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Abstract

Rainwater harvesting intervention and its relationship with building codes is becoming a growing concern in modern construction. The aim of this paper is to present a road map for developing rainwater harvesting interventions, outlining the key steps required to achieve the desired outcomes. Qualitative methods were employed to assess the rainwater harvesting implementation. The findings show that the provisions for rainwater harvesting in the Malaysian Uniform Building By-Laws were inadequate to guide the local councils in building approval, inspection and enforcement. Another noteworthy finding is the lack of a specific intervention to ensure the success of rainwater harvesting law adherence, as well as the fact that the existing guidelines referred to were inadequate, indirect and irrelevant. In this paper, a simple direction for rainwater harvesting intervention is presented. This road map can be used to inform governments and researchers about the essential stages of intervention development in the interest of the by-laws adherence and the route to achieving Sustainable Development Goal 6: Clean Water and Sanitation. Implementing an effective intervention to improve government by-laws or building codes is essential for the successful management of water resources.

Keywords: Interventions, Uniform Building By-Laws, Rainwater Harvesting, Road map, Malaysia

Introduction

Many jurisdictions have started including rainwater harvesting systems into their legislations to encourage the effective use of water resources in response to the rising concern over water shortages and environmental sustainability. Under these legislations, rainwater harvesting systems are often required to be installed in new building projects or even renovation works to collect, store and distribute rainwater onsite for non-potable applications (see: International Codes Council, 2022).

In Malaysia, provisions to rainwater harvesting were included into the Uniform Building By-Laws 1984, a subsidiary of the Street, Drainage and Building Act 1974 (Act, 133). The by-laws contain provisions requiring the installation of rainwater harvesting systems in new residential projects meeting specified requirements. The provisions are intended to encourage greater water supply, increased water usage efficiency and increased water supply security. The by-laws, however, suffer from yet to specify the necessary design specifications and installation criteria for rainwater harvesting systems. This deficiency enables the local councils to apply and interpret the by-law differently due to the different administrative procedures (Kamarulzaman et al., 2022), which lead to inconsistency of its implementation and jeopardising fidelity. This practice is in opposite to countries such as Australia and the United Stated which legislation system on rainwater harvesting is based on building codes or ordinances - developed in accordance with established scientific and engineering principles, as well as the experience of leading technical experts, construction professionals and enforcement employees (Vaughan et al., 2013). While building codes can be complicated and strict which limit the use of new technology and changes, the amendments provide essential interventions on the building design and permit required for the rainwater harvesting installation to ensure that the systems satisfy all criteria, as well as maintenance requirements are met (Fakunle et al., 2020). Thus, there is a need for the Ministry of Housing and Local Government to improve current regulatory policy in rainwater harvesting implementation to ensure that the provisions remain relevant and effective and can adjust and respond to emerging challenges as highlighted by (OECD, 2012).

This paper builds on current research findings to deliberates a road map by emphasising steps from three existing models towards developing interventions as a policy with appropriate contents and flexibility that allows the industry to make relevant changes. Developing a rainwater harvesting intervention to promote implementation fidelity is a significant step towards environmental sustainability and efficient use of water resources. Furthermore, by making intervention mandatory in residential developments, communities can contribute to ensure responsible water resources use and mitigate against the negative impacts of water shortages and extreme weather events.

Interventions for Rainwater Harvesting Implementation

The world is experiencing water scarcity issues and rainwater harvesting is being used to alleviate this problem. Consequently, numerous nations have legalised the use of rainwater collection. The purpose is to specify rainwater harvesting systems that require fulfil specific design, performance and maintenance criteria so that they are safe, functional and sustainable.

In 2011, Malaysia's government amended the 1984 Uniform Building By-Laws, demanding that newly built residential structures with a roof size of 100 square metres or more be equipped with a rainwater harvesting system. This marked a significant step forward in Malaysia's adoption of rainwater harvesting as an approach to sustainability development. For a by-laws to have the desired results after being gazetted by the state government, it must be implemented effectively under the local councils jurisdiction (Maidin & Ali, 2009).

The adherence to the by-laws by stakeholders in Malaysia is of paramount importance to ensure the safety, functionality and sustainability of the water resources. However, apart

from the general provision, the by-laws show insufficient information about the system or any supporting mandatory policies for the implementation. This lack of information undermines the entire system of sustainable local development. Moreover, the absent, insufficient and inconsistent interventions or policies by each local councils also create a barrier to a sustainable development (Sourani & Sohail, 2011). These weaknesses hinder any efforts to assess the performance or effectiveness (Fakhira & Nazri, 2022) of the rainwater harvesting system. Without this information, it is difficult to ensure that the system is actually having a positive impact to the nation.

Therefore, a variety of interventions can be utilised to help ensure unify adherence to the by-laws. This might entail strengthening laws, regulations and enforcement, as well as introducing incentives for rainwater harvesting implementation (Rahman et al., 2013). Without the interventions, organisations may become stagnant and unable to adapt to changing circumstances (Waal & Heijtel, 2016). This can lead to a lack of innovation and creativity as well as a reliance on outdated methods varied at each local council that may no longer be effective (Yusof et al., 2022).

Interventions can help improve the implementation of policies by focusing on the root causes of a problem, rather than addressing the symptoms (Madasamy, 2017). The root causes may not be addressed through implementation strategies alone (Fernandez et al., 2019). This means that interventions are more likely to bring about meaningful and lasting change. Additionally, interventions often involve the participation and collaboration of stakeholders, which increases the likelihood of successful implementation (Harris et al., 2016). By emphasizing the root cause and involving stakeholders, interventions create a platform for more meaningful and lasting change than implementation strategies alone.

The aim of this paper is to present a road map for developing rainwater harvesting interventions, outlining the key steps required to achieve the desired outcomes before the implementation stage. We suggest that the route begin with the intervention of the rainwater harvesting system in the design, installation and maintenance, as well as the approval and inspection processes for building plans. Other organisational development interventions such as providing training and incentives to promote positive behaviour in the local councils' organisation shall be strengthened to help the system's implementation. Local councils are better positioned to create adaptability, unleash innovative prospects and establish credibility on the route to attaining the United Nations' Sustainable Development Goal 6: Clean Water and Sanitation by strategically incorporating the road map into their daily operations.

Methods and Materials

This research used interviews, document analysis, observation and a focus group discussion with six municipal councils chosen as case studies. Following the research ethics procedure of Universiti Teknologi MARA, a consent form and an information sheet were emailed to the top management of all six local councils, seeking permission for the research to be carried out. After obtaining consent to participate, a desk research was conducted to identify potential participants among relevant employees. Prior to the data collection stage, the selected participants were given the information sheet and requested to sign the consent form. Semi-structured interviews were conducted with the participants to gain insight about their

abilities, viewpoints and responsibilities in adhering to the by-laws. Documents pertaining to the implementation of rainwater harvesting were also obtained concurrently from the participants.

The implementation delivery records, by-laws and a list of construction projects were among the documents received for analysis. Site visits were made to observe the installation of a rainwater collection system at the completed residential project for each district/city. The data collection stage ended with a more in-depth discussion between the governmental and academic professionals. Data were analysed every time after data collection at a local council as a single case to give insight and reasoning for other cases. NVivo was utilised to help organise and analyse of mixed and unstructured data gained from the above methods.

Findings and Suggestions

The first set of questions for this research attempted to identify the influence of rainwater harvesting interventions on adherence to Uniform Building By-Laws. The findings revealed that all participants referred to the by-laws and concluded that the rainwater harvesting provisions were flexible.

As the architect Officer from Local Council number 6 stated that the by-laws

> *"[… is one of the requirements for building approval. During the plan inspection, we have a checklist and one of them is rainwater harvesting or the need of the owner to supply rainwater harvesting system. And in there, we don't necessarily ask (the owner) to put out the calculation of how much rainwater (the owner) would be harvesting. So, usually, owners or PSP (Principal Submitting Person) would come in and ask: do we need to give you the calculation? We don't really have that. As long as (the owner) has rainwater harvesting system, it is already considered following the criteria for the planning approval…]"*

Together with the architect officer, majority of participants believed that the information in the by-laws was inadequate and that an obligatory standard was needed to ensure uniform adherence to the by-laws. Following that, participants have highlighted additional guidelines that can help to reinforce their comprehension. The most commonly identified guidelines by the local councils in implementing the rainwater harvesting for housing developments were: (1) GBI Assessment criteria for residential new construction Version 3.0 developed by Green Building Index in 2013; (2) Urban Stormwater Management Manual for Malaysia, MSMA 2nd Edition by Department of Irrigation and Drainage Malaysia in 2012; and (3) Guidelines for Installing a Rainwater Collection and Utilization System developed by Ministry of Housing and Local Government in 1999. It was discovered that these guidelines, which were written more than a decade ago, were used for evaluation criteria for green building ratings only or purposes unrelated to building plan approval. Some of the local councils affirmed that the information provided by the existing guidelines is also inadequate, indirect and irrelevant.

Moreover, while the findings revealed direct communication for knowledge between local councils and manufacturers, key rainwater harvesting technical information, which has the potential to be trialled and extended as an intervention, was not recorded. Among the unrecorded information was rainwater harvesting initiatives designed and installed at a few local councils' buildings. Basic technical information from the manufacturer, as well as the

local councils practices, would be beneficial in developing a comprehensive intervention. If recorded, the information can also provide a model for other local councils to replicate. Sharing the information and experiences across various councils could help improve the standardisation of implementation and impact of rainwater harvesting. Additionally, sharing data would also enable the assessment of the effectiveness of the initiatives.

In relation to this, all six local councils have demonstrated diverse approaches to adhere the by-laws in the lack of suitable rainwater harvesting intervention. This has caused uncertainty across departments in local councils owing to various knowledge, experience and beliefs. Their uncertainty hampered the councils' support for raising awareness among developers and the public about the design and potential benefits of rainwater harvesting. The above findings reflect those of Kamarulzaman et al (2022) who stated that local councils apply and interpret the by-law differently due to varied administrative procedures, resulting in inconsistencies in its implementation. As Kloss (2008) highlighted, the absence of consistent national regulations has resulted in disparities in requirements among state and local councils, providing a barrier to rainwater usage.

Developing an Intervention Road Map

Interventions seek to bridge the knowledge gap between evidence and practises (Shanbhag et al., 2018) to address a specific problem or issue. Moir (2018) states that for an intervention to be successful, it must be designed in a way that ensures its long-term viability. The process of developing and evaluating an intervention with several components such as the context, behaviours, organisation levels and degree of flexibility is complex (Craig et al., 2008). Figure 1 illustrates a road map to develop an effective intervention for rainwater harvesting implementation, adopted from three models/ framework; the four-stage process for producing a comprehensive draft of the intervention by Walshe et al (2019); modelling the intervention theory by Ridde et al (2020) and the policy process and outcome in evidence-based polices by (Dodson et al., 2012). The intervention road map includes activities for intervention development in two phases i.e., the exploration and adoption. It additionally indicates that a road map is necessary for the next phase of implementation in order to assist stakeholders in implementing rainwater harvesting interventions.

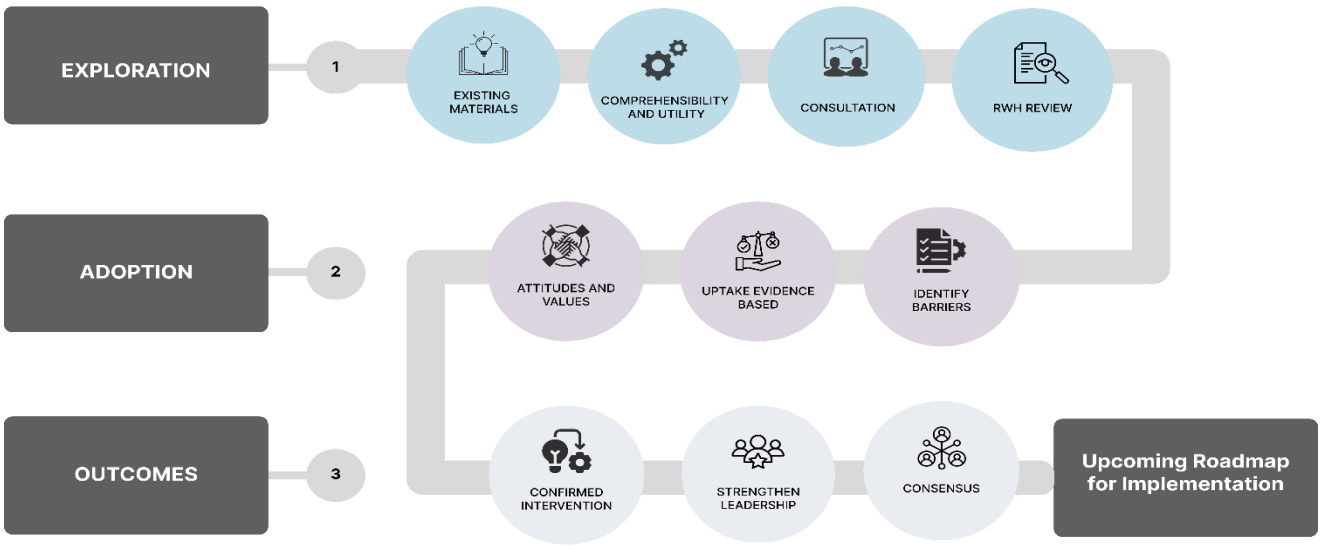

Figure 1: The implementation road map for developing an intervention for rainwater harvesting implementation.

At the beginning of the process, the exploration phase aims information from a number of organisations or groups that have expressed an interest in developing an intervention (Brownson et al., 2012). The existing rainwater harvesting guidelines and initiatives of the local councils were among the important materials that provide a better understanding of the most effective components of the system and process. Other materials may entail available solutions and the target group's, needs for water reuse. The examination of the analysed specifications, solutions and processes by consultants (such as manufacturers and developers) will aid in the discovery of best practises for rainwater harvesting implementation. A review aims to assess the benefits and feasibility of adopting a new set of evidence-based interventions as a guideline. This ensures that the stakeholders have a clear understanding and consensus on how to correctly implement the system.

In the adoption phase, the new ideas or reviewed evidence-based practices is subjected to acceptance, embracement, and incorporation into an existing system, practise or culture to improve efficiency, effectiveness or outcomes as suggested by (Dearing, 2009; Serdyukov, 2017). A successful adoption requires a serious intention, a formal decision to implement, and strategies that focus on strengthening fidelity in the field (Proctor & Brownson, 2012). Employees values are important in the adoption process because they reinforce beliefs and influence attitudes and actions (OECD, 2021) while implementing the new ideas in different contexts. Beliefs and attitudes are two key components of employees competency that allow comprehension of expectations and how tasks should be accomplished. The new ideas shall be inducted into the existing capacity of the local councils, allowing stakeholders to test and refine the interventions based on the data on its effectiveness.

The outcomes establish the new ideas as robust and comprehensive description of interventions enabling their operating principles to be made explicit (Ridde et al., 2020). At this point, leaders ability to encourage employees involvement in rainwater harvesting practices with the available capacity can help to reduce implementation effectiveness while increasing fidelity. The road map is completed with the stakeholder's consensus on project decisions and adherence to the by-laws. A well-implemented rainwater harvesting system can provide long-term benefits for the stakeholders.

Conclusions

The most potent tool for enhancing the implementation of rainwater harvesting is legislation, which is utilised by many policymakers in the world. However, there is a need to review the by-laws in streamlining and enhancing service delivery across local councils in Malaysia. Intervention development is central to improving the implementation of rainwater harvesting by-laws as it enhances local councils' understanding of the forces that hinder implementation and promotes those that appear to benefit the people.

It is essential for the local councils to identify their capacity, resources and strategies in order to create an effective intervention. This enables local councils to offer an intervention that includes key stakeholders' viewpoints and provides required support for housing development. It is envisaged that the overall efforts in rainwater harvesting intervention research would ensure that the rainwater harvesting systems specifications are tailored for

the local environment and are adaptable to changes. Whilst this paper did not detail out the sub-activities of each phase in the road map, it did substantiate the key activities for interventions development as the strategic planning process. A natural progression of this work is to provide a suitable conceptual framework, analyse relevant sub-activities and provide a planning schedule including a critical path chart so that relevant time and resources can be allocated.

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