

# SUSTAINABLE CONSTRUCTION

*Dr. Abbas Elmualim*

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## Part 1

Good morning everyone. I'm delighted to be here. My name is Abbas Elmualim. And I would like to start that English is not my mother tongue, English is my second language. So it's the same like you guys one day was here in this lecture theatre doing English classes about 10 years ago. I did here my PhD in Reading and now I became a lecturer, and I - most of my interest in sustainability especially in buildings concentrating on how to save energy in buildings. And everyone, like everyone else, you know, they try to do a bit for the environment.

The structure of my lecture will be, - I will talk about buildings in general, and then move why sustainable buildings, and then try to share with you some of the work we did here in sustainability as well. And this will be, some of it will be a technical aspect, but hopefully it will be interested for general aspect. And then I will finish with some conclusions. And after that, we have a discussion for 15 minutes, and within that discussion and questions we can see how, what we can do if you want to first? for the environment, if we really as human beings we're serious about environmental problems that's affecting everyone on this planet. What we can do, especially here, we live in hall of residence, what we can do, you know, on daily basis, in order to save energy or to save other sources like water, for example.

So, if we look at buildings, any buildings, we'll have specific four functions. These four functions, the first one will be a climate modifier. What do you mean by climate modifier? That for example, this lecture theatre we are sitting here, so that mean it has to protect us again as environmental conditions that existed outside. For example, it is a hot day today, so we need protection against the sun. We don't want too much sun, so we don't get overheated, and that are the temperature will rises, rises here in this building, and then we can be able to do our work.

And the second function, it has to be activity container. That means it has to provide comfortable conditions for us as occupants as people now sitting in this lecture theatre. For me as a lecturer to be able to interact with you and develop this lecture. And also for you as well, to interact, able to interact with me, in comfortable conditions. And to be appreciate, you know, the lecture and share you know the experience of that, teaching and learning together as well.

The other one, the third function of buildings is resource utilizer. That means we have to use the local resources available within the area effectively and efficiently. So, we don't overuse resources. And this later on we'll see this one of the main problem of the buildings, they use too much resources, in terms of energy, timber, concrete, bricks, glass, all these resources, we overuse this resources. So the third function of any building, it has to be to utilize the

resources available. The last one, the last function of any building, it will be a culture symbol. The building has to express, the context in which it fits in. It is surrounding environment, so for example, I would expect as an architect, you know that buildings in the U.K, for example have to look different from buildings for example from my parents home country, Sudan or from China, or Japan, or Finland, all these different cultures you know, as human beings we are evolving different climatic condition, we have different cultures. So, building they have to resemble these cultures and express these cultures as well. And we can look back into vernacular architecture, how traditional architecture created this type of culture symbol within buildings. So, beside those four buildings functions, as activity container, climate modifier, resource utilizer, and cultural symbol. The building itself, it has to interact within itself. So, for example, this lecture theatre is not a building by itself, it is part of other buildings here, the other lecture theatre. So, there is interaction between this part of the building and other lecture rooms.

## Part 2

And this, it has to be in three levels. The first as individual, within the building. And the second one, at urban level, so for example the interaction, there is an interaction between this building, the Palmer Building and the Students' Union and microbiology and other buildings as well, adjacent here in the area. So, within urban environment and within the whole Reading town, for example, so there is an interaction for the building itself. And also at urban level and global level, and this is what later on we can see that you know creating the problem of the environment because people will start thinking o.k we build building at local level, we think about it at local level. But we don't think about what consequence of that building will have, or what impact that building will have on the global environment. And now we start to appreciate that building they have are great impact, not only on the local level. On the occupants for example, like us. Or even on the whole town, but also globally as well. And we have to be appreciative of these kind of interactions.

And we look at vernacular architecture for example in different countries, on different climate conditions. If you look to for example here, this building, people from Malaysia, anybody from Malaysia here? Or from Singapore? Humid, hot humid climates, tropics, anybody from the tropics? If you live in the tropics, you find vernacular architecture like this, very simple, bamboo structures, created, and the idea to create more air movement inside the building. Anybody from hot dry climate? Anybody from hot dry climate, Saudi Arabia, Africa, North Africa, somewhere, yeah? So, you can relate with this, you know, if you look at traditional building you expect you know either to be tents or using mud walls. And idea for mud walls ,they are very good in this kind hot climate. They prevent the hot heat going into inside the building.

Another, for example in temperate climate here, for example in the U.K., you see this kind of pitched roof because of too much rain and the snow as well, and you can see this in colder climate as well. And if you go further north in a more cold climate, so you can see in polar climate, you can see this kind of buildings which is the igloo of the Eskimo people, the traditional people of the polar region. They created these halls which is small room inside the snow. So, this is fully snow, so

this is what we call we call the igloo. And we can see there is a lot for us to learn from this vernacular architecture, and this is what about sustainability, and this is the areas I am interested into look a vernacular architecture and look how they respond to their own, or their immediate climate conditions, whether in hot climates, tropics, or cold or temperate or polar climate.

And what we realise now you know what after the 1980's, the people you know started using air conditioning, air conditioning become very available, and artificial lighting as well. And what happened, people rather looking at vernacular architecture and learn from it, modern architecture started to rely on service equipment, for example lighting, air conditioning. So, the idea, ok, it is hot in summer for example in the U.K. to solve the problem, I will completely isolate the building from the surrounding environment. So, I don't let the sun come in, I don't let the wind come in. And what I do, I put air conditioning and I will put artificial lighting. And this what has contributed you know to the environmental problems that we know it today.

So, all this environmental problem I'm sure you aware about it. And also, issues like sick building syndrome as well. So, we see that, eh, most of these buildings, these modern buildings because they are fully closed. People inside those buildings, they started to feel sick. Productivity becoming very low, people are not productive. So, for example, if you are in a lecture theatre you get dozy after ten fifteen minutes. I hope you are not dozy now. And if things going this way, if this modern buildings in all countries around the world, they keep doing this by using this highly energy- intensive equipment like air conditionings and their lightings, what happened, there will be a lot of changes. And this, just a joke to say, greeting from Scotland, you expect that to happen. If the things going this way, and we have - this is why we have to do things about it. And what of the concept that we are doing is talking about renewable energy, how to use renewable energy and to use passive design. You know going back to just vernacular architecture, they didn't use equipment, they didn't use energy, the building didn't rely million air conditioning or lighting, and still were very comfortable, and still people, they go there and live in some part of the world in this kind of vernacular architecture.

### **Part 3**

So, passive design, renewable energy, they are the best way now forward And sustainability in buildings, when I talk about sustainability I'm just concentrating on buildings. I'm not talking about sustainability in general. And I'm sure you know there is other lecturers who will be talking about sustainability in general, but here my focus is sustainability in buildings. So, by using renewable energy and passive design, we have the opportunity to be able to do that, to reduce the impacts of buildings, having on the environment, and reduce at least, try to eradicate this environmental problems that we're facing today, in all around the globe.

So, if you look at for example at the construction industry in the U.K., it's very complex to start having a building like Palmer building to design, it is very complex and involve a lot of people, and those people, they have different

interest, so usually if you want to start a building, you have to start with the concept and planning. And after that, you move to design, to design the building. And when you design the building people like the architects, service engineers, contractors and planners will be involved. And then after the design is agreed by everybody then they move to construction. So, when the building is constructed on the site. And after that, the building will be, managed (?) through, it is a life cycle when it was in use, through operational maintenance. And then after, whatever the long life of the building, then it has either be refurbished or demolished are recycled. So, these are the whole life cycle of the building and this is very complex. An this is one of the problems of the construction industry. There is a lot of people involved. But the most important thing, that's the construction industry itself, it has a great contribution to the U.K. economy. So, it is very big. The construction industry just about contribution to the U.K. economy, for example, between 7 to 10%. So, that is massive, that's fifth of the U.K., economy is in buildings. So you can see how it is important. And everybody, if you look at all those sub-contractors, contractors, planners, architects, everybody want to make some money. Everybody want to have some of this money, and that is creating the conflict between people, between those designers. And that's sometimes you know create, leads to the complexity of the buildings and that people, they might not up to the best design, for example using renewable using passive design because it is costly for example.

And the sustainability within this complex, it has to be focus on users, buildings, with user-centred approach, that's through the life cycle. So what we in sustainability, globally, what we advocating, we're saying that you know because of this complexity of the construction industry, we have to focus on the user, everybody, the architects, the service engineers, the contractors, we have to focus on the users. Through the life cycle, to be able to be use different type of passive design and renewable energy, so that the building will be environmentally friendly and reduce the impact on the environmental, on the planet, cased by the environmental problem.

And this, what we call sustainable knowledge to say, that means we all of us, we have to be sustainably aware. That means, whatever we do whether is building, so this here we have to focus on overall sustainability issue and people they talking about information age and talking about knowledge society. We're talking about sustainable society not any knowledge society, it has to be sustainable, whatever new knowledge we are evolving, it has to be sustainable. It has to be for the betterment of human beings, all over the globe and at the same time, for the locality for different countries as well.

By mean that, by environmental sustainable knowledge, we mean three important things. We say that it has to be environmentally sustainable, that we have to be resource use, very sustainable, effective and efficiently. They emissions of the buildings for example, that causing the environmental problems CO2 or toxins (?)they have to be reduced. Also we have to appreciate the bio-diversity, and protect the bio diversity wherever we are living and whatever locality we are evolving buildings.

The other dimension of this sustainable knowledge society will be economic sustainability. That's the life cycle economy. It has to be provide, we have to make money, you know, this is reality of life, as human we have to generate

growth, economic growth, we have to create money. So, but we have to look at it through the whole life cycle, we don't have to look at it in a short term, ok we will work on this building, I will make money in ten years and after that I don't bother about it, no, we have to think about it in the long term.

And the last dimension of this sustainable knowledge society is social and cultural sustainability. That mean buildings, they have to provide good environment for us, for the health and well-being of the individual for us, all of us here. And at the same time, it has to preserve the cultural heritage of us as humans, whenever we are depending on the culture and the climatic condition. So, it has to work this sustainable knowledge society, it has to work for the environment, for the betterment environment, and for the future generation as well. So, we need to keep, you know, good future for future generations and we keep the plant in good condition for them as well. And it has to be an equity as well, that you know people all over the world, they have to be equal as well, if you wanted really to move towards sustainable and global knowledge society. And then that's through participation, we all have to feel part of this process of sustainable knowledge, and that we all have to participate in this sustainable knowledge.

#### **Part 4**

This is in general. Now I will look what I want to share with you here, some of the work aware that we have been doing in sustainability, and what we've been trying to in some buildings. And I will discuss with you how this, we manage you know to achieve this integration of passive and renewable energy in buildings (or not) and what energy saving did we manage to do, if not.

So why buildings, why do we, why we concentrate on buildings you know, that's the main question, maybe you are asking yourselves why I am interested in sustainable building. For example, if you look the energy construction in the EU, for example, in the European in Europe. 41% of energy demand is in buildings. So, you can see that it's more - coming to 50% of the energy is consumed within the building in Europe. In the U.K., it's more than 30% of energy is consumed within buildings. And for example, government there, the U.K. government, I think I Anne she gave you some of the reading. I arranged for you this green building in the U.K.? I don't know if you all have read through it. The British government, they are very proud that they are leading the way in terms of policies, in terms of protecting the environment. And I included this pre-reading for you, just show you what the U.K. is doing in terms of green buildings in general. Then, I will share with you what personally, what we are here in Reading, we are trying to do.

So, this one of this British government policy, they call it's the white paper for the environmental issues. And this white paper says that you could be 20% saving in buildings by year 2010. So, within the coming 4 years, we could save 20% of energy that we consume with buildings, if we move to more sustainable alternative. So for example, using more passive design, and using different type of renewable energies. And here in this paper, it talk about one of the examples, one of the buildings, and it is Bezet, it is the a community you can see a picture for it here, on the top of your reading in the second page. Also shows you know

what different aspects of passive design and renewable energy are used in this building.

So, we can see there is a lot of potential for sustainability in buildings. What do you mean by sustainable buildings? If you go to Google for example, and just put 'sustainable buildings,' you will come you know with hundred or even thousands of definitions for sustainable buildings, different people you know they define sustainability in different way. And there is a definition I like, personally myself, which I found in a guy called Kilbard, and cited by somebody called Boil, here is a book called renewable energy published 1996 by the Open University, very interesting book. I recommend it if you are interested in this area. It says that sustainable construction is 'the creation and responsible management of a healthily built environment, based on source efficient and ecological principle'. So why I like this definition? Because it is linked to the main functions of the buildings. You remember we said the main functions of the buildings, it has to be resource utilizer, and it has to be activity container. He tries to put those functions of the buildings but in efficient and ecological principles as well.

So, by sustainable construction what we trying to do? We try to promote building that good for the health, wealth, and environmental friendly at the same time. And this through, by using low energy and renewable energy system to provide for thermal, visual, well-being of building occupants. So, that's this building for example, if it has to be sustainable. It has to use low resources, local resources, even global resources. It has to use less artificial lighting for example. It has to use less air conditioning, and it has to be at the same time it has to provide for us. So that will be able thermally, that we have the sensation that feeling, we don't feel too hot, we don't feel too cold, we have to feel comfortable as human, human body. And also visual as well, we have to be able to see each other to interact, that means provide adequate lighting level for us, whether artificially or their lighting natural.

And then the one being for us, you know, not only we have to be thermal but we have to be well as well because you know you can provide adequate level of lighting also thermal, but it might not be because it might not be good for the well-being and productivity of the occupants.. If you see that modern office building, they use air conditioning and people, they started to develop different allergy because of the high use of air conditioning, and the lack of fresh outside air.

One of the most important tools for us now we developing here, and people are talking about it in academia in general, but we're thinking about using it here most in our sustainable construction research group. It's called post-occupancy evaluation study of buildings.

## **Part 5**

So, for example if we design this building, we come back after the construction, during the maintenance and operation, we come and look, we measure the temperature, we measure the lighting level. And we see, and we give questionnaire for example for you, for you here the user of the building. And we ask you how do you feel, you feel comfortable, do you like the environment of

this room? and so on. This what we call a post-occupancy evaluation, so we evaluate the building after it is, has been constructed, and it is directly in use by the occupants.

And, but the problem with this post-occupancy evaluation, and this also including work through, that means architect, they have to pretend to be the user of the buildings. They are rarely taken in the U.K. for example because why, because it's costly. Once people once architect designs the buildings and finish with the buildings. They found it very expensive for them to come back because they finish, their job has finished, nobody will pay them, you know to come and do this post-occupancy evaluation. So they don't want to do it, they don't have the incentive to do it.

And other issues, the architects and all those people involved in designing a constructional buildings, they have to be involved in post-occupancy evaluation. They will be forced by the new regulation for example in the U.K. I talked about you know that the British government is proud that it's leading in terms of policy, so one of those policies, new regulations, tighter regulations, that building, they have to consume less energy. One of this regulations that have to make sure that buildings they perform well. So if for example they say this building in low energy they have to demonstrate practically that this building is low energy, they can't just say you know this, 'ok, I'm designing a building, it's using renewable energy, it's all well and good but does it work?' And this what I try to do.

And some of the systems that we've been working on, it's natural ventilation to be using forms of natural ventilation of their lighting. So, for example, this is called windcatchers. People in the Middle East, they use windcatchers a lot, you know. These windcatchers, it's like a terminal on the top of the buildings. The idea is the wind will blow through it, and bring air inside the building. And there is a few here, if you seen in the Palmer building, there is about three or four windcatchers, if you go outside the building, you see the terminal of the top of the building. And if you go inside the room, you see, a big square with the kind of machine. That's the internal part of this windcatchers. And this windcatchers, they've been using in the Middle East for more than 3000 years. It's a kind of typical vernacular architecture. And it shows how people diligently use their local knowledge in order to create thermal environment, less energy, it doesn't use energy at all. It doesn't use energy at all, and it's very comfortable.

And these windcatchers, they've been using different buildings now. So, for example, here in the U.K., this building is, they call Oast houses, which is (unclear). And this was constructed in 1885, so it's more than 120 years as well - they use this windcatcher for ventilation of buildings. This modern building here is rotating windcatchers, so the idea this windcatchers rather than to be static, they move around. So whatever the wind coming from, they will encapsulate that in and take it down into the space it has to provide cooling for the user of the buildings. And here also it's been used in this here, this is the British research establishment offices in Westford, and it's been used this system of windcatchers.

Another system that's been used, it's light, listening system, natural light. We can see different forms of natural light has been in use. Here we can see there is no natural light at all, all artificial lighting, maybe this because of the nature of the this lecture room. But still they would have been possibility to use natural

light in somewhere here. Some of this natural lights, just normal windows, glazing windows on the side of the buildings. Some of them like atrium, this is in art gallery. They're using natural light here. Also, here this in the shopping area in atrium. Another system that we work on, we call it light pipes. This here you can see this is the top of it, outside the building, there is a light pipe. This light pipes are aluminium tubes, and they are very reflective aluminium tubes. And the idea the sun will shine on these diffusers, this light diffusers which is translucent. And the light will go through this diffusers will be reflected by these aluminium tubes into the spaces here.

## Part 6

And what we did, we looked at one buildings, and we did you know this kind of framework interaction. And we had this windcatcher, a light pipe. We installed it one of our buildings, the lego buildings, next to the library, and construction management. We took this windcatcher, and we have the right pipe as well you can see it here, from the inside you can see it here, it very kind of luminent that the light coming in, you can see the reflection of the light, this natural light, there is no light pipes whatever this natural, this is sun light coming inside the side room because of this reflective aluminium to you, and we did some study. We looked at it you know so what we did, we measured the temperature inside the room, we measure the day lighting labels, this post-occupancy evaluation to see that to gauge that with buildings are working properly or not. And we also gave you know the students who are using this lecture seminar, we gave them questionnaires as well to ask them about what do they feel about the thermal, visual and about they well-being, do they like the environment in that room or not.

And what we found that you know this here, just sample of the results shows different here the wind is bit, so here we're measuring the wind's beat(?)So the maximum wind is bit about 3 meters per second. And here also measuring the temperature, there is the external temperature, sorry there is the blue one is the internal temperature and the red one is the external temperature, and other one, this one is about humidity as well. This is the external humidity and this is the internal humidity. And we measure how much air is coming in and going out. We find that you know the windcatchers, they work relatively well in this kind of conditions. And where we ask you know the occupancy survey when we asked the students, we found that about 60% of the students, they are feeling more comfortable. For example, 40%, they're feeling neutral, that's meaning, they don't feel too hot or too cold. In that in 40%, so, that, it's not bad And then, when we are here, we can see here most of them, they are between slightly warm and neutral because it was a summer day as well. But still it wasn't you know they said it was performing better. They said before the windcatcher was installed in this seminar it was really hot. So the windcatcher help you know to eliminate this heat you know to relieve the sensation of this hot weather.

And this, and this here with age of the people, so usually people older people always feel much cooler than younger people, younger people, you know, the metaphoric relative, if you are young you release more heat than if you are older. When you get older you need to feel more warm most of the time.



And we did some other buildings as well, this shopping centre, I showed you the picture at the beginning. This evolving tower as well, and we here, we have different sensor for all those temperatures inside the buildings. And we also we get some results as well. Unfortunately, the results what they showed us, they showed that you know the windcatcher who are not properly used. The windcatchers were integrated with air conditioning, for example. So, if it is too hot day, for example, if the windcatchers, they are not working fully to provide good sensation for the occupants, the air-conditioning will come on. And that didn't happen, the windcatchers were not well used within the buildings, and the integration. And that's because of problems of integration as well. I talked about this problem of diversity of the construction industry, that mean a lot of people, they're working. Sometimes, they are not focus on the same desired target. This causes a problem. And this what we trying now to advocate to integrate the facility management in the design an construction. So, all those people involve at the early stage of the design planning design, construction of the building. Or people who would l be later on using the building or be managing the building, they have to be involved through the whole life circle of the buildings.

## Part 7

I think I will, I have some other examples, but I will share of you. I will just skip some of this examples. And I will talk about, a little bit in the, for the coming 5-10 minutes about this, another buildings. What we call sustainable knowledge system that's the zero energy buildings. And this buildings are, it is a building, it is outside St. Albans, It is for a renewable energy system, it is a company that manufacture wind turbine And these are the offices, and you can see here these are offices, what we installed wind turbine to generate the energy. And we use solar energy inside the building as well. On the roofs, they provide energy and also for heating water house. So the water will go through those solar, panels, and will be heated, and it will be heated, so people, they got hot water, rather than using boilers gas or electrical. And the system in the building is working very well. It is zero energy, doesn't use any energy outside. In fact the wind turbine produce more energy than needed for the building, now they sell it to the grid as well, so they making a little bit of money, it's not much, but at least you know it shows that this building is there is a possibility of not zero energy but neutral emissions building, it's a possibility. It can be done, it can be done, it everybody all those to people involved in designing of buildings, they have the energy to be able to push forward this idea of passive design and renewable energy in buildings.

I just finish with conclusions, this post occupancy evaluation I talked about, is very important for building. If we really want to make sure that buildings are sustainable that they are use less energy. And also those provide for us a learning experience. So, when if you come here we ask people if they are comfortable or not with the environment. That will give us an idea about to learn from this their experience of their use of this building. And we can use this information and use it for new buildings as well, so give us experience. Even if the building was failing, we can learn from failure as much as we can learn from successful design aspects. And also the most important thing, we say that it is imperative all those potential of adapting this integrative design approach, design, total design, which

you call design construction of facility management, everybody has to be involved. And we believe, you know, by doing so by integrating everybody, involved in the design processes of a building that you know, it will improve the businesses, it will satisfy their clients and user needs, and also will have less impact on the environment.

And that will be my presentation, but before we move to the discussion, one of the - so that you know - we I think what create where we are being designing buildings and so forth, and where we are living our life wasn't sustainable. We have to agree of that, you know. And also what we are advocating that it is a paradigm sheet; we need to change the way we think, we need to change the way we live our live, daily life, we have to think to be sustainable, every day in our life, how do we save energy, how do we save the resources like scarce resources you know, such as water. And this you know some of the cause that I really like about this idea of paradigm shift, these is a quote by Albert Einstein. He said

*A human being is part of whole, called by us the universe, a part limited in time and space. He experiences himself, his thoughts, his feelings, as something separated from the rest, a kind of optical delusion of this consciousness. This delusion is a kind of prison for us, restricting us to our personal desires and to affection for you, persons nearest to us. Our task must be to free ourselves from this prison by widening our circles of compassion to embrace all living creatures and the whole of nature in its beauty.*

Albert Einstein

In a some way, we have to think about ourselves as we are citizen of this planet. We all equal citizen of this planet. And that we say you know this motto that

*The earth is but one country, and mankind its citizen.*

And one of the issues here, establishing real, Rio Summit in 1992 is a Local Agenda 21. And Local Agenda 21 is about how people, how local people, they can save energy within their locality. And motto of Local Agenda 21, you have to think globally, and you have to act locally as well. So, I finish my lecture here and then we can move to discussion about sustainability, about any issues you know that I talked about. Or even what we can do, you know, what can simple thing that we can do to save energy in our daily life. I think that's very important as well to talk about and to be aware about. Thank you.