

DEVELOPMENT AND VALIDATION OF THE CARE BRIDGE MODEL: A DIGITAL HEALTH-SYSTEM COORDINATION PLATFORM FOR ELDERLY CARE SERVICES

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ABSTRACT

As global populations age, it creates significant and increasing demand for efficient and accessible ways of supporting elderly in becoming and being independent. Current elderly care systems can be described as fragmented, reactive, and lacking properly organized methods of establishing connection between users and relevant services. The Care Bridge Model is presented in this research as a method to overcome fragmentation in elderly care systems. Care Bridge is a digital health coordination platform that helps patients to effectively navigate among the medical services that provide rehabilitation, care, and community support. The proposed model consists of three domains, which are User Domain, Service Provider Domain, and Support Network Domain. They are united by the deterministic matching engine that enables systematic connections of users and services based on location, availability, and cost. Design Science Research was used in the study. Development process included problem identification, artefact design, prototyping, demonstration, and evaluation of the prototype. Evaluation of the prototype included expert review with the involvement of three experts and user acceptance testing with twenty participants. Thematic analysis was used in identifying the six main themes which emerged from qualitative feedback and quantitative evaluation with the use of Likert scale. Hence, this study findings indicate that criteria-based matching has potential to support service relevance, accessibility, and user experience in elderly care coordination, while expert and user evaluations provide preliminary evidence of the model's practical feasibility.

Keywords: *Elderly Care, Deterministic Matching, Mobile Application, Service Coordination, Digital Health*

1. INTRODUCTION

1.1 Background

The demographics of the world's population are fundamentally changing due to the increasing number of the aging population. Estimated that by 2050, the number of people aged 60 years and older will approximately double, reaching 2.1 billion people [22][25]. This transformation brings significant challenges for governments, health systems and families, especially in developing regions, where may not be as much access to elder care resources. Older adults usually experience

physical limitations, chronic illnesses, mobility restrictions, suffering of mental illness related to the decline of cognitive abilities and also increased frailty, which result in higher probability of accidents in the form of falling [25]. In addition, older adults are more likely to suffer from emotional problems related to solitude and social isolation, especially if they do not reside either in families or buildings with multiple generations sharing the same living places.

Aging issues are taking center stage in Malaysia as the nation's shift towards an aging demographic keeps escalating [8]. 11.3% of Malaysia's population

falls within the age bracket of 60 years and above, and in 2030, it is projected that about 15% of the total population will include individuals aged 60 years and above [24],[25]. This demographic shift indicates that elderly care systems must increasingly prioritize sustainability, effectiveness, and affordability as part of the necessary requirements.

When it comes to healthcare, both physical and social support must be effectively coordinated in order to fulfill the needs of senior citizens. Caregivers and those in need of care should have access to necessary support services in order to meet their needs, but with these services being offered by different parties within the healthcare system, it may be challenging for the elderly and caregivers to access desired services.

The decline of caregiving systems is made worse by changing socio-cultural and economic circumstances. Young family members often prefer to move to cities or travel abroad for jobs, leaving their old parents or relatives in rural or semi-urban places [24]. In this way, numerous old people of Malaysia are left on their own most of the time and have no relatives who could help them with daily issues. Although some may have access to some basic health services or community involvement, there is no systematic provision of immediate caregiving services, which expose them to a lot of danger.

1.2 Problem Statement

Despite various services and technologies in elderly care are becoming available, there are still significant gaps in the coordination and access of services for elderly people living in communities. Current solutions often address only particular issues related to elderly care, such as health monitoring, emergency response, or caregiver provision, but do not offer any integrated method for linking elderly people with a broader variety of resources for care and assistance. Therefore, elderly people and their caregivers are forced to search for appropriate elderly care services across different platforms and providers [24], [28].

Current technologies and models used in elderly care systems have numerous faults. At present most of the available elderly care services apply an event-driven and a reactive model, under which any interventions are started after the occurrence of some incident. As a matter of fact, these models concentrate on monitoring, while they do not have any means of preventing incidents and matching the elderly population with the necessary resources in a

proactive manner. Additionally, numerous systems use either rule-based or static matching methods that cannot take into consideration such dynamic factors as unavailability of caregivers, health condition changes, geographical position and personal preferences of seniors.

An important restriction is the existence of multiple architectures serving many systems, each one serving its own goal for such purposes as health tracking, alerting of emergencies or service directories. This type of architecture limits interoperability and makes it very hard to create a complete caregiving environment. People have to use a lot of different applications or service providers, which increases difficulties of use due to lots of specifications and inconveniences for those users lacking digital skills.

While the services provided by healthcare professionals, rehabilitation institutes, nursing facilities, humanitarian organizations, and community support systems are advantageous to older people, the influence of these services is diminished by a lack of collaboration between different services. Many services are provided independently, with no coordination in place, which creates fragmentation in the elderly and, consequently, makes it much more challenging for elderly people and their caregivers to use the existing services. As a result, there can be delays in obtaining the services needed, duplication of efforts and discontinuation of care, as well as increasing burden on caregivers.

Three key issues have been largely unaddressed:

1. Limited Access to Verified Guardians or Companions: Many elderly individuals and their families are unable to find available, trustworthy, qualified, and reliable caregivers on short notice. The current method of matching caregivers and elderly people lacks a centralized system to match based on availability, qualifications, and location, leading to delays and concerns about safety and trustworthiness [24].
2. Lack of Centralized Access to Rehabilitation Equipment and Home-Based Caregiving Resources: Access to rehabilitation equipment and services is spread across multiple providers. Users must make multiple calls, rely on word of mouth, or search the internet to find service

providers [24]. This disparate process is time-consuming and provides inconsistent results with little information about pricing or availability.

3. **Poor Visibility and Access to Supportive Networks and Programs:** Many elderly people and their caregivers are unaware of the numerous non-governmental organizations (NGOs), community-based initiatives, and government-sponsored elderly assistance programmes available to support their needs. The lack of public awareness, minimal digital presence of these groups, and weak connectivity to mainstream communication channels contribute to this disconnect.

These limitations imply a gap in the elderly care technology available today, which is an effective service coordination component that will link the needs of users with the proper caregivers, rehabilitation providers, equipment suppliers, and community support service by utilizing transparent and valid matching criteria. While available platforms have shown the advantages of digital care giving and health technologies, they lack the capability to coordinate among the various categories of services through one deterministic matching function. Motivation for the development of the Care Bridge Model is the identified gap.

1.3 Research Objectives

This study was undertaken with the following objectives:

1. To identify the coordination requirements and stakeholder needs within healthcare, rehabilitation, caregiving, and community support services for older adults.
2. To design and develop the Care Bridge Model as a digital health-system coordination platform that integrates multiple elderly care stakeholders within a unified service ecosystem.
3. To validate the effectiveness of the Care Bridge Model in supporting service navigation, continuity of care, and coordinated access to elderly care resources.

2. LITERATURE REVIEW

The literature and platform comparisons reviewed in this study highlight limitations in elderly care service

coordination. Existing approaches address needs such as health monitoring, caregiver discovery, and technology acceptance, but provide limited guidance on integrating caregiving services, rehabilitation equipment, and community support within a single platform. Technology acceptance models explain users' adoption of technology, whereas service coordination requires an explicit mechanism for connecting user needs with available resources. The gap addressed in this study is therefore a structured model that combines these service domains through transparent matching criteria based on service type, location, availability, and budget. This gap provides the basis for developing the Care Bridge Model.

2.1 Elderly Care Needs and Support Systems

The issue of population ageing has heightened the need for integrated healthcare and social services. Many older adults struggle with mobility issues, chronic diseases, feelings of loneliness, and increased dependency on formal and informal caregiving services. Recent research suggests that fragmented access to these support services results in negative health outcomes, lower quality of life, and more burdening of caregivers among older populations [24], [28]. Moreover, the rising number of older adults living independently has made the need for more integrated forms of community-based support, which goes beyond just health care delivery, imperative [24]. The unavailability of accessible, timely, and personalized support systems leads to negative health outcomes for older adults, including unmanaged chronic conditions, higher incidences of mental illness, and decreased overall quality of life.

In Malaysia, the National Policy for Older Persons acknowledges these challenges and commits to supporting active aging and integrating older people into society [5]. However, despite policy efforts, gaps exist with respect to practical implementation, accessibility, and affordability of services for older adults, particularly those in cities or rural regions without adequate family support systems.

There is increasing disparity in terms of care access for elderly people residing in Malaysian cities. Urban elderly people are living alone increasingly, and young people are moving away from their areas in search of opportunities leading to the breakdown of the traditional caregiving structure where they lived together with their adult offspring or relatives [1]. The authors propose a hybrid paradigm of caregiving involving the combination of formal caregivers and informal mechanisms of caregiving. Prior studies devoted to digital healthcare show that

structured frameworks are essential in integrating functional and stakeholders' requirements in the course of developing a system. For instance, in framework-based rehabilitation applications, the emphasis has been put on the numerous aspects related to the identification of end-users, functioning of service, and components of the system [1], [4]. Although these facts works deal with rehabilitation applications, they provide important insights related to the principle that the development of digital healthcare solutions relies on proper defining of project's components and relations.

Previous framework-development studies have demonstrated the importance of systematically defining system components, stakeholder roles, and service relationships during healthcare application development [20][21]. The MyPard framework developed by [21] highlighted how structured design methodologies facilitate the integration of rehabilitation requirements, user needs, and system functionality into a coherent framework. Similarly, [20] demonstrated that framework-based approaches provide a clear foundation for developing digital rehabilitation systems by establishing relationships among users, services, and technological components. Drawing upon these principles, the Care Bridge Model adopts a deterministic matching mechanism to systematically integrate users, service providers, rehabilitation resources, and community support networks into a unified service coordination framework.

2.2 Fragmentation and Coordination in Elderly Systems

As the population ages, older people increasingly rely on various kinds of services: health, rehabilitation, support, education, etc. However, various services operate in silos and offer fragmented care pathways which complicate the process of resource searching for older adults' caretakers. Issues of fragmentation become even more severe in case of elderly people suffering from multiple chronic diseases as the method of care delivery is mostly disease-specific or provider-centric rather than coordinated and centered on the patient [2].

Communication problems, limited information interchange, and separated processes of delivery of care can lead to discontinuity in the process of care and a high burden of treatment on older people. More studies prove that it is necessary to implement coordinated and integrated models of care. Study

found out that older patients with multimorbidity face barriers in the system not designed to ensure continuous and comprehensive care at different medical institutions [26]. Moreover, a scoping review in Southeast Asia proved that transportation, financing, social support, and availability of services all influence healthcare access for older adults [16].

In Asia, the requirement for integration of health and social care arises as a key aspect in building a sustainable elderly care system [12]. The study [3] point out that it is important to build stronger links between the health care and social care systems to adhere to the continuum-of-care model and assist aging populations. In Malaysia, a fragmented system of health care, insufficient coordination among agencies, and a lack of long-term care system necessitate the use of integrated approaches in service provision [28]. Therefore, there is a growing need for platforms that could assist in service coordination, improve navigability across care systems, and foster a continuity of care for elderly people.

2.3 Digital Inclusion and Mobile Technology for Elderly

The trend of utilizing mobile applications for eldercare management is increasing as societies look for technological solutions. However, many digital applications are predominantly focused on a narrow range of features such as biometric monitoring and clinical support. [4], [24] argue that reliance on sensor-based applications is insufficient to meet the needs of aging individuals. While such applications may be useful in managing chronic conditions or emergencies, many aging persons require assistance with day-to-day support needs, including navigating community-based services, securing companionship, arranging transportation, or engaging socially.

Recent systematic reviews show that many mobile health applications stay challenging for older adults due to complicated navigation systems, small interface components, vague directions, and the lack of accessibility measures [6]. Studies repeatedly recommend simple navigation, enlarged touch points, minimized cognitive burden, proper feedback mechanisms, and user-friendly design approaches to enhance usage and popularization among elders [4][24]. These data indicate that acquiring technology is not enough for digital inclusion, as applications should be designed according to the

physiological, cognitive, and sensory needs of older adults.

The future applications in the field of digital technologies should have wider tasks than simple monitoring of health-related metrics [4],[24],[24],[24]. The developers of applications should incorporate principles of human-centered design like application of bigger fonts, installation of voice support means, complicated design and usage of native languages.

These results provide insight that a mobile application designed for elderly people can be efficient not only due to the fact that it has adequate digital services but also to the way they are provided to the audience. An application can offer a great amount of features but it can remain unmanageable if the navigation system, information density, terminology and ways of interactions are not tailored according to the needs of older adults. As a result, the Care Bridge application implements principles of user-centered design in the course of service integration, treating accessibility and service coordination as mutual design problems rather than two separate issues.

2.4 Guardian and Companion Matching Services

Guardianship and companion services are recognized as necessary and beneficial non-institutional services that help older adults during transitions from hospitals, outpatient visits, and daily living [10]. These services positively affect older adults' emotional health, mobility, and daily monitoring abilities, directly related to less hospital readmissions and improved health [24].

It has been argued that even though guardianship services are crucial in various countries like Malaysia, many of the services provided are unregulated, informal, and disjointed [24][28]. Families often refer to such services through their informal networks, through community members, or through unlicensed caregivers with inconsistencies, danger, and lack of appropriateness as possible offers. The difficulty comes from matching the elderly with caretakers in terms of their accessibility, experience, availability, and language skills [24].

Digital caregiver platforms like Papa and CareLinx from United States and Homage by Singapore and Malaysia allow individuals to find caregivers through mobile applications. They typically include

properties like reviews and ratings from users and ability to verify the caregiver's identity.

The review of literature indicates that caregiver matching is a complex process involving multiple criteria other than just availability of services. Such attributes as location, availability, service type, price and characteristics of service provider may be important for suitability of the match. Nonetheless, most platforms currently available concentrate on the listing of services and choice by user rather than providing an effective uniform system for ranking options available.

The emergence of digital caregiving platforms has increased the accessibility of caregiving services, but current platforms mainly serve as service directories rather than smart coordination systems. Users still has to compare providers manually based on their availability, cost, and type of services offered. The latest studies show that transparent matching mechanisms play an essential role in care-related technologies since seniors and caregivers need to have trust, predictability, and clarity in choosing care providers. Therefore, coordination systems should be equipped with organized matching criteria that allow for transparent decision processes rather than only user search-driven systems.

2.5 Access to Rehabilitation and Care Resources

Elderly care is often characterized by difficulty in the continuum of care for elderly people, especially for the patients recovering from surgical, stroke-induced, or other mobility-restricting conditions. The unavailability of various physiotherapy devices is mostly attributed to logistical issues faced during elderly rehabilitation as opposed to clinical problems [24].

New healthcare technology research shows that rehabilitation support goes beyond clinical treatment to include coordinated access to assistive technologies, mobility equipment, and rehabilitation resources in the home [14]. Long wait times to obtain rehabilitation equipment can result in a significant burden for caregivers; therefore, digital platforms that provide comprehensive information and resources regarding rehabilitation are considered helpful in enhancing access and coordination [24].

As pointed out by [24], in Malaysia caregivers and families often resort to informal networks, word-of-mouth and hospital discharge instructions in search of proper resources. Given the uncoordinated

widespread approach, finding such devices is complicated, time-consuming, and lacks transparency in price and quality. In a bid to tackle this issue, a digital solution that aggregates vendors, rental centers, NGOs, and donation-based services was developed.

From the service coordination perspective, equipment accessibility is rather a logistical element of elderly care than merely a clinical procedure. Thus, a platform that combines equipment information with caregiving resources can reduce the burden on the users of searching for information in different providers. Therefore, in this research equipment discovery is viewed as a part of the wider service-coordination ecosystem.

2.6 Role of Elderly Associations and Community Networks

Legacy entities or non-governmental organizations, such as MyAgeing (the Malaysian Research Institute on Ageing), PAWE (Pusat Aktiviti Warga Emas), and community-centric senior centers, perform important tasks in terms of providing advocacy, education, legal help, health screening and community support. Organizations within communities, older people's organizations, and NGOs have a crucial role in promoting active aging through their work in health promotion, social engagement, assistance to the needy, and education [1],[25].

Nevertheless, many previous studies indicate that community-based services remain hard to find due to the lack of information sources, limited visibility on the internet, and reduced integration with major service providers. To raise awareness and encourage the participation of older people in these initiatives, it is necessary to include the community support services in the digital care ecosystem.

The participation of community organizations broadens the idea of elderly care since it makes it possible to grasp it not only as something clinical but also something related to community interaction. From the service coordination point of view, these organizations act as another layer of support that focuses on providing social engagement, information, welfare support, and community assistance. Thus, the Care Bridge model implements these organizations as Support Networks rather than standard service providers.

2.7 Existing Approaches and Limitations

Three widely accepted frameworks were considered for this study:

1. Technology Acceptance Model (TAM): Created by [7], TAM identifies two main influences determining an individual's intention to use an application: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). TAM is useful for evaluating usability but provides limited guidance for the design of intelligent caregiving systems.
2. Unified Theory of Acceptance and Use of Technology (UTAUT): An extension of TAM that adds factors such as Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions [23]. UTAUT emphasises social and environmental characteristics and the necessity for infrastructure and support systems.
3. Telecare and Telehealth Service Model: A commonly adopted framework for remote monitoring and support of older adults [27]. Telecare systems typically include fall detection, emergency alerts, medication reminders, and remote consultations. However, most telecare services remain reactive, focusing primarily on responding to health-related events rather than proactively coordinating caregiving services.

Table 1: Comparison of Existing Models and Frameworks

Model/Framework	Focus Area	Strengths	Limitations
Technology Acceptance Model (TAM)	User acceptance of technology	Simple and widely validated; focuses on usability and usefulness	Does not address system functionality or service integration
Unified Theory of Acceptance and Use of	Technology adoption behavior	Considers social influence and	Lacks system-level design and

Technology (UTAUT)		facilitating conditions	matching capabilities
Telecare/Telehealth Service Model	Remote healthcare delivery	Enables continuous monitoring and emergency response	

Comparison leads to the conclusion that the existing researches cover aspects of elderly care that are totally different. In particular, TAM and UTAUT explain acceptance and implementation of technologies while telecare and telehealth models are focused on remote supervision and provision of care. None of these approaches provides direct understanding of how to effectively match elderly people with several types of community-based care services according to service parameters. Thus, the present study does not use any of the above-mentioned approaches. At the same time, they confirm the importance of usability, facilitating conditions and digital accessibility. The Care Bridge Model fills the gap mentioned above by combining user needs, services providers, support systems and a deterministic matching mechanism.

2.8 Analysis of Existing Applications

A comprehensive review of existing digital solutions for elderly care reveals critical gaps:

1. **Fragmented Solutions:** Current solutions often focus on one particular aspect such as emergency alerts, health monitoring, or caregiving services. Few companies have developed a consolidated platform incorporating guardianship, rehabilitation equipment access, and community resources [4], [24], [28].
2. **Overemphasis on Medical Monitoring:** The majority of technology available for elderly care focuses on real-time biometric data but does not address non-medical support such as emotional support, logistical support, or community services access [4], [13], [24],[28].
3. **Lack of Elderly-Focused Design Principles:** Many mobile applications overlook age-related impairments that may negatively affect seniors' ability to interact

with applications, including decreased eyesight, cognitive function, and hand movement ability [4], [24], [24], [24].

The purpose of examining current applications is to pinpoint any functional shortcomings and not to assess which platform is better. The examiner took into consideration aspects such as the availability of the service, caregiver functions, services related to rehabilitation, ability to access equipment, and support from the public. The information presented in Table 2 proves that all the existing platforms offer some relevant functions of caregiving. Still, the integration of caregivers' services, rehabilitation resources, equipment accessibility, and support from the public under one coordination system has many deficiencies.

Table 2: Comparison Between Existing Web or Application Services

Features	Pearl Caregiver	Teman Malaysia	Care Bridge
Platform	Website	Website	Mobile app
Rate	Not displayed	Available on website	Available
Availability (In Malaysia)	✓	✓	✓
Stay in caregiver	✓	✓	✓
Stay out caregiver	✓	✓	✓
Hospital sitter	✓	✓	✓
Physiotherapy	✓		✓
Companion to health appointment	✓	✓	✓
Companion to dialysis treatment	✓	✓	✓
Rent/Lend/Sell Equipment			✓
Community Support			

2.9 Comparative Analysis of Existing Solutions

Existing elderly care solutions differ in their service coverage, matching mechanisms, and level of validation. The following comparison considers representative operational platforms, a recent matching method, and the proposed Care Bridge Model. Limitations refer to the scope documented in the reviewed sources; an undocumented feature should not be interpreted as an unavailable feature.

Table 3: Comparative Analysis

Solution	Main features	Advantages	Limitations
Homage Malaysia [29]	Care assessments, personalised care plans, caregiver matching, home nursing, and rehabilitation services.	Links care requirements with professionals' experience and competencies, with application-based management of care visits.	The reviewed documentation does not specify a common ranking mechanism spanning caregivers, equipment listings, and community programmes.
Teman Malaysia [30]	Companionship for medical appointments, dialysis support, customised activities, and home care packages.	Provides practical assistance for everyday activities and access to appointments, with published service packages.	The reviewed service information does not describe a formal scoring algorithm or integrated matching across equipment suppliers and community organisations.
Yu and Gao's matching method [24]	Two-sided matching incorporating the expectations of older adults and care personnel under sufficient and insufficient staffing conditions.	Explicitly considers both parties' expectations and staffing constraints when determining matches.	Uses selected representative indicators and focuses on personnel matching rather than integrating rehabilitation equipment and community support.

Care Bridge Model	Model Deterministic eligibility filtering and ranking within a model linking users, service providers, and support networks.	Provides an explicit matching process and brings caregiving, rehabilitation resources, and community information into one prototype.	Uses predefined datasets and fixed weights; evaluation provides preliminary evidence of usability and feasibility, without comparative performance testing or demonstrated healthcare outcomes.
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This comparison positions Care Bridge as an integrated service coordination model. Its intended contribution is the combination of multiple service domains with an explicit deterministic matching process. Existing platforms already provide caregiver matching and coordinated care services, while recent research offers more detailed treatment of bilateral preferences. Consequently, the present study does not establish that Care Bridge outperforms these alternatives. Such a conclusion would require direct benchmarking using common datasets, tasks, and outcome measures.

3. RESEARCH METHODOLOGY

3.1 Research Design

This study employed Design Science Research (DSR) methodology, a well-established method in information systems for solving practical problems through the creation and evaluation of purposeful artefacts [11], [19]. The main artefact developed is a non-sensor-based mobile application specifically created to address three major service gaps related to elderly caregiving: matching guardians and caregivers, locating rehabilitation equipment, and connecting service providers with seniors.

The research followed a structured iterative DSR process with the following phases:

1. Problem Identification and Motivation: An exhaustive literature review and needs analysis were completed to determine gaps in existing elderly care solutions.

2. Design and Development of the Artifact: A prototype mobile application was created following user-centered design (UCD) principles, incorporating large font sizes, simplified navigation, and contextual instruction.
3. Demonstration and Evaluation: Qualitative expert feedback from healthcare providers, social workers, and caregivers, and prototype evaluation through user acceptance testing were conducted.

The DSR method augmented by user centred design principles for facilitating usability and accessibility needs of elderly people and their caregivers means that the process of creation included five operational stages: requirements determination, low-fidelity interface creation, high-fidelity prototype construction, implementation of core features, and evaluation. The final prototype was evaluated through expert review and user acceptability testing. The combination of the methods allowed for evaluation of both the theoretical validity of the model and practical usability of its implementation.

3.2 System Architecture

The system was created using a mobile app running on cloud-based infrastructure, assuring potential for future expansion and maintainability.

- Frontend: Developed using Flutter, a mobile UI development platform based on the Dart programming language, allowing creation of apps for iOS and Android with rapid UI development and optimized performance.
- Backend: Utilizes cloud computing service such as Firebase or Node.js-based server to handle user authentication, real-time database updates, cloud storage management, and user analytics.
- APIs: RESTful APIs used to access and manage data from third-party vendors and organizations, ensuring modular communication [9].
- Data Layer: Uses JSON (JavaScript Object Notation) as structured data format for equipment listings, guardian profiles, and organizational contact information.

3.3 Deterministic Matching engine

The deterministic matching model systematically connects users and service providers who meet predetermined criteria and constraints. Unlike probabilistic or recommendation-based models, this model replicates the same input conditions and produces identical and repeatable outputs.

User attributes (U):

- L_u : User location
- A_u : Required availability (time)
- B_u : Budget constraint
- N_u : Type of need (e.g., caregiver, equipment, service)

Service provider attributes (S):

- L_s : Service location
- A_s : Service availability
- C_s : Cost of service
- T_s : Type of service offered

Deterministic Matching Model and Equation:

Upon filtering, each candidate service provider is evaluated using a deterministic scoring function:

$$\text{Score}(U, S) = w_1 \times (1 / D(L_u, L_s)) + w_2 \times M(A_u, A_s) + w_3 \times B(B_u, C_s)**$$

Where:

- $D(L_u, L_s)$ = function calculating distance between user and service provider
- $M(A_u, A_s)$ = match availability (1 if matched, 0 if not)
- $B(B_u, C_s)$ = match budget (1 if within budget, 0 if not)
- w_1, w_2, w_3 = predetermined weights (equal weighting used initially)

Matching Process Algorithm:

Algorithm 1: Deterministic Matching Algorithm

Input: User data U, list of service providers S

Output: Best matched service provider

1. Initialize CandidateList $\leftarrow \emptyset$
2. For each service provider s in S :

If $(T_s = N_u)$ AND $(A_s \text{ matches } A_u)$ AND $(C_s \leq B_u)$:

Add s to CandidateList

3. For each s in CandidateList:

Compute Score(U, s)

4. Sort CandidateList from descending order of Score
5. Return top-ranked service provider

The matching mechanism distinguishes between eligibility filtering and ranking. First, the type of service, availability, and the budget are considered as eligibility conditions. Only the eligible providers that remain after applying the eligibility criteria are then ranked with regard to geographical distance, availability, and budget matching. Equal weights were used since there was no empirical data within this study to prove different importance levels of the three criteria for scoring. Thus, the model serves the purpose of a transparent matching mechanism, not an adaptive recommender system.

3.4 Data Collection and Evaluation

Data collection involved expert review and task-based User Acceptance Testing (UAT), combining quantitative ratings with qualitative feedback. The evaluation used the Care Bridge prototype with predefined service datasets. These datasets supported simulated service-search and matching tasks, while the evaluation data comprised expert assessments, participant ratings, and feedback on the model and application.

Expert review involved three individuals: a leader of a local non-profit organisation focused on elderly care, a mobile application development specialist, and a registered nurse specialising in geriatric care. The experts examined the model diagram, system workflow, and major application features. Structured checklists and short interviews were used to gather assessments of the model and identify usability concerns. Model evaluation covered relevance, completeness, clarity, practicality, matching

effectiveness, service integration, and usability. Feedback on the application also addressed ease of navigation, text readability, and icon clarity.

UAT involved 20 participants representing the intended user groups of older adults and caregivers. Participants completed guided tasks using the prototype: searching for a caregiver based on location and service requirements, locating rehabilitation centres and viewing their details, browsing equipment listings, managing emergency contact information, and exploring associations and community support features. An observer monitored participants as they interacted with the application to identify difficulties encountered during task completion.

Quantitative feedback was collected using a structured questionnaire with a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Participants evaluated ease of use, usefulness, system efficiency, interface clarity, and overall satisfaction. Qualitative feedback was collected through open-ended questionnaire responses and semi-structured interviews immediately after the UAT tasks. Participants described their experiences, difficulties, and suggestions concerning service matching, access to providers, and support network functions. Informed consent was obtained from all participants.

Quantitative ratings were summarised using mean scores for each evaluation criterion. Qualitative responses were analysed through familiarisation, initial coding, theme development, theme review, and interpretation. Coding was guided by the Care Bridge Model components to examine participants' perceptions of the matching mechanism, interface usability, service accessibility, and integration of support networks. The evaluation assessed perceived usefulness, usability, and practical feasibility rather than clinical effectiveness.

4. RESULT AND DISCUSSION

4.1 Care Bridge Model

This study introduces the "Care Bridge Model," the primary framework for the proposed mobile application. The Care Bridge Model addresses fragmentation and inefficiencies found in current elderly care systems by employing a deterministic matching process to provide users with more appropriate services. Figure 1 shows Care Bridge

model showing user inputs, deterministic matching, service providers, and support networks.

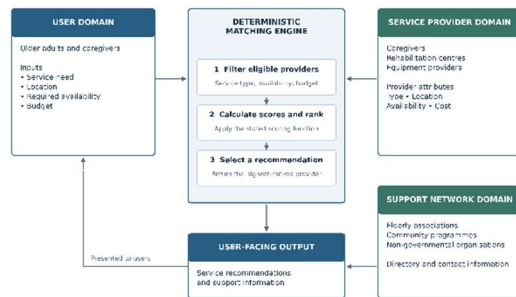


Figure 1. Care Bridge Model Architecture

The Care Bridge Model is seen as a framework for healthcare coordination instead of simply as a service-matching tool. This model helps older people connect with their caregivers, health service providers, rehab facilities, community organizations, and support agencies through means of a centralized coordination system. The assurance matching system of this model works as a coordination device allowing the users of the system to make their way through services and referrals by linking them with the needed services according to their requirements and specifications. Thus, this system links together various service sectors and helps avoid fragmentation within the elder care services field.

4.2 Mobile Application-Care Bridge

Mobile Design: The Care Bridge mobile app was created to emphasize simplicity, accessibility, and user-centred interaction. The design provides clear guidance using large call-to-action buttons such as "Get a Caretaker" and "Become a Caretaker." Visually, the application uses high-contrast color schemes, large clear typography, simple iconography, and minimal text clutter. The application supports dual-language functionality and is optimized for both Android and iOS systems.

The design of the interface was based on the results of the latest studies that examined the usability of mobile applications for older users. In particular, it has been suggested to focus on minimizing the complexity of navigation through applications while using larger interactive elements and contrasting colors on displays [4],[24], [24], [24].

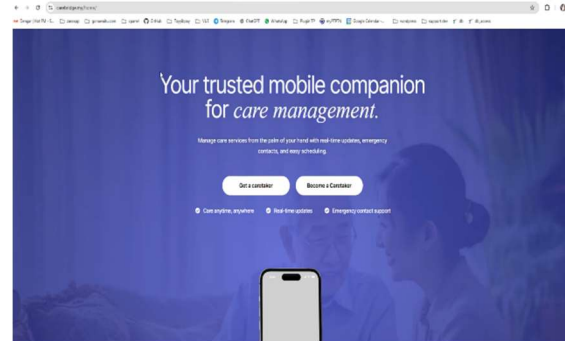


Figure 2. Web-based Application for Care Bridge

4.2.1 System Functions

The Care Bridge app combines various function sizes all on one platform. User access is managed through authentication and profile management, which give caregivers and older adults access to Care Services Management, which allows caregivers to search for caregivers as well as to request and monitor different types of services. On the other hand, Rehabilitation Center Access allows users to find rehabilitation services based on the type of service and location, while Equipment Management shares information about assistive and rehabilitation equipment.

At the same time, the platform can offer several more functions including Emergency Contact Management, as well as Association and Community Support functions. All the information about emergency contacts can be stored using this app and users have access to the information about all associations related to the elderly and community programs. Hence, the platform is offering more information beyond caregiving activities in those fields.

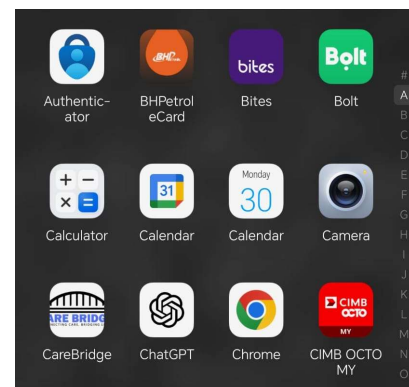
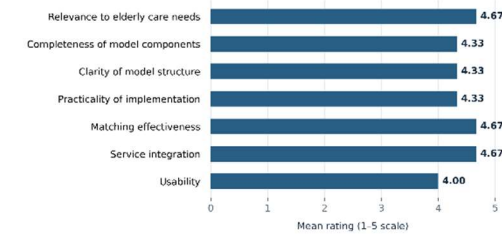


Figure 3. Web-based Application for Care Bridge

4.3 Expert Validation Results

Following figure 3 shows mean expert ratings of the Care Bridge Model across seven evaluation criteria (n = 3).



Expert review: n = 3. Overall mean = 4.43.
Ratings describe expert judgements, not measured matching accuracy.

Figure 4. Expert Validation Results

The evaluation of the Care Bridge Model by experts revealed an overall average score of 4.43, which can be classified as high level. The experts agreed that three evaluation criteria which received the highest average scores were the relevance of the model to elderly care demands, the efficiency of the matching mechanism, and service integration (4.67). The study results show that experts totally agree with the model's relevance and practical usefulness. All other criteria assessed got high scores with average value of over 4.00 which means that the Care Bridge model is simple, intelligible, and easy for implementation.

Nevertheless, despite the overall positive evaluation, the criterion of usability has the lowest average score (4.00). The result is of importance since usability is important, especially if the target users are older adults with different level of digital literacy. This leads to the need to continue improvement of the onboarding, navigation, and training process before full implementation of the model.

4.4 User Acceptance Task Results

The UAT findings in table 4 reveal consistently favorable evaluations in all five attributes. Usefulness and overall satisfaction earned the highest mean score (4.4), showing that users considered the app relevant to their needs and generally enjoyed interacting with it. The lowest score in system efficiency (4.2) still exceeded the neutral point in the scale. The relatively lower score may indicate the ways to improve response time, navigation flow, or interactions with the system in further releases.

Table 4: User Acceptance Test Results

No.	Evaluation Criteria	Mean Score
1	Ease of use	4.3
2	Usefulness	4.4
3	System Efficiency	4.2
4	Interface Clarity	4.3
5	Overall Satisfaction	4.4

From the User Acceptance Test results, the Care Bridge Mobile App demonstrated a high level of usability and acceptance, with every rating above 4.0. The Care Bridge Mobile App is a user-friendly solution providing elderly users with an appropriate solution to aid their needs in Malaysia.

1. Effectiveness of the Deterministic Matching Engine: Qualitative feedback from the participants supported positive perceptions regarding the deterministic matching mechanism, especially in terms of the relevant and convenient nature of the suggested services. Respondents expressed satisfaction with the ease and efficiency with which matching was performed through structured matching.
2. Usability of the User Domain Interface: Participant feedback indicated that providing inputs such as needs specification, location, and preferences involved minimal technical difficulty for elderly consumers and caregivers.
3. Accessibility of Service Provider Domain: Participants reported that finding providers of caregivers, rehabilitation facilities, and equipment through one source provided much convenience, reducing dependence on multiple outside sources.
4. Value of Support Network Domain Integration: Participants acknowledged having access to association and community program information through

- the same application was very useful in meeting social and emotional needs.
5. Integrated System Experience: A common theme throughout participants' responses indicated appreciation for the structured system and the seamless interconnectivity of the Care Bridge Model components.
 6. Suggestions for Model Enhancement: Recommendations included personalized matching, enhanced filter options, and guidance for first-time users.

Figure 4 shows Mean User Acceptance Testing ratings across five evaluation criteria (n = 20).

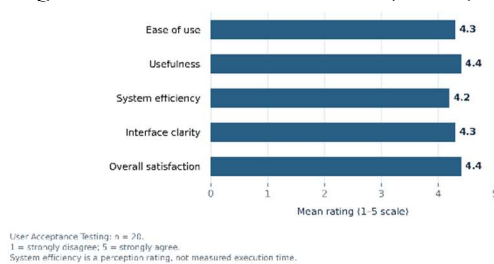


Figure 5. Mean User Acceptance Test

5. DISCUSSION

The results of the evaluation suggest that the innovative deterministic matching-based model can efficiently be applied for coordinating the delivery of services to older adults. User Acceptance Testing results indicate that the application can be understood easily and operated without difficulties. The deterministic matching-based evaluation model generates important advantage of removing uncertainty and producing consistent and reliable results based on the set criteria.

The end results achieved in this research are consistent with modern studies that show how the age-friendly interface characteristics such as easier wayfinding, bigger visuals, and less amount of information have a substantial effect on the attitudes of older users towards technology [4], [24], [24], [24]. High ratings for usability and transparency point to the fact that the app implements a number of these design suggestions successfully.

The integration of multiple service types into one platform addresses the fragmented nature of elderly care systems identified in the literature. By being able to access caregivers, rehabilitation devices, and community services from one application, efficiency is improved and user experience enhanced. The

results also confirm prior studies suggesting that aged people benefit from integrated services systems instead of standalone health apps. Recent studies on mobile health technologies noted that the majority of existing technologies serve specific functions but do not take into account such support systems as community resources, social involvement, and home care coordination [1], [24],[24], [28]. The Care Bridge Model solves the above issue by uniting several support areas into one coordination platform.

The matching engine operates on the basis of certain criteria, such as type of service, availability of the service, tax, and distance, to reduce the number of possible suppliers and rank available options. This is different from other methods of service discovery in which users may need to check thousands of suppliers themselves. Positive evaluation of the matching mechanism ($M=4.67$) and user feedback from UAT indicate that participants found the recommendations useful and adequate. Nevertheless, this finding should be regarded as the evidence of perceived relevance and usability rather than verification of high accuracy of matching due to the fact that the prototype was tested using preselected data and, hence, cannot be compared to practical applications.

The second contribution relates to the issue of integration in services. The studies examined earlier indicate the lack of cohesion in technologies for elderly care, as different applications are directed at solving problems related to monitoring, care provision, rehabilitation, and emergency care separately. The Care Bridge Model takes the issue of the lack of cohesive approach into account. This system integrates care giving services, rehabilitation facilities, assistive devices, and social support into one system. The estimation of experts according to the integration issue ($M = 4.67$) and the theme that deal with integrated system experience prove the importance of this approach. Among the reasons why integration is so important is the fact that integration leads to greater number of available functions and lowers the need to search for the needed support across different service providers.

The findings regarding usability also confirm the significance of user-oriented design for digital solutions aimed at aged individuals. The application included large font size and bright visual components, easy navigation, and made the design easier for people with different levels of digital experience. Results regarding ease of use and clarity of the interface fell at the level of a mean score of 4.3

and qualitative comments in the User Domain show that the prototype was generally perceived as usable. At the same time, the score of 4.00 from the usability expert indicates that there is a need for improvement in terms of usability. In particular, the addition of instructions, tutorials, and easy filtering systems is important prior to the introduction of the solution to older users.

By including the Support Network Domain, the proposed system moves beyond just providing direct caregiving and clinical services. Associations of older people, community organizations, and non-profit groups can supply different forms of social and information and welfare support not included in apps for health management purposes. Interviews showed that people liked the access to these facilities on the same platform. However, the current research did not measure directly social isolation, psychological health, and community engagement. Thus, the results of the research indicate the importance of including social institutions but do not prove the positive impact of these resources on society and health in the long run.

The results are more than its usability and effective performance, showing that the Care Bridge Model can play a role in counteracting fragmentation in elderly care systems. Namely, combining healthcare, rehabilitation, care provision, and community resources in a common coordination model can enhance service navigation. In other words, Care Bridge is more than just a service discovery tool. It may serve as a coordinating mechanism that enables communication among the various stakeholders of elderly care.

5.1 Comparative Performance Analysis

The proposed matching mechanism can be compared with a nearest-eligible-provider baseline and the recent two-sided matching method developed by Yu and Gao [24]. Care Bridge filters providers according to service type, availability, and budget before ranking eligible candidates. Since availability and budget are binary conditions already satisfied during filtering, these terms contribute equally to the scores of eligible providers. Ranking is therefore determined by geographical distance under the current scoring formulation. Its contribution lies in applying an explicit matching process within an integrated service coordination model; improved ranking performance over a nearest-eligible-provider approach has not been demonstrated.

Yu and Gao [24] consider the expectations of both older adults and care personnel, including conditions of sufficient and insufficient staffing. Their approach provides a more detailed representation of bilateral preferences and staffing constraints. Care Bridge uses a simpler formulation centred on user requirements, while its broader application scope includes rehabilitation resources and community support. These differences concern modelling scope and functionality rather than demonstrated superiority in accuracy or efficiency.

Regarding matching accuracy, the expert mean rating of 4.67 for matching effectiveness reflects perceived suitability rather than the proportion of correctly recommended providers. Similarly, the UAT system-efficiency score of 4.2 reflects users' perceptions rather than measured execution time. These scores cannot be directly compared with objective accuracy or runtime measures reported for other methods.

From an analytical perspective, filtering and scoring n providers require $O(n)$ operations, assuming constant-time evaluation of each provider. Sorting k eligible candidates requires $O(k \log k)$, giving an overall complexity of $O(n + k \log k)$. This characterises the computational structure of the stated algorithm but does not establish its practical speed relative to alternative methods. A controlled benchmark using common datasets and relevance criteria is required to compare recommendation quality, constraint satisfaction, and execution time. The current findings therefore support preliminary usability and feasibility, while comparative performance remains unverified.

5.2 Limitations and Research Challenges

Several limitations affect the interpretation of the findings. First, the evaluation involved three experts and 20 UAT participants. Although their feedback provided useful preliminary evidence, this sample cannot adequately represent the diversity of older adults, caregivers, and service providers. Differences in digital literacy, functional ability, care requirements, and access to technology may influence users' experiences. The findings therefore support the initial feasibility and perceived usability of Care Bridge, while its suitability for wider deployment remains to be established.

Second, the prototype relied on predefined datasets rather than live connections with service providers.

This restricted the evaluation of matching under changing conditions, including cancellations, updated prices, and fluctuations in service availability. Consequently, positive feedback on service relevance does not establish that recommendations would remain appropriate in operational settings. Maintaining accurate provider information and coordinating updates across different organisations remain implementation challenges requiring further investigation.

Third, the deterministic matching mechanism used fixed, initially equal weights. This simplified the matching process but did not establish whether the selected weights reflected users' actual priorities. Users may attach different importance to distance, affordability, and availability depending on their circumstances. The sensitivity of recommendations to alternative weighting schemes was not established, limiting conclusions about the robustness of the ranking mechanism.

Fourth, the evaluation primarily measured subjective perceptions through ratings and qualitative feedback. These measures provide evidence of acceptance and perceived usefulness but do not demonstrate objective matching accuracy, reduced service-search time, successful referral completion, or improved continuity of care. No direct performance comparison with existing platforms was conducted. The study also did not establish longer-term effects on caregiver burden, social isolation, or quality of life.

The evaluation identified practical design challenges concerning usability and trust. Experts and participants recommended clearer onboarding, additional guidance for first-time users, and more detailed filtering options, including urgency and health-related needs. Experts also recommended strengthening service provider verification. These findings indicate that combining multiple services within one application does not automatically ensure accessible or trustworthy service coordination. Further development must balance broader functionality with simple navigation, understandable recommendations, and appropriate provider verification. These issues were identified through evaluation feedback; their resolution and effectiveness require subsequent testing.

6. CONCLUSIONS

This research created and verified the Care Bridge Model as a digital health system coordination tool

for elderly care services. This model integrates health care, rehabilitation, care workers, and local community support into a single ecosystem aimed at enhancing the continuity of care and navigation for the elderly. While deterministic matching is at the core of the model's coordination process, its main contribution is the promise to minimize fragmentation and provide coordinated access to elderly care services for various stakeholders.

According to the evaluation data, this model is relevant and practically applicable. The average score of expert opinions was 4.43. The results of the UAT surveys were in the range of 4.2 to 4.4. The qualitative feedbacks have accentuated the importance of the matched services. However, certain limitations such as a small sample size and fixed parameters of matching have to be taken into account to interpret the results.

6.1 Contribution of the Study

1. Introduction of the Care Bridge Model: A structured framework for elderly care service coordination integrating User Domain, Deterministic Matching Engine, Service Provider Domain, and Support Network Domain.
2. Deterministic Matching Approach: A systematic, transparent, and criteria-driven service coordination mechanism based on factors such as location, availability, and cost, providing consistency and reliability.
3. Practical Implementation: Design and creation of a mobile application called Care Bridge incorporating caregiver matching, rehabilitation resource discovery, and community support within one application.
4. Empirical Evidence: The study provides initial empirical evidence that has come from expert reviewers, user acceptance tests and qualitative reviews on the relevance, usability and practical feasibility of the proposed model.

6.2 Future Work

The efficacy of the Care Bridge Model should be assessed in future investigations through the use of measures that reflect system-level outcomes. This may encompass measuring the rates of referral

completion, accessibility of services, continuity of care indicators, the degree of caregiver burden alleviation, stakeholder satisfaction, and successful connection with health care and community support services. Longitudinal studies that engage health care providers, rehabilitation centers, caregiving agencies, and community organizations are suggested to evaluate the effect of the model on elderly care coordination in practice.

AUTHOR CONTRIBUTIONS

Conceptualization, M.R.S., M.F.A.R. and M.F.M.A.; methodology, M.R.S., M.F.A.R. and M.F.M.A.; software, M.R.S.; validation, M.R.S., M.F.A.R., M.F.M.A., N.A.A., S.T., S.A.S.A., R.W.M.M., L.S.P. and R.R.; formal analysis, M.R.S.; investigation, M.R.S.; resources, M.R.S. and M.F.A.R.; data curation, M.R.S.; writing—original draft preparation, M.R.S.; writing—review and editing, M.F.A.R., M.F.M.A., N.A.A., S.T., S.A.S.A., R.W.M.M., L.S.P. and R.R.; visualization, M.R.S.; supervision, M.F.A.R. and M.F.M.A.; project administration, M.F.A.R.; funding acquisition, M.F.A.R. All authors have read and agreed to the published version of the manuscript.

FUNDING

This work was supported by National Defence University Malaysia.

INFORMED CONSENT STATEMENT

Informed consent was obtained from all subjects involved in the study.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ACKNOWLEDGMENTS

The authors would like to express their sincere appreciation to the National Defence University of Malaysia for providing support that made this research possible. The authors also gratefully acknowledge all faculty members, experts, and participants who contributed to this research. The authors declare that AI was only utilized in the preparation of this journal for language improvement. There was no usage of AI tools for analysis, interpretation, or generation of data. All outputs received critical scrutiny from the authors who are solely responsible for their authenticity and correctness.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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