National Cheng Kung University

Department of Biomedical Engineering

Doctoral Dissertation

智慧穿戴感測科技應用於老人跌倒風險評估之障礙與導入策略

Adoption Strategies of Wearable Fall Risk Assessment Devices for Older Adults: A Stakeholder-Driven MCDM

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摘要

因應人口老化趨勢，在地老化有其正面意義，也伴隨其他挑戰，其中老年人居家跌倒為在地老化中面臨的重大議題之一。跌倒的後遺症與照護資源短缺都對醫療照護系統造成極大挑戰。跌倒風險評估系統在預防老年人跌倒可以發揮作用，顯示科技可以促進在地老化發展，然而，因創新抵制現象，老年人在使用科技上的差異仍相當明顯。為探討此問題，本研究採用文獻回顧和半結構化訪談的質性方法，以智慧穿戴感測科技應用於老年人跌倒風險評估作為案例，針對此技術應用所面臨的採用障礙進行探討。研究範圍以台灣南部為研究區域，運用創新抵制理論架構設計訪談大綱，訪談對象包括30位老年患者和其29位家屬，探討他們對此技術應用的經驗和態度。以內容分析法編碼訪談資料，萃取障礙因素，並彙整文獻回顧所獲的因素，最終確認九項準則因素。為系統性的克服這些障礙以制定策略，以這九項準則因素為研究基礎，並以研究主題設計問卷並針對38位高齡照護專家進行發放，包含醫師、學者、護理專家與研究人員。回收問卷作為研究數據，收集的研究數據使用決策實驗室分析法分析準則因素間的因果關係和影響路徑，並以網路層級分析法分析各準則因素之相對重要性與權重。研究結果發現影響智慧穿戴感測科技採用的九項準則因素為：身體功能退化程度、適應科技的能力、使用科技成本顧慮、侵害隱私顧慮、身體安全顧慮、負面科技成見、自我效能與需求意識、社會文化影響與外觀形象顧慮。透過決策實驗室分析法釐清各因素間之因果關係與影響路徑，進一步以網路層級分析法確定因素間之權重優先順序，為策略制定提供依據。總結而言，本研究為智慧穿戴感測科技應用於老年人跌倒風險評估之業者、政府與學界提供有價值的導入策略，為老年人健康在地老化和生活品質做出貢獻。

關鍵字：在地老化、跌倒、穿戴感測、跌倒風險評估、創新抵制、內容分析、決策實驗室分析法、網路層級分析法

ABSTRACT

In response to the aging population trend, "aging in place" presents both positive implications and significant challenges, with falls among older adults at home being one of the most critical issues. The aftermath of falls, coupled with the shortage of caregiving resources, places substantial pressure on healthcare systems. Fall risk assessment systems can serve a preventative role, demonstrating that technology can facilitate the aging-in-place process. However, due to innovation resistance, significant disparities still exist in the use of such technologies among older adults. To explore this issue, this study adopted qualitative methods, including a literature review and semi-structured interviews, using the application of wearable sensing technologies in fall risk assessment systems for older adults as a case study. The research was conducted in southern Taiwan, guided by the theoretical framework of innovation resistance. A total of 30 older patients and 29 of their family caregivers were interviewed to understand their experiences and attitudes toward the use of such technologies. Using content analysis, the interviews were coded to extract adoption barriers, which were then integrated with those identified from the literature review. Ultimately, nine key criteria were identified. To systematically address these barriers, a questionnaire was developed based on these nine criteria and distributed to 38 aging care professionals, including physicians, scholars, nursing experts, and researchers. The collected responses served as the data for further analysis. The Decision-Making Trial and Evaluation Laboratory (DEMATEL) method was applied to determine the causal relationships and influence pathways among the criteria, while the Analytic Network Process (ANP) was used to evaluate the relative importance and weighting of each factor. The results revealed that the nine key adoption barriers include: degree of decline in physical function, ability to adapt to technology, cost-related concerns, privacy concerns, physical safety concerns, negative perceptions of technology, self-efficacy and perceived need, sociocultural influences, and image-related concerns. DEMATEL clarified the causal structure among the factors, and ANP prioritized their significance to guide strategic planning. In summary, this study offers practical strategies for industry, government, and academia to promote the adoption of wearable sensing technologies in fall risk assessment systems, ultimately contributing to healthier aging-in-place and improved quality of life for older adults.

Keywords: Aging in place, Falls, Wearable sensing, Fall risk assessment, Innovation resistance, Content analysis, Decision-Making Trial and Evaluation Laboratory (DEMATEL), Analytic Network Process (ANP)