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New Technology Product Dissemination in Built Environment: early adoption of LED lighting

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In the past, the construction industry which has a reputation for being highly cyclical trends have tended to exaggerate overall economic cycles. However, the tide seems to be turning because of recent financial market turmoil. The housing market has been on a downward trend in recent months and many construction projects are delayed or canceled in the UK. Despite of this fact that demand in this sector is believed to continue to increase as the UK population continues to rise and an increasing trend for single occupant household compounds the overall shortage of houses in the UK. The Government believes 2 million new homes need to be built by 2016 and 3 million by 2020 (Mintel, 2008). The increasing public demand for sustainable development has forced the construction industry to operate in a more sustainable way (Panagiotakopoulos and Jowitt, 2004) and the benefit of achieving doing so is significant. The principles of construction industry more sustainable include four main areas such as social, economic, biophysical, and technical. These principals can not always be satisfied because trade-offs and compromises may be necessary. It is best if choice of principals is made by the interested and affected parties involved in a project (Hill and Bowen, 1997).

In relation to the growth of construction sector, climate change is becoming the primary imperative challenge to the government and societies. Emissions of carbon dioxide, known as CO_2 are accounted for the main source of climate change and UK has responsibility for 550 million tonnes in 2005 (DCLG, 2007). The construction industry has been claimed of causing environmental pollution (Ding, 2007). For instance, energy consumption in the UK housing sector accounts for approximately 28 per cent of the UK's total and burning fuel for use in housing sector produces approximately 170 million tonnes of CO_2 (Todd, 2006). Thus, there has been an increased attention of issues affecting excessive use of energy and materials in construction sector (DCLG, 2007).

Although the introduction of energy efficient light bulbs in the early 1980s has led to some energy savings, the total amount of electricity consumed for domestic household lighting was increased by 63 per cent between 1970 and 2000 and by 11 per cent between 1990 and 2000. According to recent national statistics of energy consumption in the UK, domestic energy consumption by lighting and appliances accounted for 14 percent and domestic energy is occupying 29 percent of UK total energy consumption in 2006 (BERR, 2009).

UK policy has tried to respond to excessive energy use. Fortunately, comparing to the building regulations in 2002, there 40% of carbon emission

reduction is made according to ODPM in 2006. Despite of this successful achievement, however, needs for stricter regulation standards is needed to motivate designers to choose solutions that are cost effective, practical and provide an incentive to designers to consider zero carbon housing are demanding (Todd, 2006). It is imperative that policies to promote the adoption of energy-efficient technologies are linked together with energy use and climate change. Sustainable home needs to consider not only environmental sustainability but also social cultural and economic sustainability (Aburounia and Sexton, 2004). Sustainability does not have a certain style and difficult to formulate. It can exist in various styles and still in developing stage.

Accounted for this, key elements of sustainable building practice have been released by Department for Communities and Local Government (DCLG, 2006) known as 'Code for Sustainable Home' to inform better about the sustainability of new homes. This so called the code has highly ambitious targets; 25 percent of energy/carbon performance improvement set in building regulation in 2010 and 44 percent improvement in 2013 then finally zero carbon in 2016 (DCLG, 2007). To meet this target, new disruptive approaches should be made. Otherwise a company which fails to accommodate this new paradigm will extinct from the market.

Despite of the government effort above, however, there is little evidence of significant behaviour change to reduce emissions. According to recent research by NESTA (2008), the UK's emissions are still on the rise. Between 1990 and 2005, household energy consumption rose by 40 per cent. Carbon Trust (2007a) claimed that 30% of lighting cost can be saved by implementing energy saving measures. Estimation by the UK Market Transformation Programme stressed that LED lighting in homes could save 12.7 TWh per annum by 2020 comparing to compact fluorescent lamps (CFL) which can not offer more then 10 TWh per annum savings. Encouragingly 100% of domestic lighting market penetration by LEDs product with efficacy of 100 LPW would reduce the UK domestic lighting energy usage to 3 TWh per annum (Graves, 2006). For instance, case studies showed that potential energy savings by adopting LEDs, 40 % market penetration can reduce 25% of energy use compare to 0% of LEDs market entry. For this result, 5.5% of the total electricity consumption can be saved. If LEDs penetrate 80% of lighting market then 50% of energy savings will be achieved over 0% penetration scenario. This means 11% of the US total electricity consumption can be saved (Schubert et al., 2006a).

Figure 1. An example of LED lighting system

Successful introduction of energy saving products is beneficial for the company as it saves costs enhances corporate reputation and helps fight against climate change. As its room for technology development and early stagy of lighting market entry, dissemination of LEDs technology faces on barriers and challenges. Therefore, understanding this new technology and facilitating its market entry is appropriate.

Demand for energy saving in lighting has also been boosted by legislation, amendments to Part L of the Building Regulations in England and Wales in 2001 and Part J in Scotland in 2002 aimed to improve the overall energy efficiency of lighting installation, setting out standards for all dwellings and buildings

to have some form of energy efficient lighting. More recently, announced by the Environment Secretary Hilary Benn in September 2007, incandescent bulbs will be gradually disappear in the market. This scheme is well accepted by Currys and Habitat by 2009, ASDA, the Co-operative Group, Morrison's, Sainsbury's and Woolworths by 2010, and Tesco by 2011 (Mintel, 2008). This movement forces manufacturers shift towards new paradigm which requires new products that has not been done in the past.

It is critical that energy savings and CO_2 reduction should consider holistic approach.

Successful introduction of energy saving products is beneficial not only for solving climate change issues but also for the company as they save energy bills and enhance corporate reputation (Howarth et al., 2000). Evidence shows that LED lighting products have a high potential to achieve these benefits (DOE, 2008; Carbon Trust, 2007b; Schubert et al., 2006b) but dissemination of energy-efficient technologies has always been challenging (Kumar et al., 2002).

Taylor and Levitt (2004) argued that adoption of new technology fails in building industry despite of its demonstrable benefits. They argued that innovations in building industry require multiple companies to change in a coordinated way, including supply chain. When new products are introduced in the building industry, significant number of products are failed to diffuse rapidly or widely (Taylor and Levitt, 2004). For example, CFL bulbs offer an economically efficient way to mitigate anthropogenic greenhouse gas emissions through reducing net electricity consumption. However, a review of the existing literature showed that adoption level of CFL is still low and slow progress of market penetration (Sandahl et al., 2006). For this reason, clarifying reasons of innovation diffusion failure is significant and valuable to the industry.

Roger (2003) classified that innovation adopters themselves are categorised based on their behaviour as innovators, early adopters, early majority, late majority, or laggards which is illustrated in Figure 2 below. These segments formulate technology adoption cycle. Also, S-shaped innovation diffusion curve can be seen when cumulate each segment. Innovation diffusion is triggered by innovators and shift to early adopter and early majority is followed. This process is linear but most of innovation diffusion failure is occurred at early adopter stage (Moore, 1999).

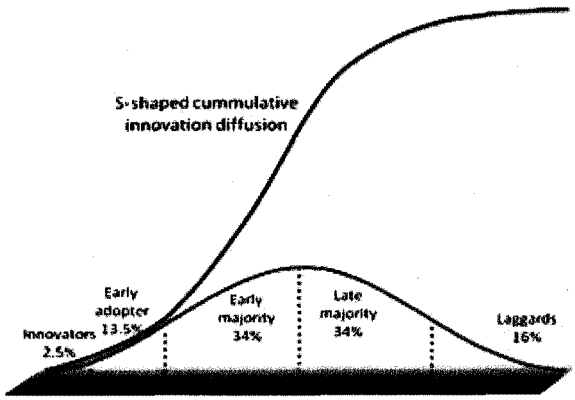

Figure 2. The diffusion of innovation curve (Source: Moore, 1999)

Roger (2003) indentified characters which affect innovation diffusion but little focus is found on the market level case study of this path dependent new high technology product development process. Thus, case study about incumbent technology, LED lighting product development and adoption process requires exalted attention to the researchers.

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