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Title: Global Thinking- Local Action: Adopting the Low Impact Design (LID) Technologies in Urban Stormwater Management

Theme: Beyond Today’s Infrastructure

GLOBAL THINKING- LOCAL ACTION: ADOPTING THE LOW IMPACT DESIGN (LID) TECHNOLOGIES IN URBAN STORMWATER MANAGEMENT

Abstract

Economic development is conceived as the successful transformation of the structures of the economy which is reflected in increased urbanization to cope with the escalating population growth. The rapid expansions of the urban landscape as a result of increase urbanization have brought about rapid alteration in the hydrological cycle resulting in increases in runoff volume; peak flow rates/flooding and water quality impacts. The conventional stormwater management systems that were designed to remove runoff via piped conveyance systems and end of pipe treatment are no longer sustainable to deal with larger and more intense storm events and the associated pollution.

The adoption of the Low Impact Design (LID) technologies is considered a more sustainable approach to stormwater management. LID encompasses the use of structural devices (engineered systems) and non-structural devices (vegetated, natural systems) to maintain or restore the natural hydrologic functions on a site with the goal of reducing the impact of development for overall eco-system sustainability.

Economic and environmental benefits of LID technologies are well documented through demonstration projects undertaken in the USA, Canada, Australia and the United Kingdom. Unfortunately, this innovative approach in stormwater management is yet to be fully adopted in new site developments in New Zealand. Hence, embracing the principles of global thinking-local action in the adoption of LID for urban stormwater management is the key to minimizing the urban footprint for the ecosystem sustainability.

Key words: Urbanization, Low Impact Design, Systemic change, Knowledge integration, Road map.

Introduction

Across the world, the impact of urbanisation on the condition of natural water catchments and receiving waters has stimulated widespread concern of citizens, scholars, and government policy-makers. This is understandable, since already fifty percent of the world's people are in urban centres and a further twenty percent will live there by the year 2050 (DESA, 2008) With the increasing urbanisation of catchments, receiving waters are declining in health. In the United States, it is estimated that over 130,000 km of rivers and streams are impaired by urbanisation and continue to decline (Goonetilleke, Thomas, Ginn, & Gilbert, 2005; USEPA, 2000). Similar trends were reported for Europe, and estimated for Australia (Beaton et al., 2006)

As urbanisation occurs, there is need for a paradigm shift to more sustainable stormwater management methods before additional damage is done to waterways. Ensuring that new development manages stormwater runoff in a way that protects natural hydrology is much less costly and more beneficial to the environment than allowing urban runoff to degrade streams and then spending significant resources in an attempt to restore them later. If there is no change in the way that land development addresses stormwater, this increase in population will lead to a double up in impervious area, with resulting stormwater impact (Stephens & Graham, 2005).

Stormwater runoff from impervious surfaces was identified as a key contributor to the collapse of healthy freshwater ecosystem in urban environments (Konrad & Booth, 2005; Ladson, Walsh, & Fletcher, 2006; Paul & Meyer, 2001). This is the result of stormwater management policies that emphasize expedient removal of stormwater from communities for the protection of human health and property, but place a low priority on ecosystem preservation (Arnold & Gibbons, 1996; Booth & Jackson, 1997).

Changes in land use have a major effect on both the quantity and quality of stormwater runoff. Increased impervious cover decreases the amount of rainwater that can naturally infiltrate into the soil and increases the volume and rate of stormwater runoff. These changes lead to more frequent and severe flooding along with the potential damage of public and private property. By its nature, urban stormwater pollutes and alters the morphology of receiving waters. It changes their chemistry and microbiology (Paul & Meyer, 2001). And by upsetting the natural hydrology of streams, it can also cause irreversible damage to aquatic ecosystems and riparian environments (Booth & Jackson, 1997; Walsh, Jack, Feminella, & Christopher, 2005), while exacerbating the flooding of poorly drained and lowland areas .

Low Impact Design (LID) encompasses the use of structural devices (engineered systems) and non-structural devices (vegetated, natural systems) for stormwater management. It uses a combination of these technologies, or a "suite of technologies," to maintain or restore the natural hydrologic functions on a site with the goal of reducing the impact of development (Guillette, 2010). The goal is to structure the development of a site so that the pre-development conditions are not altered excessively thereby supporting the framework of sustainable construction as proposed by (Hill & Bowen, 1997). Of particular concern are the rate of storm water runoff, the pollutants in the water, and recharge of water into the ground. By reducing water pollution and increasing groundwater recharge, LID helps to improve the quality of receiving surface waters and to stabilize the flow rates of nearby streams. The integrated LID devices that are available allow the designer to restructure the built environment to control stormwater and capture rainwater in order to minimize the impact of development.

The LID approach differs from conventional conveyance systems as it promotes the highest and best use of the intrinsic land form and built structure(s) to both distribute storm water and collect rainwater. The uniqueness of LID is the interaction and function of water on a site. It capitalizes on the integration of infrastructure, architecture, and landscape in order to create a balanced, hydrologically functional and sustainable site. The LID strategy is not a static design approach, however, is very dynamic and adaptable. The integration of LID devices permits the developer and designer to use an array of stormwater management devices that are both cost-effective and environmentally sound. The primary benefits of LID are:

- To prevent degradation of water quality and natural resources,
- To manage stormwater efficiently and cost effectively,
- To protect groundwater and drinking water supplies, and
- To help community grow more attractively.

Nevertheless, the construction industry struggles with the slow diffusion of new technologies, products, processes and services (Reichstein, Salter, & Gann, 2005). Hence, the slow adoption and integration of the LID principles in urban development can be linked to the compartmentalized nature which is identified as one of the barriers to an increased diffusion speed (Gann, 2000; Gann & Salter, 2000; Pries & Janszen, 1995; Winch, 1998). Although projects allow the directed allocation of resources to meet the specific requirements of clients, their one-off nature leads to discontinuities in the development and transfer of knowledge within and between organisations (Dubois & Gadde, 2002; Slaughter, 2000). This paper as part of an ongoing research work will provide an exploratory overview of the challenges to adoption of LID, and the way forward.

The Construction Industry Context

An awareness of the limitations of conventional methods of stormwater management as a result of developmental activities is driving a number of changes to encourage the development and adoption of new technologies towards achieving sustainable environment. New technologies face high barriers to adoption compared to existing technologies for several reasons including a perceived sense of increased risk, high cost of implementation due to lack of cost history, a lack of experience with the new technologies among managers and/or regulators, or simply the fact that decision makers are not aware of the availability of the technology (Chen & Chambers, 1999; Meryman & Silman, 2004; Seager & Gardner, 2005). Implementation of the LID technologies in the development of the urban cities may become a fourth competitive dimension "Sustainability" to be added to the existing dimensions of cost, quality and time (Newton, 1999) .

Many studies on how innovation could be implemented in construction projects have been undertaken (Slaughter, 1993a, 1993b, 1998, 2000; Tatum, 1987; Winch, 1998). For an innovation to be successfully adopted and implemented, it would be necessary for firms to work together, erode boundaries between professions and for project-based firms to embrace new roles and develop new capabilities (Gann, 2000).

The contract of employment between a client and a contractor specifies the work the contractor is required to perform and the nature of the payment the contractor will receive for carrying out the specified work. A fundamental difficulty with such contracts arises due to a significant degree of uncertainty about the nature of the work and the time and resources necessary to complete this work especially when innovative or untried technology is involved. It has been suggested that cost risk should be allocated to the party best able to anticipate and control that risk (Beard, 1982), although this may not be the party best able to bear it. One way of achieving the adoption of LID technologies is the adoption of risk-sharing contract mechanisms for both the controllable and uncontrollable risks. The owners and contractors risk allocation contracting practice is mainly a function of their trust (or mistrust) relationship between each other. If the owner-contractor contract is based on a strong relationship, the amount of the premiums associated with disclaimer clauses will be very low, or even better, the disclaimer clauses would not exist on the contract from the outset (Ramy & Francis, 2003).

In general, the process of risk allocation through disclaimer clauses does not encourage any creative ways of doing business between the contracting parties and destroys the level of trust between them. Above all, the existence of a disclaimer clause in any contract might affect the relationship negatively and encourages contracting parties to work on different sets of personal objectives instead of common ones. To enhance a better risk allocation process, a clear understanding of the risk being born by both parties and the party best able to bear and manage the risk needs clarification. This should be followed by a joint negotiation prior to contract drafting to enhance the trust relationship contrary to the practice today in which the drafting of the contract is at the discretion of the client and tend to avoid risk through exculpable clauses. In this context, the client and contractor will be prepared to negotiate a level of risk- sharing or risk-reward system.

The introduction of LID technologies that is often site specific may increase the complexity of the construction contracts since there would be additional submissions and approvals, making workflow convoluted. Non-specificity of the design details will increase the uncertainties associated with implementation of LID. Hence, "realism," "competence", and 'specificity' are listed as some of the important quality variables for writing specifications (Kululanga & Price, 2005) and must be fully incorporated to avoid disputes which may degenerate to conflicts between the contracting parties and ultimate failure of the LID implementation (Chan, 1996; Kumaraswamy, 1997; Yogewaran, 1998).

Construction contracts are often thought to be too complicated and this is sometimes made worse by the inclusion of archaic language in the drafting of the contracts conditions along with the desire to provide for many 'what if' scenarios (Hibberd, 2004; Naseem, 2008). The use of archaic language is understandable in that it is familiar and possibly has legal significance, but, exact interpretations are not well understood for individuals without a legal background. Hence, the use of modern English drafting should be adopted between the parties (Naseem, 2008).

Furthermore, post-construction liability and construction insurance (Pollington, 1999) are two important aspects that should also be considered in the integration of the LID technologies into any urban development design so as to offer some sort of comfort to parties involved in the implementation of the technology, should the system fail. Environmental contractors and consultants working under current regulatory and legal conditions are faced with extreme liability risks scenarios as they provide their services. Taking into account the inherent uncertainty associated with innovative technology, contractors and consultants can be held liable for negligence or be subjected to strict, joint, or several liabilities whose cost may be catastrophic should there be failure.

Multi-party Engagement

Complex environmental issues such as air pollution, climate change and degraded waterways health are the result of mismanagement of environmental resources brought about by the compartmentalisation of current scientific and professional practice and the sectorial division of responsibility in contemporary society. Following the complexity of the structures and the interactions required to achieve a sustainable urban development, knowledge integration is pertinent among professionals in planning, designing, constructing and maintaining the built infrastructures.

Collaboration amongst the disciplines will enable knowledge to transcend the dimensions of strategic planning and management, manifesting in sustainable on the ground action. It is important to stress that this relationship is complementary as without specific disciplines there would be no knowledge depth (Godemann, 2008). This requires all disciplines to interrelate, where the combination of disciplines share a task to ensure a synthesis not only within but across traditional boundaries (Petts, Owens, & Bulkeley, 2008). Stemming from the need for differentiation and integration (Lawrence & Lorsch, 1967), the theory of knowledge (Grant,

1996) emphasizes the economic value of specialization and the effectiveness of integration. Exploring knowledge integration in cross-functional organisation like construction is important towards the promotion and implementation of the LID technologies that proffers solutions to the myriads of environmental impacts resulting from urbanisation (Blackler, 1995; Brown & Duguid, 1991; Huber, 1991; Marwick, 2001; Nonaka & Takeuchi, 1995). The need to draw on past innovation for future innovation is reflected in the notion of infusion (Cooper & Zmud, 1990), which portrays how organisation increase their effectiveness by synthesizing lessons learned from past innovation. According to (Senge, 1990), an organisation cannot learn effectively simply by concentrating on fixing problems with quick solutions. Rather, it is vital to promote generative learning by constantly evaluating the way in which solutions are created.

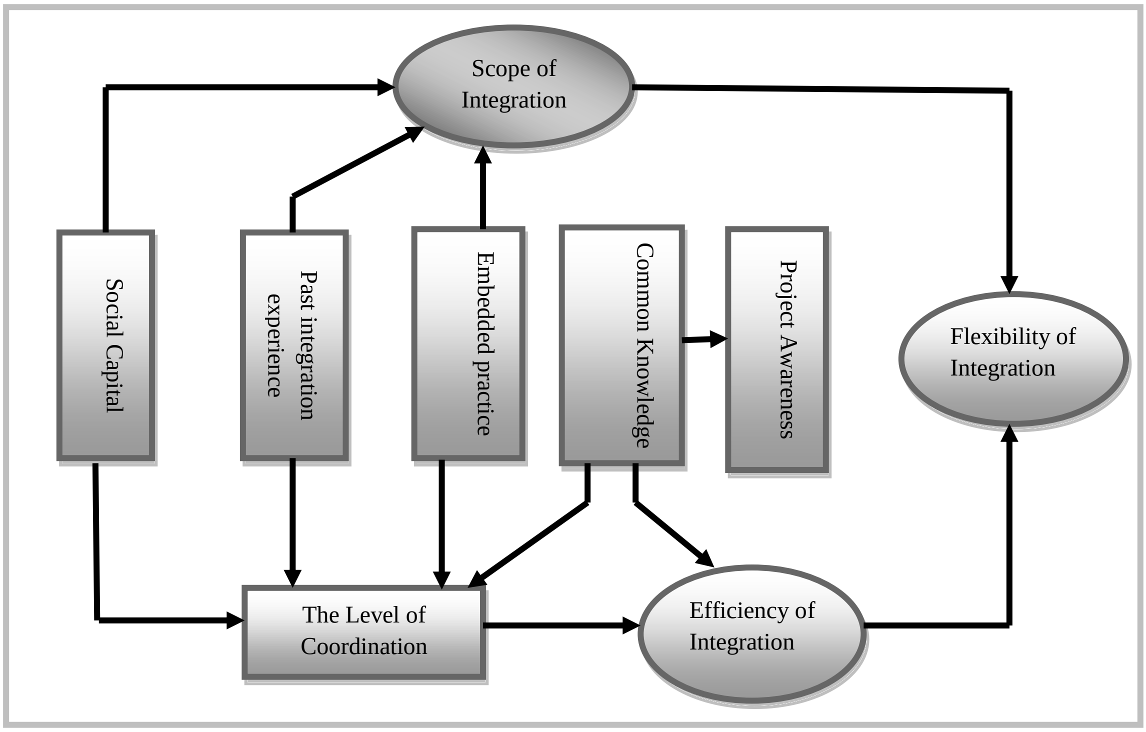

Fig 1: The model of knowledge integration – efficiency, scope and flexibility –in the context of cross-functional project teams (Source: Sue Newell & Jimmy Huang)

From knowledge integration research, social capital, past integration experience and embedded practices, appear collectively to influence the level of co-ordination achieved and the way in which the scope of integration is accommodated. The influence of these three forces suggests that to develop a higher level of co-ordination and fulfil the demand of larger scope integration requires more than just the development of teamwork within the project team itself. It is equally crucial for team members to engage with other stakeholder group through utilizing their social capital. The importance of social capital is reflected not only in the need for developing teamwork, but also in aligning different stakeholders to ensure commitment to the project (Huang, Newell, & Pan, 2001).

Theoretical Implementation Roadmap

The process of technological change is one of substitution rather than a diffusion phenomenon. The previous focus has been centred on the diffusion of the technology awareness. Hence the need for a paradigm shifts towards the promotion of the rate of adoption. Strong political will and support is therefore the starting point as depicted in Fig.2 to provide the legislative enactments that support the substitution of the LID technologies for the conventional methods of stormwater management. Moreover, LID technologies integrates knowledge from a number of disciplines including engineering, hydrology and hydraulics, surface and groundwater flow, soil science, horticulture, and landscape architecture. The design of guidelines for this technology requires a team approach from the various disciplines highlighted above. An important consideration in developing set of guidelines less cumbersome is to look at what lessons can be gleaned from overseas experience to avoid some pitfalls. Published guidelines of successful implementation from countries like Australia, Canada, and the USA be acquired and modified to suit local conditions and existing enactment.

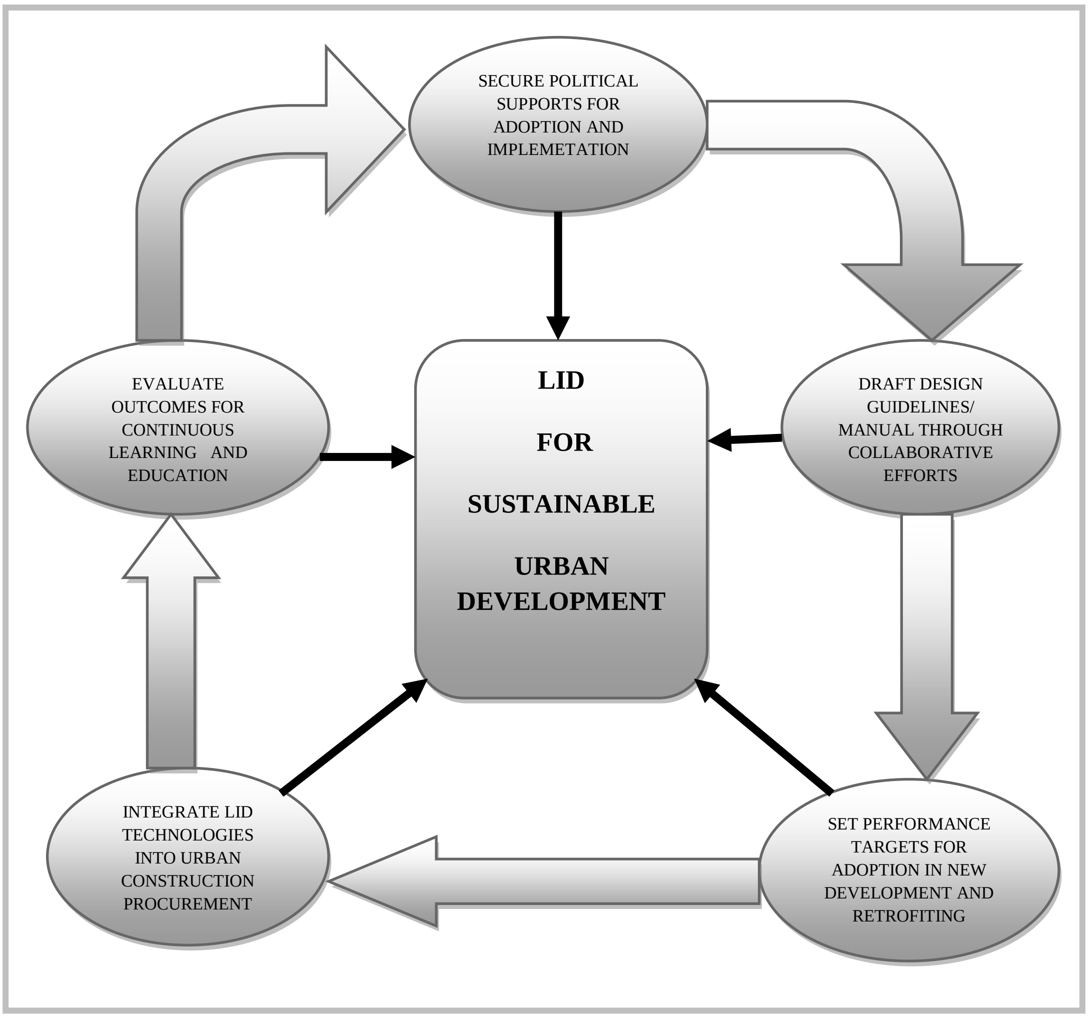

Fig.2: Roadmap for adopting and Implementing LID Technologies for Sustainable Urban Development

Conclusion

The promotion of LID adoption can be achieved via external and internal approaches. The external has to do with the institutional supports in form of legislation and design guidelines for LID implementation while the internal has to do with relationships between the contract parties. The legislative support is the starting point in providing the necessary frameworks for adoption and other incentives to prospective adopters. The incentives may either be technical, financial or other forms that are deemed appropriate. For example, the magnitude of the perceived risks associated with the technology can be minimised through government incentive in form of post construction insurance fully or jointly undertaken for a period of six (6) or twelve (12) years in line with the Limitation Act of 1950 or as may be agreed based on a joint evaluation of the probability and severity of risk within the development area.

On the other hand, early contractor involvement will ensure collaborative exchange of ideologies between the design and construction team. This alliance will provide the framework for buildability as knowledge of design and construction are integrated which ultimately reduces construction failure to the barest minimum. Moreover, risk complicity is one of the many issues ignored in conventional risk assessment, an understanding of complicity looks especially necessary when risk generates anger rather than fear. Once the relevant emotion is anger, the imposition of risk-or failure to reduce it-is seen not merely as being harmful but also wrongful. The risk becomes a reason for anxiety and for blame or censure. To avoid this, joint risk negotiation between the contractor and the client prior contract drafting is advocated. The joint evaluation and allocation of risks through the contract conditions framework will form the bedrock for a trust necessary for successful project execution. Hence, any form of adversarial relationships which has characterised construction projects is reduced to the barest minimum and the team works towards same project goals and objectives.

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