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IoT-enabled emergency information supply chain architecture for elderly people: The Australian context

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ABSTRACT

The effective delivery of emergency information to elderly people is a challenging task. Failure to deliver appropriate information can have an adverse impact on the well-being of the elderly people. This paper addresses this challenge and proposes an IoT-enabled information architecture driven approach, which is called "Resalert". Resalert offers IoT-enabled emergency information supply chain architecture pattern, IoT device architecture and system architecture. The applicability of the Resalert is evaluated by the means of an example scenario, a portable Raspberry Pi based system prototype and user evaluation. The results of this research indicate that the proposed approach seems useful to the effective delivery of emergency information to elderly people.

1. Introduction

Australia is a disaster prone country and the effective delivery of emergency information notification to affected residents is critical and challenging, especially to those who represent the elderly population [18,32]. The major challenges are around message delivery, comprehension, and ensuring that the message is acted upon [16,31,34]. Failure to address these challenges may have an adverse impact on the well-being of the elderly people. This paper addresses part of this issue and focuses on the following research question:

How to enable the effective delivery of emergency information notification to elderly people in the Australian context?

This research employs a constructive design research approach [12] and develops the Internet of Things (IoT) enabled architecture driven approach [42] containing the (1) IoT-enabled information architecture pattern and (2) system architecture for the effective emergency information notification delivery to elderly people, which is deemed as a gap in the current emergency information notification delivery infrastructure. IoT is a "dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual 'things' have identities, physical attributes, and virtual personalities, use intelligent interfaces, and are seamlessly integrated into the information network" [6]. The proposed novel IoT-enabled approach is called here "Resalert". The Resalert approach is evaluated by the means of an example scenario and an implementation prototype. The Resalert aims to guide the delivery of emergency information to elderly residents in a meaningful and effective manner.

This paper is organised as follows. Firstly, it discusses the research method and limitations. Secondly, it presents the literature review to provide the theoretical foundation and research motivation. Thirdly, it discusses the IoT-enabled information architecture driven approach-Resalert. Fourthly, it evaluates the applicability of the proposed Resalert by the means of an example scenario and a portable Raspberry Pi

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device based system implementation prototype. Finally, it discusses the research results before concluding.

2. Research method and limitations

The focus of this research is the development and evaluation of the Resalert. Therefore, this research adopted a design research (DR) approach [12]. DR is concerned with the design and evaluation of a product or an artefact in response to some real or perceived problem [7]. The newly realised artefact could be a sole contribution of the research, however, the knowledge gained from the novel artefact design is also an important contribution. The DR approach [12] is organised into following three main steps:

1. Literature Review – Related literature is reviewed to identify the research problem within the domain of emergency information delivery to elderly people in the Australian context.
2. Design – An IoT-enabled information architecture driven approach, Resalert, is designed to address the problem identified in literature.
3. Evaluation – Applicability of the proposed Resalert approach is evaluated with the help of an example scenario, a portable Raspberry Pi device based system implementation prototype and user evaluation. The prototype is offered as a proof of concept to guide further research and development in this important area of research.

The scope of the Resalert is limited to the delivery and presentation of emergency information to elderly people. The items such as information generation, processing, analysis or measurement of the information itself are beyond the scope of this research paper. It is intended that the emergency information can be sourced from existing emergency information warning systems that adhere to the state guidelines [3–5]. Since the research project scope is to focus on only elderly people, therefore, special consideration is given to non-functional requirements such as user-friendliness and ease of use for elderly people. This research complements the prior research that highlights the information relevance: getting information to the right people, at the right time, to the right location [19]. Additionally, this research adopts the typical standard of elderly classification as followed by the UN along with many other institutions, i.e. 60+ years old [38]. The terms, “elderly residents,” “seniors,” “the old,” “the ageing population,” and “the elderly people” are used interchangeably to describe the primary target user demographics for the proposed Resalert.

The significance of this research and the proposed Resalert can be illustrated from three perspectives. Firstly, it can be linked to the need of developing novel IoT-enabled information architecture design pattern in the context of elderly population. Secondly, Australia has a high occurrence of emergencies, which has prompted the development of better or alternate emergency information notification architecture for enabling effective communication to affected residents [19]. Thirdly, the ageing population and the emergency information notification delivery architecture have not been extensively covered in the literature. This research is an attempt to fill this small gap of research in the Australian context. Although, this research project was proposed and conducted in the Australian context, it is anticipated that other countries may find the findings of this research useful for their local context.

3. Literature review

Australia has historically witnessed some catastrophic disasters, which not only caused extensive property damage but also caused loss of life (e.g. the Black Saturday bushfires of Victoria in 2009 killing 173 people; and the Queensland floods in 2010-2011 claiming 33 lives) [23,36]. Communities are warned about emergencies by a group of agencies, known as warning originators, mostly comprised of Commonwealth agencies and Emergency Service Agencies (ESA) [25,28].

The complexity of multi-agency response and emergency warning information (to be sourced and disseminated) can lead to possible delays, miscommunications, warning message replication and ineffective response [16].

There are a number of emergency information warning systems. For instance, Emergency Alert (EA) is a national telephone-based emergency information warning system [15]. EA was introduced in 2009 and uses landline and mobile telephones to relay emergency information from several authorised emergency agencies to those in affected areas (e.g. SMS to mobiles and voice messages to landlines) [37]. The Early Warning Network (EWN) is a mobile-based solution that provides subscribers with emergency information alerts [14]. In addition to traditional emergency warning information systems, a new crowdsourcing ways of emergency information sourcing and sharing are emerging [21]. Crowdsourcing is a collaborative way to source and share information in order to solve an individual, community or organisational problem [33]. There is also a growing interest among industry, government and communities to develop IoT enabled smart architectures and systems. For instance, recently an IoT-enabled architecture has been developed for smart healthcare systems [8]. The emergence and widespread use of crowdsourcing (e.g. [20]) and smart devices such as IoT (e.g. tablets, GPS and various sensors) offer new ways of emergency information delivery [1].

The future for many Australians, old and young, is likely to be much ‘smarter’. ‘Smart’ technology adoption is expected to hit homes in Australia with the implementation of the National Broadband Network scheme for high speed Internet. The scheme is currently being rolled out across the nation and will likely continue over the period of next 10 years [30]. The applicability of smart technologies is being researched for a number of contexts [2]. The application of smart technologies aimed at older generations has typically been broken down into the broad categories of: smart-homes, robotics, virtual reality, telemedicine and social connection [24,29].