永續性產品與產業管理研討會論文摘要集

[2025]

SYMPOSIUM OF SUSTAINABLE PRODUCT AND INDUSTRIAL MANAGEMENT

04.19

Sat. 09：00 - 17：00

Design Building 3 of College

國立雲林科技大學 設計三館

Design and Innovation of Sustainable Products

補助單位 I 國家科學技術委員會、教育部

主辦單位 I 國立雲林科技大學 跨域整合設計學士學位學程

目　　錄

序 3

籌備委員會 4

議程表 6

論文發表 8

主題演講 13

口頭論文發表 A 永續產品設計與創新 16

口頭論文發表 B 企業與產業永續管理發展 28

口頭論文發表 C 淨零碳排政策制定與評估 54

口頭論文發表 D 消費者行為與永續教育 62

口頭論文發表 E 英文論文發表 78

海報發表論文 P 84

序

隨著全球氣候變遷與環境挑戰加劇，實現 2050 年全球淨零碳排目標成為當前的迫切任務。為因應這一挑戰，綠色消費、永續設計、循環經濟、低碳智慧生活等趨勢逐漸成為主流，並強調在經濟、社會及環境範疇中推動永續發展。這些趨勢與 ESG（環境、社會及治理）標準和聯合國 SDGs（可持續發展目標）密切相關，共同推進全球永續目標。

「永續性產品與產業管理研討會」自 2003 年成立以來，已歷經二十餘年，每年在北、中、南三地輪番舉辦，致力於推動與實踐永續發展的理念與策略，分享在學術研究與實務操作中的新發現與成果。本年度的研討會將於國立雲林科技大學舉行，期待邀請產業界、政府部門、學術界及有興趣的專業人士共同參與，踴躍投稿，會議主題為「AI 時代之永續發展」，旨在聚焦於淨零目標下的永續產業管理實務、創新永續產品與服務之設計、永續績效與資訊揭露以及相關的低碳與智慧生活議題。研討會特別關注如何利用人工智慧（AI）技術來促進永續產品設計與管理，提升效率並減少資源浪費。透過跨域整合設計，推動淨零碳排的創新解決方案，並集思廣益凝聚各界的力量，實現世代間的永續共存與繁榮。

杜瑞澤

總召集人

國立雲林科技大學 設計學院院長 Tu, Jui-che

籌備委員會

總召集人

杜瑞澤 國立雲林科技大學 設計學院院長 跨域整合設計學士學位學程主任

召集人

詹敦學 國立雲林科技大學 跨域整合設計學士學位學程

籌備委員

尤宏章 國立雲林科技大學 創意生活設計系暨研究所
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喬納維 國立雲林科技大學 智慧數據科學研究所
羅艾希 國立雲林科技大學 工程科技研究所
康澤善 國立雲林科技大學 國際人工智慧管理研究所

永續產品設計展示協力單位

徐人凱 倍創科技
何正良 仲威文創
廖崇義 元力智庫
陳炳松 旭利興紙器公司
徐祥禎 國際 ESG 永續發展協會
陳林政 盛群半導體
黃建東 展聖印刷
鄭國信 風巢居
陳家明 薪威科技
蔡坤益 亞太色材創新協會 (籌備會)
楊書林 天涵設計有限公司

工作人員

黃姵綺 楊心芳 黃雅毓 許瀞分 Kharisma Creativani 黃亭瑄 廖玟琪 連展蔚
王昱蓁 尤靖瑜 林侃盈 蘇湘芸 王婷立 張育瑄 沈育慈 廖珮芯 陳佩琪 吳睿祥
李松展 吳品睿 陳妤安 王雅蕙 楊欣悅 蔡翔宇 吳庭維 韓永羿 簡凱庭

議程表

<table>
<tr><td>時間</td><td colspan="5">中華民國 114 年 4 月 19 日(星期六)</td></tr>
<tr><td>8:50-9:10</td><td colspan="5">報到(多功能會議廳)</td></tr>
<tr><td>9:10-9:30</td><td colspan="5">開幕式</td></tr>
<tr><td>9:30-10:10</td><td colspan="5">主題演講 1
Building a sustainable future together toward
education, collaboration, and innovation in the age of AI
實踐大學 國際學院 Nick Vasiljevic</td></tr>
<tr><td>10:10-10:20</td><td colspan="5">中場休息</td></tr>
<tr><td>10:20-11:10</td><td colspan="5">主題演講 2
Biomass energy toward circular economy
馬來西亞雙威大學 王槐銓 榮譽教授</td></tr>
<tr><td>11:10-12:00</td><td colspan="5">主題演講 3
sustainable design and the method using
narrowing thinking.
日本國立和歌山大學/京都女子大學 山岡俊樹 教授</td></tr>
<tr><td>12:00-13:10</td><td colspan="5">午餐</td></tr>
<tr><td rowspan="4">13:10-14:40</td><td colspan="5">論文發表-場次一(設計三館)</td></tr>
<tr><td>主持人：
林心恬</td><td>主持人：
陳俊益</td><td>主持人：
陳建志</td><td>主持人：
鍾武勳</td><td>主持人：
張瑋真</td></tr>
<tr><td>DA101</td><td>DA103</td><td>DA106</td><td>DA204</td><td>DA208</td></tr>
<tr><td>A03 A04 A06
A11 A12 B06
B12</td><td>B02 B03 B15
B16 B26 B27
B28</td><td>A01 A02 A05
A13 D04 D07
D16</td><td>C01 C02 C03
C04 C05 C06
C07</td><td>D01 D03 D08
D09 D13 D14</td></tr>
<tr><td>14:40-15:10</td><td colspan="5">中場休息：海報展示</td></tr>
</table>

15:10-16:40	論文發表-場次二(設計三館)				
	主持人： 饒忻	主持人： 林煥章	主持人： 林志丞	主持人： 邱銘傳	主持人： 葉笛卡、 喬納維、 羅艾希、 康澤善
	DA101	DA103	DA106	DA204	DA208
	B01 B20 B22 B23 B29 B30	B08 B09 B10 B11 B14 B19	D11 D02 D05 B05 D12 D15	A07 A10 B13 B18 B24 D06	E08 E09 E11 E12 E06
16:40	歸賦				

論文發表

場次一

時間 13:10–14:40

場次二

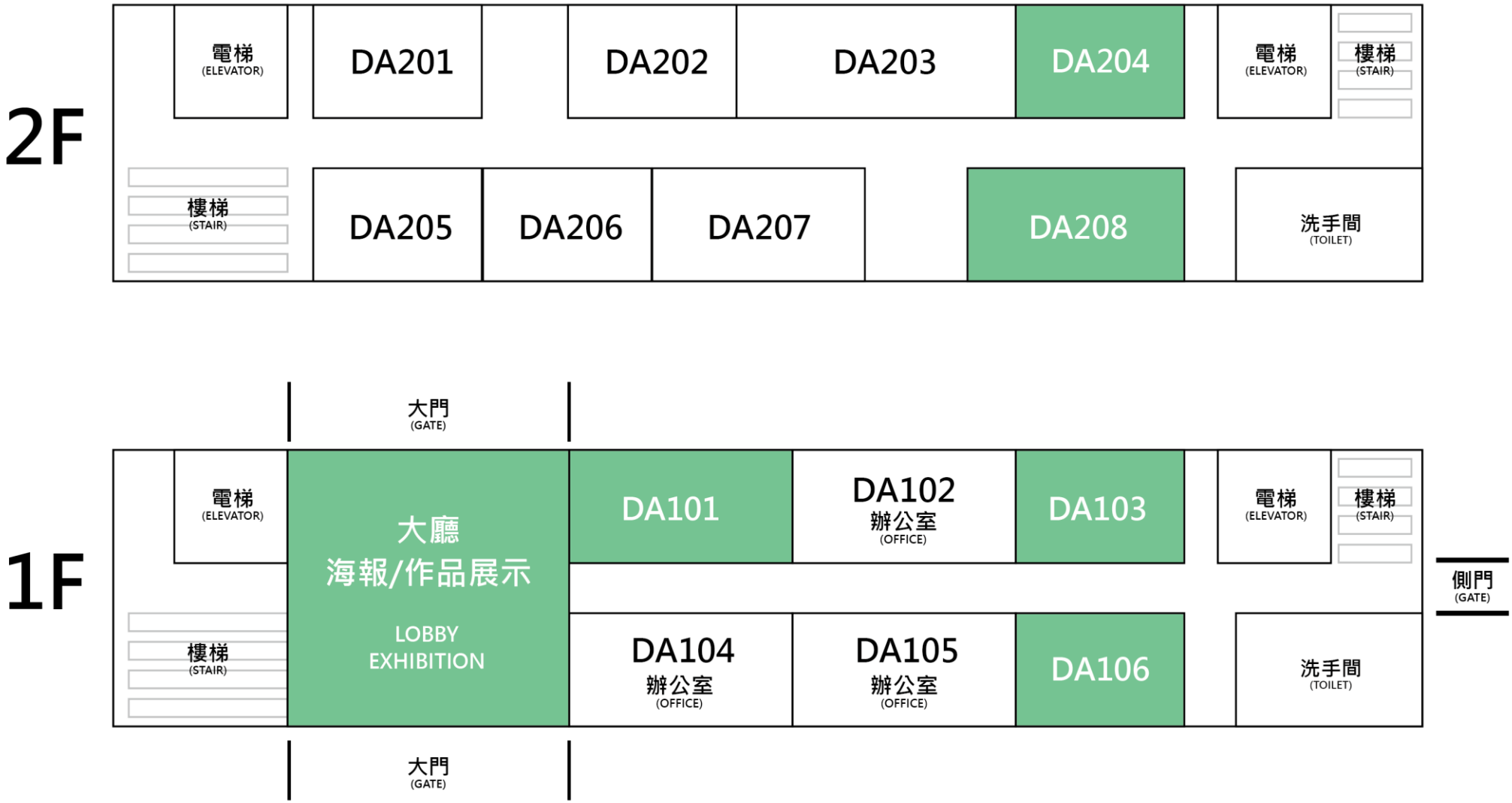
時間 15:10–16:40

海報論文發表

時間 08:50–16:40

校區配置圖(前往會場路線)

設計三館平面圖


2F
電梯
(ELEVATOR)
DA201
DA202
DA203
DA204
電梯
(ELEVATOR)
樓梯
(STAIR)
樓梯
(STAIR)
DA205
DA206
DA207
DA208
洗手間
(TOILET)
1F
大門
(GATE)
電梯
(ELEVATOR)
大廳
海報/作品展示
LOBBY
EXHIBITION
DA101
DA102
辦公室
(OFFICE)
DA103
電梯
(ELEVATOR)
樓梯
(STAIR)
側門
(GATE)
樓梯
(STAIR)
DA104
辦公室
(OFFICE)
DA105
辦公室
(OFFICE)
DA106
洗手間
(TOILET)
大門
(GATE)

主題演講

一:

Building a sustainable future together toward education, collaboration, and innovation in the age of AI

演講人簡介

姓名:Professor Nick Vasiljevic

單位: Assistant Professor in International Business (ETP) –Shih Chien University, Taipei, Taiwan

經歷:

- Assistant Professor in International Business (ETP) – since 2018 Shih Chien University, Taipei, Taiwan
- Adjunct Assistant Professor in the School of Design - 2017 to 2018 Shih Chien University, Taipei, Taiwan
- Managing Director –2015 to 2016 Made Ltd., Taipei, Taiwan
- General Manager –2014 to 2015 UXSwiss, Taipei, Taiwan
- Managing Director –2007 to 2013 Pilotfish, (荷商普羅設計公司) Taipei, Taiwan
- Analyst –2005 to 2007 Channel Advisor Corp., Morrisville, NC, USA
- Field Application Engineer –2003 to 2005

學歷：PgDip (MSc) in Computer Science, University of Kent, UK

專長領域： ESG、碳盤查、減碳生活、永續教育、設計創新

二:

Biomass energy toward circular economy

演講人簡介

姓名: Professor (Ir) Ong Hwai Chyuan (王槐銓)

單位: Distinguished Professor in department of Engineering Sunway University, Malaysia

經歷:

- Distinguished Professor Department of Engineering Sunway University
- Malaysia 2022 Highly Cited Researchers (Engineering), Clarivate Analytic
- 2022 Australia's top 40 early career researchers
- Professional Engineer (Ir), Board of Engineers Malaysia (BEM)
- Chartered Engineer (CEng), Engineering Council, UK

學歷：PhD in Engineering, University of Malaya (2013)

專長領域：能源與燃料、生物質能與廢棄物管理、熱化學轉換技術、技術經濟分析與循環經濟、永續能源

三:

sustainable design and the method using narrowing thinking.

演講人簡介

姓名: Professor Yamaoka Toshiki

(山岡俊樹)

單位: Honor professor of National Wakayama University / Kyoto Women University, Japan

經歷:

- 日本國立和歌山大學 榮譽教授 兼株式會社 HAL デザイン研究所 顧問
- 京都女子大學 家政學部 生活造形學科 教授
- Design in chief, Toshiba co. R&D center, Human Interface Technical Center.
- 出版超過 10 本英日文人因工程、設計領域專業書

學歷：國立千葉大學 設計與人因工程學術博士

專長領域：工業設計、產品開發、人因工程、服務設計、永續產品設計、認知人間工學、使用者介面

口頭論文發表 A 永續產品設計與創新

A01 運用永續設計導入 CMF 設計邏輯與未來趨勢

A02 永續與生成式 AI 創新運用: 移動屋的綠色轉型

A03 城市意象在城市交通與城市記憶關係建構中的角色：以台灣高鐵為例

A04 探索失智症患者智慧空間引導系統之應用現況

A05 從產品生命週期探討寵物玩具永續設計開發策略

A06 考慮生命週期評估下的循環經濟決策框架：以廢棄物再利用

A07 積層製造技術之晶格性能比較與誤差補償方法研究

A10 蜂巢型水上漂-減蒸發保水設計

A11 以生命週期評估為基礎之永續發展目標評估架構開發-以農特產品與 SDG 14 為例

A12 以工程預算書估算工程碳足跡可能誤差之探討

A13 以問卷調查解析大學生對綠色設計之需求：以手機為例

A01

運用永續設計導入 CMF 設計邏輯與未來趨勢

王柏智[1*]，蔡坤益[2*]

[1] 中原大學設計學博士學位學程/健行科技大學數位多媒體設計系助理教授
[2] 華梵大學工業設計學系/亞太色材創新協會(籌備會)常務理事長
[*]通訊作者 email: denis7373@uch.edu.tw，schneider0412@gmail.com

摘要

隨著全球環保意識抬頭，永續設計逐漸成為各種產業的核心價值挑戰。CMF（Color, Material, Finish）設計作為設計開發的重要元素，逐漸邁入永續性的重要考量之一，透過生態友善與功能創新的目標。本文探討如何運用永續設計的邏輯整合CMF來應對未來趨勢與設計的轉變。本研究資料將有三大指標1:.從永續設計核心原則出發，並以CMF設計為主導來減少產品生命週期得環境衝擊，來提升產品本身的循環性。此外，並透過各種回收機制與生產模型，產生不同材質與色彩的整合開發，創造出高效創新的解決方案。2.將數位科技永續再CMF扮演的角色，以及透過AI跟大數據捕捉市場需求，協助設計師開發符合消費者永續產品。透過模擬工具選擇材料以及優化加工，減少物理樣品生產需求，並有助助於產品開發的靈活性與資源的高效利用。3.永續設計與CMF邏輯整合是技術層面突破，其中需要融合材料加工設計與美學，並透過設計展現尊重生態環境保護，以及創新設計表現來增加消費者對環境保護的認同，進而促進市場接收度與產業升級。本文將永續設計導入CMF設計邏輯，提供了一條兼顧環境、經濟與社會發展的可行道路。提供未來設計師需結合技術創新與價值重塑之建議，共同為實現永續發展貢獻力量。

關鍵字：CMF 設計開發、永續設計、AI、環保。

Abstract

As global awareness of environmental protection grows, sustainable design has become a critical challenge across industries. CMF (Color, Material, Finish) design, a key component of product development, is increasingly aligned with eco-friendly and innovative approaches. This study explores integrating sustainable design principles with CMF logic to address future design trends.

Key aspects include:1.Sustainable Principles: CMF focuses on reducing environmental impact and enhancing recyclability, using recycling mechanisms and production models to create innovative solutions.2.Digital Technology: AI and big data identify market needs, supporting designers in developing sustainable products. Simulation tools optimize material selection and reduce physical prototypes, enhancing flexibility and resource efficiency.3.Aesthetics and Technology Integration: Designs blend material processing with aesthetics to reflect ecological values, fostering consumer support for sustainability and driving industrial growth.This study offers a roadmap for balancing environmental, economic, and social goals through technology and innovation, advancing sustainable development.

Keywords: CMF design、integrating sustainable design、AI design、environmental friendly

A02

永續與生成式 AI 創新運用：移動屋的綠色轉型

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[2]中原大學商業設計學系
[3]國立雲林科技大學跨域整合設計學士學位學程
[*]通訊作者 email: soleview@gmail.com

摘要

在永續發展成為全球焦點的時代，鋁製品因其輕量、耐用與可回收特性，成為永續建築的重要材料，尤其在鋁製移動屋設計中具潛力。然而，傳統貨櫃屋設計依賴複合材料，導致回收困難與資源浪費。本研究透過文生圖與圖生圖生成式AI，探討其在永續鋁屋設計中的應用潛力，並評估設計師操作後的心理感受與業界專家對AI生成提案的偏好。實證結果顯示，文生圖組平均耗時3小時，比圖生圖組的3.25小時快。然而，專家訪談顯示，圖生圖方案因創新性、市場適應性與永續性表現優異，獲6/7位專家青睞（平均得分4.57），遠超文生圖組（1.85）。依技術接受模型（TAM, Davis, 1989），文生圖因生成結果不可控與創意受限，評價較低（平均2與1.5）。圖生圖則因直觀介面與高效性受肯定（平均4與4.5）。研究表明，文生圖適於快速發想，圖生圖提升設計品質與效率，專家並指出其能探索新材料與結構形式，平衡美學、功能性與環境責任。本研究展示生成式AI在永續鋁屋設計中的價值，但受限於小樣本規模，未來需擴大驗證，為綠色轉型提供新思路。

關鍵字：生成式 AI、永續設計、鋁製移動屋、創新應用。

Abstract

In an era where sustainability is a global priority, aluminum's lightweight, durable, and recyclable properties make it a key material in sustainable architecture, particularly in aluminum mobile home design. Traditional container homes, reliant on composite materials, pose recycling challenges and resource waste. This study explores the potential of text-to-image and image-to-image generative AI in sustainable aluminum house design, assessing designers' psychological responses post-use and industry experts' preferences for AI-generated proposals. Empirical findings indicate that the text-to-image group averaged 3 hours per design, slightly faster than the image-to-image group's 3.25 hours. However, expert interviews favored image-to-image outputs (6/7 selections, mean score 4.57) over text-to-image (1.85), highlighting its superiority in innovation, market adaptability, and sustainability. Applying the Technology Acceptance Model (TAM; Davis, 1989), text-to-image scored lower (mean 2 and 1.5) due to limited control and creativity, while image-to-image earned higher ratings (mean 4 and 4.5) for its intuitive interface and efficiency. Results suggest text-to-image excels in rapid ideation, whereas image-to-image enhances design quality and efficiency, with experts noting its capacity to explore novel materials and structures, balancing aesthetics, functionality, and environmental responsibility. This study underscores generative AI's potential in sustainable aluminum housing, though its small sample size limits generalizability, necessitating broader validation for future green transformations.

Keywords: Generative AI, Sustainable Design, Aluminum Mobile Homes, Innovative Applications.

A03

城市意象在交通與記憶關係建構中的角色：以台灣高鐵為例

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[1]國立雲林科技大學設計學研究所 [2]樹德科技大學會展行銷與活動管理系
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摘要

二十世紀末，策略規劃的概念開始融入城市規劃過程中。在高速鐵路線的周邊，城市自身的形象亦可見一般。本研究主要探討了有關城市景觀的意象如何在認知中被表徵。研究旨在檢視城市意象與民眾集體記憶的形成相互關係。此外，本研究還試圖識別與城市有關的新興主題。因此，研究對經由高鐵通過的城市意象中構成居民個人記憶的資訊進行了綜合分析，利用搭乘高鐵時進行採樣。並利用語意差異法（SD法）對150位受訪者進行調查。受訪者所提及城市意象表明，城市記憶與城市身份可以視為基本的空間元素。從數據中顯示出的最突出主題涉及休閒區域、其中進行的各種活動以及周邊全景景觀。儘管受訪者的職業背景差異很大，他們的記憶卻顯示出相當程度的一致性。儘管許多學者已對城市認同和文化景觀進行了廣泛分析，但城市交通對這些現象的影響仍然是個未充分探討的領域。

關鍵字：城市形象、城市記憶、高鐵沿線、集體記憶

Abstract

At the close of the 20th century, the notion of strategic planning began to be incorporated into the urban planning process.The image of the city itself can also be perceived along the high-speed railway line.This study primarily explores how images of urban landscapes are represented in cognition, with the aim of examining the relationship between the formation of urban image and people's collective memory.Furthermore, this study attempts to identify emerging themes related to cities. To this end, the study conducted a comprehensive analysis of the information that constitutes residents' personal memories in the image of the city that passes through the high-speed rail, using sampling during the high-speed rail ride.The semantic differential method (SD method) was used to investigate 150 respondents.The urban images mentioned by the interviewees show that urban memory and urban identity can be regarded as basic spatial elements. Thematic analysis of the data revealed that recreational areas, the activities therein, and the surrounding panoramic landscapes were the most prominent themes.Despite the respondents' diverse professional backgrounds, their memories exhibited a substantial degree of consistency.While numerous scholars have extensively analysed urban identity and cultural landscape, the impact of urban transportation on these phenomena remains an under-explored area.

Keywords: City Image, City Memory, High-speed Rail Line, Collective Memory

A04

探索失智症患者智慧空間引導系統之應用現況

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摘要

本研究探討智慧空間引導系統在失智症照護中的應用現況與發展趨勢，並結合聯合國永續發展目標（SDGs）第3項「良好健康與福祉」（Good Health and Well-being）的概念，強調智慧科技在長者照護中的角色。隨著全球老齡化加劇，失智症患者的空間定向障礙已成為重要挑戰，約70%患者會出現迷路行為，影響安全並增加照護負擔（健康新聞, 2024）。如何在不增加醫療與照護資源負擔的情況下，提升長者的生活品質，是未來智慧照護與永續醫療發展的重要課題。

智慧空間技術結合物聯網（IoT）、人工智慧（AI）與感測設備，透過智慧定位、監測警示、環境指引，提供即時照護與安全保護，降低醫療機構與家屬的照護壓力。本研究採用文獻回顧、觀察法與案例分析，探討2015-2024年間智慧空間技術在失智症患者照護中的應用與發展趨勢。

結果顯示，現有引導系統存在整合度低、成本高且人性化設計不足的問題。本研究建議應建立標準化平台、推動模組化設計，並以患者需求為核心，以提升智慧空間技術的永續性與可行性，促進健康高齡社會的發展，符合聯合國SDGs對於健康福祉與智慧永續城市的發展方向。

關鍵字：失智症、智慧空間、引導系統、AI 技術

Abstract

This study explores the current applications and development trends of smart space guidance systems in dementia care, incorporating the concept of Goal 3: Good Health and Well-being from the United Nations Sustainable Development Goals (SDGs) to emphasize the role of smart technology in elderly care. With the acceleration of global aging, spatial disorientation among dementia patients has become a major challenge. Approximately 70% of patients experience wandering behavior, which affects their safety and increases the burden on caregivers. Finding ways to improve the quality of life for elderly individuals without adding to the strain on medical and caregiving resources is a crucial issue in the future development of smart healthcare and sustainable medical systems.

Smart space technology integrates the Internet of Things (IoT), Artificial Intelligence (AI), and sensor devices to provide smart positioning, monitoring alerts, and environmental guidance, offering real-time care and safety protection while reducing the caregiving burden on medical institutions and families. This study adopts literature review, observational research, and case analysis to examine the applications and effectiveness of smart space technologies in dementia care from 2015 to 2024.

The results indicate that existing guidance systems have issues such as low integration, high costs, and insufficient human-centered design. This study suggests establishing standardized platforms, promoting modular design, and placing patient needs at the core to enhance the sustainability and feasibility of smart space technology. These improvements aim to foster the development of a healthy aging society, aligning with the SDGs' goals for health, well-being, and smart sustainable cities.

Keywords: Dementia, Smart Space, Wayfinding System, AI Technology

A05

從產品生命週期探討寵物玩具永續設計開發策略

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摘要

近年來，疫情、少子化與高齡化趨勢推動全球寵物市場成長，寵物已成為家庭的重要成員。根據美 國寵物用品協會(APPA)調查，狗與貓是最常見的飼養對象，除了關注寵物食品健康，飼主對寵物玩具的 安全性與環保性也日益重視。本研究旨在探討寵物玩具於產品生命週期各階段的永續設計策略，包括原 料取得、製造、配送、使用與維護，以及廢棄與回收，並聚焦於三大問題：(1) 高破壞性與快速汰換造 成的資源浪費；(2) 材質對寵物健康與安全的影響；(3) 消費者對永續玩具的態度與接受度。本研究將透 過專家深度訪談，針對寵物玩具專家、永續設計專家進行分析，本研究目的分別為以下三點：(1) 分析 與探討寵物玩具產品生命週期衝擊；(2) 探索永續設計準則與檢核工具；(3) 建構永續設計開發策略，幫 助企業減少環境負擔，同時兼顧經濟效益與社會責任。本研究期望提供具體策略，推動產業永續發展， 並提升消費者對永續寵物玩具的認知與接受度，共同實現永續未來。

關鍵字：產品生命週期、寵物玩具、永續設計、開發策略、市場接受度。

Abstract

In recent years, the trends of the pandemic, declining birth rates, and aging populations have driven the growth of the global pet market, making pets an essential part of households. According to the American Pet Products Association (APPA), dogs and cats are the most commonly owned pets. In addition to prioritizing pet food health, pet owners are increasingly concerned about the safety and environmental sustainability of pet toys. This study aims to explore sustainable design strategies for pet toys at various stages of the product life cycle, including raw material acquisition, manufacturing, distribution, usage and maintenance, as well as disposal and recycling. It focuses on three key issues: (1) resource waste caused by high destructibility and rapid replacement of pet toys; (2) the impact of materials on pet health and safety; and (3) consumer attitudes and acceptance of sustainable pet toys. This research will employ expert interviews, and surveys to analyze insights from pet toy experts, sustainable design specialists, and pet owners. The objectives are to: (1) analyze and assess the environmental impact of the pet toy life cycle; (2) explore sustainable design principles and evaluation tools; and (3) develop sustainable design strategies to help businesses reduce environmental burdens while balancing economic benefits and social responsibility. This study aims to provide concrete strategies to drive sustainable development in the pet toy industry and enhance consumer awareness and acceptance of sustainable pet toys, ultimately contributing to a more sustainable future.

Keywords: Product Life Cycle, Pet Toys, Sustainable Design, Development Strategies, Market Acceptance

A06

考慮生命週期評估下的循環經濟決策框架：以廢棄物再利用為例

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摘要

永續發展是現代社會面對環境、經濟與社會挑戰的重要目標，而有效的廢棄物管理是實現永續發展的關鍵之一。本研究致力於建立生命週期評估（Life Cycle Assessment, LCA）的2E 決策輔助系統，評估廢棄物處理技術在環境和經濟層面的綜合效益，是推動永續廢棄物管理的重要工具。本研究以 Decarbonizer 新型系統作為案例，採用小型分散式低碳排設計與氫氣發電技術，適合中小型企業實踐「延長生產者責任」的理念，並展現在多數情境下的最佳環境效益與能源轉化效率。研究顯示，新型系統能顯著降低碳排放，並促進廢棄物的高效資源利用。此外，本研究比較焚化爐與厭氧消化場等再生能源技術，發現在特定廢棄物類型或場景下仍具備優勢。以有機類廢棄物作為研究材料，用於評估在不同技術處理與能源轉化效率。本研究應用案例分析，結合 VIKOR 和 TOPSIS 決策方法進行加權分析，針對不同廢棄物類型進行精細排名。結果顯示， Decarbonizer 技術在多數場景中具有明顯優勢，但不同技術選擇應根據廢棄物特性及實際需求進行綜合考量。最終，研究以循環經濟為核心，強調將廢棄物視為潛在資源，為資源的高效利用與永續發展提供實踐方向，並創造新的經濟機會，推動綠色經濟的發展。

關鍵字：廢棄物回收；循環經濟；低碳；生命週期評估；永續發展。

Abstract

Sustainable development is a critical goal for modern society in addressing environmental, economic, and social challenges, with effective waste management being one of the key components to achieving it. This study aims to establish a 2E decision support system based on Life Cycle Assessment to evaluate the integrated benefits of waste treatment technologies from both environmental and economic perspectives. The study focuses on the Decarbonizer system as a case, utilizing a small-scale, decentralized low-carbon design with hydrogen power generation technology, suitable for small and medium-sized enterprises to implement the concept of "extended producer responsibility." The system demonstrates the best environmental benefits and energy conversion efficiency in most scenarios. The results show that the new system significantly reduces carbon emissions and promotes the efficient use of waste as a resource. Additionally, this study compares technologies such as incinerators and anaerobic digestion in waste-to-energy applications, revealing that certain technologies still offer advantages for specific waste types or scenarios. Using organic waste as a case material, the study assesses various treatment and energy conversion efficiencies. Case analysis combined with VIKOR and TOPSIS decision methods for weighted analysis is applied to rank different waste treatment options. The findings indicate that the Decarbonizer technology has significant advantages in most scenarios; however, the choice of technology should be based on waste characteristics and actual needs. Ultimately, the study emphasizes the core of circular economy by viewing waste as a potential resource, providing practical directions for efficient resource utilization and sustainable development.

Keywords: Design Theory, Graphics, Social Design, Service Design, Fashion Design

A07

積層製造技術之晶格性能比較與誤差補償方法研究

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摘要

聯合國於 2015 年通過 2030 永續發展目標(SDGs)，致力於推動全球邁向永續發展，然而傳統包裝材料如發泡聚苯乙烯(EPS)與發泡聚乙烯(EPE)，在少量多樣的產品需求下，仍需依賴開模成型，導致碳足跡增加，若採用減法加工，則產生大量材料浪費，因此本研究使用積層製造(AM)技術，開發晶格結構作為保護包裝的替代方案。積層製造過程可能產生列印誤差，導致實際結構與設計模型不符，本研究提出兩階段圖檔補償方法以減少誤差，實驗選用三重週期最小曲面(TPMS)晶格結構，並依據 ASTM D3574 Test C 壓縮試驗進行力學分析，最終篩選出 Gyroid 晶格結構最適合作為保護包裝，提供永續性的包裝解決方案。

關鍵字：積層製造、晶格結構、三重週期最小曲面、誤差補償、永續包裝解決方案。

Abstract

In 2015, the United Nations adopted the 2030 Sustainable Development Goals (SDGs) to promote global sustainable development. However, traditional packaging materials such as expanded polystyrene (EPS) and expanded polyethylene (EPE) still rely on mold forming to meet the demand for small-batch, diverse products, leading to increased carbon footprints. Subtractive manufacturing methods further result in significant material waste. Therefore, this study employs additive manufacturing (AM) technology to develop lattice structures as an alternative protective packaging solution. Since the additive manufacturing process may introduce printing errors that cause discrepancies between the actual structure and the design model, this study proposes a two-stage file compensation method to reduce errors. The experiment selects triply periodic minimal surface (TPMS) lattice structures and conducts mechanical analysis based on the ASTM D3574 Test C compression test. The results identify the Gyroid lattice structure as the most suitable option for protective packaging, providing a sustainable packaging solution.

Keywords: Additive Manufacturing, Lattice Structure, Triply Periodic Minimal Surface, Error Compensation, Sustainable Packaging Solution.

A10

蜂巢型水上漂-減蒸發保水設計

Honeycomb type water float –evaporation reduction and water retention design

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摘要

全球氣候變遷造成水資源分配不均，台灣長期以來，被列為水資源缺少的國家，主要由於高溫蒸發及 水資源儲存不易。本研究基於此，設計目標考慮保水效率、成本因素及碳排放，開發能減少因太陽光輻射 而蒸發的水量，減緩儲水不易的困境。研究方法，包含產品設計、實作量測及根據生命週期評估推估碳足 跡。其中研發產品設計，組裝 PP 板及氣包柱，並將多個單元產品緊密結合形成大面積的蜂巢型設計，應 用於水面覆蓋，利用產品封閉的氣室空間，形成內部的水蒸發及水凝結交互循環作用，以達到減少水資源 蒸發的目的。減少水蒸發量之預估方法，主要透過梅耶爾式理論及實際量測驗證。經實驗預估蒸發量結 果，由實驗組與對照組比較，量測不同季節水溫(17~29oC)環境條件，在一周時間內，水位下降幅度差異 大約可以減少 3%之蒸發量，顯示本蜂巢型產品設計應用於表面水保水，具有減少蒸發之實質效益。在碳 足跡方面，本產品使用材料單片產品面積 1623cm2 ，其產品碳足跡=0.1595kg CO2eq 應應用於具有減少水 或埤塘之水資源蒸發，其產品特色，包括產品材料取得容易且成本較為低，產品不佔空間，拆解與回收容 易，及碳足跡排放較少，相關產品應用，將可運用於池塘、魚塭、水 、湖泊等水域均能發揮減少水蒸發 的作用，以增加水資源保護。

關鍵字： 低碳設計應保水設計

A11

以生命週期評估為基礎之永續發展目標評估架構開發-以農特產品與 SDG 14 為例

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摘要

農業活動對海洋生態存在實質效益及潛在衝擊，包含農業化肥逕流導致海洋優養化、有害藻華大量繁殖，嚴重影響海洋生態及人類健康，對永續發展造成負面衝擊，但目前仍缺乏可量化數據證明其對於永續發展目標(SDGs)的貢獻及衝擊，企業在制定永續策略時也因數據標準化不足缺乏可比較性，無法做出更永續的企業決策。因此本研究目的為發展農業活動對於 SDGs 貢獻之評估工具，為產業追求永續轉型之決策工具。生命週期評估(LCA)涵蓋環境與社會面，且能彌補量化標準化的不足，由於 SDG-LCA 之整合性方法論仍在發展中，故本研究透過文獻回顧鑑別農業活動產生之壓力與 SDGs 指標之關聯性，並優先聚焦在 SDG 14海洋生態保育與各項環境衝擊之連結，擬定農業之 SDG 14海洋生態保育衝擊路徑，以作為後續農業活動對於人類生產力及永續福祉損失之量化基礎。目前已建立農業活動造成海洋環境衝擊的 DPSIR 模型及衝擊路徑圖。DPSIR 模型指出農業營養物質過剩，進而造成水體污染、海洋優養化，最終產生海洋生態系統失衡的負面衝擊。建立 SDG 14之衝擊路徑圖鑑別各壓力因子造成的環境狀態改變，並整理對應 SDGs 及地球臨界理論指標及閾值，如優養化潛力指標、磷與氮循環閾值，作為後續農業活動環境衝擊量化評估與改善方案之依據。

關鍵字：永續發展目標(SDGs)、SDG-LCA、海洋生態保育。

Abstract

Agricultural activities significantly impact marine ecosystems through fertilizer runoff, causing eutrophication and harmful algal blooms, negatively affecting marine ecology and human health. However, quantifiable data demonstrating the contributions and impacts of agriculture on the Sustainable Development Goals (SDGs) remain lacking. Enterprises also face challenges in formulating effective sustainability strategies due to insufficient data standardization and comparability, limiting sustainable decision-making. Therefore, this study aims to develop an assessment tool to quantify the contributions of agricultural activities to SDGs, serving as a decision-making instrument for industries pursuing sustainable transformation. Life Cycle Assessment (LCA), encompassing both environmental and social dimensions, can bridge existing gaps in standardized quantification. Since integrated methodologies of SDG-LCA are still under development, this study conducts a literature review to identify relationships between pressures generated by agricultural activities and relevant SDG indicators. It particularly emphasizes SDG 14 (Life Below Water), proposing an impact pathway that links agricultural activities to marine ecosystem conservation and associated environmental impacts. Currently, the DPSIR model and impact pathway illustrating agricultural impacts on the marine environment have been established. A DPSIR model was developed to link agricultural pressures, such as nutrient excess, to marine eutrophication. The established SDG 14 impact pathway identifies environmental changes caused by various pressure factors, integrating corresponding SDG indicators and Planetary Boundary thresholds such as the Indicator for Coastal Eutrophication Potential (ICEP) and phosphorus and nitrogen cycling thresholds. These serve as the basis for future environmental impact quantification and the formulation of improvement strategies for agricultural activities.

Keywords: Sustainable Development Goals (SDGs), SDG-LCA, SDG 14 (Life Below Water)

A12

以工程預算書估算工程碳足跡可能誤差之探討

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摘要

建築及工程業進行碳足跡評估時，若以工程預算書中的工料（建材）使用量與工程施作量作為主要計算依據，具快速盤點的優勢，然而這種方法可能導致碳足跡評估的誤差。本研究透過一實際工程案例，建立建築工程預算書與建築碳排放數據的對應關係，深入探討透過工程預算書估算碳排放量會造成誤差的關鍵因素，讓使用者了解其估算之局限性。並透過預算資訊利用經濟法估算排放量，探討工程預算書擔任何種碳管理角色。初步結果顯示，在「產品階段」及「施工階段」目標建物的排放量大約 19981 噸二氧化碳當量，然而以建築工程預算書中的工料（建材）使用量與工程施作量作為主要計算依據，可能低估實際碳排放量，因為預算書中部分描述無法非常完整的反應排放源的活動，如利用「一式」或「一樘」等不明確的單位進行描述。但作為設計階段時的碳管理工具依然是具有實用性，在設計階段時如有設計變更，皆可以透過預算書的估算了解設計變更對於環境的影響，幫助建商在碳管理上能夠有參考依據。

關鍵字：建築碳足跡、工程預算書、設計階段、碳排放估算、永續建築

Abstract

In the architecture and engineering industry, carbon footprint assessment based on the material usage and construction volume recorded in engineering budget reports offers the advantage of rapid evaluation. However, this method may lead to inaccuracies in carbon footprint estimation. This study utilizes a real construction project to establish a correlation between engineering budget data and building carbon emissions. It further investigates the key factors contributing to estimation errors when using budget reports for carbon footprint calculation. The aim is to help users understand the limitations of this approach and explore the role of historical project carbon intensity and budget reports in carbon management. Preliminary results indicate that engineering budget reports may underestimate actual carbon emissions, as they fail to fully capture the activities responsible for emissions.

Keywords: Building Carbon Footprint, Engineering Budget Report, Design Phase, Carbon Emission Estimation, Sustainable Building

A13

以問卷調查解析大學生對綠色設計之需求:以手機為例

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摘要

國際電信聯盟於2024年的報告指出，網路通訊部門的碳排放量約占全球總量的2%，而個人裝置在該部門碳排放中排名第二，僅次於使用階段。其中手機為人們日常生活中使用頻率極高的個人裝置，推動手機的綠色設計將有助於減少碳排放並促進環境永續。綠色設計強調在產品設計階段即納入環境友善考量，從而減少製造過程中的能源消耗及碳排放。本研究聚焦於大學生群體，透過問卷調查蒐集其使用體驗與對綠色設計的需求，並結合狩野模型與 SPSS 軟體分析，歸納出消費者對手機綠色設計的核心需求。

關鍵字：綠色設計、網路通訊產品、狩野模型、問卷調查

Abstract

Since the International Telecommunication Union (ITU) reported in 2024, the Information and Communication Technology (ICT) sector has accounted for 2% of global carbon emissions from 2020 to 2022, with the manufacturing stage of personal devices contributing 27% of the sector's carbon footprint. Eco-design effectively reduces carbon emissions and energy consumption during the manufacturing stage. Given that mobile phones are the most frequently used personal devices in daily life, implementing eco-design in mobile phone production can significantly reduce carbon emissions and promote sustainability. Through a systematic literature review, we found that over the past decade has primarily used these methodological researches: (1) scenario simulation and Life Cycle Assessment (LCA); (2) questionnaires and interview surveys exploring corporate implementation strategies; (3) reflecting on product design strategies through recycling stages; and (4) synthesizing insights from literature and related documents. However, relatively few studies have examined eco-design from a customer perspective. Therefore, this research constructs a systematic eco-design process through a customer and business-oriented methodology: (1) reviewing international environmental regulations and corporate sustainability reports to establish an indicator framework; (2) conducting questionnaires to collect data from undergraduates and postgraduates; (3) utilizing the Kano model and SPSS software to prioritize product design indicators, analyze variations in mobile phone usage habits, and assess differences in consumer preferences for eco-design features.

Keywords: eco-design, ICT, questionnaire, KANO model,

口頭論文發表 B 企業與產業永續管理發展

B01 探討機車拆解效率：以台灣為例

B02 發展綠色散裝航運關鍵因素與最適融資方案分析

B03 運用混合整數規劃決定最佳減碳策略之研究 - 以中小型製造業為例

B05 永續城市化與劇團經營：以果陀劇場為例

B06 基於生成式 AI 的智慧能源與維護建議系統：優化設備運行效率以降低碳排放量

B08 綠色組織文化對永續訓練投入與綠色數位轉型能力的影響

B09 員工綠色職能對綠色組織公民行為之影響

B10 利害關係人壓力對綠色共同生產之影響-以企業環境承諾為中介變項

B11 基於電力預測與大型語言模型的用電量預測與改善建議方案推薦系統

B12 產品循環材料績效與顧客願付價格關係探討

B13 應用機器學習預測半導體產品碳足跡的實證研究

B14 運用大數據分群建構企業永續能源採購策略

B15 探討利害關係人與增效工具在台灣製造業推動永續實踐之影響與績效

B16 航運營運減碳策略情境分析之研究

B18 多溫共配的低碳冷鏈電動車配送路徑與充電站選址問題

B19 基於深度學習驅動的工業廢熱回收與節能效益優化推薦系統

B20 群眾募資之 ESG 情結:以美國 Indiegogo 平台驗證

B22 資源稟賦論與漁電共生對地方經濟發展及國際案例的比較研究

B23 運用 NotebookLM 分析企業永續報告書：以永續報告獎獲獎企業為例

B24 傳統半導體封裝技術之生命週期評估比較研究-以台灣某公司為例

B26 烘焙產品碳中和路徑規劃—以吐司為例

B27 台灣上市公司之範疇三碳排放揭露及相關減排行動之研究

B28 以生命週期評估探討鐵道客運運輸之碳足跡-以台灣某捷運公司為例

B29 歐盟數位產品護照之實施對臺灣紡織業的影響研析

B30 《全球塑膠公約》對台灣塑膠產業的衝擊

B01

探討機車拆解效率：以台灣為例

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摘要

研究探討台灣摩托車拆解的效率及其對環境永續與資源回收的影響，聚焦拆解時間、經濟效益與環境影響評估。由於摩托車在台灣的主導地位，提升回收效率至關重要。然而，目前拆解過程以人工為主，成本高昂，進而影響回收率與經濟效益。透過現場觀察與數據分析，記錄拆解時間與流程，識別影響效率的關鍵因素。結果顯示，車殼拆解耗時最長，回收價值低，建議優化設計以降低成本。螺絲數量與標準化程度顯著影響拆解效率，減少螺絲種類並統一規格可縮短拆解時間並降低人力需求。成本效益與環境影響評估顯示，適當設定拆解「停損點」能提升整體回收效益。本研究揭示當前機車拆解的挑戰，並透過回收效益模型提供流程優化建議，以提升回收經濟性與環境永續性。

關鍵字：End-of-life vehicles (ELVs); Disassembly; Recycling process improvements; Life cycle assessment

B02

發展綠色散裝航運關鍵因素與最適融資方案分析

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摘要

自環保概念興起以來，航商適應與轉型過程持續演進，不僅反映了航運營運策略的演變與造船及航行技術的進步，更反映出因溫室效應而引起的自然生態保育議題對航運發展的影響，以及綠色航運及綠色金融結合之重要性。本研究透過層級分析法(Analytic Hierarchy Process, AHP)與理想解相似度順序偏好法(Technique for Order Preference by Similarity to an Ideal Solution, TOPSIS)彌補綠色航運發展所需之最適綠色金融商品融資方式的研究空白。並以環境保育(E)、社會責任(S)與公司治理(G)等綠色航運發展構面，針對臺灣散裝航運高階經理人進行問卷調查，以檢視散裝航運發展綠色航運之關鍵因素重要性與各關鍵因素之最適綠色融資方案。研究結果顯示，「託運人與供應商協調」為主要關鍵因素，而「綠色基金」為散裝航運永續發展過程中之最適綠色融資方案。

關鍵詞：綠色航運、綠色金融、綠色基金、綠色債券、託運人與供應商協調

Abstract

Since the rise of environmental awareness, the adaptation and transformation process of shipping companies has been continuously evolving. This not only reflects changes in operational strategies, advancements in shipbuilding, and navigation technologies but also highlights the impact of ecological conservation issues caused by the greenhouse effect on shipping development. Furthermore, it underscores the importance of integrating green shipping with green finance. This study aims to fill the research gap regarding the optimal green financial products and financing methods required for sustainable shipping development by employing the Analytic Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS). Using the dimensions of Environmental Conservation (E), Social Responsibility (S), and Corporate Governance (G) in green shipping development, a questionnaire survey was conducted among senior managers in Taiwan's bulk shipping companies. The study examines the importance of key factors for the development of green shipping in bulk shipping and identifies the most suitable green financing solutions for each key factor. This results show that "shipper and supplier coordination" is the main key factor, and "green fund" is the most suitable green financing solution in the sustainable development of bulk shipping companies.

Keywords: Green shipping, Green finance, Green funds, Green bonds, Coordination with shippers and suppliers

B03

運用混和整數規劃決定最佳減碳策略之研究－以中小型製造業為例

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摘要

全球暖化造成嚴重氣候變遷對於人類生存環境及經濟活動造成巨大衝擊。為了達到2050淨零排放政策，各企業組織也紛紛積極減少碳排放，尤其是製造業更是碳排放的主要來源之一。因此，本研究旨在運用混和整數規劃(Mixed Integer Programming, MIP)的方法，建立一個目標最佳化模型，利用ISO 14064-1組織碳盤查之盤查結果為參考依據，系統性分析製造業中的碳排放來源，篩選出具有減排潛力的選項，得出多種減碳組合並計算最佳之減碳策略。根據研究顯示，電力的來源與輸入量將很大程度影響碳排放的減少，其中目標1（最大碳減排量）實現5,811.36公噸CO2e減排，成本1,496.37萬元，主要由電力貨車（貢獻89.5%減排）和合成鋁驅動，但高成本限制普及；目標2（最小成本）和目標3（最小總體排碳成本）成本分別為609.27萬元與586.81萬元，減排僅748.91公噸，依賴低成本柴油貨車與鋁錠，碳價0.3元/kg僅降低22.46萬元，激勵不足以推動高效技術轉型。再者，再生能源除了能夠幫助減少排放外，其對於全球環境的恢復及邊境效益自不言述。最後透過情境分析，探討供應鏈總碳排放量、供應鏈總生產成本，以及供應鏈碳費與生產成本，三種目標函數的變化與影響因素。研究模型可供新興製造業及中小企業參考，作為減碳模板，助其降低環境風險，提升競爭力與利潤，應對氣候變遷，達成減排目標與可持續發展，為全球環境保護積極貢獻。

關鍵字：碳排放、混和整數規劃、減碳策略、碳盤查

B05

永續城市化與劇團經營：以果陀劇場為例

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摘要

將文化視為永續發展的第四支柱意味著在理論和經驗層面上進行新的知識和辯論，重新審視經濟學和發展社會學中已經建立的關於文化作為地方和社區發展的框架、資源和策略的核心知識。從城市永續性的角度考慮，城市面臨特殊的問題。一方面，人口和社會經濟不平衡對發展過程中資源和主體的調動方式構成了嚴格限制。另一方面，豐富的物質和非物質遺產、傳統、強烈的社區意識和文化認同，都是重要的地方資產，可以透過適當的政策和計劃轉化為有效的發展工具。本文透過探討果陀劇場長期戲劇演出計畫的具體案例研究，討論了將文化作為城市永續發展所面臨的挑戰和機會。其目的是利用豐富的演出作為城市集體參與永續文化驅動發展策略的基礎。本文透過實證研究揭示了該計畫對當地發展的影響方式，強調了文化作為城市永續發展工具的潛力。

關鍵字：果陀劇場、文化產業、城市化、隱性知識、地方永續

Abstract

The concept of culture as the fourth pillar of sustainable development gives rise to new knowledge and debates at both theoretical and empirical levels, necessitating a re-evaluation of the established knowledge in economics and development sociology on culture as a framework, resource and strategy for place and community development.Cities face unique challenges from the perspective of urban sustainability. On the one hand, demographic and socio-economic imbalances impose severe constraints on the mobilisation of resources and agents in the development process. Conversely, the rich tangible and intangible heritage, traditions, strong sense of community and cultural identity that cities possess can be transformed into effective development tools through appropriate policies and programmes. This article discusses the challenges and opportunities of using culture as a tool for sustainable urban development through a specific case study of the long-term theatre performance project of the Godot Theatre Company. The objective is to utilise the depth and variety of performance as a foundation for the city's collective participation in a sustainable, culturally motivated development strategy. This article employs empirical research to illuminate the project's impact on local development, underscoring the capacity of culture as a catalyst for urban sustainability.

Keywords: Gotot Theatre Company, Cultural Industry, Urbanism, Tacit knowledge, Local Sustainability

B06

基於生成式 AI 的智慧能源與維護建議系統：優化設備運行效率以降低碳排放量

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摘要

現代工業場域中，設備非計劃性停機已成為影響生產效率與永續發展的關鍵挑戰。特別是傳統產業中的板金加工產業，其高度依賴設備穩定性的特性，使得突發性停機可能引發一連串連鎖效應，導致資源浪費與碳排放增加。傳統的預防性與反應性維護策略常無法針對設備實際狀態進行精準維護，而近期的預防性維護與健康監測系統（Proactive Health Systems, PHS）又缺乏對多模態數據的整合與應用，導致模型效能與應用場景受到限制。本研究提出一個結合大型語言模型（Large Language Model, LLM）與多模態技術的智慧維護建議系統，利用物聯網（IoT）數據、圖像與文本資料進行深度分析與多模態融合。該系統可實現設備異常檢測與故障預測，並生成具個性化且即時的修復建議。目前實驗結果顯示，本研究系統在多模態數據的異常檢測中可能達到分類準確率90%以上，生成的維修建議文本BLEU評估分數預期超過40分。此外，透過縮短停機時間與提高維修效率，本系統每次維修可減少10%至15%的碳排放量，顯著提升資源利用效率。此研究成果展示了生成式AI在智慧維護系統中的應用潛力，期望為工業永續發展提供技術支援。

關鍵字：智慧維護、生成式 AI、大型語言模型、資源利用效率、減碳策略

Abstract

Unplanned downtime in industrial settings has become a critical challenge affecting both production efficiency and sustainable development. This issue is particularly severe in the sheet metal processing industry, where operational stability is essential. Unexpected machine failures can trigger a chain reaction, leading to resource waste and increased carbon emissions. Traditional preventive and reactive maintenance strategies often fail to provide precise maintenance based on real-time equipment conditions. Meanwhile, existing Proactive Health Systems (PHS) lack the integration of multimodal data, limiting their model performance and practical applicability. This study proposes an intelligent maintenance recommendation system that integrates Large Language Models (LLMs) with multimodal technologies, leveraging Internet of Things (IoT) data, images, and textual records for deep analysis and multimodal fusion. The system enables anomaly detection and failure prediction while generating personalized and real-time repair recommendations.

Preliminary experimental results indicate that the proposed system can achieve an anomaly classification accuracy of over 90% when analyzing multimodal data, with BLEU scores expected exceeding 40 for generated maintenance recommendations. Additionally, by reducing downtime and improving maintenance efficiency, the system is expected to reduce carbon emissions by 10% to 15% per repair cycle, significantly enhancing resource utilization efficiency. The findings highlight the potential of Generative AI in intelligent maintenance systems, providing technical support for sustainable industrial development.

Keywords: Intelligent maintenance, Generative AI, Large Language Models, resource utilization efficiency, carbon reduction strategies

B08

綠色組織文化對永續訓練投入與綠色數位轉型能力的影響

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摘要

本研究以動態能力理論為基礎，探討綠色組織文化如何驅動企業對永續訓練的投入以及企業的綠色數位轉型能力。本研究將從組織層級之觀點探究綠色組織文化與永續訓練投入及綠色數位轉型能力之間的關聯，選以臺灣製造業為研究對象，使用問卷調查法發放 2016 份紙本問卷，共回收 140 份有效樣本。經由統計分析結果可得知：(1) 綠色組織文化對永續訓練投入有正向顯著影響 (2) 綠色組織文化對綠色數位轉型能力有正向顯著影響。此研究結果可為企業高階管理者提供實務上的寶貴參考，藉此協助他們在面對永續發展及數位轉型的挑戰時，重新思考企業文化的塑造以及擬定更具成效的轉型策略。

關鍵字：綠色組織文化、永續訓練投入、動態能力理論、綠色數位轉型能力。

Abstract

Grounded in dynamic capability theory, this research investigates how green organizational culture drives firms' sustainability training input and their green digital transformation capabilities. Adopting an organizational-level perspective, this research explores the relationships between green organizational culture, sustainability training input, and green digital transformation capabilities. Data were collected from the Taiwanese manufacturing industry through a questionnaire survey. Out of 2016 distributed paper questionnaires, 140 valid responses were received. Statistical analysis revealed that: (1) green organizational culture has a positive and significant impact on sustainability training input, (2) green organizational culture has a positive and significant impact on green digital transformation capabilities. The findings of this research offer valuable practical insights for senior managers, assisting them in reconsidering the development of their corporate culture and formulating more effective transformation strategies when addressing the challenges of sustainable development and digital transformation.

Keywords: Green Organizational Culture, Sustainability Training Input, Dynamic Capability Theory, Green Digital Transformation Capabilities

B09

員工綠色職能對綠色組織公民行為之影響

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摘要

自 2004 年聯合國提出 ESG 概念，至 2021 年歐盟推出碳邊境調整機制，再到世界經濟論壇《2024 年全球風險報告》將環境因素列為最具影響力風險，全球企業面臨的環境永續挑戰日益嚴峻。員工作為組織永續發展核心，其「綠色職能」（因應環境挑戰所需的知識、技能、能力和個人特質）對企業至關重要。此外，企業實現環境永續不僅需要員工履行正式職責，更需要員工展現自發性綠色組織公民行為。本研究之研究對象為參與過永續訓練、活動或專案的企業員工，採用問卷調查法，共回收 194 份有效問卷。根據研究結果得知：（1）員工綠色職能對綠色組織公民行為有正向顯著之影響；（2）綠色知識對綠色組織公民行為有正向顯著之影響；（3）綠色技能對綠色組織公民行為無顯著之影響；（4）綠色能力對綠色組織公民行為有正向顯著之影響；（5）綠色態度與綠色意識對綠色組織公民行為有正向顯著之影響。

關鍵字：職能、員工綠色職能、綠色組織公民行為

Abstract

Since the United Nations introduced ESG in 2004, the EU launched the Carbon Border Adjustment Mechanism in 2021, and the Global Risks Report 2024 identified environmental risks as highly influential. As employees are central to organizational sustainability, their "green competence"—knowledge, skills, abilities and others characteristics attributes for addressing environmental challenges—is crucial. Achieving sustainability requires not only formal duties but also proactive green organizational citizenship behavior.

This study surveyed 194 employees who participated in sustainability training, activities, or projects. The findings indicate: (1) Employee green competencies positively influence green organizational citizenship behavior; (2) Green knowledge positively influences green organizational citizenship behavior; (3) Green skills show no significant effect on green organizational citizenship behavior; (4) Green abilities positively influence green organizational citizenship behavior; and (5) Green attitudes and awareness positively influence green organizational citizenship behavior.

Keywords: Competencies, Employee Green Competencies, Green Organizational Citizenship Behavior

B10

利害關係人壓力對綠色共同生產之影響-以企業環境承諾為中介變項

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摘要

隨著永續發展議題興起，企業面臨來自政府法規、消費者需求與投資人期待等利害關係人壓力，影響 其綠色發展策略。本研究基於利害關係人理論，探討利害關係人壓力對企業綠色共同生產的影響，並檢視 企業環境承諾的中介作用。綠色共同生產強調企業與供應商、顧客、政府及非政府組織協同合作，以提升 環境績效。本研究認為，企業在回應外部壓力時，若能強化環境承諾，將有助於推動環境友善行為與綠色 共同生產。 本研究以台灣製造業為對象，透過問卷調查蒐集數據，共回收 140 份有效問卷。根據研究分析結果得 知：(1) 利害關係人壓力對企業環境承諾有顯著正向影響；(2) 企業環境承諾對綠色共同生產有顯著正 向影響；(3) 利害關係人壓力對綠色共同生產有顯著正向影響；(4) 企業環境承諾在利害關係人壓力與 綠色共同生產之間具有中介效果。

關鍵字：利害關係人理論、利害關係人壓力、企業環境承諾、綠色共同生產

Abstract

With the rise of sustainable development issues, companies face stakeholder pressures from government regulations, consumer demands, and investor expectations, all of which influence their green development strategies. Based on stakeholder theory, this study examines the impact of stakeholder pressure on corporate green co-production and explores the mediating role of business environmental commitment. Green co-production emphasizes collaboration between companies and stakeholders such as suppliers, customers, governments, and non-governmental organizations to enhance environmental performance. This study posits that when companies strengthen their business environmental commitment in response to external pressures, it can promote environmentally friendly behaviors and facilitate green co-production. This study focuses on Taiwan's manufacturing industry and collected data through a questionnaire survey, resulting in 140 valid responses. The analysis of the research results revealed the following: (1) Stakeholder pressure has a significant positive impact on Business environmental commitment; (2) Business environmental commitment has a significant positive impact on green co-production; (3) Stakeholder pressure has a significant positive impact on green co-production; and (4) Business environmental commitment plays a mediating role between stakeholder pressure and green co-production.

Keywords: Stakeholder Theory, Stakeholder Pressure, Business Environmental Commitment, Green Co Production

B11

基於電力預測與大型語言模型的用電量預測與改善建議方案推薦系統

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摘要

隨著全球能源需求不斷攀升及氣候變遷挑戰日益嚴峻，用電量評估已成為實現高效能源管理與制定節能策略的關鍵。現有文獻多聚焦於用電量預測，鮮有進一步針對預測結果進行問題診斷及提出具體解決方案之研究。為此，本研究提出一種創新整合方法，首先收集歷史耗電數據與設備耗電資訊，運用 Transformer 模型預測未來用電量，並識別高耗能環節；隨後，再利用大型語言模型 Llama 對預測結果進行生成針對性節能策略。該方法不僅能有效捕捉用電趨勢，也能為組織提供建議的節能改善措施。

關鍵字：用電量預測、Transformer、大型語言模型（LLM）、能源管理。

Abstract

With the continuous rise in global energy demand and the escalating challenges posed by climate change, assessing electricity consumption has become pivotal for achieving efficient energy management and formulating effective energy-saving strategies. Existing literature primarily focuses on forecasting electricity consumption, with limited research addressing subsequent diagnostic analyses of forecasting outcomes and the development of specific solutions. To address this gap, this study proposes an innovative integrated approach. Initially, historical electricity consumption data and equipment information are collected, and a Transformer model is employed to forecast future electricity consumption while identifying high-energy consumption segments. Subsequently, a large language model, Llama, is utilized to generate targeted energy-saving strategies based on the forecasting results. This approach not only effectively captures electricity consumption trends but also provides organizations with actionable recommendations for energy-saving improvements.

Keywords: Electricity consumption forecasting, Transformer, Large language model (LLM), Energy management

B12

產品循環材料績效與顧客願付價格關係探討

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摘要

近年來，全球氣候變遷和環境保護議題受到重視，隨著資源的日益稀缺，如何有效利用資源並減少對環境的負面影響成為了各界關注的焦點。政府即在「台灣 2050 淨零排放路徑及策略」的「十二項關鍵戰略」中，擬 訂「戰略 8-資源循環零廢棄關鍵戰略行動計畫」，企業方面也開始重視產品採用回收材料的比例，為了能有效 推廣綠色產品，企業會想了解消費者對綠色產品的願付價格。因此本研究使用自適應性選擇式聯合分析方法來估計產品的回收材料比例增量和消費者願付價格之間的關係，並以筆記型電腦和電視兩種產品為例，透過 聯合分析得到各屬性的相對重要性，同時估計回收材料比例增量的願付價格差。透過問卷分析得到的結果發 現，全體受訪者對於筆記型電腦的屬性重要性的排序為價格、中央處理器、產品採回收材料比例(%)、電池壽 命、記憶體；電視的屬性重要性排序為價格、螢幕尺寸、產品採回收材料比例、解析度、螢幕顯示技術。產品採 回收材料比例增量和願付價格的分析，分析結果顯示，筆記型電腦採回收材料比例 25%和完全未採回收材料 比例(0%)的願付價格差約 3,083 元，採回收材料比例 50%和 0%的願付價格差約 3,752 元、採回收材料比例 75% 和 0%的願付價格差約 3,014 元；電視採回收材料比例 25%和完全未採回收材料比例(0%)的願付價格差約 9,206 元，採回收材料比例 50%和 0%的願付價格差約 11,760 元、採回收材料比例 75%和 0%的願付價格差約 11,028 元

關鍵字：綠色產品、循環經濟、願付價格、自適應性選擇式聯合分析

B13

應用機器學習預測半導體產品碳足跡的實證研究

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摘要

本研究旨在探討半導體產業於碳足跡評估過程中面臨的挑戰，並提出結合機器學習技術之快速預測方法，以提升碳管理效率，隨著「氣候變遷因應法」及歐盟「碳邊境調整機制（Carbon Border Adjustment Mechanism, CBAM）」等政策陸續實施，要求企業強化產品碳排放管理。傳統生命週期評估（Life-cycle assessment, LCA）雖具高度科學性，但其資料取得困難、建模成本高，已難以支援企業即時決策所需。因此，本研究擬結合機器學習技術，發展一套快速碳足跡預測方法，強化半導體產業於產品開發階段之碳排管理能力。

本研究使用某半導體企業2021至2023年之生產數據資料為基礎，透過生命週期評估軟體SimaPro 9.4.0.2，並基於IPCC 2021 GWP 100之方法學計算單位產品碳排放量。數據預處理階段將資料標準化與類別變數編碼處理。模型訓練階段使用Lasso迴歸(Least Absolute Shrinkage and Selection Operator, Lasso)進行特徵選擇，以降低高維資料所帶來的過擬合(Overfitting)風險，後續以Ridge迴歸(Ridge Regression)、支持向量迴歸（Support Vector Regression, SVR）及輕量梯度提升機(Light Gradient Boosting Machine, LightGBM) 進行模型訓練與效能評估，進一步透過 SHAP 方法解析關鍵變數與其交互影響，建構具備可視化與解釋力之預測系統，本研究預期可建構出一套兼具效率與解釋性的預測工具，協助企業於產品設計早期即快速掌握碳排熱點，縮短碳足跡核算周期，並提升對永續法規之因應能力。

關鍵字： 產品碳足跡、機器學習、半導體產業、生命週期評估（LCA）、碳排放預測

B14

運用大數據分群建構企業永續能源採購策略

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摘要

在全球致力於實現淨零碳排的趨勢下，預計於2050年時，太陽能與風能將供應超過全球一半的電力。然而，由於這兩種再生能源具有間歇性，且高度依賴天候條件，導致能源供應的不確定性，成為能源管理的一大挑戰。為了符合全球供應鏈的需求，許多企業積極參與RE100計劃，承諾全面使用再生能源。然而，在達成RE100目標的過程中，企業如何確保能源供應穩定、最佳化再生能源採購策略並同時降低成本，成為一項重大課題。雖然永續發展通常由政府政策主導，但政策執行往往存在侷限，使企業在規劃再生能源採購時，需自行尋求最佳解決方案。因此，本研究從企業角度出發，旨在提升能源採購規劃的效率，並在成本控制與實際運作情境間取得平衡。本研究提出一多元再生能源採購模型，利用大量數據來建立統計分布，以確保模型能夠反映實際能源供需的變動特性。研究數據來源涵蓋台灣各地區，共計52,560筆數據。模型透過大數據分析與統計方法建立變數，並運用分群技術處理數據，以解決計算耗時及提升模型精確度。本研究選定工研院南分院作為案例研究對象，利用其能源使用數據作為建模依據，深入分析能源使用模式，並為模型提供實證支持。在建模過程中，數據被分為不同群集，以分析各群集特徵，從而更精確地匹配能源供需曲線。透過本研究所開發的模型，企業能夠更有效率地管理再生能源採購，降低能源成本，並確保能源供應的穩定性，進一步推動企業永續發展目標的實現。

關鍵字：RE100、再生能源、分群、多元儲能系統、再生能源憑證

Abstract

By 2050, solar and wind energy are expected to supply half of the world's electricity. However, their intermittency and dependence on weather conditions create uncertainties in energy supply, posing a major challenge for energy management. To meet global supply chain demands, many companies have joined the RE100 initiative, committing to 100% renewable energy. Achieving RE100 requires balancing energy supply stability, procurement optimization, and cost reduction. While government policies drive sustainability, their limitations compel companies to seek independent solutions for renewable energy procurement. This study develops a stochastic programming model to enhance procurement efficiency while balancing cost and real-world constraints. Using 52,560 data points from Taiwan, the model applies big data analytics and clustering techniques to improve computational efficiency and accuracy. The Industrial Technology Research Institute (ITRI) Southern Branch serves as a case study, providing empirical insights into energy consumption patterns. By segmenting data into clusters, the model better aligns energy supply and demand. This approach enables companies to optimize renewable energy procurement, reduce costs, and ensure energy stability, contributing to corporate sustainability goals.

Keywords: RE100, Renewable Energy, Clustering, Energy Storage, Renewable Energy Certificates

B15

探討利害關係人與增效工具在台灣製造業推動永續實踐之影響與績效

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摘要

近年來，隨著環境問題日益嚴重，企業對永續發展的關注逐漸增加。為了實現永續發展，企業正逐步轉向更環保的做法，並努力從傳統製造模式轉型為永續製造模式。同時，利害關係人對企業的期望也日益提高，不僅要求企業具備良好的經濟績效，還關注其在環境、社會責任與公司治理方面的永續表現。儘管精實管理、數位技術與綠色創新被視為提升企業效能的關鍵工具，但它們在推動環境永續方面的作用仍需要深入探討。

本研究透過文獻回顧建立研究模型，旨在分析利害關係人壓力如何影響企業的永續實踐，並探討增效工具在永續實踐與績效之間的關聯。研究以台灣製造業為對象，通過問卷調查收集數據，並運用偏最小平方法的結構方程模型（PLS-SEM）進行分析。研究結果顯示，利害關係人壓力對企業永續實踐（環境管理、清潔生產、綠色供應鏈、安全實踐）具有正向影響，並且這些永續實踐對企業的永續績效（包括環境、社會和公司治理績效）也有顯著的正向影響。此外，增效工具(精實管理、數位技術與綠色創新)的應用能有效提升企業的永續績效，顯示這些增效工具在推動企業永續發展中扮演著關鍵角色。相信這些研究結果有助於企業制定更有效的永續發展策略，提升競爭優勢。

關鍵字：企業永續、精實管理、數位數據、綠色創新、永續績效

Abstract

As environmental issues worsen, companies shift to sustainable manufacturing models amid rising stakeholder expectations for ESG performance. This research examines how stakeholder pressure influences sustainability practices and the role of enhancement tools in performance. Data from Taiwan’s manufacturing industry are analyzed using PLS-SEM. Results show that stakeholder pressure positively impacts sustainability practices (environmental management, clean production, green supply chain management, and safety), which enhance ESG performance. Lean management, digital technology, and green innovation further boost sustainability performance, highlighting their importance in strengthening competitive advantage.

Keywords: Corporate Sustainability, Lean Management, Digital Data, Green Innovation, Sustainability Performance

B16

航運營運減碳策略情境分析之研究

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摘要

隨著國際間減少碳排放的壓力持續增加，航運產業正面臨日益嚴峻的環保法規與市場變遷，因此積極尋求可持續性的減碳解決方案已成為當務之急。碳稅與碳排放交易制度逐步納入航運業監管範圍，使得航運公司在營運決策上需更加關注低碳轉型策略。本研究透過情境分析方法，探討航運業如何透過營運策略實現減碳目標，並重點關注船舶燃料型態轉換、國際碳價波動、岸電使用等因素對航運業營運成本與減碳效益的影響。研究中綜合替代燃料應用、港口岸電供應狀況，以及國際碳稅政策的變動，建構不同條件情境，以評估各種減碳策略的可行性與經濟效益。研究結果顯示，不同燃料選擇與岸電使用策略在各種市場與政策條件下，對營運成本與碳排放減量的影響有所不同，航運公司需根據碳稅機制與燃料技術發展趨勢，選擇最適合的轉型路徑。藉由本研究的綜合分析結果，為航運產業在邁向淨零碳排的過程中提供具體可行的策略建議，協助航運公司在符合環保法規的同時維持競爭優勢，實現永續經營目標。

關鍵字：綠色航運、碳排放、情境分析、永續性

B18

多溫共配的低碳冷鏈電動車配送路徑與充電站選址問題

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摘要

隨著全球對環境保護意識的不斷提升，綠色物流已成為物流業發展的重要方向。其中，電動車作為低碳排放的運輸工具，在冷鏈物流領域的應用日益增長。冷鏈物流系統涉及對溫度敏感產品的運輸，這些產品需在不同的溫度條件下進行配送，因此，多溫層配送技術在冷鏈物流中扮演關鍵角色。然而，電動車在冷鏈配送中的應用仍面臨續航里程受限與充電需求等挑戰，使得充電站選址與路徑規劃成為核心議題。本研究提出一個帶時間窗的多目標低碳多溫層電動車選址路徑最佳化問題(MOLCMTJD-EVLRPTW)模型，旨在同時解決電動車配送路徑規劃與充電站選址問題。該模型充分考量電動車的關鍵因素，並結合冷鏈物流的多溫層配送需求，進行多目標最佳化，以降低運營成本與碳排放，同時提升服務品質。此外，透過選擇最佳充電站位置，最大化電動車的運行範圍與使用效率。為求解此複雜問題，本研究採用 Gurobi 求解器進行精確計算，並輔以演算法處理複雜的組合優化問題，透過兩者結合驗證模型的有效性。預期該模型能夠優化冷鏈配送路徑與充電設施佈局，提升電動車在冷鏈物流中的運營效率並減少碳排放。進一步導入基因演算法，有助於提高模型在大規模問題求解上的效率，為企業提供創新的解決方案，促進電動車於冷鏈物流領域的廣泛應用。

關鍵字：冷鏈物流；電動車；多溫層配送；車輛路徑問題；充電站選址問題。

Abstract

With the growing awareness of global environmental protection, green logistics has become a critical development direction for the logistics industry. Electric vehicles (EVs), as low-carbon transportation tools, are increasingly being applied in cold chain logistics. Cold chain logistics systems involve the transportation of temperature-sensitive products that require delivery under different temperature conditions, making multi-temperature distribution technology essential. However, the application of EVs in cold chain logistics faces challenges such as limited driving range and charging requirements, making charging station location and route planning crucial. This study proposes a Multi-Objective Low-Carbon Multi-Temperature Joint Distribution Electric Vehicle Location Routing Problem with Time Windows (MOLCMTJD-EVLRPTW) model, which aims to simultaneously optimize the vehicle routing and charging station location for EV-based cold chain logistics. The model considers critical EV factors while integrating multi-temperature delivery requirements for cold chain logistics, focusing on minimizing operational costs and carbon emissions while enhancing service quality. By selecting optimal charging station locations, the model aims to maximize the operational range and efficiency of EVs. To solve this complex problem, the Gurobi solver is employed for exact optimization, with supplementary heuristic algorithms to handle the complexity of combinatorial optimization, ensuring the model's effectiveness. The proposed model is expected to optimize cold chain delivery routes and charging infrastructure layouts, improving EV efficiency in cold chain logistics while reducing carbon emissions. The incorporation of genetic algorithms further enhances the model's efficiency in solving large-scale problems, providing a new solution for enterprises to promote EV adoption in logistics.

Keywords: Cold Chain Logistics; Electric Vehicle; Mul-ti-Temperature Co-Delivery; Vehicle Routing Problem; Charging Station Location Problem

B19

基於深度學習驅動的工業廢熱回收與節能效益優化推薦系統

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摘要

隨著全球能源需求的持續攀升與碳中和目標的推動，提升工業能源使用效率已成為產業轉型升級與永續發展的重要議題。然而，目前多數工業製程仍存在大量廢熱未被有效回收利用的現象，導致能源浪費與碳排放問題日益嚴重。傳統的廢熱回收系統設計大多基於靜態參數與經驗判斷，廠商如何選擇最適合方案仍有困擾，回收效率與節能效益因此受限。本研究針對上述問題，提出一套基於深度學習技術的工業廢熱回收與節能效益優化推薦系統。透過即時溫度監測數據，結合深度神經網路模型，卷積神經網路（CNN, Convolutional Neural Network）與長短期記憶網路（LSTM, Long Short-Term Memory）的模型聯合運作，來進行熱源辨識、廢熱分級管理與回收效率預測。系統設計則強調回收設備運作的智能化與最佳化控制，能根據製程不同階段的溫度分布自動調整回收策略，提升整體熱能使用效率。本研究展示了深度學習技術應用於工業廢熱回收領域的可行性與效益，為能源密集型產業提供高效節能的技術解決方案，進一步促進產業低碳轉型與永續發展目標的實現。同時，本研究將以工業鍋爐為例，整合鍋爐運行參數進行即時數據監控，並透過深度學習模型對廢熱潛力進行預測與分析，研究重點聚焦於鍋爐排煙餘熱回收，結合熱交換器與有機朗肯循環（ORC）系統進行熱能再利用，並透過最佳化控制策略提升回收效率與能源利用率。

關鍵字：深度學習、工業廢熱回收、節能效率優化、預測模型、鍋爐排煙餘熱、熱交換器、有機肯朗循環

Abstract

Improving industrial energy efficiency has become a key objective in response to the growing global energy demand and carbon neutrality goals. However, a large amount of waste heat in industrial processes, particularly from coal-fired and gas-fired boilers, remains underutilized, resulting in energy waste and increased carbon emissions. Traditional waste heat recovery systems often rely on static parameters and empirical judgments.

This study proposes a deep learning-based industrial waste heat recovery and energy efficiency optimization system. By utilizing real-time temperature monitoring and deep neural network models, including the collaborative operation of Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks, the system enables heat source identification, waste heat classification, and recovery efficiency prediction. The research focuses on the flue gas waste heat recovery of industrial boilers, combining heat exchangers and Organic Rankine Cycle (ORC) systems to improve thermal energy reutilization. The optimized control strategy enhances overall energy efficiency and reduces carbon emissions, providing a sustainable solution for energy-intensive industries.

Keywords: Industrial Waste Heat Recovery, Boiler Flue Gas Heat Recovery, Heat Exchanger, Organic Rankine Cycle (ORC), Energy Efficiency Optimization, Carbon Emission Reduction

B20

群眾募資之 ESG 情結：以美國 Indiegogo 平台驗證

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摘要

本研究主要探討美國 Indiegogo 群眾募資平台上之消費者或支持者，是否會因專案具有 ESG 理念與否，影響其購買與資助之意願，進而影響專案募資成功與否及成功率高低。此外，本研究進一步納入 ESG 市場情緒作為調節變數，探討市場情緒高漲期間是否增強 ESG 導向專案的募資成功機會。運用傾向分數配對及差異中之差異（PSM-DiD）方法進行實證分析，結果顯示，相較於非 ESG 之專案，ESG 導向募資專案，在 ESG 市場情緒高漲期間，較易受到消費者或支持者的青睞，不僅提高籌資成功的機率，也顯示出群眾募資市場之消費者與支持者具有 ESG 情結。此外，若僅針對已達目標籌資金額的成功專案子樣本進行分析，則是發現 ESG 屬性籌資專案相較於非 ESG 群眾籌資，並未有顯著較高的籌資成功率。顯示出具 ESG 導向的專案，雖有較高的成功機率，但並不保證能獲取較高的籌資金額。本研究不僅為近年來全球對 ESG 議題的關注注入新的研究方向，更期能為透過群眾募資此替代融資管道取得創業資金的 ESG 新創企業作出貢獻。

關鍵字：群眾募資、ESG、Indiegogo、傾向分數配對-差異中差異。

Abstract

This study primarily investigates whether consumers or backers on the U.S.-based crowdfunding platform Indiegogo are influenced by the presence of ESG (Environmental, Social, and Governance) principles in a project, affecting their willingness to purchase or fund it, and consequently influencing the project's fundraising success and success rate. Furthermore, this research incorporates ESG market sentiment as a moderating variable to explore whether heightened market sentiment enhances the success likelihood of ESG-oriented projects. Using Propensity Score Matching (PSM) and Difference-in-Differences (DID) methodologies for empirical analysis, the results indicate that compared to non-ESG projects, ESG-oriented crowdfunding projects are more favored by consumers or backers during periods of heightened ESG market sentiment. These projects not only demonstrate a higher probability of fundraising success but also reflect the presence of an ESG preference among crowdfunding participants. Additionally, when analyzing a subsample consisting only of successfully funded projects, it is found that ESG projects do not exhibit significantly higher success rates than non-ESG crowdfunding projects. This suggests that while ESG-oriented projects may have a higher likelihood of success, they are not guaranteed to secure greater fundraising amounts. This study not only contributes a new research perspective to the growing global attention on ESG issues in recent years, but also aims to support ESG-focused startups in obtaining entrepreneurial funding through crowdfunding as an alternative financing channel.

Keywords: Crowdfunding, ESG, Indiegogo, PSM-DID

B22

資源稟賦論與漁電共生對地方經濟發展及國際案例的比較研究

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摘要

本研究為資源稟賦論解釋不同地區如何依賴其特定資源優勢發展產業，探討漁業如何與新能源技術（如漁電共生）之前導研究，並針對部分試驗對象作範例，以作後續調查之輔助。隨著可再生能源發展，太陽能技術成熟，使漁電共生成為可同時維持漁業生產與發電收益的新模式。然而，此模式可能影響漁業生產與地方經濟，光電設施亦可能改變水體環境，因此需考量適當的架設高度、水質管理及智慧科技導入，以提升產出效率並降低勞動成本。

漁電共生產業在環境、經濟和社會影響方面的量化研究仍然不足(Zhu et al., 2024)，而本研究選擇嘉義縣布袋鎮作為國內研究場域，該區漁電共生發展迅速，且研究者熟悉當地環境，利於田野調查與資料蒐集。並透過國內外案例比較，分析不同國家如何因地制宜發展漁電共生，評估其對生產要素與自然資源的影響。

資源稟賦論強調善用地方優勢，而漁電共生正是利用沿海地區的漁業資源與日照條件，推動漁業與再生能源共存，促進地方經濟多元化。本研究將聚焦如何在能源轉型、漁業及科技發展間取得平衡，以確保漁電共生模式的永續發展，並符合聯合國永續發展目標（SDGs）。

關鍵字：漁電共生、資源稟賦論、新能源、智慧科技

Abstract

This study applies Resource Endowment Theory to explain how regions leverage specific resource advantages for industrial development, particularly how fisheries integrate with new energy technologies like fishery-solar symbiosis. With the advancement of solar power, this model enables both fishery production and electricity generation. However, its impact on local economies and aquatic environments must be considered, requiring appropriate panel placement, water quality management, and smart technology adoption to enhance efficiency and reduce labor costs. The government must balance energy development with fishery protection to minimize ecological impacts.

This study compares international and domestic fishery-solar projects, selecting Budai Township, Chiayi County, as the primary research site due to its rapid development and the researcher's familiarity, facilitating field research. By analyzing production factors and natural resources, this study evaluates region-specific adaptations.

Fishery-solar symbiosis utilizes Taiwan's coastal resources to integrate renewable energy with fisheries, promoting economic diversification. This research aligns with the UN Sustainable Development Goals (SDGs), aiming to balance energy transition, fisheries, and technology for sustainable development.

Keywords: Fishery-solar symbiosis, Resource Endowment Theory, new energy, smart technology.

B23

運用 NotebookLM 分析企業永續報告書：以永續報告獎獲獎企業為例

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摘要

永續報告書揭露企業在環境（E）、社會（S）與公司治理（G）等面向的績效，是利害關係人評估企業永續經營能力的重要依據。然而，此類報告篇幅龐大，往往超過百頁，使讀者獨立分析其內容面臨挑戰。現行永續報告書之評比多僅提供等級資訊，缺乏具體分數，使企業間的永續表現難以量化比較，亦限制後續研究之延伸。本研究運用大型語言模型（Large Language Model, LLM）工具 NotebookLM，探索其於永續報告書分析上的應用可行性。研究對象為「台灣企業永續獎」中「永續報告獎」不同等級之獲獎金融與保險業企業。研究設計參考該獎項評選標準，撰寫標準化分析指令，並針對永續報告書與企業永續網站分別執行五次評分，取平均數與標準差，以觀察模型穩定性與企業間差異。研究結果顯示，NotebookLM 所產出之評分結果大致與官方排名趨勢一致，並能反映不同企業在資訊結構與揭露品質上的差異。相較於僅提供等級資訊之官方數據，LLM 所生成之具體分數更有助於細部比較與量化分析，提升 ESG 評估之透明度與應用價值。

關鍵字：永續報告書、人工智慧、大型語言模型、NotebookLM、ESG 評比

Abstract

Sustainability reports disclose corporate performance in environmental (E), social (S), and governance (G) dimensions, serving as key references for stakeholders to evaluate a company's long-term sustainability. However, these reports are often lengthy—frequently exceeding a hundred pages—making independent analysis challenging for general readers. Existing evaluations of sustainability reports typically provide only qualitative grades without concrete scoring, limiting cross-company comparisons and hindering further academic analysis. This study applies a large language model (LLM), specifically NotebookLM, to explore its feasibility in analyzing sustainability reports. The research targets four award-winning financial and insurance companies of different levels from the “Sustainability Reporting Award” under the Taiwan Corporate Sustainability Awards. Using the award’s evaluation criteria, standardized prompts were developed to guide the model’s analysis. Each company’s sustainability report and sustainability website were evaluated five times, with the average score and standard deviation calculated to examine the model’s consistency and the differences among companies. The results show that the scores generated by NotebookLM generally align with the official award rankings and reflect differences in report quality and information structure across companies. Compared to traditional evaluations that offer only level-based classifications, the quantitative scores produced by LLMs provide greater granularity for detailed comparison and extended analysis, enhancing the transparency and practical value of ESG evaluations.

Keywords: Sustainability Report, Artificial Intelligence, Large Language Model, NotebookLM, ESG Score

B24

傳統半導體封裝技術之生命週期評估比較研究

-以台灣某公司為例

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摘要

本研究運用生命週期評估（Life Cycle Assessment, LCA）方法，分析四種IC封裝技術BGA（球狀閘陣列）、QFN（四方平面無引腳封裝）、QFP（四側引腳扁平封裝）及SOP（釘架封裝），以生產1mm³的封裝產品為功能單位，評估從「搖籃到大門」範圍內的碳足跡與環境衝擊。結果顯示，製造階段的碳足跡最高，其中QFN為四種中最高的，數值達6.89E-04 kgCO_2e/mm³。此外，環境損害主要來自原物料階段，BGA與QFN的衝擊最明顯。從環境總衝擊來看，QFN封裝產品的衝擊最大，其值約為2.5E-04 Pt，進一步分析發現，封裝技術中的金線用量是碳足跡與環境負荷的主要來源。未來可透過替代材料與製程改善來降低衝擊。

關鍵字：生命週期評估、半導體封裝技術、碳足跡、環境衝擊

Abstract

This study applies Life Cycle Assessment (LCA) to evaluate the carbon footprint and environmental im-pact of four IC packaging technologies: Ball Grid Array (BGA), Quad Flat No-Lead (QFN), Quad Flat Package (QFP), and Small Outline Package (SOP). Using 1 mm³ of packaged product as the functional unit, the analysis covers the "cradle-to-gate" scope. Results show that the manufacturing stage has the highest carbon footprint, with QFN being the highest at 6.89E-04 kg CO_2e/mm³. Environmental damage primarily stems from the raw material stage, with BGA and QFN exhibiting the most significant impacts. Among the four technologies, QFN has the greatest overall environmental impact, approximately 2.5E-04 Pt. The analysis identifies gold wire usage as the main contributor to the carbon footprint and ecological burden in the packaging process. To reduce these impacts, adopting alternative materials and methods is recom-mended.

Keywords: Life Cycle Assessment, Semiconductor Packaging Technology, Carbon Footprint, Environmental Impact

B26

烘焙產品碳中和路徑規劃—以吐司為例

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摘要

烘焙業作為食品業的一環，雖廚餘量少，但因烘烤、發酵與冷藏等大量能源消耗環節，因此成為食品業碳排放的重要來源之一。在全球氣候緊急背景下，各產業積極尋求碳中和與與永續經營的策略辦法。本研究以吐司為案例，透過實地調查麵包工坊的生產流程，並蒐集相關數據，建立搖籃到墳墓的碳足跡基線，進一步分析主要的碳排放來源並彙整國內外策略，篩選適合的減碳方案，以規劃可行的碳中和路徑。結果顯示，在短期內優先採用在地原料可有效降低碳排放達 59%，因為當地採購可減少運輸過程中的燃料消耗與相關包裝需求。中長期則轉用綠電，可再削減 5%，進一步降低生產過程中能源消耗的碳排放量。然而，即便採取上述措施，仍有 35% 的排放無法避免，需透過碳信用額度抵換。本研究以現實層面及實際可行性為基礎進行研擬與規劃碳中和路徑，為烘焙業提供具體行動方案，協助業者減碳並推動食品產業永續發展。

關鍵字：碳中和、科學方法、碳足跡、減碳策略、烘焙業

B27

台灣上市公司之範疇三碳排放揭露及相關減排行動之研究

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摘要

範疇三排放涵蓋企業價值鏈中與其運營非直接相關的溫室氣體排放，通常是企業溫室氣體排放的最大部分。本研究在探討台灣上市公司永續報告書中碳盤查與範疇三減排行動，運用 Python 文字探勘檢索2018~2023年度的永續報告書中關鍵詞相關之資訊，比較不同產業及年度碳盤查與減碳行動上的資訊揭露情形。結果顯示，隨著國際與國內環保政策逐漸嚴謹，企業在永續報告書中對碳盤查及範疇三減排行動的揭露呈現逐年增長趨勢，以證交所 ESG 數位平台上的33個產業的永續報告書為研究標的，企業碳盤查覆蓋率逐年提升，從2018年的232家增加至2023年的703家，盤查範疇三的企業數量則從39家增至391家，在第三方查驗證或確信方面，從2018年的93家上升至2023年的390家。範疇三類別中，盤查最為顯著的三大類別為「營運中產生之廢棄物」、「購買之商品及勞務」及「商務旅行」，範疇三減排行動在2018年僅有88家企業執行，但2023年已提升至524家。研究顯示企業在減碳行動上逐漸積極化，且永續供應鏈管理、綠色採購及綠色設計成為企業減碳策略的重要方向。研究成果不僅有助於了解台灣上市公司在減碳轉型中的現況，也發現政策對於企業的要求不同導致在永續報告書揭露資訊大不相同。

關鍵字：企業永續、企業永續報告書、範疇三、文字探勘

Abstract

Scope 3 emissions refer to indirect greenhouse gas emissions within corporate value chains, typically comprising the largest portion of a company's emissions. This study utilizes Python text mining techniques to analyze carbon inventory disclosures and Scope 3 reduction actions in sustainability reports of Taiwanese listed companies across 33 industries from 2018 to 2023. Results indicate increasing corporate transparency due to stricter international and domestic environmental policies. Companies conducting carbon inventories rose from 232 in 2018 to 703 in 2023; Scope 3 inventories increased significantly from 39 to 391, and third-party verification expanded from 93 to 390. Prominent Scope 3 emission categories included operational waste, purchased goods/services, and business travel. Companies undertaking Scope 3 emission reduction actions increased dramatically from 88 in 2018 to 524 in 2023, highlighting proactive efforts toward sustainable supply chain management, green procurement, and eco-design strategies. Findings demonstrate policy impacts on disclosure variations and reflect Taiwan's corporate transition toward carbon reduction.

Keywords: Scope 3 Emissions, Carbon Inventory, Sustainability Reports, Text Mining

B28

以生命週期評估探討鐵道客運運輸之碳足跡－以台灣某捷運公司為例

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摘要

本研究旨在利用生命週期評估（Life Cycle Assessment, LCA）量化某捷運系統之碳足跡，並依據環境 部旅客運輸服務(陸上及水上運輸)碳足跡產品類別規則（CFP-PCR），僅盤查服務(營運)階段能源使用與 碳排放，採用 IPCC 2021 GWP 100 方法計算溫室氣體排放量，並以 1 pkm（延人公里）為功能單位。結果 顯示，該捷運系統碳足跡為 101.12 gCO_2e/pkm，與此相比，台北捷運 2023 年碳足跡為 78.22 gCO_2e/pkm，其 兩者之差異可能源自於台北捷運在能源節能方面之優勢，其優勢包含再生能源導入、機廠廠房頂部太陽 能板發電、車站設施節能(照明、電梯、手扶梯、冰水主機與變壓器汰換等)及其他減碳措施等，故導致本 研究與台北捷運數據有所落差。另一方面，該捷運系統溫室氣體年總排放量為 5.64E+08 $kgCO_2e$，其中列 車牽引用電占 60.6%為大宗，為主要排放熱點來源。本研究建議，針對該捷運系統服務（營運）階段應採 取更新列車機電系統（更加省電之 IGBT 牽引變流器控制技術）、再生煞車電能回收技術及汰換車站耗電之 設施等其他減碳策略，以利有效降低碳排放。

關鍵字：鐵道交通、碳足跡、碳排放。

B29

歐盟數位產品護照之實施對臺灣紡織業的影響研析

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摘要

歐盟數位產品護照(Digital Product Passport, DPP)預計於 2027 年起強制實施，要求產品揭露材料組成、 碳足跡、生產過程與可回收性等全生命週期資訊，以提升供應鏈透明度與可追溯性，實現循環經濟與永續 發展目標。紡織產業為首波重點實施對象，未來將面臨高度的資訊揭露與技術整合壓力。DPP 政策採取 「Carrot and Stick」策略：以法規強制推動企業轉型(Stick)，並透過市場准入、品牌形象等正向誘因(Carrot) 鼓勵企業投入永續創新。對臺灣紡織業而言，能否妥善因應此政策變革，將深刻影響其國際競爭力與永續 發展佈局。本研究聚焦於探討 DPP 實施對臺灣紡織產業所帶來的挑戰與對應策略。研究首先透過文獻回 顧，歸納出「資訊需求」與「技術挑戰」兩大核心構面，作為後續分析基礎。邀請實際參與或關注 DPP 導 入之紡織企業代表進行焦點團體訪談，了解企業在實務上遇到的問題與應對情形，並彙整具代表性的挑 戰因子。隨後設計專家問卷，邀請熟悉 DPP 政策與產業現況之專家進行評估，針對挑戰因子的重要性與可 行性進行排序，進一步釐清企業在導入 DPP 過程中的優先因應方向。研究成果可作為企業制定策略與政府 擬定配套措施之參考，協助臺灣紡織業掌握政策動向，降低法規遵循風險，並強化永續轉型能力。

關鍵字：數位產品護照、紡織業、焦點訪談、專家問卷

Abstract

The European Union's Digital Product Passport (DPP) is scheduled for mandatory implementation starting in 2027. It requires products to disclose full life cycle information, including material composition, carbon footprint, production processes, and recyclability, with the aim of enhancing supply chain transparency and traceability, thereby advancing circular economy and sustainability goals. The textile industry has been identified as a priority sector for the initial rollout, which will face significant pressure in terms of information disclosure and technological integration. The DPP policy adopts a "carrot and stick" approach: regulatory mandates are used to drive corporate transformation (Stick), while positive incentives—such as market access and enhanced brand image—are employed to encourage sustainable innovation (Carrot). For Taiwan's textile industry, the ability to effectively respond to this policy shift will profoundly affect its international competitiveness and sustainable development strategy. This study focuses on exploring the challenges and response strategies that the implementation of DPP presents to Taiwan's textile industry. It begins with a literature review to identify two core dimensions: "information requirements" and "technological challenges," which serve as the analytical framework. Subsequently, focus group interviews are conducted with representatives from textile enterprises who are actively involved in or attentive to the DPP initiative, to gain insights into the practical issues encountered and the corresponding coping strategies. Representative challenge factors are then compiled and assessed through an expert questionnaire survey, which invites specialists familiar with the DPP policy and industry context to evaluate and rank these factors based on their significance and feasibility. The findings of this research aim to serve as a reference for enterprises in formulating strategies and for the government in designing complementary measures. Ultimately, it seeks to help Taiwan's textile industry navigate policy developments, reduce regulatory compliance risks, and strengthen its capacity for sustainable transformation.

Keyword: Digital Product Passport (DPP), Textile Industry, Focus Group Interview, Expert Questionnaire

B30

《全球塑膠公約》對台灣塑膠產業的衝擊

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摘要

聯合國《全球塑膠公約》對塑膠議題制定具法律約束的規範。由於台灣的塑膠產業高度依賴出 口，將受到影響。本研究透過物質流分析評估台灣塑膠包裝與紡織產業的塑膠流動。結果顯示，塑膠包 裝業對原生塑膠的依賴度達 96%，再生料僅占 4%，產品主要供應國內市場，經消費後，98%塑膠包裝進 入廢棄階段，70%被焚燒，25%被回收。紡織業主要使用原生塑膠，再生料占比 16%，最終產品 47%流向 國外，留在國內的部分多以使用存量的形式存在，在末端處理方面，焚燒占 50%，回收率僅 4%。整體而 言，台灣塑膠回收及再生料體系仍待改善，以維持產業競爭力並促進永續發展。

關鍵字：全球塑膠公約，包裝，紡織，物質流分析

Abstract

Global Plastics Treaty establishes legally binding regulations on plastic-related issues. Given Taiwan's heavy reliance on plastic exports, the industry is expected to be significantly impacted. This study employs material flow analysis (MFA) to evaluate plastic flows in Taiwan’s packaging and textile industries. The results indicate that the packaging sector depends on virgin plastics for 96% of its material, with recycled plastics accounting for only 4%. Most products are supplied to the domestic market, and after consumption, 98% of plastic packaging enters the waste stage, with 70% incinerated and 25% recycled. In the textile sector, virgin plastics remain the dominant raw material, while recycled plastics make up 16%. Around 47% of final textile products are exported, while those remaining in Taiwan largely exist as in-use stocks. At the end-of-life stage, 50% of textile plastics are incinerated, with a recycling rate of just 4%. Overall, Taiwan's plastic recycling and recycled material system requires further improvement to maintain industrial competitiveness and promote sustainable development.

Keywords: Global Plastics Treaty, Packaging, Textile, Material Flow Analysis (MFA)

口頭論文發表 C 淨零碳排政策制定與評估

C01 農民對果樹類農糧剩餘副產物循環利用意願之主要因素研究

C02 考慮通勤意願之綠運輸模型

C03 海洋塑膠生命週期評估-以 PET 瓶為例

C04 多期多階段供應鏈中的氫氣生產與配送策略

C05 利用投入產出分析法評估能源轉型政策對台灣產業之影響

C06 投入產出分析法與傳統碳排放評估方法之比較研究：以台灣產業為例

C07 組織型碳盤查應用於產品碳足跡之可行性研究—以臺灣上市公司為例

C01

農民對果樹類農糧剩餘副產物循環利用意願之主要因素研究

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摘要

因應極端氣候衝擊及國家2040年淨零排放目標，農業生產經營過程中所剩餘之副產物，如稻草、果樹枝條等，露天燃燒是常見的去化作法，但容易產生汙染及溫室氣體，所以亟需建立農糧剩餘副產物循環利用模式，有助於農業加速邁向淨零排放。

本研究以「計畫行為理論」探討農民對於採用農糧剩餘副產物循環利用的決策構面模式，透過文獻整理形成因素，衡量農民的態度、主觀規範、知覺行為控制及意圖之因果關係，了解農民意圖驅動因素的差異。採用偏最小平方結構方程式(partial least squares-SEM，PLS-SEM))分析彰化縣種植果樹159位農民的訪問資料，研究結果顯示受訪者對於循環利用的態度對決策有正向且較大的影響，次為社會及群體的主觀規範於之影響，而受訪者自我認知具備的能力影響力最小但仍重要。若想提升農民採用農糧剩餘副產物循環利用的意圖，應加強農民認同感，也可透過群體影響、提供技術、資金資源支援來強化效果。

關鍵字：農糧剩餘副產物循環利用、計畫行為理論、決策意圖

Abstract

In response to the impact of extreme weather and the country’s goal of achieving net-zero emissions by 2040, agricultural by-products such as rice straw and fruit tree branches are often left over during the agricultural production process. Open burning is a common practice, but it easily leads to pollution and greenhouse gas emissions. Therefore, there is an urgent need to establish a circular utilization model for agricultural by-products, which will help accelerate agriculture's transition toward net-zero emissions.This study uses the Theory of Planned Behavior to explore the decision-making model of farmers adopting the circular utilization of agricultural by-products. Through a review of the literature, factors were identified to measure the causal relationships between farmers' attitudes, subjective norms, perceived behavioral control, and intentions, which helps to understand the driving factors behind farmers' intentions. Partial Least Squares Structural Equation Modeling (PLS-SEM) was used to analyze survey data from 159 fruit tree farmers in Changhua County. The results indicate that attitudes toward circular utilization have a significant positive impact on the decision to adopt it. The influence of social and group subjective norms comes second, while the impact of farmers' self-perceived abilities is the smallest but still important. To increase farmers' intention to adopt the circular utilization of agricultural by-products, it is crucial to enhance their sense of identification. Additionally, group influence, as well as the provision of technical and financial resources, can further strengthen the effect.

Keywords: Agricultural Waste, Theory of Planned Behavior, Decision Intention

C02

考慮通勤意願之綠運輸模型

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摘要

本研究建構加入通勤意願之綠運輸模型，著重於探討通勤意願對於通勤者之通勤時間與碳排放量之影響。近年來，都市化與私人運具的大量使用已導致交通擁堵、環境污染及碳排放急劇增加，成為迫切需解決的問題，根據政府統計資料，台灣除雙北外，公共運輸使用率低於15%，反映出現行政策在促進大眾運輸轉乘方面效果有限，且關於通勤意願對於運輸系統與碳排放影響之研究仍相對缺乏。

針對此一議題，本研究提出一綠色運輸模型，首先透過群集分析方法 K-Means與 DBSCAN對公車站點之數量與位置進行優化，確保站點分佈能夠符合通勤者之需求，此外，本研究採用貪婪演算法（Greedy Algorithm）進行運行路徑與公車班次之分配，以增加公車運行效率並減少通勤者之等候與通勤時間。為進一步探討通勤者選擇不同交通工具之意願對於大眾運輸系統與環境之影響，本研究建立一通勤意願指標，以模擬通勤者選擇大眾運輸之意願，後續透過敏感度分析不同通勤意願設定下的公共運輸使用率、總通勤時間、碳排放量之變化，並透過情境模擬不同地區之運輸特性與不同政策下之運輸系統情況，進而探討通勤者意願對於目前政策之影響與可能之優化方向，期望為決策者提供具體之改善建議，提升公共運輸使用率，以利發展更永續之綠色交通。

關鍵字： 綠運輸模型、通勤意願、公共運輸優化

C03

海洋塑膠生命週期評估-以 PET 瓶為例

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摘要

海洋廢棄物塑膠對全球環境造成嚴重的影響。本研究主要以海洋廢棄物 PET 瓶為例，以產品生命週期評估及碳足跡為方法，探討海洋廢棄寶特瓶 PET 回收再利用不同情境之碳足跡。結果顯示，以功能單位 1kg PET 回收。海洋塑膠廢棄物 PET 塑膠採用焚化處理回收路徑，將增加碳足跡排放。海洋廢棄物 PET 瓶的回收再利用潛力遠高於焚化處理，未來能在捕撈作業提高效率以及提升回收再利用之經濟效益，將能有機會解決海洋塑膠廢棄物之環境問題。

關鍵字：海洋塑膠廢棄物，碳足跡，PET 回收再利用

C04

多期多階段供應鏈中的氫氣生產與配送策略

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摘要

隨著傳統能源枯竭及化石燃料燃燒導致的環境惡化，能源問題備受關注。氫燃料因燃燒過程無二氧 化碳排放，被視為清潔能源的最佳選擇之一，也是實現 2050 年淨零碳排目標的關鍵。台灣因能源資源短 缺，主要依賴進口天然氣生產氫氣，但傳統技術如蒸汽甲烷重整、煤氣化與電解仍伴隨碳排放。因此，本 研究聚焦於“甲烷裂解”技術，開發多週期、多階段氫供應鏈模型。甲烷裂解可將天然氣分解為氫氣和固 態碳，實現零碳排放。該模型以混合整數線性規劃 (Mixed Integer Linear Programming, MILP)建構多週 期多階段網路運輸問題，涵蓋天然氣接收站、氫氣加工廠、儲存罐、工廠、加氫站及氫氣發電廠的各階段。 氫氣加工廠依賴風能和太陽能提供電力，但再生能源供應具有不穩定性，容易因環境條件波動導致能源 供應不足或過剩。為應對這種挑戰，本研究設計儲能裝置，用於儲存過剩能源，確保在供應不足時提供穩 定電力支持。本研究採用商業軟體 Gurobi 建立數學模型進行求解，首然後結合設計的演算法進行求解， 以提高大規模數據下的求解效率。通過多變數分析和約束條件的綜合考量，演算法能快速識別最佳成本 及運輸路線。數值實驗結果顯示，該模型與演算法的結合有效應對了氫供應鏈的複雜性，在成本控制與運 輸效率方面實現了顯著的優化效果。

關鍵字：氫氣供應鏈；再生能源；多週期模型；氫氣生產；混合整數線性規劃

Abstract

As traditional energy sources diminish and the combustion of fossil fuels accelerates environmental degradation, hydrogen fuel has gained recognition as a promising clean energy alternative. Since hydrogen produces no CO2 during combustion, it plays a critical role for nations striving to achieve net-zero carbon emissions by 2050. Many countries are now actively promoting hydrogen usage across power generation, industrial applications, and transportation sectors. In Taiwan, where energy shortages are a concern, hydrogen production currently relies on imported natural gas. However, traditional methods like steam methane reforming and coal gasification generate significant carbon emissions. To address this, the present study develops a multi-period, multi-stage hydrogen supply chain transportation model based on methane cracking technology, which produces hydrogen and solid carbon without harmful emissions. Utilizing Mixed Integer Linear Programming (MILP), the model incorporates natural gas terminals, hydrogen production plants, storage facilities, factories, refueling stations, and power plants, while integrating renewable energy sources with energy storage systems. Solved using Gurobi, the model aims to minimize costs and optimize transportation routes, effectively managing the complexity of hydrogen supply chains.

Keywords: Hydrogen supply chain; Renewable; Turquoise hydrogen; Hydrogen production; mixed integer linear programming

C05

利用投入產出分析法評估能源轉型政策對台灣產業之影響

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摘要

隨著全球氣候變遷日益嚴峻，世界各國開始推動「淨零碳排政策」(Net Zero)，以降低溫室氣體排放，減緩氣候變遷帶來的影響。台灣響應國際減碳趨勢，政府於2021年發佈「2050淨零排放路徑圖」，並提出四大轉型策略，包括能源、產業、生活及社會轉型，其中能源轉型是實現淨零目標的核心關鍵。而能源轉型不只涉及技術與政策調整，也會影響各產業的經濟與環境衝擊。本研究使用投入產出分析，以110年主計處產業關聯表為基礎，與台電產業分類和能源平衡表進行分配，並設立「非核家園」以及「核能復興」，探討不同能源結構下對各產業的影響，初步結果顯示「非核家園」下2050年的電力排放係數降至0.2187，「核能復興」下2050年的電力排放係數降至0.2071，後續研究將會分析兩種情境下對產業的影響，以及用電成本的評估。

關鍵字：能源轉型、碳排放、投入產出分析。

Abstract

As global climate change becomes increasingly severe, countries around the world are adopting "Net Zero Carbon Emission Policies" to reduce greenhouse gas emissions and mitigate the impacts of climate change. In response to the international trend of carbon reduction, Taiwan's government released the "2050 Net Zero Emissions Pathway" in 2021, outlining four major transformation strategies: energy, industry, lifestyle, and societal transformation. Among these, energy transformation is the core key to achieving the Net Zero target. Energy transformation involves not only technical and policy adjustments but also impacts the economic and environmental effects on various industries. This study uses Input-Output analysis based on the 2021 Industrial Input-Output Table from the Directorate-General of Budget, Accounting, and Statistics (DGBAS), alongside Taiwan Power Company’s industry classification and energy balance sheet, to set up two scenarios: the "Nuclear-Free Homeland" and the "Nuclear Revival". The study explores the impacts of different energy structures on various industries. Preliminary results show that under the "Nuclear-Free Homeland", the electricity emission coefficient for 2050 will drop to 0.2187, while under the "Nuclear Revival" , the coefficient will drop to 0.2071. Future research will analyze the industry impacts and assess electricity costs under both scenarios.

Keywords: Energy Transition, Carbon Emissions, Input-Output Analysis

C06

投入產出分析法與傳統碳排放評估方法之比較研究：以台灣產業為例

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摘要

許多企業透過碳盤查評估碳足跡，但現有方法計算過程繁瑣且耗時，對中小企業成本較高。傳統方法依賴生命週期評估和排放因子，數據需求龐大。投入產出分析法能通過金錢流、產值和電力消耗等數據計算碳排放，並顯示產業間的相互依賴性，相較傳統方法，資料需求較低，有助於簡化數據收集並迅速提供碳排放狀況。本研究基於能源平衡表，估算台灣產業電力消耗，並結合投入產出分析法計算碳排放量與碳強度，與台灣上市企業根據 GHG Protocol 或 ISO 14064 方法的碳排放結果進行比較。研究主要目的是分析兩者結果高估或低估現象，並評估投入產出分析法是否具備實際應用價值。若兩者結果存在差異，則第二步將深入探討這些差異原因，並分析其背後影響因素。目前研究結果顯示，與 GHG Protocol 或 ISO 14064 方法相比，利用投入產出分析法計算的碳排放結果較低，部分原因在於同一產業中不同企業性質可能導致差異。例如，若企業生產多個產品並跨足多個產業領域，則分配與計算會產生誤差；反之，產業屬性越單一，結果越接近。後續研究將計算範疇二，並將範疇一與範疇二加總，達成最終比較目標。進一步將深入探討某些產業中子產業的碳排放強度，以及比較 2021 年基準值推算至 2023 年的結果，驗證本研究方法的精準度與可行性。

關鍵字：投入產出分析法、碳強度、方法學比較、台灣產業

Abstract

As global climate change intensifies, carbon emission management has become an important issue for governments and businesses worldwide. However, existing carbon accounting methods require extensive data collection and calculations, which place a financial and time burden on small and medium-sized enterprises. Input-Output Analysis (IOA), as a macroeconomic tool, simplifies the data collection process and can calculate carbon emissions using data such as monetary flows, output values, and electricity consumption, offering an advantage in quickly understanding carbon emission status. This paper estimates electricity consumption in Taiwan's industries based on energy balance tables and combines IOA to calculate carbon emissions and carbon intensity, comparing the results with those obtained by Taiwan's listed companies using the GHG Protocol or ISO 14064 methods. The results show that the carbon emissions calculated using IOA are higher, mainly due to inconsistent data disclosure scopes, reflecting the challenges and areas for improvement in current calculation methods.

Keywords: Input-Output Analysis (IOA), Carbon Intensity, Methodology Comparison, Taiwanese Industries

C07

組織型碳盤查應用於產品碳足跡之可行性研究—以臺灣上市公司為例

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摘要

目前全球企業日益重視供應鏈管理與碳中和目標，組織型碳盤查遂成為各大企業每年的必要任務。 有鑒於品牌大廠有逐漸向供應商要求特定數據或產品碳足跡的趨勢，而產品碳足跡的盤查及評估既耗時 又費力。因此，本研究嘗試探討組織層面之碳盤查數據，分配至產品層面的可行性。本研究將針對臺灣上 市公司的永續報告書及財務年報進行數據整理，鑑別組織數據之邊界，透過物理單位或是價值進行分配 至該公司之產品，將結果與已揭露的產品碳足跡進行比較，來探討本研究的可行性與不同分配方法的差 異性。 初步結果顯示，不同產業在碳盤查數據分配存在顯著差異。特定產業（如水泥業）在物理分配上較具 有優勢，而其他產業則可能更適合經濟分配。此外，供應鏈管理的透明度與企業內部數據的完整性對數據 的準確性影響甚鉅。後續研究將進一步評估兩種盤查方法（由上而下、由下而上）的數據差異與優缺點， 並探討不同產業在組織碳盤查數據分配的方法建議，透過本研究協助中小型企業可以快速提供數據給供 應鏈，讓大型企業在供應鏈碳管理中提升減碳績效的可追蹤性，進而促進臺灣企業 ESG 永續發展與國際競爭力。

關鍵字：碳中和、組織型碳盤查、產品碳足跡、供應鏈管理

Abstract

As global enterprises increasingly emphasize supply chain management and carbon neutrality, organizational carbon inventory has become an essential annual task. Given the growing trend of major brands requiring specific data or product carbon footprints from suppliers, assessing carbon footprints is often time consuming and labor-intensive. This study explores the feasibility of allocating organizational carbon inventory data to the product carbon footprint level. By analyzing sustainability reports and financial statements of listed companies in Taiwan, this study identifies organizational data boundaries and applies physical or economic allocation methods to distribute emissions to products. The results are then compared with disclosed product carbon footprints to evaluate feasibility and differences between allocation methods. Preliminary findings indicate significant variations across industries in allocating organizational carbon inventory data. Certain industries, such as cement manufacturing, benefit from physical allocation, while others may be better suited to economic allocation. Moreover, supply chain management transparency and the completeness of internal corporate data significantly impact data accuracy. Future research will further assess the differences and advantages of top-down and bottom-up inventory methods and explore optimal allocation strategies for different industries. By enabling SMEs to efficiently provide data within the supply chain, this study aims to enhance the traceability of carbon reduction efforts for large enterprises. Ultimately, the findings will support Taiwan's corporate ESG sustainability and global competitiveness.

Keywords: Carbon Neutrality, Organizational Carbon Inventory, Product Carbon Footprint, Supply Chain Management

口頭論文發表 D 消費者行為與永續教育

D01 消費者環境意識真的能增強零售商的綠色行銷與永續消費行為的關係嗎？-以全家及 7-11 便利商店為例

D02 探討企業環境投資對於投資人影響因素分析—以我國綠色債券為例

D03 提升環保集點參與意願之策略探討

D04 循環包裝服務之影響因素探討

D05 永續認知、利他主義、人格特質對綠色產品購買意圖之影響

D06 結合 RaQFD 與 TRIZ 工具評估暨開發永續產品

D07 軟裝產業的永續發展-生成式人工智慧導入顧客旅程地圖階段之探討

D08 環保訊號之廣告對購買意願的影響：品牌好感度和環保意識為中介效果

D09 以轉換障礙理論探討消費者循環杯使用意圖

D11 人力資源管理效能與永續轉型：探討主管-員工關係影響機制

D12 雙層規劃下的奢侈品市場定價模型：從全新到二手市場的賽局分析

D13 探討科技公司如何運用 ESG 行為提升消費者知覺價值與購買意願,品牌溝通、生活型態為調節變數-以華碩為例

D14 社群媒體參與、生活型態、購買意願與環境意識之關聯性研究-以 Z 世代為例

D15 UTAU 在獨立音樂製作中的應用與優勢

D16 從永續行為設計觀點探討循環餐盒行為採用阻礙與設計關鍵要素

D01

消費者環境意識真的能增強零售商的綠色行銷與永續消費行為的關係嗎？-以全家及 7-11 便利商店為例

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摘要

近年，全球消費者對環保議題的意識逐漸增強，使環境保護議題成為社會焦點。而 Z 世代消費族群（以下簡稱為 Z 世代）將成為消費市場主力，其除了具有永續環境意識外，也願意購買永續產品或服務，改變親朋好友的消費行為。現今企業開始將永續概念納入各種營運目標，尤其在行銷策略中融入永續概念，已成為企業的競爭優勢，其中以綠色行銷策略是最常應用的。然而目前在推動消費者永續消費，卻面臨一大障礙，就是在實際消費市場中，消費者的「環境意識」與實際的「購買行為」並不完全相同，但消費者的永續消費行為卻深受零售商的綠色行銷策略影響。因此，本研究以 Z 世代為研究對象，共發放 326 份問卷，並以全家和 7-Eleven 作為零售商代表，運用統計分析，探討零售商綠色行銷策略對 Z 世代永續消費行為的關係，以及其永續環境意識對兩者間的影響程度。研究發現零售商綠色行銷策略對 Z 世代的永續消費影響程度不一，且此族群的環境意識對其永續消費具顯著正向影響，但其環境意識對零售商綠色行銷策略與其永續消費間不具調節效果。最後，本研究建議，零售商應調整綠色產品與促銷策略、提高 Z 世代的消費動機與永續消費行為的連結性、增強社群經營與行動支付的運用，以及增強廢棄物回收策略。

關鍵字：綠色行銷、永續消費、環境意識

D02

探討企業環境投資對於投資人影響因素分析
—以我國綠色債券為例

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摘要

隨著氣候變遷與 ESG 議題備受關注，企業日益重視永續發展與社會責任。本研究探討臺灣企業環境投資對投資人之影響，聚焦我國綠色債券發展，並針對具金融知識之商管學院學生為對象，以計畫行為理論(TPB)為基礎，態度、主觀規範、知覺行為控制、氣候風險感知、環境關注與漂綠擔憂構面進行問卷分析。研究結果顯示，氣候風險感知對態度與環境關注皆具顯著正向影響，環境關注亦能進一步正向預測態度，而態度、主觀規範與知覺行為控制對投資行為意圖皆呈現顯著影響，顯示 TPB 模型在解釋潛在投資人行為意圖上具有良好適配性。此外調節效果分析顯示，漂綠擔憂顯著調節態度與主觀規範對行為意圖之影響，代表當投資人對企業綠色主張的真實性抱持較高疑慮時，其行為意圖更容易受到內部價值評估與社會期待之影響。綜合研究發現，建議政府與教育機構強化永續金融之教育推廣，提升未來投資人對企業環境資訊與永續聲明之辨識與解讀能力；企業亦應提高其永續揭露之透明度與可信度，以增進市場信任並有效促進綠色金融體系之深化與發展。

關鍵字：氣候變遷、環境投資、綠色債券、漂綠、偏最小平方結構方程模型。

Abstract

With the increasing global attention to climate change and ESG issues, corporations are placing greater emphasis on sustainable development and social responsibility. This study explores the influence of corporate environmental investment in Taiwan on investors, focusing specifically on the development of green bonds. The research targets business school students with financial knowledge and adopts the Theory of Planned Behavior (TPB) as its theoretical foundation. Constructs such as attitude, subjective norm, perceived behavioral control, climate risk perception, environmental concern, and greenwashing concern are examined through a questionnaire-based analysis.The results indicate that climate risk perception has a significant positive impact on both attitude and environmental concern, while environmental concern further positively predicts attitude. Additionally, attitude, subjective norm, and perceived behavioral control significantly influence investment behavioral intention, demonstrating that the TPB model is well-suited to explaining the behavioral intentions of potential investors. Furthermore, moderation analysis reveals that greenwashing concern significantly moderates the effects of attitude and subjective norm on behavioral intention. This suggests that when investors have greater doubts about the authenticity of corporate green claims, their behavioral intentions are more susceptible to being influenced by internal value judgments and perceived social expectations.Based on these findings, this study recommends that governments and educational institutions enhance sustainable finance education to improve future investors' ability to interpret corporate environmental information and sustainability claims. Enterprises should also improve the transparency and credibility of their sustainability disclosures to strengthen market trust and effectively advance the development of a robust green finance ecosystem.

Keywords: Climate Change, Environmental Investment, Green Bonds, Greenwashing Concern, PLS-SEM.

D03

提升環保集點參與意願之策略探討

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摘要

本研究旨在探討影響環保集點 APP 使用意願的關鍵因素，並透過說服科技設計有效的誘因，以提升使用者的參與度與持續性。首先透過 MAT 模型架構，分析影響使用意願的主要變數，接著運用情境式問卷，模擬環保集點 APP 不同行為階段的介面與功能，以評估不同說服策略對使用行為的影響。研究結果顯示，在動機方面，擁有集點習慣、較高的集點興趣的使用者更傾向持續使用，而回饋不足可能是降低使用意願的主因；在能力方面，不熟悉操作及科技接受度是主要障礙；在觸發方面，未曾聽過可能會降低使用意願。此外，研究篩選出 15 項適用之說服策略，結果顯示引導 Tunneling (5.841)、互惠 Reciprocity (5.840)與簡化 Reduction (5.783) 對提升使用者參與度最具成效。這樣的結果為政策制定者提供依據，以促進更全面的環保鼓勵措施，同時也為 APP 開發者指明改善介面設計與誘因機制的具體方向，有助於推動環保行為的長期實踐。

關鍵字：環保集點、說服科技、MAT 模型、綠色消費

D04

循環包裝服務之影響因素探討

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摘要

循環包裝作為減少廢棄物的有利解方被提出，但目前循環包裝在國內似乎尚不普及，故本研究想瞭解影響消費者使用循環包裝的因素，並比較不同預測模型的差異，以對現存與未來可能的服務進行評估。為此，本研究回顧文獻了解影響使用意願的因素，並使用迴歸分析以及類神經網路分析對循環包裝的服務設計進行探討。研究結果顯示，歸還方便性、衛生疑慮及攜帶方便性等主觀因素是影響消費者使用循環包裝最重要的因素；客觀因素中最重要的是預支付金額、退款金額，以及回饋模式與包裝類型；此外，包裝可折疊的比例、可能造成的金錢損失也是影響使用意願的重要因素。類神經網路的結果則顯示，攜帶方便性、縮減比、平均損失與退款金額對使用意願可能存在非線性影響。而模型預測指出，循環包裝無須付費的使用意願最高，最低者為在家歸還，改使用押金制則與配客嘉的現狀使用意願相同。建議未來循環包裝服務可降低預支付金額，增加退款金額，並且提高包裝可折疊收納的比例，而且必須重視循環包裝的歸還方便性、攜帶方便性與衛生疑慮等主觀感受。最後，建議循環包裝提供者避免收取罰金或使用在家歸還的服務模型。

關鍵字：循環包裝、服務設計、使用意願、迴歸分析、類神經網路。

D05

永續認知、利他主義、人格特質對綠色產品購買意圖之影響

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摘要

過去研究對人格特質如何影響消費者綠色購買決策缺乏系統性實證探討，僅關注永續認知與利他主義對綠色購買意圖的影響。因此，本研究以計劃行為理論為主軸，納入永續認知、利他主義及人格特質，探討影響消費者綠色產品購買意圖的因素。本研究透過問卷調查法收集 309 份有效問卷，並運用 SPSS 與 AMOS 進行數據分析，結果顯示：1.永續認知對主觀規範與知覺行為控制具有正向顯著影響。2.利他主義對主觀規範與知覺行為控制具有正向顯著影響。3.知覺行為控制對綠色產品購買意圖具有正向顯著影響。

關鍵字：永續認知、利他主義、人格特質、計劃行為理論、綠色購買意圖。

Abstract

In the past, there was a lack of systematic and empirical discussion on how honesty-humility affect consumers' green purchase intentions, merely focusing on the impact of SDGs knowledge and altruism on green purchase intentions. Therefore, this research takes the theory of planned behavior as the core, incorporates SDGs knowledge, altruism and honesty-humility to explore the factors that affect consumers' intention to purchase green products. In this study, 309 valid questionnaires were collected through the questionnaire survey method, and SPSS and AMOS were used for data analysis. The results showed that: 1. SDGs knowledge has a positive and significant impact on subjective norms and perceived behavioral control. 2. Altruism has a positive and significant impact on subjective norms and perceived behavioral control. 3. Perceived behavioral control has a positive and significant impact on green purchase intentions.

Keywords: SDGs Knowledge, Consumers Altruism, Honesty-Humility, Theory of Planned Behavior, Green Purchase Intentions

D06

結合 RaQFD 與 TRIZ 工具評估暨開發永續產品

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摘要

本研究是以「最小資源消耗」為核心、同時納入使用者真實感受及設計(工程)參數與挑戰，建立一「重新配置品質機能展開(Rearranged Quality Function Deployment, RaQFD)」工具，並協同「TRIZ技術演進/理想最終解(Technique Evolution/Ideal Final Result, IFR)與矛盾矩陣(Contradiction Matrix)」進行設計解題，獲取更貼近需求且滿足精確量化評析的永續產品。本研究嘗試以上述方法發展可適用於即食熟食包裝，過程中重新檢視消費者真實感受，並對一模擬的自身現有設計與主要競爭對手進行量化評估，得到適切的設計參數與可挑戰問題，最後得到可行的新設計。

關鍵字：重新配置品質機能展開(RaQFD)、TRIZ、永續設計、即食熟食包裝

Abstract

This study centers on the concept of "minimal resource consumption" while incorporating users' real experiences, design requirements, and challenges. A "Rearranged Quality Function Deployment (RaQFD)" tool was established and can integrate itself with "TRIZ Technique Evolution/Ideal Final Result (IFR) and the Contradiction Matrix" to solve design problems. The proposed tool aims to develop sustainable products that better meet user needs while allowing precise quantitative evaluation. The study applied the proposed tool to develop packaging suitable for instant or ready-to-eat foods, several design requirements and challenges were met after conducting a quantitative evaluation of a simulated existing design and major competitors, finally a new feasible design was reached by inspirations.

Keywords: Rearranged Quality Function Deployment(RaQFD), TRIZ, Sustainable Design, Ready-to-eat Package

D07

軟裝產業的永續發展-生成式人工智慧導入顧客旅程地圖階段之探討

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摘要

台灣軟裝產業自傳統製造轉型為品牌整合，面臨消費者對個性化體驗與永續議題的雙重需求，亟需透過GAI技術優化服務流程。本研究透過文獻與實地調查建構顧客旅程地圖，識別各階段之痛點；並以問卷調查消費者對GAI接受度與永續偏好，並結合IKEA Kreativ等個案分析，驗證GAI技術之效益。

研究發現，消費者對GAI應用整體持審慎樂觀態度，其中年輕族群對AI工具接受度顯著更高，而高學歷者對AI生成方案可信度較為保留。永續偏好方面，消費者重視環保資訊，但旅程痛點仍以「設計與實際效果落差」及「資訊不透明」為主，顯示實用性需求優先於永續數據的不足。技術應用層面，GAI於各階段具顯著潛力：靈感階段可減少實體樣本製作；方案階段透過AR可視化降低實體參訪碳足跡；決策階段透明化環保數據提升信任；售後階段以AI客服加速問題處理，延長產品週期。

基於上述，本研究提出「GAI導入CJM的整合應用」，建議產業嵌入環保數據模組（如碳排計算）、優化數位接觸點（如AI客服與AR工具），並強化消費者永續教育。總而言之，GAI技術結合CJM不僅能解決消費者痛點，更有助推動低碳消費生態，為軟裝產業數位轉型與永續發展提供方向。

關鍵字：生成式人工智慧、顧客旅程地圖、永續發展、軟裝產業

Abstract

This study investigates the integration of Generative Artificial Intelligence (GAI) with Customer Journey Maps (CJM) to address sustainability and digital transformation challenges in Taiwan's soft furnishings industry. Through mixed-method research—including CJM construction, consumer surveys, and case studies (e.g., IKEA Kreativ)—the study identifies key pain points across four customer journey stages: inspiration, design, decision-making, and post-purchase feedback.

Findings indicate cautious optimism toward GAI adoption, with younger consumers showing higher acceptance and highly educated individuals expressing reservations about AI-generated solutions. While sustainability concerns are prioritized, practical issues like design-reality gaps and information opacity dominate consumer pain points. GAI demonstrates transformative potential by enabling virtual design prototyping, AR-driven visualization, transparent sustainability reporting, and AI-enhanced after-sales support.

The study proposes a GAI-CJM integration framework, emphasizing three pillars: embedding sustainability metrics (e.g., carbon footprint tracking), optimizing digital touchpoints (e.g., AR tools, AI chatbots), and fostering consumer education on eco-conscious choices. This approach not only addresses critical consumer challenges but also aligns with low-carbon practices, offering a strategic roadmap for the industry's sustainable and digital evolution.

Keywords: Generative Artificial Intelligence, Customer Journey Map, Sustainable Development, Soft Furnishings Industry

D08

環保訊號之廣告對購買意願的影響：品牌好感度和環保意識為中介效果

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摘要

近年來，全球環境議題日益受到關注，推動消費者環保意識的轉變。在市場競爭激烈的環境下，廣告成為企業傳遞品牌訊息與吸引消費者的關鍵工具，而消費者的環保意識則影響其對廣告的評價與購買行為。然而，永續行銷的效果並非總是如預期，部分消費者可能對環保廣告產生懷疑或反感。根據訊號理論，消費者在資訊不對稱的交易情境下，難以辨別商品品質，導致購買前後的預期落差。因此，本研究基於訊號理論，透過實驗法探討環保概念廣告對消費者態度的影響。本研究共有 327 位填答者，其中有效問卷 304 份，分析結果顯示，廣告態度對品牌好感度與環保意識具有正向顯著影響，品牌好感度亦正向影響購買意願，同時環保意識對購買意願具有正向影響。此研究結果有助於深化對廣告與品牌關係的理解，並為企業及行銷人員提供設計環保廣告的實務建議，以提升消費者對品牌的好感度、環保意識與購買意願，進一步提升企業競爭力並回應社會對環保的期望。

關鍵字：廣告態度、品牌好感度、環保意識、購買意願

Abstract

In recent years, global environmental issues have received increasing attention, driving a shift in consumer environmental awareness. In a highly competitive market, advertising has become a crucial tool for companies to convey brand messages and attract consumers, while consumer environmental consciousness influences their evaluation of advertisements and purchasing behavior. However, the effectiveness of sustainable marketing does not always meet expectations, as some consumers may feel skeptical or resistant toward environmental advertisements. According to signaling theory, in a transaction environment with information asymmetry, consumers find it difficult to assess product quality accurately, leading to a gap between their pre-purchase expectations and post-purchase experience. Therefore, based on signaling theory, this study employs an experimental method to explore the impact of environmental concept advertisements on consumer attitudes. A total of 327 respondents participated, with 304 valid questionnaires collected. The analysis results indicate that advertising attitudes have a significant positive effect on both brand favorability and environmental consciousness. Furthermore, brand favorability positively influences purchase intention, and environmental consciousness also has a positive impact on purchase intention. The findings of this study contribute to a deeper understanding of the relationship between advertising and branding, providing practical recommendations for businesses and marketers in designing environmental advertisements. By enhancing consumer brand favorability, environmental awareness, and purchase intention, companies can strengthen their competitiveness while responding to society's expectations for environmental sustainability.

Keywords: advertising attitudes, brand favorability, environmental consciousness, purchase intention

D09

以轉換障礙理論探討消費者循環杯使用意圖

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摘要

台灣為飲料王國，一年需使用的一次性飲料杯十分可觀，如何在消費中達到環境永續成為問題。近 年為配合SDG12責任消費與生產及政府政策，業者推出循環杯，然而效果不如預期。本研究為瞭解消 費者對於循環杯之使用行為，以轉換障礙、環保意識、使用情境之觀點切入，並將使用情境分為自用及 地點便利性作為干擾變數納入考量，剖析使用情境在轉換障礙、環保意識及使用行為之間的干擾效果。 綜合以上，本研究將以問卷調查方式，總回收313份有效問卷，並且以 SmartPLS 進行資料分析，研究 結果顯示慣性對於使用意圖具有負面影響、環保意識能強化消費者使用意圖、地點便利性對於慣性及使 用意圖具干擾效果、自用對於替代品及環保意識及使用意圖不具顯著干擾效果、地點便利性對於轉換成 本及使用意圖不具顯著干擾效果、轉換成本及替代品對於使用意圖不具顯著負面影響。期望本研究結果 能給予學術界與業界更具建設性的依據參考，為台灣循環經濟成長路上注入養分；期許研究結果有助於 引導消費者了解並實踐循環經濟，為地球盡一份心力。

關鍵字：循環杯、轉換障礙、環保意識、自用、地點便利性

Abstract

Taiwan is often referred to as a beverage kingdom, with a significant number of disposable drink cups used annually. Achieving environmental sustainability in consumption has become a crucial issue. In recent years, aligning with Sustainable Development Goal 12 (responsible consumption and production) and government policies, businesses have started to introduce circular cups. However, the effectiveness of these efforts has not met expectations. This study aims to understand consumer behavior towards reusable cups by examining switching barriers, environmental awareness, and usage scenarios. It categorizes usage scenarios into two main types: personal use and location convenience, which serve as moderating variables. The research analyzes how these usage scenarios influence the relationships between switching barriers, environmental awareness, and usage behavior. A total of 313 valid responses were collected through a questionnaire survey, and SmartPLS was employed for data analysis. The findings indicate that existing habits negatively impact the intention to use reusable cups, while environmental awareness positively strengthens this intention. Furthermore, location convenience moderates the relationship between habits and usage intention. In contrast, personal use does not significantly moderate the relationships between switching barriers, environmental awareness, and usage intention. Additionally, location convenience does not significantly moderate the impact of switching costs on usage intention. This study aims to provide valuable insights for both academia and industry, contributing to the development of Taiwan's circular economy and assisting consumers in understanding and practicing circular economy principles for the benefit of the planet.

Keywords: Circular Cups、Switching Barriers、Environment Awareness、Self-Use、Location Convenience

D11

人力資源管理效能與永續轉型：探討主管-員工關係影響機制

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摘要

本研究探討人力資源管理中主管與員工關係的中介效應，聚焦於領導風格、溝通質量、信任與情緒智力對組織效能的影響，並研究主管在推動企業ESG目標中的角色。研究透過問卷調查20家中大型企業的400-600位主管與員工。結果顯示轉換型與交易型領導對員工績效具正向影響，溝通質量是領導效能的重要中介因素。研究發現高度信任關係與領導者情緒智力能強化領導效果，主管的永續發展認知也與組織永續實踐呈現正相關。透過Google、Starbucks和台積電的案例分析，驗證理論發現的實務價值，為組織提供優化主管-員工關係的建議。

關鍵字：人力資源管理、領導風格、主管與員工關係、永續發展、ESG。

Abstract

This study examines the mediating effects of supervisor-employee relationships in human resource management, focusing on how leadership styles, communication quality, trust, and emotional intelligence impact organizational effectiveness, while also investigating supervisors' roles in advancing corporate ESG objectives. The research employed questionnaire surveys of 400-600 supervisors and employees across 20 medium to large enterprises. Results indicate that both transformational and transactional leadership styles positively influence employee performance, with communication quality serving as a crucial mediating factor in leadership effectiveness. The study reveals that high levels of trust and leaders' emotional intelligence significantly enhance leadership outcomes, while supervisors' sustainability awareness shows a positive correlation with organizational sustainability practices. Through case analyses of Google, Starbucks, and TSMC, the research validates its theoretical findings in practical applications, providing organizations with recommendations for optimizing supervisor-employee relationships.

Keywords: Human Resource Management, Leadership Styles, Supervisor-Employee Relationships, Sustainable Development, ESG.

D12

雙層規劃下的奢侈品市場定價模型：從全新到二手市場的賽局分析

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摘要

根據美國貝恩策略顧問公司2023年報告，全球全新奢侈品市場較2022年增長約10%，顯示自2018年以來奢侈品消費顯著增長，預計2030年市場規模將達5300至5700億歐元。隨著年輕消費者和綠色消費觀念的興起，越來越多人選擇價格較低的二手奢侈品。2022年全球二手奢侈品市場產值達330億歐元，未來五年內年增長約15%，成長速度已達全新市場的四倍，對其構成重大挑戰。奢侈品市場的顧客分為「時尚領導者」與「時尚追隨者」。時尚領導者通常在新品上市初期購買，而追隨者則根據價格決定購買時機。第一型追隨者在價差不大的情況下會選擇全新市場，第二型追隨者則偏向二手市場。過去多數研究聚焦於全新市場，忽略二手市場的影響。為解決全新與二手市場的定價問題，本研究提出雙層歸劃模型，強調時尚領導者與追隨者的購買行為。研究發現，全新市場推出新品時，價格高且供應稀少會推動時尚領導者需求，進而影響追隨者的購買意願。當全新與二手市場價差較小，第一型追隨者仍會選擇全新市場。隨著需求增加，領導者也可能將部分商品轉售至二手市場，吸引第二型追隨者。結果顯示，全新市場適度減少供應並調降售價，若與二手市場價差不超過20%，能吸引最多時尚領導者，並刺激第一型追隨者的需求，最大化全新市場利潤。該策略滿足領導者需求的同時，也吸引更多消費者，實現最佳盈利效果。

關鍵字：奢侈品定價、雙層規劃、二手市場、領導者-追隨者市場、賽局理論

Abstract

Since 2018, global luxury consumption has significantly increased, with market projections estimating an expansion to €530-570 billion by 2030. In 2023, the secondary market's growth rate was four times of the primary luxury market, posing a substantial challenge. Thus, primary luxury enterprises must determine optimal pricing strategies to attract consumers while maintaining scarcity. Research segments luxury market customers into fashion leaders and followers, whose behaviors influence the industry. Fashion leaders purchase in the initial phase through early channels, while followers base decisions on price differentials. First-type followers buy early despite price differences, while second-type followers purchase later. Previous studies focused on the primary market, neglecting the secondary market's impact. This study develops a bi-level optimization model to address pricing issues between primary and secondary luxury markets, considering fashion leaders and followers. When a new product is released in the primary market, fashion leaders drive demand due to high prices and limited supply. Followers, influenced by leaders' demand, increase their purchase intentions. However, due to price-sensitive followers and secondary market prices forecast; if the price differential is minimal, first-type followers buy in the primary market. Increased demand from followers leads fashion leaders to sell more in the secondary market due to the prestige effect, while second-type followers buy there. Results show that reducing supply, lowering prices in primary market, and ensuring price gap with secondary market to not exceed 20%, can attract maximum number of fashion leaders. This minimal price differential boosts demand from first-type fashion followers, maximizing primary market profits. This strategy does not solely target fashion leaders with high prices for exclusivity but maintains scarcity and appeals to a broader consumer base for optimal profitability.

Keywords: Luxury Product Pricing, Secondary Market, Bi-level, Leader-Follower, Game theory

D13

探討科技公司如何運用 ESG 行為提升消費者知覺價值與購買意願，品牌溝通、生活型態為調節變數－以華碩為例

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摘要

近年來，全球對 ESG 議題的關注日益提升，尤其 COVID-19進一步加速企業永續發展的轉型，使 ESG 行 為成為品牌競爭力的重要指標。許多國際組織與政策也倡導企業將 ESG 納入營運策略，以實現經濟效益與社 會責任的雙贏。然而，過去多數研究著重於企業如何透過 ESG 策略提升財務表現，較少關注消費者是否能感 知企業的 ESG 行為，以及這些行為對其購買意願的影響。因此，本研究以華碩為例，探討企業 ESG 行為對消 費者知覺價值與購買意願的影響，並進一步分析品牌溝通與生活型態的調節作用。現今，品牌溝通已變得更 加互動化與多元化，企業能否透過有效的溝通方式傳遞 ESG 理念，將影響消費者的認知與態度。此外，不同 收入水平、世代與文化背景的消費者，對企業 ESG 行為的重視程度可能有所不同。因此，本研究期望能夠提 供更全面的視角，幫助企業縮小消費者「意圖－行為落差」，提升其永續競爭力，並促進社會的永續發展。本 研究透過量化問卷調查，收集消費者對企業 ESG 行為的認知與購買行為，並利用 SPSS 進行數據分析。最後， 藉由分析結果提出結論，並加以給予相關建議。

關鍵字：ESG 行為、消費者知覺價值、消費者購買意願、品牌溝通、生活型態。

Abstract

Global attention to ESG issues has risen in recent years, making ESG practices a crucial indicator of brand competitiveness. Many international organizations and policies advocate integrating ESG into corporate strategies to achieve a win-win situation between economic benefits and social responsibility. However, in existing studies, little attention is given to whether consumers can perceive corporate ESG practices and how those influence their purchase intentions. Therefore, this study takes ASUS as an example to examine the impact of corporate ESG practices on consumer perceived value and purchase intention, while further analyzing the moderating effects of brand communication and lifestyle. Today, brand communication has become increasingly interactive and diverse. Whether companies can effectively convey their ESG practices through appropriate communication strategies will influence consumer perception and attitudes. In addition, consumers of different income levels, generations, and cultural backgrounds may vary in their emphasis on corporate ESG practices. Thus, this study aims to provide a more comprehensive perspective to help businesses bridge the "intention-behavior gap" among consumers, enhancing their sustainable competitiveness, and promoting societal sustainability. This study is quantitative research and SPSS was used for data analysis. Finally, based on the analytical results, conclude the conclusions, and provide relevant recommendations.

Keywords: ESG Practices, Consumer Perceived Value, Consumer Purchase Intention, Brand Communication, Lifestyle

D14

社群媒體參與、生活型態、購買意願與環境意識之關聯性研究－以 Z 世代為例

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摘要

本研究探討社群媒體參與如何影響 Z 世代的生活型態，進而改變其消費模式，並分析環保意識在其中的調節作用。隨著社群媒體的普及，年輕世代的消費行為正受到前所未有的影響。本研究透過量化方法，蒐集並分析 Z 世代使用社群媒體的行為數據，以檢驗社群媒體參與對於生活型態的影響，以及生活型態如何進一步影響消費模式。此外，環保意識作為調節變數，可能影響社群媒體參與與生活型態之間的關係，以及生活型態與消費模式之間的關聯。本研究採用問卷調查法，針對 Z 世代進行數據蒐集研究。結果顯示，社群媒體參與對 Z 世代的生活型態具有顯著影響，而生活型態亦顯著影響其消費模式。此外，環保意識在其中發揮關鍵調節作用，能夠強化或削弱這些關聯。本研究的結果有助於企業與政策制定者更深入理解 Z 世代的消費行為，並提供企業在行銷策略上的實務建議，以因應綠色消費趨勢。同時，本研究也為學術界提供新的視角，以進一步探索社群媒體、環保意識與消費行為之間的關係。

關鍵詞：社群媒體參與、Z 世代、生活型態、環保意識、消費模式

Abstract

This study examines how social media engagement influences the lifestyle of Generation Z, subsequently altering their consumption patterns, and analyzes the moderating role of environmental awareness. With the widespread use of social media, the consumption behavior of younger generations is being impacted in unprecedented ways. Through quantitative methods, this research collects and analyzes data on Gen Z's social media usage to investigate the impact of social media engagement on lifestyle and how lifestyle affects consumption patterns. Environmental awareness serves as a moderating variable, potentially influencing the relationship between social media engagement and lifestyle, as well as between lifestyle and consumption patterns. Using a survey-based approach, the study collects data from Gen Z participants. The results show that social media engagement significantly influences Gen Z's lifestyle, which in turn affects their consumption patterns. Additionally, environmental awareness plays a crucial moderating role, either strengthening or weakening these associations. The findings provide insights for businesses and policymakers to better understand Gen Z's consumption behavior and offer practical marketing strategy recommendations to align with green consumption trends. The study also offers new perspectives for academia to further explore the relationships between social media, environmental awareness, and consumption behavior.

Keywords: Social media engagement, Generation Z, Lifestyle, Environmental Awareness, Consumption Patterns

D15

UTAU 在獨立音樂製作中的應用與優勢

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摘要

UTAU 是一款免費的歌唱合成軟體，廣泛應用於獨立音樂製作領域。本文探討 UTAU 的技術基礎、使用優勢及在獨立音樂製作中的實際應用案例，研究聚焦於其基於連結合成（Concatenative Synthesis）的核心機制，以及其相對於商業軟體（如VOCALOID）進行對比。研究發現，UTAU 的聲庫可取得多樣性、高度歌聲表演參數自訂性和免費特性，及社群支持等優勢下，顯著賦能獨立音樂人，使其成為提供獨立音樂人低成本、高創意的理想工具。此外，本文也分析 UTAU 的技術限制，並提出未來發展可能的改進方向。

關鍵字：UTAU、獨立音樂、歌唱合成、開源軟體、音樂製作。

Abstract

UTAU is a free singing synthesis software that is widely used in the field of independent music production. This paper explores the technical foundation of UTAU, its advantages in use, and actual application cases in independent music production. The research focuses on its core mechanism based on concatenative synthesis, as well as its comparison with commercial software such as VOCALOID. The study finds that, with advantages such as the diversity of voice libraries, highly customizable vocal performance parameters, its free nature, and strong community support, UTAU significantly empowers independent musicians, making it an ideal tool that offers low-cost and highly creative possibilities. Additionally, this paper analyzes the technical limitations of UTAU and proposes possible improvements for its future development.

Keywords: UTAU, Independent music, vocal synthesis, open source software, music production.

D16

從永續行為設計觀點探討循環餐盒行為採用阻礙與設計關鍵要素

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摘要

隨著循環經濟與淨零碳排目標的推動，循環餐盒被視為減少一次性包裝廢棄物的重要解方。然而，消費者對循環餐盒的接受意願受限於心理動機、社會文化與使用限制等多重面向。本研究旨在探討消費者對循環餐盒採用行為的主要阻礙因素，並關注如何透過設計介入策略改變消費者使用參與意願。本研究主要透過系統性文獻回顧將循環餐盒行為採用阻礙歸納為：(1)消費者內在動機與情感價值、(2)功能需求與衛生安全考量、(3)使用便利性與實踐成本、(4)社會影響與規範目標。同時運用「永續行為設計(Design for Sustainable Behaviour, DfSB)」理論架構，藉由綜合分析現有循環餐盒實行案例，探討永續行為設計介入策略如何改善消費者在使用意圖、衛生考量、社會影響等行為阻礙，進而整理影響使用意圖與持續使用的關鍵設計要素，為實務推廣提供參考依據。

關鍵字：循環餐盒、永續行為設計、消費者行為

Abstract

With increasing emphasis on the circular economy and net-zero carbon goals, reusable food containers are viewed as a key solution to reduce single-use packaging waste. However, consumer adoption remains limited due to psychological motivations, cultural norms, and practical constraints. This study explores the behavioral barriers to adopting reusable food containers and examines how design interventions can increase user participation and willingness to use. Through a systematic literature review, four categories of barriers are identified: (1) intrinsic motivation and emotional value, (2) functional needs and hygiene concerns, (3) usability and perceived cost, and (4) social influence and normative expectations. Using the Design for Sustainable Behavior (DfSB) framework, the study analyzes existing cases to understand how design strategies can mitigate these barriers, especially those related to convenience, hygiene perception, and social dynamics. The research aims to extract key design elements that influence both initial adoption and continued use, offering insights to support the practical promotion and implementation of reusable container systems.

Keywords : Reusable Food Containers, : Design for sustainable behavior, Consumer Behavior

口頭論文發表 E 英文論文發表

E06 Exploring the Inclusivity of Sustainable Consumption Design: Strategies for Cause-Related Marketing in Addressing Menstrual Poverty

E08 The development of a series of sustainable, educational mechanical science toys designed for elementary and junior high school students

E09 Practicing local performance through corporate social responsibility: the case of Grand Vision Co., Ltd. as an example

E11 Predictive Analytics for Financial Econometric Hyper-Chaotic System Exploiting the Knacks of Modified Gauss-Newton and Gradient Descent Methods

E12 AI-Driven Market and Team Evaluation Strategies for Early-Stage CVC in Sustainability

E06

Exploring the Inclusivity of Sustainable Consumption Design: Strategies for Cause-Related Marketing in Addressing Menstrual Poverty

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Abstract

In the context of sustainable consumption, cause-related marketing (CRM) has shown potential for addressing social challenges. This study explores the feasibility of applying CRM to alleviate menstrual poverty by examining its relationship with menstrual health through a literature review and case studies. It assesses whether CRM can contribute to achieving the Sustainable Development Goals (SDGs), particularly “No Poverty” and “Gender Equality. “Menstruation is a critical aspect of female well-being (Ganguli, 2022), and addressing menstrual poverty is essential for health equity. This study aims to bridge the research gap by integrating CRM and menstrual health, positioning CRM as a sustainable strategy to enhance access to menstrual health products and services. Additionally, this research investigates AI-driven innovations in menstrual health management, optimizing products and services while exploring how businesses can align profitability with social responsibility. By integrating corporate incentives with efforts to address menstrual poverty, companies can achieve both financial sustainability and social impact. This approach fosters collaboration between industry and academia, ensuring technological advancements benefit both market growth and public welfare. Survey results indicate that participants are aware of and concerned about their rights as women. They are willing to use AI-driven menstrual health products, share data for product improvements, and promote these innovations while supporting other needy women. These findings highlight a strong connection between AI, creative industry design, and menstrual poverty solutions, emphasizing the potential for interdisciplinary approaches to tackling this issue.

Keywords: SDGs(Sustainable Development Goals), AI(Artificial Intelligence), Cause-Related Marketing, Sustainable Consumption, Sustainable Production , Female Rights.

E08

The development of a series of sustainable, educational mechanical science toys designed for elementary and junior high school students

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Abstract

This research investigates the development of a series of sustainable, educational mechanical science toys designed for elementary and junior high school students. The project employs a multidisciplinary approach, integrating origami-inspired papercraft, utilizing materials such as corrugated and hard cardboard, with 3D-printed mechanical components to create interactive representations of Taiwan's intangible cultural heritage. The primary objective is to enhance students' understanding of fundamental mechanical principles and foster cultural awareness through hands-on assembly and manipulation. Six culturally significant Taiwanese festivals, including the Dajia Mazu Pilgrimage and the Dragon Boat Festival, serve as thematic foundations for toy designs. The study aims to demonstrate the efficacy of integrating traditional cultural elements with STEM education, providing a novel pedagogical tool for engaging students in both mechanical learning and cultural preservation. Preliminary findings suggest that the integration of papercraft and 3D printing offers a viable and engaging method for conveying complex mechanical concepts and cultural narratives to young learners. Future work will focus on evaluating the pedagogical impact of the toys through controlled educational studies and exploring the potential for commercialization and wider dissemination.

Keywords: Mechanical Toys & STEM / STEAM, Education Cultural Heritage Papercraft, 3D Printing & Automata Design, Hands-on & Focused Learning

E09

Practicing local performance through corporate social responsibility: the case of Grand Vision Co., Ltd. as an example

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Abstract

Recent years have seen a progression in economic globalisation, which ostensibly improves living standards and offers a more promising future. However, this progression has also resulted in various social problems. Taiwan and Japan have a number of similarities, including declining birthrates, an ageing population and excessive population concentration in cities. In response to these challenges, the Executive Yuan of Taiwan declared 2019 as the "First Year of Local Revitalization," emulating Japan's local revitalization policy. This initiative aimed to curb the outflow of local population and to attract the younger generation back to their hometowns for development. The objective of local industrial development is threefold: to integrate local history, culture, and humanistic characteristics; to revitalize the local economy; and to create employment opportunities. The concept of local industrial development aligns with the objective of social enterprises to address social issues through business models. Hsinchu, a city with a rich cultural heritage and a notable transformation into a "cultural and technological city" through the establishment of the Science Park, serves as a case study. In this context, a crucial question emerges: What role do social enterprises play in local revitalization? The article will examine the role of social enterprises in local revitalisation, focusing on the case study of the Grand Vision Co., Ltd.. Through a combination of conceptual proposal and empirical testing, the article will explore the relationship between social enterprises and local creation practices, and will contribute to our understanding of the importance of cultural and technological development in the context of local revitalisation.

Keywords: Social Enterprise, Corporate Responsibility, Grand Vision Co., Ltd., Placemaking, Local Sustainability

E11

Predictive Analytics for Financial Econometric Hyper-Chaotic System Exploiting the Knacks of Modified Gauss-Newton and Gradient Descent Methods

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Abstract

The hyperchaotic economic system exhibits (reveals) an extreme form of complex chaotic dynamics that even slight changes could result in significant diverged outcomes. These complex economic models are susceptible to initial conditions leading to uncertainty, unpredictability, and erratic system behavior. Numerous positive Lyapunov exponents characterize the system where the chaos level is much more extreme than the standard chaotic systems. The predictive analysis based on the solution of the financial econometric hyperchaotic system (FEHCS) model exploiting the knacks of non-linear auto-regressive with exogenous input (ARX) neural network optimized with the modified Gauss-Newton and gradient descent methods namely damped least square algorithm (DLSA) is presented. The Adams numerical technique, a multi-step method appropriate for solving ordinary differential equations (ODE) is leveraged to generate the high-fidelity dataset that serves as the proxy for real-world FEHCS dynamics. The four-dimensional FEHCS model comprises the interest rate, investment rate, price exponent, and average profit margin as state variables, however, the saving rate, investment expense rate, demand sensitivity, decay rate for profit margin, and interaction strength between interest rate and investment signifies the real-valued parameters. For a deeper insight into the underlying behavior of the FEHCS dynamics and to assess the robustness of the non-linear ARX-DLSA technique, the study profiles are formulated with diverse variants by altering the system parameter values and initial conditions. The nonlinear ARX-DLSA performance is rigorously evaluated through various graphical illustrations in error histograms, cross-correlations, auto-correlations, regression trends, network performance plots, training state, and training state response. The evaluation criteria are based on the comparative assessment of the simulated FEHCS data and the ARX-DLSA predictions, showing the overlapping curves with the minimum discrepancy as quantified in terms of absolute error, emphasizing the accuracy and predictive capabilities of the exploited ARX-DLSA strategy for solving non-linear least squares problems and well suited for uncertain, probabilistic, and temporal estimating.

Keywords: Hyperchaotic economic system; Econometrics; Financial economics; Neural networks; Adams numerical solver; Damped least square algorithm; Nonlinear autoregressive systems; Modified Gauss-Newton and Gradient Descent Methods.

E12

AI-Driven Market and Team Evaluation Strategies for Early-Stage CVC in Sustainability

Abstract

AI is transforming early-stage venture evaluation by offering data-driven insights into startup teams and markets, especially in sustainable ventures like circular economy startups and digital fashion. Case studies of RheEnergise, Inclusive Energy, and UpCircle demonstrate AI's ability to evaluate founder-market fit, team dynamics, and execution by analyzing large datasets. AI tools also assist in market analysis, estimating size, identifying opportunities, and modeling scaling strategies. While AI shows potential in predicting success and growth, limitations like data biases and inability to assess leadership resilience remain. Combining AI with expert judgment enhances investment decisions in sustainable startups.

海報發表論文 P

P03 Deep Learning Applications in Supply Chain Carbon Reduction

P04 校園永續服務對話機器人

P05 通過人工智慧驅動的模組化設計和循環經濟實踐革新永續時尚

P06 探討筆記型電腦外殼材料對環境衝擊之研究-以複合性塑膠與金屬為例

P09 人工智慧於螺絲產業碳足跡追蹤與減碳管理之應用

P10 以文獻分析法探討 ESG 與企業經營績效之變數

P11 綠色會計與營收成長率之研究—以品牌行銷策略為干擾變數

P12 企業內外部因素對環境績效之影響：探討內部碳定價採行意願之中介效果

P13 中小企業碳盤查與減碳策略之研究-以 A 公司為例

P14 以 Google 環境洞察分析工具(EIE)進行高雄市交通運輸溫室氣體排放初探

P15 上市公司溫室氣體排放資訊揭露對股票報酬之影響-追蹤資料實證分析

P16 台灣機車產業淨零永續發展的關鍵考量因素

P17 結合 AI Agent 模擬與配送網絡最佳化之碳排放決策評估

P20 AI 個性化學習與問題導向學習法(PBL)於淨零碳排教育中的應用與驗證

P22 從 ESG 課程到永續管理專業: 大學生 ESG 知識、態度與行為意圖之轉變

P23 電商平台的綠色行銷策略對消費者購買意願之影響

P24 餐具設計對食物浪費和健康的影響

P25 低碳經濟與綠色消費趨勢下的消費者行為研究：以電動車與海廢再生產品為例

P26 台灣大專校院 ESG 課程發展趨勢：數據分析與政策啟示

P28 從綠色設計觀點探討陶瓷綠工藝發展與應用之研究

P29 從消費者需求探討食品包裝循環設計之關鍵要素

P30 通過 Agent-based 建模模擬評估數位產品護照在電池永續生態系統中的導入影響

P31 Discussing the Design Strategies of Fengshan Water Resources Game

P03

Deep Learning Applications in Supply Chain Carbon Reduction

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Abstract

This study investigates the application of deep learning in supply chain carbon reduction, focusing on demand forecasting, intelligent logistics, anomaly detection, and optimization. Long short-term memory (LSTM) networks and variational autoencoders (VAE) enhance demand forecasting and reduce inventory waste. Reinforcement learning (RL) and convolutional neural networks (CNN) optimize transportation and warehousing, lowering fuel consumption and carbon emissions. Generative adversarial networks (GAN) and autoencoders improve anomaly detection and strengthen supply chain resilience, as demonstrated in the cases of Amazon, Walmart, and Tesla.

Keywords: Deep Learning, Supply Chain Optimization, Carbon Reduction, Demand Forecasting, Sustainable Logistics

P04

校園永續服務對話機器人

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摘要

本研究以中文大型語言模型 TAIDE 為基礎，結合 QLoRA 量化微調與檢索增強生成（RAG）技術，開發一款永續對話機器人。研究參考了雲科的校園永續報告書，確保機器人能提供精準的永續發展資訊。我們將資料分為一般型對話（具固定標準答案）及知識型對話（融合專家見解與豐富上下文），分別採用參數量化微調和 RAG 策略進行訓練。訓練資料包含雲科報告書及2023 Yuntech 永續報告文本，共生成1800筆對話，其中300筆知識型對話經 RAG 優化。實驗結果顯示，此方法能顯著提升機器人對永續議題的問答精準度、專業性與可靠性。

關鍵字：校園永續報告、永續對話機器人、擷取增強生成

Abstract

This study is based on the Chinese large language model TAIDE and integrates QLoRA quantized fine-tuning with Retrieval-Augmented Generation (RAG) technology to develop a sustainability conversation chatbot. The research referenced YunTech's campus sustainability report to ensure that the chatbot provides accurate sustainable development information. We divided the data into general dialogues (with fixed standard answers) and knowledge-based dialogues (incorporating expert insights and rich context), applying quantized fine-tuning for the general dialogues and the RAG strategy for the knowledge-based ones. The training data include YunTech's report and the 2023 Yuntech sustainability report text, generating a total of 1800 dialogues, with 300 knowledge-based dialogues further optimized through RAG. Experimental results demonstrate that this approach significantly enhances the chatbot's accuracy, professionalism, and reliability in addressing sustainability issues.

Keywords: campus sustainability report, sustainable dialogue chatbot, retrieval-augmented generation

P05

通過人工智慧驅動的模組化設計和循環經濟實踐革新永續時尚

Revolutionizing sustainable fashion through AI-driven modular design and circular economy practices

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摘要

台灣雖科技發達，傳統產業技術卻仰賴進口，在當今國際社會越發重視永續的議題下， 時尚產業被列為全球第二大汙染源，昔日台灣的製造業輝煌也早已不在。

本研究旨在透過智慧化、模組化及循環化，帶動台灣傳統服飾產業改革，藉此達到減少碳排、延長壽命及創新的消費體驗。

經由案例分析後，建構傳統展業結合人工智慧技術，並通過引入永續發展和客製化設計，轉變傳統商業模式。

本研究經由驗證，預期解決產業缺工、環境汙染等議題，預計於一年內減少240公斤廢棄物、1噸二氧化碳及979.2立方公尺用水。

關鍵字:永續時尚、AI 輔助設計、循環經濟、環境影響、傳產改革

P06

探討筆記型電腦外殼材料對環境衝擊之研究-以複合性塑膠與金屬為例

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摘要

現代科技產品汰舊換新的速度相當快，而在原料開採和製造科技產品階段上，難以避免地造成環境的危害，然而，筆記型電腦（以下簡稱筆電）成為現代人不可或缺的配備，為了追求筆電的輕量化與攜帶性，其發展趨勢朝向輕量化、輕薄化發展，然為追求其趨勢，導致機體內部空間壓縮；因此在保護力及支撐力方面上更為重要。所以，在選擇機殼材質時，需考量其重量、耐用性等因素，以滿足機殼得各項需求。目前筆電機殼材質可分為塑膠、金屬合金與新興材料三大類，然為了具備各項良好的特性，目前以塑膠以及金屬合金為主。本研究進行複合性塑膠與金屬合金作為筆電殼主要材料之生命週期評估，探討其資源消耗與環境衝擊之程度。結果顯示單位材料搖籃到大門階段中，複合塑膠在能源消耗與溫室氣體議題上較金屬合金衝擊量小，然在夏季煙霧議題上複合塑膠造成之衝擊會較合金材質來的高；以一部 15.6 吋大小的外殼作為比較基準，在經權重單一得點比較條件下，複合塑膠材質整體環境衝擊為 0.0279 Pt 會小於金屬合金材質的 0.1744 Pt，在材料選擇上複合塑膠材質之環境衝擊量會小於金屬合金材質。如金屬合金之原料部分來自回收後之材料，將有助於環境衝擊量之減少。

關鍵字：筆記型電腦、外殼材料、金屬合金、塑膠複合材質、生命週期評估。

P09

人工智慧於螺絲產業碳足跡追蹤與減碳管理之應用

Application of Artificial Intelligence in Carbon Footprint Tracking and Carbon Reduction Management in the Screw Industry

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摘要

在2050年全球邁向淨零碳排的趨勢下，傳統螺絲製造業正面臨低 碳轉型的迫切需求，其碳足跡管理與減排成效對整體產業的永續發展 至關重要。本研究探討人工智慧技術在螺絲產業碳足跡追蹤與減排管 理創新應用，透過整合物聯網與大數據分析，提出一套系統化智慧管 理，實現碳排放的即時監測、精準預測與動態優化。AI(Artificial Intelligence)應用仍面臨數據品質不一、初期投資成本高及跨部門協 作門檻等挑戰。本研究建議企業分階段導入 AI 解決方案，優先從高能 耗製程切入，並結合政府補助與產業聯盟資源，以加速技術落地。未 來研究可進一步擴展至生命週期評估(Life Cycle Assessment, LCA)與 碳權交易的整合，以實現螺絲產業碳中和的長期永續目標。

關鍵字：人工智慧、碳足跡、減碳管理

P10

以文獻分析法探討 ESG 與企業經營績效之變數

The Variables of ESG and Corporate Performance: A Document Analysis

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摘要

隨著氣候變遷加劇，企業需將 ESG（環境、社會、治理）納入經營策略。本研究透過文獻分析，從28篇文獻與三大永續評鑑機構中篩選影響企業績效的關鍵變數，作為數值分析的前期研究。結果顯示，在環境構面，總碳排放量、綠色供應鏈管理及總用水量影響企業績效，企業需平衡環境責任與經濟效益。在社會構面，員工薪酬、流動率及女性員工比例影響企業表現，突顯人力資本管理的重要性。治理構面則顯示，董事持股比例、董事會規模與獨立董事比例影響決策透明度與穩定性。此外，Tobin's Q、ROE、ROA 與 EPS 等財務指標常用於衡量 ESG 與企業績效的關聯，未來可探討在不同產業的適用性。

關鍵字: ESG（環境、社會、治理）、企業經營績效、文獻分析法 。

P11

綠色會計與營收成長率之研究－以品牌行銷策略為干擾變數

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摘要

本研究之目的是針對企業綠色會計實踐與營收 成長率之間的關聯進行探討。接著檢驗品牌行銷投 入程度是否在綠色會計實踐與營收成長率之間扮演 干擾角色。 本研究主要採用次級數據分析法，透過 TEJ Pro 資料庫收集企業財務與 ESG 數據，並針對主要研究變數進行衡量與分析。研究結果顯示，綠色會計 與營收成長率之間的關聯性不顯著，品牌行銷投入 程度與營收成長率呈現顯著正相關，品牌行銷投入 程度對綠色會計與營收成長率之間的關係並無顯著 干擾效果。最後在根據研究結果，本研究亦進一步提 出對學術與實務界的影響。

關鍵詞：綠色會計、營收成長率、品牌行銷策略

Abstract

The purpose of this study is to explore the relationship between corporate green accounting practices and revenue growth rate. Furthermore, it examines whether the level of brand marketing investment plays a moderating role in the relationship between green accounting practices and revenue growth rate. This study primarily adopts a secondary data analysis approach, utilizing the TEJ Pro database to collect corporate financial and ESG data and measure key research variables. The results indicate that the relationship between green accounting and revenue growth rate is not significant, while brand marketing investment shows a significant positive correlation with revenue growth rate. However, brand marketing investment does not have a significant moderating effect on the relationship between green accounting and revenue growth rate.

Based on the findings, this study further discusses its implications for both academia and business practices.

Keywords: Green Accounting, Revenue Growth Rate, Brand Marketing Strategy

P12

企業內外部因素對環境績效之影響： 探討內部碳定價採行意願之中介效果

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摘要

內部碳定價(Internal carbon pricing, ICP)已成為企業永續發展的主流趨勢之一，本研究透過組織韌性 理論與制度理論的觀點，探討企業內部因素(感知、獲取與重新配置能力)與外部因素(強制、模仿與規範壓 力)對環境績效之影響，並進一步研究內部碳定價採行意願在企業內外部因素與環境績效之間的中介效果。 本研究透過問卷調查蒐集2024年250家臺灣上市櫃製造業公司數據，並以廣義結構方程模型(GSEM)進行 實證分析。研究發現，企業內部碳定價採行意願在企業內外部因素與環境績效之間具有顯著的中介效果， 顯示組織韌性與制度理論的觀點適用解釋企業內外部因素對環境績效之影響；再者，企業內部因素的感 知能力、重新配置能力與外部因素的強制壓力、模仿壓力，均能顯著提高企業內部碳定價之採行意願；最 後，企業若提高內部碳定價採行意願可有效提升企業環境績效。在理論貢獻上，本研究證實組織韌性理論 與制度理論適用解釋企業內外部因素對環境績效之影響；在管理意涵上，企業若能強化感知能力與重新 配置能力，將有助於提高企業內部碳定價的採行意願，進而提升企業環境績效。

關鍵字：組織韌性理論、制度理論、企業內外部因素、內部碳定價、環境績效

Abstract

Internal carbon pricing (ICP) has emerged as a prominent trend in corporate sustainability. This study investigates the impact of both internal and external corporate factors on environmental performance through the frameworks of organizational resilience theory and institutional theory. Additionally, it examines the mediating effect of the willingness to adopt internal carbon pricing between corporate factors and environmental performance. Data were collected through a survey of 250 publicly listed manufacturing firms in Taiwan in 2024, and empirical analysis was conducted using Generalized structural equation modeling (GSEM). The results indicate that the willingness to adopt internal carbon pricing significantly mediates the relationship between corporate factors and environmental performance, supporting the applicability of organizational resilience and institutional theories in explaining these relationships. Additionally, internal corporate factors, such as sensing capability and reconfiguring capability, as well as external factors, including coercive and mimetic pressures, significantly enhance the willingness to adopt internal carbon pricing. Lastly, firms that increase their willingness to adopt internal carbon pricing can effectively improve their environmental performance. From a theoretical perspective, this study confirms the applicability of organizational resilience theory and institutional theory in explaining the influence of corporate factors on environmental performance. From a managerial perspective, strengthening sensing and reconfiguring capabilities can enhance firms' willingness to adopt internal carbon pricing, thereby improving environmental performance.

Keywords: Organizational resilience theory, Institutional theory, Internal and external factors of corporate, Internal carbon pricing, Environmental performance

P13

中小企業碳盤查與減碳策略之研究-以 A 公司為例

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摘要

面對全球氣候變遷威脅帶來日益嚴峻的挑戰，氣候相關災害對社會和經濟造成嚴重影響，引起世界各國對永續發展的關注與重視，零碳經濟將主導未來產業發展，在國際低碳發展浪潮中，台灣中小企業面臨綠色轉型的巨大挑戰與壓力。本研究以個案研究法，選定粉末冶金產業的個案公司為研究對象，利用ISO 14064-1: 2018標準實地進行碳盤查，量化個案公司的碳排放量、明確碳排放來源，以了解個案公司溫室氣體實際排放情況；進一步利用實際盤查與訪談結果進行分析，針對個案公司研擬減碳目標與減碳推動方向，進行減碳策略規劃，協助企業發展淨零減碳方案，提升個案公司綠色競爭力。本研究結果不但可以作為中小企業廠商推動碳排查與減碳策略規劃之借鏡，同時也可提供粉末冶金產業與政府相關部門淨零減碳永續發展策略制定之參考。

關鍵字：中小企業、永續發展、碳盤查、減碳策略

Abstract

In response to the escalating challenges of global climate change, the increasing frequency of climate-related disasters has drawn worldwide attention to sustainable development. A zero-carbon economy is expected to lead future industrial growth, posing significant transformation pressures on Taiwan’s small and medium-sized enterprises (SMEs). This study adopts a case study approach, selecting a powder metallurgy SME to conduct an on-site carbon inventory based on the ISO 14064-1:2018 standard. The company’s greenhouse gas emissions were quantified to identify emission sources and understand its actual carbon footprint. Through analysis of inventory data and interviews with key personnel, the study establishes carbon reduction goals and strategies to support the company's transition toward net-zero emissions and enhance its green competitiveness. The findings serve as a practical reference for other SMEs seeking to implement carbon inventory and reduction plans, and provide insights for the powder metallurgy industry and policymakers in formulating sustainable net-zero strategies.

Keywords: Small and Medium-sized Enterprises (SMEs), Sustainable Development, Carbon Inventory, Carbon Reduction Strategies

P14

以 Google 環境洞察分析工具(EIE)進行高雄市交通運輸溫室氣體排放初探

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摘要

近年來隨著人們對碳排放等相關議題的重視(例如：碳關稅、政府的淨零碳排政策…等)，碳排放成為了一個重要的指標，受到了各國政府的重視，而透過 Google Environmental Insights Explorer(以下簡稱 EIE)這個工具可以幫助我們更容易地蒐集和整合數據，繼之前用該系統探討台南市的數據後，這次研究則以高雄市利用 EIE 來進行交通運輸的溫室氣體排放分析。這次研究透過 EIE 來取得高雄市交通運輸的溫室氣體排放量。EIE 是透過 Google 蒐集的資料和模擬功能，得到的資料是根據交通運輸等活動的實際測量結果模擬而出的估算值，而透過 EIE 這個工具，我們可以省下實地調查的時間和精力，並能蒐集到相當接近真實城市的交通運輸業的溫室氣體排放活動、排放量等數據。這些數據的數據。運輸車輛有兩種排放溫室氣體的方式，一種是直接燃燒化石燃料而產生，另一種是透過電動車 (EV) 消耗電力間接產生。一個城市的交通運輸業的溫室氣體排放量取決於下列因素：1.交通方式；2.使用的燃料類型；3.車隊的車齡與能源效率；4.總行程；5.每年行駛的里程數。EIE 估算高雄市 2022 年交通運輸業的溫室氣體排放量為 2,690,000 公噸，包括：公車(總共: 55341.7783 百萬公噸二氧化碳當量)、機車(總共: 624745.2579 百萬公噸二氧化碳當量)、汽車(總共: 2916872.6662 百萬公噸二氧化碳當量)、步行、鐵路、單車、捷運(皆為 0 百萬公噸二氧化碳當量)等交通方式。

關鍵字：Google 環境洞察分析工具、交通運輸業、溫室氣體

P15

上市公司溫室氣體排放資訊揭露對股票報酬之影響 —追蹤資料實證分析

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摘要

我國於 2023 年通過「氣候變遷因應法」，在淨零碳排放願景之下，2024 年 10 月確定台灣的碳費起徵費率，首批約有 141 家股票掛牌公司，正式進入碳有價時代，且歐盟啟動「碳邊境調整機制 CBAM」。股票市場的預期心理，會事先反應碳成本在投資標的選擇上。本文採用證交所 2021 年自願揭示溫室氣體排放的公司 250 家為樣本，2021 至 2023 年共 3 年的追蹤資料 (Panel Data)，經由檢定採用橫斷面的隨機效果分析，實證結果顯示公司的範疇二溫室氣體排放量、溫室氣體排放密集度，對於該公司股價的年度報酬率有顯著負向影響，而市場報酬率、股價淨值比與個股報酬率存在顯著正向關聯。

關鍵字：溫室氣體排放、永續發展、氣候變遷、追蹤資料。

Abstrac

In response to global climate change, the Climate Change Response Act was established to form strategies to reduce and manage greenhouse gas emissions in Taiwan during 2023. Taiwan's carbon fee rate was determined in October 2024, and about 141 listed companies officially entered the era of carbon pricing. The EU has launched the CBAM. The expectations in the stock market will reflect the impact of carbon costs on investment targets in advance. The samples of this study are 250 listed companies on the Taiwan Stock Exchange that voluntarily disclosed their greenhouse gas emissions in 2021. Using three years of panel data with cross-sectional random effect, the empirical results evidence that scope 2 greenhouse gas emissions and emissions intensity significantly negatively impact the company's stock price return. Meanwhile, a significant positive relationship existed between market return rate, M/B ratio and individual stock return rate.

Keywords: Greenhouse Gas Emissions, ESG, Climate Change, Panel Data

P16

台灣機車產業淨零永續發展的關鍵考量因素——基於 TOE 架構的 AHP 實證分析

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摘要

本研究以 TOE（技術、組織、環境）架構結合層級分析法（AHP），探討台灣機車產業在達成2050 淨零排放目標中的關鍵考量因素，隨著全球淨零目標的推進，台灣需平衡傳統燃油機車的環境影響與產 業轉型的挑戰，包括基礎設施不足及技術升級成本。經由專家問卷結果顯示，台灣機車產業邁向永續的 關鍵考量因素以主構面而言，「環境」構面影響最大，次為「技術」最後是「組織」。而次構面之前三大 因素為：碳稅徵收及監管政策（27.8%）、消費者對綠色產品的偏好（19.5%）、 創新研發（17.5%）。基於 上述結果，本研究建議制定漸進式碳稅政策、加強電動機車宣導與補助政策，並聚焦技術創新以提升競 爭力，以上策略對於台灣機車產業的永續轉型具有重要參考價值，為政策制定者提供實證依據。

關鍵字：台灣機車產業、淨零永續、TOE 架構、層級分析法

Abstract

This study uses the TOE (technology, organization, environment) framework combined with the analytic hierarchy process (AHP) to explore the key considerations of Taiwan's motorcycle industry in achieving the 2050 net zero emission target. As the global net zero target advances, Taiwan needs to balance the environmental impact of traditional fuel motorcycles with the challenges of industrial transformation, including insufficient infrastructure and the cost of technology upgrades.The results of the expert questionnaire show that the key considerations for Taiwan's motorcycle industry to move towards sustainability are mainly in the aspects of "environment" which has the greatest impact, followed by "technology" and finally "organization". The top three factors in this sub-dimension are carbon tax implementation and regulatory policies (27.8%), consumer preference for green products (19.5%), and innovation and R&D (17.5%).Based on the above results, this study recommends formulating a progressive carbon tax policy, strengthening electric motorcycle promotion and subsidy policies, and focusing on technological innovation to enhance competitiveness. The above strategies have important reference value for the sustainable transformation of Taiwan's motorcycle industry and provide empirical evidence for policymakers.

Keywords: Taiwan's Motorcycle Industry, Net Zero Sustainability, TOE Framework, Hierarchical Analysis

P17

結合 AI Agent 模擬與配送網絡最佳化之碳排放決策評估

Evaluating Carbon Emission Decisions via AI Agent-Based Simulation and Optimization of Distribution Networks

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摘要

在全球淨零趨勢的推動下，臺灣於2022年公布《2050淨零排放路徑與 策略》，其中運輸部門已列為四大轉型面向之一，積極推動智慧運輸系 統與低碳物流的落實。為提升運輸決策的效率，本文透過 AI Agent 模擬 技術與配送網絡最佳化方法，建構可應用於台灣零售商貨車配送路徑決 策與碳排放分析之模擬模型。本研究以單一生產工廠配送至台灣地區 15 個零售據點為例，建立動 態配送場景，並透過 AI 代理人結合 GIS 地理資訊，模擬需求變動與車輛 派送行為，進一步計算行駛過程中的碳排放量，以量化不同策略下的運 輸碳足跡。透過模擬比較不同配送策略的差異，評估其環境與經濟影響。 研究結果顯示，運用 AI 智能體基模（ABM）模型，可精準分析不同 配送策略對運輸行為與碳排放的影響。在相同配送需求條件下，採用單 趟配送兩單的策略，相較於單趟僅配送一單，能有效減少總車趟數與行 駛距離，進而降低碳排放總量與碳成本。此結果顯示，提高每趟配送承 載量具有顯著的環境效益與經濟效益，有助於物流系統達成運輸最佳化 與碳減排的雙重目標。

關鍵字：AI Agent-based、運輸配送決策、淨零排放、最佳化、碳足跡、 代理人基模型

P20

AI 個性化學習與問題導向學習法(PBL)於淨零碳排教育中的應用與驗證

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摘要

本研究探討 AI 賦能的個性化學習與問題導向學習（PBL）在淨零碳排教育中的應用。透過質性研究 方法，包括文獻回顧、案例分析與專家訪談，本研究分析 AI 如何提升能源教育的個性化學習體驗，PBL 如何促進系統思維與能源轉型的實踐能力，以及 AI 與 PBL 的融合如何回應 2025 年碳費開徵政策。研究結 果顯示，AI 與 PBL 的結合能顯著提升學生的學習效率與問題解決能力，並對企業可持續發展策略產生重 要影響。未來能源教育可透過 AI 與 PBL 的進一步創新，提升教育質量與效果。

關鍵字：AI 在能源教育中的應用、個性化學習、問題導向學習、碳費政策、能源教育創新。

Abstract

This study explores the application of AI-enabled personalized learning and Problem-Based Learning (PBL) in net-zero carbon education. Using qualitative research methods, including literature review, case analysis, and expert interviews, this study examines how AI enhances the personalized learning experience in energy education, how PBL promotes systems thinking and practical capabilities for energy transition, and how the integration of AI and PBL responds to the 2025 carbon fee policy. The results show that the combination of AI and PBL can significantly improve students' learning efficiency and problem-solving abilities and have an important impact on corporate sustainable development strategies. Future energy education can further innovate through AI and PBL to enhance the quality and effectiveness of education.

Keywords: Application of AI in Energy Education, Personalized Learning, Problem-Based Learning, Carbon Fee Policy, Innovation in Energy Education.

P22

從 ESG 課程到永續管理專業:大學生 ESG 知識、態度與行為意圖之轉變

From ESG Courses to Sustainable Management Expertise: Transformations in College Students' ESG Knowledge, Attitudes, and Behavioral Intentions

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摘要

本研究探討 ESG 課程對大學生知識、態度與行為意圖的影響，特別關注課程對 ESG 概念理解與參與實習、證照意願的提升。以 113 學年度管理學院一年級學生(n=103)為對象，採用前後測問卷(李克特量表)，並以配對樣本 t 檢定分析成效。結果顯示，課程在 ESG 知識，尤在環境與治理領域；行為意願；生成式 AI 增強數據分析與決策能力面向均顯著提升 。建議高等教育機構結合 AI 技術提升 ESG 課程成效。

關鍵詞：ESG 教育、永續管理、生成式 AI、學習成效、行為意圖

P23

電商平台的綠色行銷策略對消費者購買意願之影響

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摘要

疫情肆虐與網路盛行，造成宅經濟蓬勃發展，居家消費與線上購物成為主流的消費模式之一，同時永續發展與綠色環保受大眾關注，為打造差異化策略並提升市場競爭力，電商平台推出綠色行銷策略，追求綠色供應鏈，積極地創造品牌差異，跟上永續潮流。本研究探討綠色電商平台的綠色行銷模式，透過將品牌特色與促銷活動作為變數，探討綠色行銷策略對消費者購買意願的影響。研究架構將電商平台的綠色行銷與關係利益設為自變數，消費者對綠色產品的購買意願做為依變數。設立三個假說，一、 電商綠色行銷的相關利益對消費者購買意願有正向影響，二、電商綠色行銷的宣傳活動效果對消費者購買意願有正向影響，三、電商綠色行銷的相關利益和宣傳活動對購買意願有正向影響。利用李克特量表製作問卷，問卷透過網路採便利抽樣進行發放，填答對象主要為大學生，填答者年齡集中於 18 至 25 歲，本研究共收回 50 份問卷，運用 SPSS 統計分析軟體進行問卷數據分析。分析結果顯示 三個假說皆成立，本研究結果顯示，電商平台透過關係利益推動綠色行銷，可以有效提升消費者對綠色產品的購買意願。

關鍵字：綠色行銷、消費者行為、電商平台、永續發展

Abstract

The pandemic and the internet have resulted in the rapid development of the stay-at-home economy, resulting in home consumption and online shopping becoming one of the main consumer models. The public has become more aware of sustainable development and green environmental protection. To create a differentiated strategy and enhance market competitiveness, e-commerce platforms have introduced green marketing strategies, pursued green supply chains, and actively created brand differentiation to align with the sustainability trend. This study explores the green marketing model of green e-commerce platforms by using brand characteristics and promotional activities as variables to examine the impact of green marketing strategies on consumers' purchase intentions. The research framework considers the green marketing strategies and relational benefits of e-commerce platforms as independent variables, while consumers' purchase intentions for green products serve as the dependent variable. Three hypotheses are proposed: (1) relational benefits positively influence purchase intentions, (2) promotional activities positively influence purchase intentions, and (3) both relational benefits and promotional activities positively influence purchase intentions. A Likert-scale questionnaire was distributed online via convenience sampling, primarily targeting university students aged 18 to 25. A total of 50 responses were analyzed using SPSS. Results confirm all three hypotheses, indicating that e-commerce platforms can effectively enhance consumer purchase intentions for green products through relational benefits.

Keywords: Green Marketing, Consumer Behavior, E-commerce Platform, Sustainable Development

P24

餐具設計對食物浪費和健康的影響

The Impact of Tableware Design on Food Waste and Health

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摘要

根據《Food Waste Index Report 2021》統計，全球每年約有 17 億 噸食物被浪費，因此聯合國希望在 2030 年將食物浪費減半並減少食 物損失，促進永續發展。而研究發現，餐具的選擇可能對食物的攝取 量和浪費情況產生重要影響。因此，本研究旨在深入探討食物浪費的 根本原因，並尋找有效的方法來減少浪費。透過不同場所的觀察，分 析食物浪費的根源，並探討如何利用餐具，防止食物被浪費且營養不 會因此消失，使食物得到合理使用，最大限度地減少浪費。 從文獻中發現，餐具的設計、大小和材質等影響人們的食物攝 取量和準備方式。而此次透過訪談法和觀察法以及文獻分析法進行研 究。透過訪談了解受訪者對於餐具的使用情況，以及其對食物的準備 和浪費的影響。且觀察食物浪費的情況並在進一步使用文獻分析法收 集資料以數據分析，以確立餐具與食物準備和浪費之間的關係，進而 達到更有效地管理食物，減少不必要的浪費。

關鍵詞：食物浪費、食物攝取量、使用者體驗、餐具設計、飲食行為

P25

低碳經濟與綠色消費趨勢下的消費者行為研究：以電動車與海廢再生產品為例

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摘要

全球環境問題日益嚴峻，從氣候變遷導致的災害頻傳到海洋廢棄物造成的生態浩劫，都警示著人類必須採取行動邁向永續發展。本研究旨在探討在低碳經濟與綠色消費趨勢下，消費者的行為模式與其背後的驅動力。本研究將聚焦於兩個具代表性的面向：電動車的使用者需求（呼應低碳經濟的轉型）以及消費者對海廢再生產品的接受度（體現綠色消費的實踐）。透過分析文本文獻與專家調查等進行研究，本研究旨在理解消費者在面對環境議題時的態度、購買意願以及實際行為，透過綠色行銷策略品牌影響力與市場策略，在碳排放意識提升達到淨零碳排的永續教育，以探討消費者行為等面向研究期能制定更有效的環保推廣策略提供參考。

關鍵字：低碳經濟、綠色消費、消費者行為研究、電動車、海廢再生產品

Abstract

The global environmental issues are becoming increasingly severe, from frequent disasters caused by climate change to ecological catastrophes caused by marine debris, all warning humanity to take action towards sustainable development. This study aims to explore consumer behavior patterns and their underlying drivers in the context of a low-carbon economy and green consumption trends. The study will focus on two representative aspects: the demand of electric vehicle users （in response to the transition to a low-carbon economy） and the acceptance of marine waste recycled products by consumers （reflecting the practice of green consumption）. Through the analysis of textual literature and expert surveys, this study aims to understand consumers' attitudes, purchasing intentions, and actual behaviors when facing environmental issues. Through green marketing strategies, brand influence, and market strategies, the awareness of carbon emissions is raised to achieve sustainable education for net-zero carbon emissions. This study explores consumer behavior and other aspects to provide a reference for formulating more effective environmental promotion strategies during the research period.

Keywords: Low-Carbon Economy, Green Consumption, Consumer Behavior Research, Electric Vehicles, Marine Waste Recycled Products

P26

台灣大專校院 ESG 課程發展趨勢：數據分析與政策啟示

Trends in ESG Course Development in Taiwan's Higher Education: Data Analysis and Policy Implications

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摘要

本研究探討台灣大專校院做為在推動永續發展與社會責任方面的 角色，包括校務治理、課程設計、學術研究、產學合作、社會參與和 校園示範等方面，實踐永續發展力道相當強大。呼應政府 2050 淨零 口號，因應業界需要大量專業人才進行 ESG 相關活動，培育人才不僅 是對外對內也能提供其專長。透過課程大數據資料庫分析五個學期的 資料，試圖觀察台灣大專校院在 ESG 課程的開設趨勢，聚焦於各校在 課程數量的變化、開課模式的差異性、學科領域的分布特性、教學模 式的多樣設計，以及教育部政策是否在課程發展中產生支持作用。有鑑於此，本研究提出深化跨領域整合、強化產學協同、提升師資專業 能力及拓展社會面向教育的建議，以期為台灣大學教育的永續轉型提 供理論與實務參考。

關鍵字：ESG、大學教育、永續發展

P28

從綠色設計觀點探討陶瓷綠工藝發展與應用之研究

Exploring the Development and Application of Green Ceramic Craft through the Lens of Green Design

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摘要

本研究探討陶瓷產業在綠色設計與永續發展中的挑戰與機遇。 透過文獻探討與專家訪談，分析陶瓷綠工藝的現況與未來發展方向。 研究發現，陶瓷產業逐漸轉向工作室模式，專注於創作與生活陶瓷， 然而，由於綠色製造成本高，若無市場效益，藝術家難以承擔相關技 術。現階段，回收材料的再利用與節能燒窯技術成為關注焦點，但回 收系統尚不完善，推廣難度高。未來發展可關注材料創新，如低溫燒 製土質、廢棄陶瓷再利用（如路面填充、剪黏工藝、馬賽克拼貼 等），以提升資源循環利用的可行性。本研究提供綠色陶瓷設計的參 考框架，助力產業永續發展。

關鍵字：陶瓷綠工藝產品、綠色設計、永續發展

P29

從消費者需求探討食品包裝循環設計之關鍵要素

Exploring the Key Elements of Food Packaging Recycling Design from the Perspective of Consumer Needs

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摘要

隨著環境與健康問題的關注，傳統塑膠包裝對生態與人 體健康造成重大威脅。為應對這些挑戰，綠色食品包裝成為 重要替代方案，天然生物材料（如竹子、甘蔗纖維等）逐漸 被應用於包裝設計中，具有低環境負擔並能減少塑膠包裝對 健康的影響。本研究通過文獻探討與消費者調查，確立了循 環包裝設計的關鍵要素及指標，並提出一套符合消費者需求 的調查模型。研究顯示，成功的循環設計應兼顧材料的再生 性與設計的多樣性，進而推動永續包裝市場的發展，減少環 境負擔，促進零廢棄的消費行為，為地球的未來貢獻力量。

關鍵字：食品包裝、循環設計、消費者需求

P30

通過 Agent-based 建模模擬評估數位產品護照在電池永續生態系統中的導入影響

Using agent-based modeling to simulate and evaluate the impact of introducing digital product passports in the sustainable battery ecosystem.

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摘要

電池生產和處置率的上升確認其建立循環價值鏈和加強終端策略的必要性。儘管有這些目標，但仍存在一些挑戰，包括缺乏標準化的健康狀態定義和全面的歷史電池數據。認識到這些挑戰的嚴重性和緊迫性，歐盟通過監管措施積極應對這一問題。歐洲議會和理事會頒布了關於電池和廢電池的法規，旨在建立一個涵蓋整個產品生命周期的可持續性、可追溯性和循環性的法律框架。這項法規引入關鍵元素，特別是數位產品護照(Digital Product Passport)和確定電池健康狀態的參數。數位產品護照將電池導入是一項重要舉措，需要建立一個系統的框架，以便在整個電池價值鏈中共享信息和透明度。同時，健康狀態作為一個關鍵指標，總結了影響整體電池狀況的因素，從而影響與終端策略相關的決策。

本文重點研究電池生態系統中經濟運營者之間的動態資訊交換，闡明其如何增強循環性並為經濟運營者創造新角色，從而促進在重覆使用、再利用和再製造等領域的商業機會。收集的結果被用來評估新監管框架在歐洲電池市場實施後的影響。本文採用模擬建模，特別是基於代理的建模方法，對電池生態系統的抽象表示進行實驗並觀察模型輸出。通過定義代理人基為核心元素（以 Agent-based）的行為，研究旨在提供對系統隨時間變化行為的全面理解。利用 AnyLogic 建模工具來進行。研究探討了三個重要的案例，評估測量健康狀態和導入數位電池護照的影響狀況，做為本文的主要討論內容。

關鍵字：數位產品護照、數位電池護照(DBP)、代理人基、生態系統、模擬建模

P31

Discussing the Design Strategies of Fengshan Water Resources Game

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ABSTRACT

Game-based Learning combines educational goals with game elements, and enhances the practicality of learning by allowing learners to actively acquire knowledge and skills through games. Under the implementation of the 108 curriculum, educational games have become innovative tools to encourage learners to work in teams and emphasize interdisciplinary learning and communication skills. Through gamification learning, historical culture is transformed into educational games, connecting the humanities and history of Fengshan community with daily life. The purpose of the study is to understand Fengshan water resources through educational game design, use semi-structured interview method, literature discussion method, field investigation method, semantic difference method to analyze core values, explore educational game design elements and emotional design factors, and evaluate design strategies. The research results can be used as a reference for educational game designers and educational institutions to promote cultural education.

Keyword: Sustainable education, Fengshan culture, water resources education, cultural heritage, design strategy