



A practice mining system for the delivery of sustainable retirement villages

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ABSTRACT

With the wide recognition of sustainable development, a range of sustainable practices has been incorporated into the development and operation of retirement villages to provide a sustainable living environment for residents in Australia. The retirement village sector is seeking effective methods of reusing these historical practices to facilitate the future development and operation of sustainable retirement villages. However, this is challenging and there has been no research to date into this issue. Therefore, this study aims to develop a practice mining system (PMS) to address the research gap. By using multiple case studies for data collection and case-based reasoning (CBR) for data mining, the study develops the CBR-PMS, which comprises a Data Transforming and Location System, a Data Warehouse, and a Data Mining and Reusing Engine. The CBR-PMS is a data management and mining system that can be adopted to retain, capture, reuse, and revise prior sustainable practices to facilitate the future development and operation of sustainable retirement villages. Case studies and expert judgements are used in its demonstrations and validation, and satisfactory performance is achieved. It is concluded that the CBR-PMS is an effective tool for retaining and transferring prior practices and acts as an innovative tool of knowledge management and organizational learning in the retirement living sector. Although the CBR-PMS is at its conceptual stage and requires some automation to make it user-friendly, it provides practical insights into the development of a sustainable living environment and benefits the development of data mining systems for other sustainability initiatives.

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1. Introduction

Sustainable development, which means meeting the needs of the present without compromising the ability of future generations to meet their own needs, has been widely accepted in both theory and practice (Hopwood, 2005). In recent decades, sustainable development has been increasingly incorporated into the development of communities to provide the public with a livable environment (Xia et al., 2015). It is believed that developing sustainable communities helps achieve a balance between environmental concerns and economic development, while simultaneously enhancing local social relationships (Bridger and Luloff, 1999).

Consequently, various government-based sustainable community initiatives have emerged in different countries, such as *Sustainable communities: Building for the future* in the United Kingdom and *Working together for better sustainable communities* in Queensland, Australia (Department of Housing and Public Works, 2016; Office of the Deputy Prime Minister, 2003).

Retirement villages are a viable living option for older Australians, accommodating 5.7% of seniors aged 65 years and over in 2014 (Hu et al., 2017a). This penetration rate is projected to increase to 7.5% in 2025 due to population ageing and the benefits of living in retirement villages (Retirement Living Council, 2014). Similar to general communities, the development of retirement villages is suggested to embrace social, economic, and environmental sustainability features to deliver a sustainable living environment (Xia et al., 2015). Sustainable retirement villages can respond well to residents' social, economic, and environmental sustainability needs (Xia et al., 2015), and living there can benefit residents in many

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ways, such as improved social interaction, safety, affordability, respect, and protected privacy (Hu et al., 2017a).

Currently, an increasing number of village developers, both private and not-for-profit, have demonstrated their commitment to providing a sustainable living environment for their residents (Hu et al., 2017b). Consequently, various sustainable practices have been incorporated into the development and operation of retirement villages, such as innovative design, age-friendly site planning, and waste management (Zuo et al., 2014). Reusing these practices provides developers with useful insights into the future development and operation of sustainable retirement villages (Zuo et al., 2014). They especially help developers avoid repeating prior mistakes and to learn from past best practices by revisiting historical situations and reexamining the lessons learnt in those situations.

However, reusing historical sustainable practices is not easy in the Australian retirement living sector. First, it is hard to assemble prior practices, as sustainable practices are retained in different sites and there is a lack of databases for gathering and storing relevant information. Second, the reuse of sustainable practices is unstructured and intuition-based, for which it is difficult to define accurate rules to facilitate the reuse process. Moreover, developers do not usually have enough knowledge of data mining, and their reuse of past practices is mainly limited to their own projects, which hinders the effective reuse of previous experiences with a wider range of villages. Therefore, the Australian retirement village industry is calling for effective approaches to reusing historical sustainable practices to benefit the development and operation of sustainable retirement villages. Notwithstanding, there has been no research to date into this important issue. In response, this study aims to propose a strategy of effectively retrieving and reusing historical sustainable practices of village developments and operations. To achieve this aim, the study develops a practice mining system (PMS) based on case-based reasoning (CBR). CBR is adopted due to its strong data mining capabilities. It is expected that the CBR-PMS will not only benefit developers' knowledge management and organizational learning but also promote the reuse of best practices of other sustainability initiatives. In addition, the CBR-PMS expands the knowledge areas of environmental gerontology by incorporating knowledge management and organizational learning philosophies based on artificial intelligence technologies, which represents an advancement in the literature of developing an age-friendly living environment.

2. Literature review

2.1. Age-friendly retirement villages in the world

The provision of housing and care-services with age-friendly features for older people has become a consensus of policy makers and service providers around the world, which has consequently promoted the development of age-friendly communities (e.g., lifetime neighborhoods, livable communities) (Lui et al., 2009). Retirement villages are a long-term accommodation and care option for older adults in many industrialized countries, such as the United Kingdom, the United States, Australia, and New Zealand (Hu et al., 2017a). Encouraging the development of age-friendly environments to facilitate older adults' active ageing promotes the incorporation of age-friendly features in the retirement village setting (Bernard et al., 2007). An age-friendly retirement village promotes the residents' active ageing based on optimized physical and social environments and supporting infrastructure (Liddle et al., 2014). The development and operation of an age-friendly retirement village should focus on its "strategic and ongoing improvement process", "physical environment", "social environment", "supportive infrastructure", and "respect and social

inclusion" (Liddle et al., 2014). Living in age-friendly retirement villages benefits residents in such ways as improved health, safety, reduced social isolation, and affordability (Bernard et al., 2007; Liddle et al., 2014).

It should be noted that age-friendly retirement villages focus more on the economic and social sustainability of their environments. First, age-friendly retirement villages place a high priority on residents' affordability to ensure that their living environments are economically sustainable, which is crucial given the residents' reduced financial capacity after retirement (Finn et al., 2011). In addition, age-friendly retirement villages provide residents with a socially-sustainable living environment (e.g., support, participation, safety, and engagement) such as in selecting a suitable location and delivering appropriate services and facilities (Sugihara and Evans, 2000; Liddle et al., 2014). However, environmental sustainability has been largely ignored in the development and operation of age-friendly retirement villages (Hu et al., 2017b). This is not consistent with older people being generally concerned with consumption of resources and their need for their communities to be more environmentally sustainable (Pillemer et al., 2011; Xia et al., 2014). In Australia, the development and operation of sustainable retirement villages alleviates this issue through incorporating green features into the delivery of an age-friendly living environment (Hu et al., 2015).

2.2. Sustainable retirement villages in Australia

Delivering a sustainable living environment in retirement villages is a new phenomenon in Australia, which is contributed to by an increasing level of public awareness of sustainable development, and a growing demand for delivering an age-friendly living environment to older adults (Barker et al., 2013). The residents' social, economic, and environment needs can be well satisfied in sustainable retirement villages. In particular, a sustainable retirement village enables its residents to be socially connected within their community to prevent their social isolation, loneliness, and depression (Buys, 2001). Additionally, a sustainable retirement village is affordable to residents, given their reduced financial capacity in older age (Finn et al., 2011). Moreover, a sustainable retirement village has green features (e.g., energy efficiency and a qualified indoor environment) to improve the health of its residents and the environment (Zuo et al., 2014).

The benefits resulting from residing in sustainable retirement villages have increased stakeholders' interests in their development. For instance, residents are concerned with the consumption of unsustainable resources, and would like their villages to be greener even though they may have to pay more (Barker et al., 2013; Xia et al., 2014). In addition, the Green Building Council of Australia has developed a Green Star rating tool for retirement living, which positively supports the development of sustainable retirement villages (Green Building Council of Australia, 2015). More importantly, many developers have incorporated sustainable strategies into the development of their villages (e.g., care and services provision and accessibility, energy efficiency, and affordable living) (Hu et al., 2017b). Consequently, a number of sustainable practices have been adopted. For instance, Xia et al.'s (2015) case study in an Australian private retirement village found that its sustainable practices were reflected in landscaping and design, the provision of facilities and services, internal communication, social activity organization, cost, and affordability. In not-for-profit retirement villages, Zuo et al. (2014) and Hu et al. (2018) found that sustainable practices were adopted in project location selection, design, construction, site planning, services and facilities provision, social activity organization, and cost arrangements. It is undoubtedly that prior sustainable practices provide valuable insights into

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