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The Impacts of Sustainable Upgrades of Shopping Centres on Property Performance in Australia:a Preliminary Framework

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Abstract: Existing shopping centres are a large consumer of electricity energy and potable water, and they generate massive waste and carbon footprint. Stakeholders are restricted to invest in the uptake of sustainable upgrades of shopping centres due to the lack of transparency with impacts of sustainable upgrades on property performance. The problem is examined by the investigation into whether sustainable upgrades of shopping centres can result in significant improvements in property performance from environmental, economic and social perspectives in Australia. Multiple-case study method was used, including literature review, document research in relation to five cases, and interviews with two sustainability managers of regional and sub-regional shopping centres. The combination of triangulation and multiple-case studies led to a robust understanding of relationship between sustainable upgrades and property performance. The results shows that sustainable upgrades lead to significant reduction in energy and water consumption, decrease in carbon emissions, and higher waste segregation rate. Besides, sustainable upgrades result in reduced operating costs, and promoted marketability and market value. Further, sustainable upgrades contribute to promotion of health, safety and wellbeing of tenants and customers, promotion of corporate social responsibility and brand image, promotion of shopping centres' attractiveness, and benefits for the community. The findings can assist sustainability managers and engineers to consider the typical measures for an existing shopping centre. Besides, shopping centre stakeholders can use the conceptual framework developed in the study for measuring the projected performance of a sustainable upgrade project and provide reference for investment decision or a project optimisation.

1. Introduction

1.1 Background

Human being has developed numerous resources to enhance the built environment for health and well-being, sometimes coming at a great ecological cost. The Australian built environment accounts for a quarter of Australia's greenhouse gas emissions and more than half of electricity consumption (Parliament of Australia, 2018). Besides, Australia is the driest inhabited continent. Protection of water resources in the Australian built environment would mitigate the shortage of potable water.

Australia has attached significant importance to sustainability in the built environment. Australian government signed the Paris Agreement in 2015 to contribute to sustainable development, committing to a global goal of zero net emissions by 2050. Particularly, Australia will reduce emissions to 26-28 per cent on 2005 levels by 2030 (Department of Industry, Science, Energy and Resources, 2015). Besides, there are many rating tools used to assess buildings' environmental performance such as BASIX, FirstRate, Green Star, the National Australian Built Environment Rating System and so on.

1.2 Research Gap and Questions

The study uses a Venn diagram to illustrate how sustainability, building upgrades and property performance relate to each (see Figure 1 below). The middle overlapping area present the relationship that the study is going to explore and uncover.It is a complicated issue for stakeholders to decide whether to invest in shopping centres' sustainability because the impacts of sustainable upgrades are still ambiguous. Results from Australian studies broadly indicate barriers of sustainable upgrades of exising commercial buildings. Dadzie *et al.* (2018) highlight the effectiveness of sustainable upgrades and the ambiguousness of payback periods which are the two main barriers. Additionally, Bruce *et al.* (2015) and Marquez *et al.* (2015) point out stakeholders' lack of awareness of sustainable upgrades of commercial buildings, and uncertainties about costs involved on simple and effective upgrades. Further, Warren-Myers and Reed (2010) argue that the lack of transparency with economic and financial information on the sustainable outcomes of a green building restricts substantial capital investment in sustainability of the Australian commercial buildings because stakeholders lack support from economic and financial perspectives to measure the benefits of sustainable upgrades of commercial buildings and understand the influences on return value. Rock *et al.* (2019) supplement the barriers with the opinion that current regulatory regimes are out of step with developments in sustainability.

Fig.1 Venn Diagram Model of the Research Gap

Apart from the aforementioned barriers, there are other factors negatively affecting the implementation of sustainable upgrades of shopping centres. From a quantitative perspective, the number of shopping centres rated by sustainability rating tools are seriously not in line with the number of the Australian shopping centres, as mentioned in the last section. Besides, the number of studies on sustainable shopping centres is insufficient to fill the gap in Australia, which will be further explained in the next chapter.

In conclusion, investigation into the impacts of sustainable upgrades of shopping centres in Australia has academic, environmental and socioeconomic value.

1.3 Aim and Objectives of Research

The study aims to explore whether sustainable upgrades of shopping centres can result in significant improvement in property performance from environmental, economic and social perspectives. Research objectives are as follows:

2. Literature Review

It is confusing to define sustainable development because of over 500 diverse definitions existing (Warren-Myers and Reed, 2010; Phillips, 2003). The most acceptable definition of 'sustainability' appeared in the Report of the World Commission on Environment and Development: Our Common Future: "*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (Brundtland Commission, 1987).

Some studies define sustainable upgrade from different perspectives. Sustainable upgrade refers to measures of improving environmental sustainability of existing buildings in the built environment (Dadzie et al., 2020). It is the process of converting a normal building to a sustainable building (having the ability of protecting the ecosystem, natural resources, human health and wellbeing, and social values and public stuffs; and of protecting and preserving funds and substances (Lutzkendorf and Lorenz, 2005)) or a green building (characterised by sustainable site

development, design and construction, operational performance, and removal and reuse of building materials, therefore reducing its influences on the environment and human being (Yudelson, 2010)). In addition, Shah (2012) defines sustainable upgrade as demolishing existing buildings at a minimal scale and, meanwhile, maximally enhancing the sustainability of buildings by employing sustainable approaches. Menassa (2011) also describes the definition of sustainable upgrade. That is a capital enhancement with the expense of costs that increase building durability, improve operational performance, and make buildings' statuses more transparent during a period of time after upgrading.

3. Hypotheses and Methodology

3.1 Conceptual Framework and Hypotheses

The study designed and developed a conceptual framework (see Figure 2 below). It is based on the following hypotheses:

The main Hypothesis (H) of the research is that typical sustainable upgrade measures can significantly improve the performance of an existing shopping centre from environmental, economic and social perspectives. There are four sub-hypotheses:

H1: Typical sustainable upgrade measures include energy efficiency, water efficiency, indoor environmental quality and waste management (see Table 2).

H2: Sustainable upgrades can improve the environmental performance of shopping centres, including significant reduction in energy consumption, water consumption and emissions, and better waste management.

H3: Sustainable upgrades can improve the economic performance of a shopping centre, involving decreased operational expenses, reasonable periods of cost offset, increased rental income, increased occupancy rate, enhanced marketability, and increased market value.

H4: Sustainable upgrades can improve the social performance of a shopping centre, relating to guarantee of health, safety and wellbeing of tenants and customers, improved corporate social responsibility and corporate image, benefits for the local community, and improved attractiveness.

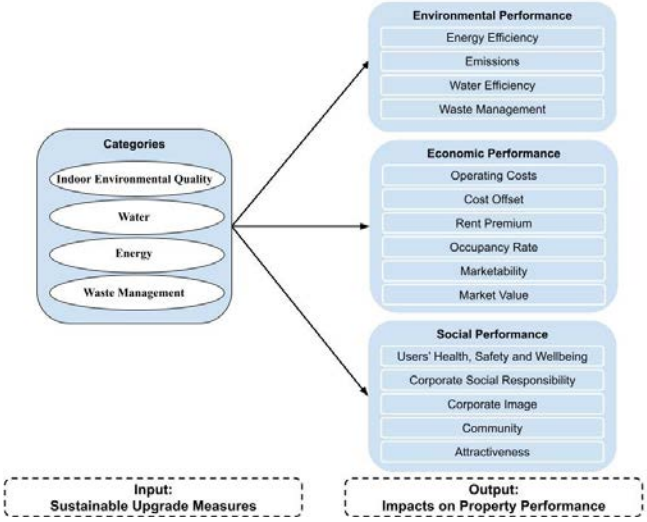

Fig.2 Conceptual Framework

3.2 Type and Nature of Research

This study involves an exploration of typical sustainable upgrade measures of shopping centre and impacts of sustainable upgrades on property performance from environmental, economic and social aspects. According to Stebbins (2001), social science exploration is a systematic, purposeful and broad-ranging investigation into the disclosure of generalisations resulting in presentation and understanding of an aspect of the descriptive facts, social processes and so on. The outcomes of the exploration study can uncover the generalisations of typical sustainable upgrade measures and their impacts from the three aspects.

The research employs a qualitative method to validate the hypotheses. Minchiello *et al.* (1990) explains that qualitative research relates to understanding human behaviour from the participant's perspective, and data collection are through participant observation and interviews. This method can uncover in-depth perceptions of informants and identify the trends in thought and opinions, and therefore validate the hypotheses. However, lacking relevant studies and the verification of statistics data, it is difficult to quantify the outcomes of sustainable upgrades of shopping centres, especially in the economic and social aspect. Besides, from a time being's perspective, the study was only taken ten weeks so there was not enough time for conducting a quantitative research.

3.3 Research Design

The research design is about the logic to test the research hypotheses. Given that this study demanded in-depth perceptions from industry professionals to test the hypotheses, multiple-case study approach was the most reasonable choice for the study. This method is able to explore and uncover special cases within the scope of the research to provide practical evidence to the research data (Proverbs & Gameson, 2008). Besides, multiple-case study can deliver results with a high degree of certainty (Yin, 2009), and thereby result in stronger conclusions than single case study (Yin, 2018). Within the multiple case study approach, the strategy of the study was to adopt three approaches including literature document, document research and interviews to discover common themes aligning with hypotheses or contradictions with hypotheses. The incorporation of multiple approaches in qualitative research to generalize a synthetic understanding of phenomena is known as triangulation method which can result in robust conclusions (Patton, 1999) (see Figure 3 below).

The study aimed to establish the foundation for the study through literature review. The basis of the study is about sustainable upgrade measures of shopping centres and property performance impacted by conduction of this practice. The study identified comprehensive sustainable upgrade measures and changes of property performance caused by sustainably upgrading shopping centres from a global perspective. Accordingly, the study developed a conceptual framework to reflect changes of property performance in relation to conduction of sustainable upgrades.

Fig.3 Triangulation Method

3.4 Targeted Respondents

The study strictly selected participants who were knowledgeable and experienced enough to complete the interviews. Proverbs and Gameson (2008) recommend that target interviewees should be concerned persons who are straight related to the cases and are able to give relevant and profound insights into the cases. The targeted respondents were sustainability practitioners working in real estate investment trusts who had managed the implementation of sustainable upgrades of shopping centres. Besides, there was a requirement for participants' work experience. Participants have worked as retail property sustainability managers for at least two years or employees have worked in the department of sustainability for at least three years. Therefore, participants were experienced enough to provide in-depth perceptions for the study.

3.5 Data Analysis Techniques

Thematic Content Analysis (TCA) analytical technique (Anderson, 2007) was used to analyse the data collected from the document research and the multiple-case study to draw common trends of typical sustainable upgrade measures and the impacts on property performance.

After completing interviews, data was collected from multiple sources. The first step of data analysis was to prepossess data in order to make them easy to use, such as transcribing interview records and sorting out materials from document research. As suggested by Richard and Liu (2008), visual aids such as diagrams and tables were provided in data analysis because they are helpful to illustrate patterns and relationships. The second step was to analyse data. TCA analytical technique was exploited for primary and secondary data to draw common themes. Anderson (2007) asserts that researchers can acquire a list of common themes from interview transcriptions and documents by using TCA to give expression to the commonality of voices across participants. Finally, the TCA results from the document research and the multiple-case study were used to test the hypotheses and hence the conceptual model.

3.6 Summary and Reflection

The qualitative method of multiple case study allowed the study to select cases with unique characteristics in line with the research context and conduct detailed analysis to validate the hypotheses. Combined with this method, a triangulation method was employed including literature review, document research and multiple-case interview. It played an essential role in ensuring the study to draw comprehensive conclusions, taking advantage of convergence and corroboration using different data sources and methods. The ethical considerations were well considered. The identifies of all informants and the cases that they have chosen for the study are conditional.

There are some limitations in methodology. Firstly, although the researcher tried to be duly diligent to conduct document research, only several cases were founded so biases of case selection might exist in the study. Secondly, the number of participants in interviews only met the minimal criteria suggested by researchers due to the limited time being of contacting candidates.

4. Results and Discussion

4.1 Document Research

Vicinity Limited, also known as Vicinity Centres, is an Australian Real Estate Investment Trust company. It specialises in ownership and management of Australian shopping centres. The Vicinity shopping centre portfolio involves all types of shopping centres existing in Australia. The background of the portfolio is shown in Table 1.

Table 1 Background of The Vicinity Shopping Centre Portfolio in 2020.

Regional	Sub regional	Neighbourhood	Others
16	24	4	14

From Table 2 below, Vicinity has been increasingly improving sustainability performance of the portfolio. The Green Star - performance rating has been improved from 2 stars to 4 stars. NABERS Energy and Water ratings have been growingly improved as well. These sustainability ratings benefited from sustainable upgrade measures conducted in the past years.

portfolio rating (Stars) (Stars)

(Stars)

Table 2 Sustainability Ratings Of the Portfolio

Year	Jun-16	Jun-17	Jun-18	Jun-19	Jun-20
Gross Lettable Area (m²)	2,971,964	2,850,039	2,751,687	2,564,531	2,497,577
Green Star - Performance	2	3	3	4	4
NABERS Energy rating	3.4	3.7	3.6	3.5	3.9
NABERS Water rating	2.9	3.2	3.1	3.1	3.4

The sustainable upgrade measures involved in the portfolio are classified into energy, water and waste. The Table 3 below shows major upgrade measures.

Table 3 Major Sustainable Upgrade Measures of the Portfolio

Energy:
- Promote the energy efficiency of all operational equipment including lighting systems, vertical transport, building management systems, and air conditioning systems
- Application of renewable energy by solar panels, along with battery storage systems and electric vehicle charging

Water:
- Improve water efficiency, especially dealing with the most water intensive elements of shopping centres, centre amenities, air conditioning plants, cleaning and retailer usage by installation of high efficiency and waterless features
- Installation of smart water metres to monitor and manage water use, and identify any leaks

Waste and recycling:
- Provide infrastructure and guidance to retailers and consumers for waste segregation and recycling
- Separate and recover waste generated at the source to ensure that waste is reused and recycled as much as possible
- Set resource recovery targets to enhance recycling rates and minimise waste sent to landfill

Vicinity has achieved obvious outcomes in environment aspects (see Table 4 below). Energy intensity and carbon emissions have been significantly reduced. Besides, waste diversion rate has greatly increased. Thus, the portfolio's contribution to reduction in detrimental impacts on the environment is significant. Although measures have been taken to water efficiency, the change in water intensity is inconspicuous, which will be further studied in interviews.

Table 4 Environmental Performance Of the Portfolio

Year	2016	2017	2018	2019	2020
Energy intensity (MJ/sqm[3])	323	305	300	298	270
Water intensity(Kl/sqm[3])	1.04	1.03	1.02	1.06	0.95
Carbon intensity(kg TCO_2-e[4])	77	70.9	69.1	67.9	58.5
Waste diversion rate (%)	35	36	43	45	49

The economic and social impacts of the sustainable upgrades are also beneficial to shopping centres. The benefits from these two aspects are shown in Table 5 below.

Table 5 Impacts on Economic and Social Performance of the Portfolio

Economy: ● Reduce exposure to volatile energy pricing ● Save approximately $320,000 per year from lighting upgrades Society: ● Reduce the retail portfolio's reliance on the grid and avoid the requirement of extra electricity network capacity which demand costly infrastructure upgrades ● Increase resilience to extreme weather events

4.2 Case Interview

In-depth qualitative interviews were conducted with two sustainability managers who separately provide a portfolio of regional shopping centres and a sub-regional shopping centre for the study.

This case is based on a portfolio of regional shopping centres on the South Coast. Of them, the minimal gross lettable area is more than 50,000 square metres and each shopping centre has one or two department(s). These shopping centres underwent sustainable upgrades in the past decade.

(1)Environmental Impacts:

● Energy:

The conducted measures in relation to energy efficiency and prevention of energy waste have achieved significant outcomes. The most efficient approach was lighting upgrades by replacing high-intensity discharge lights by LED lights, improving energy efficiency by 50 to 80 percent. Besides, the energy saving from air conditioning, the biggest source of energy consumption, varied from 10 to 15 percent. Apart from lighting and air conditioning upgrades, upgrades on vertical transportation and building management control systems has significantly reduced energy consumption.

● Emissions:

Emissions from the portfolio have been substantially decreased, majorly because of reduction in energy use. The biggest source of emissions is the electricity. Thus, outstanding decrease in energy consumption resulted in remarkable reduction in carbon emissions. However, there is a slow improvement in reduction in emissions from waste and gas consumption. This is because the success of reduction in waste emissions depends on the corporation of all retailers, which has not achieved yet; and there are not much leeway to replace the use of natural gas due to few alternatives. Finally, the interviewee confirmed that refrigerants are not a main source of emissions if air conditioning equipment is maintained well in a shopping centre.

The renewable energy can help eliminate 80 percent of inherent emissions. The approach of

acquiring renewable energy includes installment of solar panels and buying green power.

● Water efficiency

Approximately 40 percent reduction in water use has achieved in the portfolio. The biggest part of water efficiency improvements was to stop leaks and waste. Shopping centres have stopped retailers, especially fish shops, from wasting water by waterless work programs where shopping centres meter their water use and charge them for water. Besides, shopping centres improved water efficiency of amenities including flow restricted taps, waterless urinals and high-efficiency toilets. Further, upgrading device efficiency such as cooling towers saved a large amount of water. Shopping centres changed landscaping by having more drought tolerant plants so they have been not wasteful with irrigation.

● Waste management

The study identified helpful measures of waste management. Implementing the outcomes-based reporting approach is the biggest upgrade about waste management. Such can help shopping centres to know what is going on and make smart decisions on waste management. In a range of recycling programs, the most effective waste management is the organic recycling.

(2)Economic Impacts:

● Operating costs

Cost savings on energy and water are obvious in capital expenditure. The cost saving of energy can be up to 50 percent reduction, saving millions of dollars in one asset. The cost saving of water is between 35 to 40 percent, which can be up to one fifth of the savings at a shopping centre level. However, there is no economic benefits from improvements in waste management because there is little difference between disposing of general waste and sending it to the recycling facility.

● Cost offset

The interviewee maintained that it is difficult to tell whether the operating cost savings can offset the costs of sustainable upgrades. This is due to a split incentive in some shopping centres, which means most returns go to the tenants, but the capital costs for upgrades is borne by the landlord.

● Rental income & occupancy rate

The interviewee considered that it is impossible to directly demonstrate that shopping centres can get more rents and improve occupancy rate by sustainable upgrades because both rental income and occupancy rate highly depend on sales per square.

● Marketability

Sustainable upgrades help with marketability. Sustainable features play a significant role in attracting national chains such as Coles and Woolworths who do care about the environmental outcomes.

● Market Value

Sustainable upgrades certainly improve market value of a shopping centre, whilst there is a split incentive. When shopping centres reduce operating costs, net income raises and then market value increases.

(3)Social Impacts:

● Heath, safety and wellbeing

Shopping centres which are free and accessible for temperature-controlled environment provide a refuge in times of heat waves and the public service to the broader community.

● Corporate social responsibility and corporate brand image

Sustainability is a significant part of the company brand and image. Improving shopping

centres' sustainability is an effective approach to achieving the target of being the most sustainable property company in Australia. Besides, investors respect a long term approach to management of environmental impacts to meet their responsibility as well.

● Community

Sustainable upgrades reduce peak energy demand of a shopping centre. Besides, sustainable upgrades eliminate the need to invest in additional costly infrastructure to deal with peak requirements.

● Attractiveness

Shopping centres' sustainable characteristics become more attractive to younger people because they have more respect for places where they have more responsible position. Besides, younger people choose retailers, based on their sustainable outcomes.

4.3 Summary

Combining the findings in both the document research and the interviews, the study finds that typical sustainable upgrades are able to significantly improve the environmental and social performance of a shopping centre and improve the economic performance to some extent. In other words, the findings mostly validate the main Hypothesis. In this regard, the Hypothesis 2 and the Hypothesis 4 are fully validated, whilst the Hypothesis 1 is mostly valid the Hypothesis 3 is partially valid.

The findings in the study mostly validated the Hypothesis 1. The typical upgrademeasures identified in document research and the interviews are majorly in line with those examined in the literature review. Minor adjustments should be made to 'Table 2: Typical sustainable upgrade measures for shopping centres. Firstly, in terms of energy upgrade measures, upgrading building envelope is not a common measure because it is difficult to achieve in typical sustainable upgrades of shopping centres. Upgrades for vertical transport is significant in reducing energy consumption. Secondly, in terms of water-related measures, rainwater collection tank is a useful facility to reduce dependence on potable water so it should be added to typical upgrade measures. Thirdly, sound level comfort in indoor environmental quality is not significant in sustainable upgrades because it does not occur in any cases in the study. Finally, the process of waste disposal in shopping centres mentioned in the literature review should be modified. Incineration should not be a common measure to waste disposal because it is not environmentally friendly. Instead, shopping centres should pay much attention to limitation of waste generation, and waste segregation for reuse and recycling, especially organic waste recycling. The revised typical sustainable upgrade measures for shopping centres are presented in Table 6.

Table 6 the Revised Sustainable Upgrade Measures for Shopping Centres

Energy ● Intelligent automation control ● Energy metering ● Light system ● HVAC system ● Vertical transport ● Renewable resources (solar panels, battery storage and EV charging)	Water ● Water metering ● Cooling tower water conservation ● Rainwater collection tank ● Water-efficient landscaping ● Indoor water conservation (prevention of leaks ● and waste, high efficiency and waterless features)
Indoor Environmental Quality ● Thermal comfort	Waste Disposal ● Reuse

● Light level comfort ● Pure air comfort	● Recycling ● Composting (Organic waste) ● Limitation of generation of waste

It is worth noting that the effect of these typical upgrade measures may vary according to some factors such as types and sizes of shopping centres.

The study has fully validated the Hypothesis 2. The study recognises that the typical sustainable upgrades can significantly improve the environmental performance of a shopping centre. Upgrades regarding lighting, HVAC and building management control are the most effective measures to improve energy efficiency. They have significant ability to reduce energy use by over 50 percent, which is in line with the findings of Canbay *et al.* (2004), Hodgson (2011), Lewry and Suttie (2015), Haase *et al.* (2015), Belleri *et al.* (2017) and Haase and Ampenberger (2017), Avantaggiato *et al.* (2017), and Curto and Milone (2018) in the literature review. Accordingly, carbon emissions can be significantly reduced due to substantive energy reduction. Water efficiency and water waste can be significantly improved by indoor water conservation (including prevention of leaks and waste, high efficiency and waterless features) by approximately 40 percent, which is line with Hodgson's findings (2011) in the literature review. Improvement in waste management promotes rates of waste segregation, waste recycling, and waste reuse, reducing waste in landfill. Therefore, the Hypothesis 2 has been fully validated.

The study ascertains that the typical sustainable upgrades can improve the economic performance of a shopping centre in operating costs, marketability and market value. The operating costs on energy and water can be saved up to 40 to 60 percent, which is in line with Curto's and Milone's findings (2018) in the literature review. Marketability can be improved because shopping centres after sustainable upgrades are more attractive to investors and certain types of tenants who have sustainable goals. Market value can be promoted due to decreased operating costs. However, rent income and occupancy rate are not affected by sustainable upgrades, which is in line with Veld's and Vlasveld's findings (2014) in the literature review.

Whether operating savings can offset costs of most sustainable upgrade measures is still inconclusive. Nonetheless, costs of lighting upgrades can be offset within months or years, which is line with Curto's and Milone's findings (2018). Therefore, the Hypothesis 3 has been partially validated.

The study confirms that sustainable upgrades can significantly improve the social performance of a shopping centre. The upgrades can improve health, safety and wellbeing of tenants and customers such as mental health, provision of a comfortable place for a rest, and protection from extreme weather situations. Conduction of sustainable upgrades for a shopping centre can significantly promote corporate social responsibility and corporate brand image, thereby attracting more younger people who cares about sustainability a lot to shop in a sustainable shopping centre and increasing customers' satisfaction. The upgrades are beneficial to the local community. Shopping centres that underwent sustainable upgrades reduce their electricity peak demand from the grid in the community, which is line with the findings of Barchi *et al.* (2019). Therefore, the Hypothesis 4 is fully validated.

Apart from testing the hypotheses, the study also find that the scale of sustainable upgrade projects determines the extent of shopping centres' sustainability such as the large difference of a project of installing sustainable plants and a project of major refurbishment for sustainability. Although it is an easy-understanding point, the scale of sustainable upgrade projects and their

impacts are highly dependent on investment from stakeholders. Also, stakeholders also consider that sustainable upgrades may impact their sale outcomes. If regulatory authorities and government agencies could provide support to this practice, it would greatly contribute to a higher uptake of this practice.

In conclusion, the conceptual framework is mostly confirmed because the Hypotheses 2 and 4 are fully confirmed, while the hypothesis 1 is mostly valid the Hypothesis 3 is partially valid. The revised conceptual framework is shown in Figure 4 below.

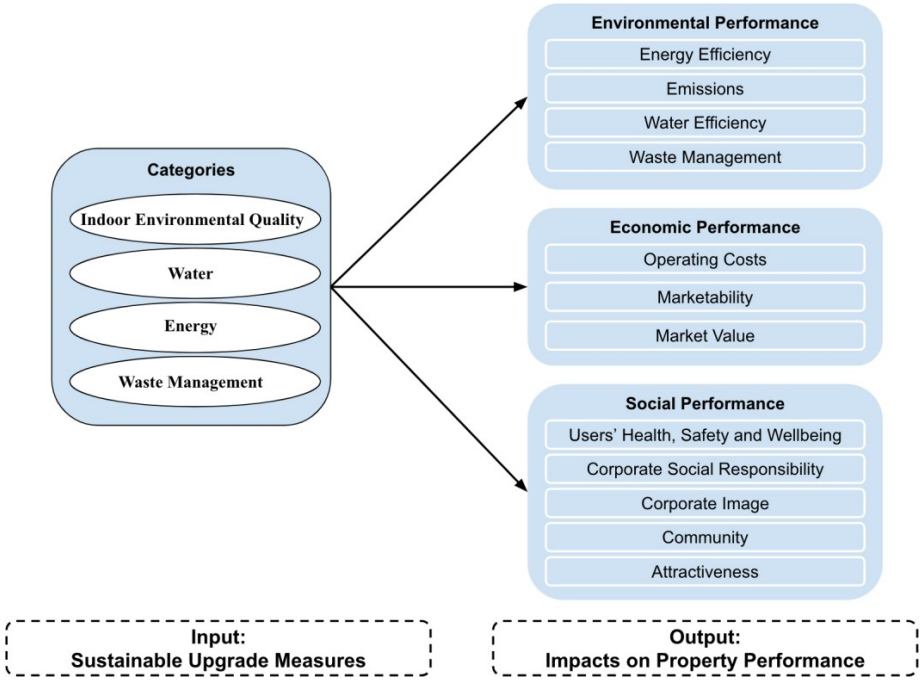

Fig.4 The Revised Conceptual Framework

The findings can assist sustainability experts, regulatory authorities, government agencies, and engineers to consider typical sustainable upgrade measures for the existing Australian shopping centres. Besides, shopping centre investors, landlords, managers and their sustainability consultants can use the conceptual framework for measuring the projected performance of a sustainable upgrade project and subsequently provide reference for investment decision or a project optimisation. Practically, the findings in the study can contribute to a probable higher uptake of this practice in Australia.

5. Conclusion

Existing shopping centres are a large consumer of electricity energy and natural resources in the Australian built environment, and they produce a large amount of carbon footprint in Australia. It is necessary to become them more environmentally friendly. However, stakeholders are restricted to invest in the uptake of sustainable upgrades of shopping centres due to the lack of transparency with impacts of sustainable upgrades on property performance from environmental, economic and social perspectives. To fill this gap, the study identified and proved typical sustainable upgrade

measures, sustainability performance metrics of shopping centres, and impacts of these measures on sustainability performance by literature review and a qualitative multiple-case study (including document research and interviews). The relationship between sustainable upgrade measures and property performance forms a conceptual framework for considering and understanding impacts of sustainable upgrades of existing shopping centres on environmental, economic and social performance.

The research aim has been achieved in the study. The study identified that sustainable upgrades of shopping centres can significantly improve property performance in environmental and social aspects and improve economic performance to some extent.

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I also would like to thank the two interviewees for taking their time to complete the interviews in this study.

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There are some limitations in the study because of time limit. The typical sustainable upgrade measures mentioned in the study may cannot represent all the most effective, cost-effective and advanced measures worthy of promotion. Besides, the assessment metrics of sustainability performance identified in the study may be not intact because sustainability performance of shopping centres is complicated and deserves further studies. Further, the framework of the relationship of sustainable upgrade measures and property performance should be regarded as "conceptual". Stakeholders may have different objectives and considerations for sustainable upgrades of shopping centres. Thus, the framework may further vary according to different sustainable upgrade projects. Another limitation is the lack of findings on evidence of neighbourhood shopping centres because the study only covered regional shopping centres (super regional, major regional and regional) and sub-regional shopping centres. Therefore, criticisms for the study may argue that the findings on neighbourhood shopping centres are probable to differ from the study. Last but not least, there is a limitation in terms of locations of shopping centres that have been examined in this study. The case studies in the study are based on shopping centres in New South Wales and Victoria. Hence, the study lacks cases from the other places in Australia.

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