab.

- Development (Capacity Building for Staff): The aim is to develop a capacity building and staff development programme in the field of thermal insulation. The main focus of the activities will be on developing human resources and upgrading skills and capacities in the field by providing exposure to practical training, experiments and equipment. This should include actual training on experiment and laboratory running, technical assistance and counseling services which will be organized for professors, researchers, students, engineers and technicians. This will be beneficial for capacity building in environment. Furthermore, the access to information, skills and training will enable the faculty and researchers to evaluate existing thermal curricula and effectively redesign the courses to include state-of-the-art-technologies. This will also greatly assist in establishing thermal insulation training centre as a local resource and training point in Jordan.
- Accreditation: Once the program is specified, new students will enter the accredited program and get high-quality modern knowledge and practical skills, including team competencies. Students will form inter-university teams and work on real projects offered by companies. The introduction of courses in official curricula is an official procedure, it has to be confirmed by the Scientific Council/ Board of the corresponding universities. Teachers will keep using modern teaching approach and developed pedagogical tools (hands on). To update teaching methods, they will share experience and best practices with colleagues in unis and companies. Unis are interested in the stable and long-term development of this concept and support faculty staff. The importance of this project comes from highlighting the importance of the thermal insulation.

3.3 Laboratory Equipment

In Mutah University at least four courses will be developed (two theoretical and two labs). One special course in thermal insulation into Civil Engineering curriculum and one course in Mechanical /Electrical Engineering curriculum. Those courses will be built based on the Engineering courses. Two Labs will also be established. One special laboratory in thermal insulation into Civil Engineering curriculum and one in Mechanical Engineering. The teaching by hands will be implemented in those labs and academic staff, students, and technicians will be trained and they will get some required skills. The items listed below are diverse in nature and can be used in control, measurement and storage of different types of experimental data. Purchase of these items can add huge benefit for teaching and conducting research projects, especially in civil and mechanical and related fields. The items

are listed in a sequence of sections based on their applicability and technical specifications.

- 1) Dual Drive System Syringe Pump: This multi-purpose syringe pump employs advanced syringe mechanisms that include a tight gripping, extremely secure syringe clamp that accommodates syringe sizes 0.5 µl to 60 ml.
- 2) Infrared Camera: An infrared camera is a non-contact device that detects infrared energy (heat) and converts it into an electronic signal, which is then processed to produce a thermal image on a video monitor and perform temperature calculations.
- 3) Thermo hygrometer: Thermo hygrometers are useful for measurements of humidity. Humidity is a representation of the concentration of water vapor in the air where the value is shown as a percent. Thermo hygrometers have sensors which measure humidity of the air and temperature of the air.
- 4) Thermo Anemometer: Thermo-Anemometer is a versatile dual function unit that quickly and easily measures air velocity or volumetric flow as well as air temperature in imperial or metric units.
- 5) Temperature measurements: including Thermocouple wire, Thermocouple Connector (Male), Thermocouple Connector (Female), Temperature Controller to measure flowrate in heat exchanger experimental test setup.
- 6) Differential Pressure Transducer to measure the pressure drop in heat exchanger experimental test setup.
- 7) Dilatometers to measure the expansion or shrinkage of the material. This material might be solids, melts, powders, polymers, and resins. This is required to see how temperature changes affect parts of a system that are interdependent or adjacent to one another.
- 8) Laser/Light Flash Analysis (LFA): It is a test that determines the thermal diffusivity of a sample being solid, fluid or powder. Thermal diffusivity of a sample with a known density and thickness is then determined based on the time interval between the pulse being fired and the infrared sensor picking up the energy from that pulse.
- 9) Melting Point Meters to measure the melting point of the substance which is essential for recognizing its various qualities and potential applications. It is good to use for Phase Change Material (PCM).
- 10) Surface Area Analyzers: The surface area is an important property especially for porous media.

4 RESULT AND DISCUSSION

The new graduates will be more demanded in the labor market and can use project work skills gained in university. According to the main goal of the study, the first target group is students. Students of piloting modernized curricula and a new one will receive in addition to traditional thorough theoretical knowledge innovative practical skills and competencies, abilities to operate management techniques in project teams, so-called "soft skills". The result will benefit to improve the teaching methods in the University as it will reflect on teachers by enriching their professionalism and enlarging their qualification-portfolio as well as developing their skills on curriculum design. The reflection on the students will be

through enriching their qualification-portfolio, expanding their employability, be skilled competent and professional specialists. Developing the curriculum is not just a matter of changing. It often requires a paradigm shift among all involved: the higher education institution administration, the teachers, the students, especially if stakeholders outside the higher education institution are to be involved. Jordanian higher education institutions will be developed and adapted curricula to make them more relevant to the changing needs of the markets and industries. When the institutions develop the curriculum of engineering to include the insulation concepts, the program will be flexible and modular interdisciplinary and multidisciplinary. It would be more in line with the changing requirements and helped improve the employability of graduates. As an example, the competence requirements for graduates will be formulated by both national and international professional organizations dealing with the accreditation of programs. Additionally, the study will improve the quality of higher education in Jordan and contribute to solving the energy issue. The economy of Jordan is knowledge-based; therefore, the development and growth of the educational system are important to its economy. Higher Education (HE) is traditionally governed at the national level by the creation of public policies. However, the role of governments in HE governance is challenged as globalization erodes national sovereignty and marketizes HE. This project describes internationalization of higher education as "the process of integrating an international/intercultural dimension into the teaching, research and service functions of the institution". This study will enhance the growth of specific visibly international, border-crossing operations. Modern societies do not consider Higher Education a luxury good, but a condition for development (World Bank, 2002) [14]. Such study will improve the quality of higher education in Jordanian and contribute to solving the great problem in Jordan such as thermal insulation. The economy of Jordan is knowledge-based and therefore the development and growth of the educational system are important to its economy. Also, this study will increase the trend towards universalization, globalization, internationalization or 'regionalization' of the substance and the functions of higher education. One of the few projects pursuing this aim, undertaken by the OECD, on the internationalization of curricula (cf. van der Wende 1996 [15] stated that internationalization can be classified according to the following categories: International subjects such as thermal insulation and Utilization of internationally comparative approaches.

It can be concluded that the innovation character in this study can be summarized as follow:

- 1) To introduce the new teaching method in Jordanian universities which is a hands-on method. The modernized lab will be taught by hand (practical part) which is considered as a new concept in the Jordanian higher education teaching method by establishing a sophisticated laboratory in thermal insulation.
- 2) To set of two theoretical courses in thermal insulation to the undergraduate curriculum. These courses are based on society need for welfare by improving the quality of life in cooled winter and hot summer. This project will introduce the concept of thermal insulation in order to graduate professional Engineering who can meet the market needs of the country as well as it will develop

and integrate a bachelor's degree program with an appropriate laboratory component in thermal insulation jointly taught by universities in Jo.

3) University would also train trainees how to develop their own in house engineering software's in a recently also popular programs as Matlab, SciLab or similar.

5 CONCLUSION AND RECOMMENDATIONS

There needs to be a new effective and efficient way for insulate the construction building in Jordan. This is to achieve a goal of not to spend as much money as possible. This study introduces two new concepts into the Jordanian Universities Teaching by hand and thermal insulation. This in harmonic with (Engineering, Method of Education, Environment, Architecture and construction, welfare to Jordanian people). The study also meets the higher education priorities in many ways by developing the engineering program and introducing method of Education (i.e. hands on). The goal can be achieved by adapting insulation in Architecture and construction namely; reduction the adverse effect of climate change, lower fuel consumption and emissions by clean Environment, welfare and good health to Jordanian people, creating more jobs, making business by trading and manufacturing the insulation material. The development of the engineering program in such way will develop a relationship with local community and try to enhance the rules instructed by Governmental entities based on scientific principles. The new developed courses (theoretical and practical) focusing on insulation along with new equipment will improve the learning outcomes of engineering program. All Jordanian universities have to develop training curricula for target groups by specialists in different fields. There are collaboration between all Jordanian Universities in different activities related to introducing thermal insulation and new teaching method and open educational resources in education through workshops and conference. There will be needs of staff and students to use software (Computational Fluid Dynamics (CFD) in teaching and learning. This encourage all Jordanian Universities to adopt such study. This enhances relationships by developing innovative national ICT to be as a hub to design and evaluate e-enabled curricula built on use in ICT in education, being available on a portal to every learner and teacher for sharing and customization to fulfill the learner needs. This leads the transition toward knowledge based economy and acquiring skills. Thermal insulation in buildings is a necessary task in achieving thermal comfort for the occupants. The idea is to decrease the undesirable heat loss or gain in addition to reduce the energy demand for heating and cooling systems. Dealing with Heating Ventilation and Air Conditioning (HVAC) system which has or has not an effect on the insulation is not the target of this study. The study might refer for example to the insulation materials used in order to slow heat loss. All of the obstacles of which could be resolved if this goal was put in the right hands. The study aims to enhance the capacity of higher education institutions in the field of thermal insulation of civil engineering constructions in Jordan. It is expected that if the graduate engineers who are equipped with those concepts will have an impact of the places where they might work. For example, if some engineers work at the Ministry of work and Housing, they might work on amending some of the regulations and rules addressed by the Ministry and related to the construction sector.

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