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Metadata Record: https://dspace.lboro.ac.uk/2134/9742

Version: Accepted for publication

Publisher: Coventry University in partnership with the Chartered Institute of Building (CIOB)

Please cite the published version.
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DEVELOPING KNOWLEDGE REGARDING SUSTAINABLE CONSTRUCTION IN THE NATIONAL UNIVERSITY OF CIVIL ENGINEERING OF VIETNAM (NUCE)

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Abstract. International collaboration is one of the most effective ways for solving sustainable development problems. This paper briefly introduces the current situation on sustainable construction in Vietnam and some research trends for development of sustainable construction research at three Universities - the National University of Civil Engineering (Vietnam), Loughborough University (UK) and the University of Liverpool (UK). The paper presents preliminary work undertaken by the three universities to implement the British Council-funded DelPHE 743 project on developing knowledge regarding sustainable construction in the National University of Civil Engineering of Vietnam (NUCE).

1 INTRODUCTION

This project, funded by the Development Partnerships in Higher Education (DelPHE) programme, has its objective to develop knowledge regarding sustainable construction in the National University of Civil Engineering (NUCE) of Vietnam. The DelPHE programme is based on a partnership between the British Council, the UK Government's Department for International Development (DFID), and the participating institutions in other countries. DFID is investing annually about £3 million in DelPHE and provides funding to support partnerships between Higher Education Institutions (HEIs) working on collaborative activity linked to the UN Millennium Development Goals (MDGs). The overall goal is to enable HEIs to act as catalysts for poverty reduction and sustainable development. DelPHE aims to achieve this by building and strengthening the capacity of HEIs to contribute towards the MDGs and promote science and technology related knowledge and skills. The programme will run for seven years (June 2006 to March 2013). 40 projects have been supported under
DelPHE round five (2010-2013). The **British Council** is the UK’s international organisation for cultural and educational relations, and is the UK’s second biggest charity (British Council, 2010). They have offices in over 100 countries and territories and are active in many more. Their aim is to “build engagement and trust for the UK through the exchange of knowledge and ideas between people worldwide” in order to “create long-term relationships that provide cultural, diplomatic and economic benefit for the UK”. They are operationally independent from the UK government, thus enabling them to build trust “on the ground” in places and with people where relationships with our country, society and values may be strained.

Vietnam is a developing country with the population of approximately 86 million. The economy of Vietnam is a developing market economy, with GDP of $256.584 billion estimated in 2009. The Vietnam’s economy is currently one of the fastest growing in the world, the GDP growth is approximately 7% annually. The construction industry of Vietnam is in the form of a mix between private, in small and medium sized enterprises, and state-controlled in large companies. The construction industry of Vietnam is part of the general industry which contributed 40.1% of GDP in 2004 and employed around 13% of workforce. However, the fast growth rate in economy of Vietnam needs to ensure that it is sustainable. The United Kingdom is a developed country with a GDP of $2.183 trillion estimated in 2009, i.e. approximately 8.5 times that of Vietnam’s GDP. The GPD growth in 2009 was 1.6%. The population of the UK was approximately 62 million in 2010. The construction industry of the UK is considered to be private sector and consists of over 250,000 firms employing 2.1 million people. The sector is defined as one which embraces construction materials and products; suppliers and producers; building services manufacturers, providers and installers; contractors, sub-contractors, professionals, advisors and construction clients and those organisations that are relevant to the design, build, operation and refurbishment of buildings. The UK construction sector contributed 9.2% of the nation’s GVA (Gross Value Added) in 2007. UK designers, civil engineers, contractors, component & product manufacturers have a worldwide reputation for working overseas, providing high-tech solutions to environmental, transport & building projects. The sustainable development in construction in the UK is currently regulated by the UK government tightly. Therefore, the knowledge transfer from the sustainable construction in the UK to Vietnam is an effective way for the UK to help Vietnam in terms of sustainable development. The DelPHE programme to sponsor for this kind of knowledge transfer project is one of the main objectives in the operation of the UK Government’s Department for International Development (DFID) in developing countries.

The main objective of the project is knowledge transfer and network building for achieving sustainable construction. NUCE and the UK universities of Loughborough and Liverpool will visit each other and exchange academics and knowledge in activities such as short-term training, seminars, lectures and field studies on sustainable construction at each others’ institutions. Through these activities, NUCE will be able to access and learn about the up-to-date information and sources on sustainable construction which are being carried out in UK and internationally. A number of academics from NUCE will spend up to 1 month per stay in the UK to attend training courses or programmes and carry out field studies to extend their knowledge on sustainable construction and to extract appropriate knowledge for use in
education and training at NUCE. Academics from the UK Universities will also spend up to 1 month per stay in Vietnam to deliver training courses or implement appropriate surveys in order to extend their knowledge and experience of sustainable construction in a developing country. Furthermore, the two UK universities will gain practical experience in construction developments in Vietnam through visiting on-site construction projects which are being built in Vietnam. Regular discussions via email, teleconferences and meetings between the three parties will investigate realistic definitions on what is appropriate sustainable construction for Vietnam and come up with recommendations for implementing more sustainable construction in Vietnam. The final report of the project will be used as primary documents in lecturing on sustainable construction for all training courses and programmes delivered by NUCE. The report will also be submitted to the appropriate bodies and policy makers in the Vietnamese government to enhance their awareness on sustainability in construction in Vietnam.

The National University of Civil Engineering (NUCE) was established in 1966 and is one of the leading Universities in Vietnam. It has approximately 620 staff, and each year admits over 3,000 undergraduate students, with a total student population of around 15,000. More details are available at http://nuce.edu.vn/. Loughborough University’s Faculty of Engineering is one of the largest of its kind in the UK and holds ‘Centre for Excellence in Teaching and Learning’ status. In the most recent Government Research Assessment Exercise (RAE), over two thirds of its research activity was classified as ‘internationally excellent’ or ‘world-leading’ (3* and 4*). The University also has a new Sustainability Research School, a cross-cutting department committed to interdisciplinary collaboration with other academic institutions and businesses in the areas of Sustainable Energy and Transport, the Built Environment and Sustainable Societies and Economics. The University of Liverpool has been carrying out research and teaching on sustainable construction for many years and has been funded by The Veolia Environmental Trust, The Flinshire Community Trust, AD Waste Ltd, The North West Operational Programme, European Regional Development Fund (ERDF), Carbon Trust Ltd. and many more. The work is ongoing with funding from the last two organisations to the amount of £1.3 million.

2 SUSTAINABLE CONSTRUCTION IN VIETNAM

Responding to the Rio Declaration 1992 on environment and development with the Agenda 21 and the Johannesburg Declaration 2002 on sustainable development, the Vietnamese government has issued various policies and decisions concerning the sustainable development in Vietnam, such as the Agenda 21 for Vietnam and the Decision No. 153/2004/QD-TTg for the Strategic Orientation for Sustainable Development in Vietnam. In these documents, the construction industry has been mentioned as playing one of the key roles in the sustainable development in Vietnam. The government asked for all organisations operating in construction education and industry to improve the sustainability in all activities and transfer the knowledge on sustainable construction to people as much as possible. However, the implementation of the policies in practice is generally limited. The exploitation of raw materials and natural resources for using in construction is badly organised. In addition, the investment in building construction materials factories and industrial zones is not
sufficiently effective in term of sustainable construction. Construction activities in Vietnam still use large amounts of energy and raw materials, and also produce a large amount of waste. This has caused significant environmental pollution and affected the quality of life of the Vietnamese people.

In order to tackle this issue of a low level of sustainable construction in Vietnam, various works have been carried out to try and improve the sustainability\textsuperscript{13}. A large number of research projects have been sponsored and funded by Government organisations such as Ministry of Construction, Ministry of Education and Training, Ministry of Science and Technology, and Ministry of Natural Resources and Environment. The National Standard System for Construction and Environment has gradually improved and it is being applied for the design of new construction projects. The most notable development in sustainable construction work might be the use of fly ash in production of construction materials. The use of fly ash for construction materials offers sustainable benefits such as reducing the environmental impacts caused by cement production and ash landfill; improving the durability of construction materials and reducing the cost of construction materials. Fly ash has been used in research in Vietnam on producing binder mixtures, ceramic products, lightweight aggregates for concrete, etc. However, the chemical composition of fly ash in Vietnam shows a high content of unburned coal (25-35\%)\textsuperscript{14} compared with international standards (around 5\%). Therefore, fly ash in Vietnam is commonly required to be processed more thoroughly to reduce the unburned coal before it can be used for partial cement replacement in concrete. On the other hand, the fly ash in Vietnam also contains a high content of aluminium oxide (Al\textsubscript{2}O\textsubscript{3}) and it is hence more attractive for use in the production of ceramics.

Coal ash waste discharged from the Pha Lai thermal power station in Vietnam only is approximately 6,000 tonnes per day\textsuperscript{15}. A landfill area for this coal ash waste is shown in Figure 1. The amount of coal ash waste produced nationally is considerably larger once other thermal power stations such as Uong Bi, Hai Phong, Na Duong, Cao Ngan, Cam Pha, Quang Ninh, etc are also taken into consideration. Furthermore, a huge project is underway for the construction of yet another thermal power station. Kien Luong received an investment of 6.7 billion USD) and it will be able to consume an estimated 10 to 11 million tonnes of coal per year. This will significantly increase the total amount of coal waste produced in Vietnam. The Institute of Energy, Ministry of Industry estimated that the coal ash waste produced from this new power station will be around 2.3 million tonnes in 2010. Therefore, fly ash is still considered to be a waste unless it can be shown that it is advantageously used in the future for the production of construction materials in Vietnam.
Blast furnace slag waste in Vietnam should also be considered as another major industrial waste which needs urgent solutions to reduce its environmental impact. The capacity of the iron and steel factories of Vietnam was approximately 5.3 million tonnes in 2006. Furthermore, the Vietnamese government forecasts that the demand of the iron and steel industry in Vietnam is going to increase from about 10-11 million tonnes in 2010 to 24-25 million tonnes in 2025. The development of the iron and steel industry obviously causes environmental problems for the society due to consuming a very large amount of energy and discharging a huge volume of slag waste. Up to now, the use of this industrial waste in Vietnam has been relatively limited as the chemical composition of blast furnace slag in Vietnam contains quite high alkali oxides and free lime contents, which therefore makes unsuitable for use as a partial cement replacement for concrete production.

High performance concretes have been used in Vietnam for some recent structures such as bridges and high-rise buildings in order to help reduce the volume of concrete and improve its durability. However, fly ash and ground granulated furnace slag appear not to have been utilised sufficiently in these concretes. This means that the sustainability of the new generation of concretes in Vietnam has not been fully considered or utilised.

Another issue affecting the development of sustainable construction in Vietnam significantly is burnt-clay building products. Currently, up to 90% of the building blocks in Vietnam are burnt clay red bricks. Manufacturing burnt red bricks causes a significant carbon dioxide emission, as well as wasting agricultural soil. The government does not seem to be properly controlling the manufacturing of these products and as a result it is estimated that approximately 42 billion of burnt bricks will be required annually by the construction industry by 2020. For the manufacture of this number of burnt red bricks, 30,000 – 32,000 ha of agricultural soil and 6 – 6.4 million tonnes of coal will be needed, emitting up to 24 millions
of carbon dioxide. Therefore, the Vietnamese government currently encourages the development of un-burnt building blocks such as light-weight aerated or foamed concrete blocks in order to reduce the quantity of burnt red bricks used in construction. Some burnt-clay product factories have even been closed.

Sustainability has now become an important factor in construction all over the world. Vietnam is not able to be separated from this development progress. In fact, it has actually had some encouraging developments in using fly ash. Blast furnace slag in Vietnam is produced in a huge amount and needs to be investigated further in its use for construction materials. More research will be needed to reduce the pollution caused by slag waste, as well as reduce the volume of landfill for this kind of waste. However, the processing cost to recycle industrial wastes for using in construction works is still a big challenge for Vietnam. The production of burnt red bricks in Vietnam also needs to be minimised to reduce the quantity of carbon dioxide emitted and to save agricultural soil.

3 SUSTAINABILITY WORK AT THE NATIONAL UNIVERSITY OF CIVIL ENGINEERING (NUCE) OF VIETNAM

NUCE has been interested in sustainability in construction for many years, in both training students and carrying out research. As well as being taught some fundamental knowledge in construction, students of NUCE have also been taught the information concerning the influence of construction on the environment and the necessity of conserving raw and natural materials. Regarding research, construction materials have been identified as a key part in the sustainable development of construction in Vietnam. NUCE has three main targets in this area: (a) Manufacturing and effectively using building materials in construction to save energy and minimise construction waste; (b) Use of industrial waste in manufacturing construction materials; and (c) Development of high performance materials to improve the service life for buildings.

Some typical research projects are outlined here. Used tyre rubber powder has been used for asphalt concrete in tropical weather conditions in order to use up some of the rubber waste produced from the millions of bicycles, motorbikes and cars in Vietnam. The experimental results showed that 9% recycled rubber powder to replace the bitumen content could improve the heat resisting durability for asphalt concrete, and also improve the strength by approximately 60% at normal temperatures, and by approximately 92% at 50°C, compared with the asphalt concrete using pure bitumen. Rice husk, which is a waste discharged from Vietnamese rice (Vietnam is one of the largest rice-exporting countries in the world), has been processed to become an ash admixture for use in concrete products. For example, 20% rice husk ash has been employed to partially replace cement in a 70 – 90 MPa high strength concrete. Fly ash, a by-product discharged from thermal power stations, has also been used widely in some research concerning roller compacted concretes at NUCE. The experimental results confirmed that the cement content could be reduced by up to 30% without any changes in the compressive strength. Additionally, other high performance materials have also been developed in NUCE such as high strength concrete, corrosion resistant concrete, fire and heat...
resistant concrete, and thermal insulating ceramics, etc. The research carried out in NUCE has confirmed that sustainable construction should be developed more urgently in Vietnam as it will help improve Vietnamese life now and in the future.

4 IMPACT AND LEARNING ON SUSTAINABLE CONSTRUCTION FOR THE DELPHE PROJECT

For the lead institution NUCE, the DelPHE project will help to extend their capacity of knowledge in sustainable construction for all staff, and help transfer this knowledge to approximately 3,000 civil engineering students at NUCE each year. The outcomes of this project will also be used as the basis for a curriculum in training courses in NUCE for all students in the future. The staff and students will hence disseminate this knowledge regarding sustainable construction to other people working in the Vietnamese construction industry, and hence enhance the awareness regarding sustainable construction in Vietnam now and in the future.

At Loughborough and Liverpool, the findings from this DelPHE project will feed to staff across the relevant Departments, Faculties and Schools, as well as into the undergraduate and postgraduate teaching programmes in civil engineering and built environment disciplines. It will assist in gathering the information from the several ongoing research projects and help create taught material for specific modules on sustainable construction. Research needs to be disseminated and this must not be only at conferences but also to students that will be the next generation of practising engineers. Liverpool has identified sustainability as a key research theme and is in the process of creating a centre with expertise from not just civil engineers but from other departments, i.e. to take an interdisciplinary approach to this topic, in a similar way to Loughborough’s School of Sustainability.

An additional aim is to improve the networking and exchange of information between the partner institutions in order to establish a long-term collaboration in training and research in sustainable construction. Specific outputs include:

- Two research papers published in international referred journals:
  - ‘Sustainable construction in Vietnam and the solutions to improve it’ and
  - ‘Application of the knowledge about sustainable construction from UK to Vietnam’.
- Paper presentations at key international conferences on sustainable development and construction, one in Vietnam and one in the UK.
- Development and delivery of a new module on sustainable construction to be taught at NUCE.
- Input into the civil engineering teaching at the two UK universities on sustainable construction in developing countries.
- At least three international events per year such as seminars and field visits to disseminate knowledge regarding sustainable construction.
- Recommendations to the Ministry of Construction of Vietnam and the Ministry of Natural Resources and Environment to help and inform policy makers in construction when developing new policies and construction schemes in Vietnam.
An aim of the project is to contribute to at least two of the UN Millennium Development Goals, i.e. Goal 7: Ensure environmental sustainability and Goal 8: Develop a global partnership for development. The outputs and outcomes will widely enhance the knowledge regarding sustainable construction for academics of NUCE who deliver training programmes, as well as the people being trained by NUCE to work in construction. The project will also help stimulate a global partnership for development between Vietnam (NUCE) and the UK (Loughborough University and University of Liverpool). The project members will have various opportunities to carry out research in sustainable construction through field visits. The seminars held at NUCE will invite representatives from the Ministry of Construction, Ministry of Natural Resources and Environment of Vietnam and other associated construction companies. Therefore, the information about sustainable construction will be widely spread to other parties within the construction industry and to governmental organisations that are the policy makers in construction in Vietnam. Through the project NUCE and the UK Universities will have increased mutual understanding in order to help further establish co-operation on training programmes on undergraduate, Master and Doctorate level courses.

**Dissemination and learning**

The dissemination of the findings of the project will be carried out in stages. The first group informed and educated will be the lecturers of NUCE. Next, these academics will disseminate the knowledge on sustainable construction to all the students at NUCE. Approximately 3,000 graduates per year from NUCE will graduate and work in the construction industry throughout the country and internationally. They will disseminate the knowledge about sustainable construction learnt during their study at NUCE in their working activities. This knowledge regarding sustainable construction will therefore be able to reach both social and professional communities to help them improve their attitudes to sustainability in construction.

Regular project seminars at each of the 3 universities will also invite representatives from other higher education institutions to learn, contribute and have their opinions on the project. One international conference will be held at the end of project which will gather experts and people working in construction in the region and the world to share the outcomes of the project in sustainable construction. Journal and conference papers are also planned in order to extend the dissemination internationally as widely as possible.

In addition, the key academics of NUCE frequently advise the technical committees of governmental bodies such as the Ministry of Construction and the Ministry of Natural Resources and Environment, which will make sure that the key people representing governmental bodies will attend and follow the activities of the project. As a result, these people will be able to provide valuable advice for policy makers and decision-makers in construction in Vietnam.
5 CONCLUSIONS

Currently, the development of sustainable construction in Vietnam is still limited. Therefore, developing knowledge regarding sustainable construction in the National University of Civil Engineering of Vietnam is essential in order to stimulate sustainability thinking in construction in Vietnam more widely and deeply. The outcomes of this DelPHE project will also benefit the two UK universities of Loughborough and Liverpool, in terms of understanding the issues that need to be considered for sustainable construction in a developing country. This will enable them to include information about developing countries in their training and research activities.

Construction materials play an important role in developing sustainability policies. Scientists at the three universities agree that effective use of materials, saving natural resources and recycling and reuse of industrial waste are crucial aspects in the development of sustainable construction.

6 REFERENCES