

Mobile technology to give a resource-based knowledge management advantage to community health nurses in an emerging economies context

Judith Fletcher-Brown, Diane Carter, Vijay Pereira and Rajesh Chandwani

Abstract

Purpose – Knowledge is a key success factor in achieving competitive advantage. The purpose of this paper is to examine how mobile health technology facilitates knowledge management (KM) practices to enhance a public health service in an emerging economies context. Specifically, the acceptance of a knowledge-resource application by community health workers (CHWs) to deliver breast cancer health care in India, where resources are depleted, is explored.

Design/methodology/approach – Fieldwork activity conducted 20 semi-structured interviews with frontline CHWs, which were analysed using an interpretive inductive approach.

Findings – The application generates knowledge as a resource that signals quality health care and yields a positive reputation for the public health service. The CHW's acceptance of technology enables knowledge generation and knowledge capture. The design facilitates knowledge codification and knowledge transfer of breast cancer information to standardise quality patient care.

Practical implications – KM insights are provided for the implementation of mobile health technology for frontline health-care professionals in an emerging economies context. The knowledge-resource application can deliver breast cancer care, in localised areas with the potential for wider contexts. The outcomes are valuable for policymakers, health service managers and KM practitioners in an emerging economies context.

Social implications – The legacy of the mobile health technology is the normalisation of breast cancer discourse and the technical up-skilling of CHWs.

Originality/value – First, this paper contributes three propositions to KM scholarship, in a public health care, emerging economies context. Second, via an interdisciplinary theoretical lens (signalling theory and technology acceptance model), this paper offers a novel conceptualisation to illustrate how a knowledge-resource application can shape an organisation's KM to form a resource-based competitive advantage.

Keywords Breast cancer, India, Knowledge management, Signalling theory, TAM

Paper type Research paper

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Introduction

India is facing a significant public health challenge as breast cancer rates of incidents and mortality steadily increase (Khokhar, 2018). Statistics show by the end of 2020, 2.5 million Indian women will be living with a biologically aggressive breast cancer because of late diagnosis and a lack of awareness about self-examination (Breast Cancer India, 2016; Rath and Gandhi, 2014). In Western countries, incidence rates increase with age unlike India, where the rate is reversed with the highest female mortality rate found in those aged 25-50 years (Khokhar, 2018). Limited knowledge about breast cancer and poor public health

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information combine to prevent early diagnosis and cause a rise in cancer rates. There are two main reasons for this situation. First, excluding India's National Cancer Control Programme in 1976, there has been no large-scale implementation of breast cancer prevention or knowledge management (KM) strategies to date (Pramesh *et al.*, 2014). The second is bound in India's cultural complexities surrounding the female body, meaning discussions about female cancers are rare and taboo (Fletcher-Brown *et al.*, 2020).

India, therefore, operates a fragmented approach to constructing a nationwide KM system for breast cancer health care. This is evidenced by the limited understanding of the Ministry of Health and Family Welfare (MoHFW) about the nature of medical knowledge flow, the types of KM tools suitable to disseminate breast health information and the barriers to enablers of KM (Chib, 2010; Nicolini *et al.*, 2008). Observers have also witnessed a less than substantive investment in educational resources as to normalise breast self-examination or technological innovations to assist prevention activities (Gupta *et al.*, 2017).

The management of health care to India's population of over one billion citizens is the responsibility of the state governments, with overall control held by the central MoHFW. During the past two decades, the inadequate flow of public health information about breast cancer has not enhanced patient care or positively affected the efficiency and effectiveness of the organisation (Dey, 2017). The ineffective KM system has continued to substantially reduce MoHFW's reputation as a quality health provider (Fletcher-Brown *et al.*, 2018; Sheffield, 2008). Consequently, without an effective KM strategy, the capability of the organisation to establish an excellent situational awareness of the ensuing breast cancer crisis will inevitably mean that the MoHFW will be coping with an epidemic in the foreseeable future (Khokhar, 2018).

Knowledge is a key success factor in achieving competitive advantage in fast-paced economic environments like India and has been found to improve organisational performance (Mehralian *et al.*, 2018). Furthermore, while knowledge has been highlighted as the most precious asset for many organisations, accumulated knowledge can manifest as a source of sustainable competitiveness (Nguyet *et al.*, 2019). While extant literature has extolled the potential of KM to influence and improve private-sector performance, fewer authors have investigated public-sector themes that yield recommendations for professional practice (Massaro *et al.*, 2015). Indeed, if KM can enable innovation in organisational systems to positively affect the performance of employees and benefit all stakeholders, then the examination of a public health sector organisation is worthwhile (Papa *et al.*, 2018).

Research evidences incorporating information communication technology (ICT) in a health-care organisation enriches complex channels of knowledge flow among stakeholders at every stage of the health-care process (Singh *et al.*, 2018). Furthermore, innovations such as mobile health (m-health) technologies may be useful KM tools for frontline health workers, in particular for those in an emerging economies context with a large geographical area and who operate from a low-resource setting (Chandwani *et al.*, 2018). M-health innovations may, therefore, expedite KM (including knowledge sharing and seeking) to enhance the flow of public health information about breast cancer and improve the reputation of the public health service provider. However, to embed facilitating KM practices, the skills, capabilities and competencies of employees must be assessed to develop efficient processes that produce quality products or services to meet the market's demands (Baines and Smith, 2020; Kuciapski, 2017).

The World Health Organisation (2016) reports that m-health initiatives to enhance health-care delivery have risen significantly. India has experienced some success with m-health to facilitate information efficiency about Type 2 diabetes and childhood diseases, but a sustained robust KM system is still required (Ilozumba *et al.*, 2018; Muralidharan *et al.*, 2017). Furthermore, there is scant insight into the ability of m-health technology to relieve

the complexities of the breast cancer problem with an effective and efficient outflow and inflow of KM (Dwivedi *et al.*, 2008; Pereira *et al.*, 2019).

Recent research in India revealed that the essential cog in the KM wheel are community health workers (CHWs) (Fletcher-Brown *et al.*, 2018) known as accredited social health activists (ASHAs) and Anganwadi (AWW), both key cadres in India's health prevention programme. In particular, these workers are responsible for disseminating maternal and child health knowledge and treatments. It is their unique standing within the community which provides the potential for an m-health innovation to manage breast health-care knowledge effectively to all stakeholders and, therefore, requires further exploration.

Against this backdrop, this study undertakes an in-depth inquiry into KM practices and strategies for enhancing breast health-care delivery with a knowledge-resource application (*App*) (run on a mobile tablet) and posit the following research objectives:

- to explore the effectiveness of m-health technology as a KM tool;
- to reduce asymmetry of breast cancer information; and
- to examine how m-health technologies can shape breast cancer KM as a resource-based competitive advantage for a public health organisation.

The complexity of this KM problem in India demands a theoretical interdisciplinary approach to enhance the KM domain. In so doing, this paper answers the call for theory development to deliver new models, tools and techniques specific to the health sector (Van Beveren, 2003). This empirical study uses Spence's (1978) signalling theory as a lens to explore m-health technology as a resource-based KM advantage for the MoFHW, to reduce breast cancer rates. Therefore, it is pertinent to assess the MoFHW's potential to deliver these core expectations. Rarely in published literature is the signalling theory explored in a health KM setting, but greater investigation has been invited (Simaens and Koster, 2013).

The effectiveness of m-health technology to facilitate KM by CHWs will be explored using an adapted technology acceptance model (TAM) devised from earlier models (Davis, 1989; Venkatesh and Bala, 2008; Maruping *et al.*, 2017). Originally conceived for business use, this model is increasingly applied in m-health research to gauge the usefulness of technology to improve the access to and quality of health-care information (Yarbrough and Smith, 2007; Kalnad *et al.*, 2017). It is the most frequently applied research model to predict the use of a person's intention to perform a particular behaviour and acceptance of information systems and technology by individual users (Rahimi *et al.*, 2018).

The overall structure of the study takes the form of the following sections including a development of the theoretical framework, frontline health-care delivery in India, research design, findings and discussion, theoretical and managerial contributions and limitations of the study including directions for future research.

The development of the theoretical framework

Situational context

India has grown rapidly over the past decade to achieve the status of the fastest-growing economy in 2018. The McKinsey Global Institute report identified employing more women in the workforce would add an additional \$2.9tn to India's annual gross domestic product (GDP) by 2025 (Woetzel, 2015). Therefore, a healthy female Indian workforce is crucial if the country is to benefit from its demographic advantage and sustain its economy. However, 1 in 12 women in India are at high risk because women seek medical care extremely late because of a lack of public health resourcing and India's unique socio-cultural complexity (Gupta *et al.*, 2017). Various cultural and religious issues prevent women from accessing health services, including a reluctance to consult with male doctors, family obligations and little autonomy to control their own medical care (Deshpande *et al.*, 2013).

Recent initiatives in India suggest that the government is recognising its own resource limitations in women's health care and has begun to partner with private players to provide affordable services to the underserved such as The Pink Initiative. However, the majority of the population of India remain reliant on the state for their primary health care (Saxena, 2015). In the latest Indian National Health Policy (2017), the percentage of GDP by 2020 for health care rose to 2.5%, a rise of 1.5%, but without a strategic focus on cancer. This has an impact on the reputation of MoFHW as an efficient provider of women's health care (Gangane *et al.*, 2016).

While the international resourcing standards state a minimum of 25 health workers per 10,000 population, India's scarcity of skilled medical staff remains high with only a little over 8 health workers per 10,000 population. This situation of poor resourcing impacts on the amount of knowledge that can be captured by health workers and transferred into the community (Srinivasan and Chandwani, 2014). Wide interstate disparities and rural–urban differentials in the availability of a medical workforce affect the ability to capture knowledge about breast cancer health in the communities (Esposito *et al.*, 2012). For example, Tamil Nadu is the only state that has scaled up services for the prevention of common cancers. This was a successful programme that revealed the link between the need for knowledge about screening, diagnosis and treatment, to be presented in the correct manner for successful knowledge transfer (Krishnan *et al.*, 2013). However, there is limited evidence of investment by MoHFW in a breast cancer KM resource.

An interdisciplinary theoretical approach

Previous research has examined resource-based KM in Western health-care contexts (Mason and Pavia, 1998; Kim *et al.*, 2012). An array of resources were highlighted including information about particular cancers, access to support groups, cancer workshops and rehabilitation advice, all available to women online and offline. The large amount of knowledge produced by these health-care resources (e.g. electronic health record systems and pharmaceutical R&D reporting systems) galvanised the health-care organisations into making considerable investments in technology to strengthen their organisational resource capability (Wang and Byrd, 2017). According to Hoffman *et al.* (2005), technology can facilitate the four main processes of KM: *generation of knowledge* (all activities that discover “new” knowledge); *knowledge capture* (the continuous scanning, organising and packaging of knowledge after it has been generated); *knowledge codification* (representation of knowledge in a manner that can easily be accessed and transferred) and *knowledge transfer* (the absorption of that knowledge). To leverage knowledge is an organisations' most critical resource (Desouza and Awazu, 2006) and knowledge sharing is recognised as one of the most important ways to improve organisational performance (Kim *et al.*, 2012). Furthermore, knowledge is valuable, rare, hard to imitate and non-substitutable and has been noted as a strategic asset for any organisation to gain and nourish competitive advantage (Jha and Varkkey, 2018).

With this appreciation of KM, it is important to understand India's health-care infrastructure. Organisations improve their efficiency and effectiveness through a possession of valuable knowledge relating to their products, processes, management and technologies. However, the absence of the four specified KM processes indicates the necessity for the MoHFW to control the flow of consistent communication about breast health information for maximum advantage (King *et al.*, 2002). The lack of motivation by the Indian Government to establish a KM system to oversee breast cancer health delivery portrays them as woefully inadequate (Gupta *et al.*, 2017). This study aligns to the WHO's (2016) strategic focus to increase the incorporation of m-health technology to improve global health care. Using the signalling theory as a lens, we explore the effectiveness of m-health technology as a KM tool, to reduce asymmetry of breast cancer information.

The signalling theory is fundamentally concerned with reducing information asymmetry between two parties, striving for perfect information in a situation where the “signaller” or sender conveys some meaningful information about its products or services to another party, the receivers (Spence, 1978, 2002; Stiglitz, 2000). In this investigation, the sender is the MoHFW and the receivers are CHWs and Indian women. Receivers are important in the signalling cycle because on receipt of the message, they can determine if the organisation is genuine in the practice they espouse. Their belief in the sender’s reputation links to the notion of quality, which shares some characteristics with reputation and prestige (Khatri *et al.*, 2017). Careful management of information encourages trust between sender and receiver, fostered via a two-way dialogue, rather than a one-way signal transmission. In this study, the knowledge-resource App would incorporate accessible breast cancer knowledge represented in different formats including audio and three-dimensional (3D) visual imagery (Appendix).

However, research states that to be effective, the signals must be observable and costly to imitate (Bruton *et al.*, 2009; Connelly *et al.*, 2011). Often, the level of cost invested has a two-fold effect:

1. it reduces information asymmetry; and
2. highlights the organisation’s commitment to the cause (Vargo and Lusch, 2017).

Therefore, investment by the signaller in a knowledge-resource application could reduce asymmetry of breast cancer information and improve reputation through superior performance.

The TAM has gained significant interest and is widely used in m-health interventions and is, therefore, viewed as an influential model to explain intervention for technology use (Bagozzi, 2007; Hoque, 2016). The TAM was devised by Davis (1989) as a need to gauge technology acceptance in the workplace for effective and efficient organisational practices. Based on the psychology theory, the theory of reasoned action and theory of planned behaviour (Ajzen and Fishbein, 1980), the TAM was conceived to predict the willingness of users to embrace new technology and to understand attitude and beliefs as the cause of intention and to better understand the behaviour relationship between humans and technology.

To fully understand resistance to technology, this model consisted of two core elements perceived usefulness (PU) and perceived ease of use (PEU), which in turn describe the behavioural intention to adopt an m-health system. PU is centred on the idea that by using the technology, it will enhance both current and continuous job performance. PEU measures the degree to which the technology is effortless and easy to use. Further models have incorporated the impact of personal/professional experiences, organisational factors and social/political influences which in later models are referred to as external variables (Venkatesh and Davis, 2000). Studies suggest that external influences cannot be ignored in adequately assessing technology acceptance (Burton-Jones and Hubona, 2006; McKechnie *et al.*, 2006). Thus, later models of the TAM such as TAM 2 and the unified theory of acceptance and use of technology consider external factors such as subjective norm, job relevance, output quality, social influence, organisational influences and facilitating conditions.

These later models have become useful in determining the acceptance of technology in health, delivering solutions for physicians and health workers worldwide. The m-health expansion following e-health has revolutionised the way in which health services can deliver essential health interventions. Literature searches and studies have critically examined the TAM as a theoretical model for understanding resistance to technology (Marangunić and Granić, 2015; Durodolu, 2016), whereas Holden and Karsh (2010) and Yarbrough and Smith (2007) relate the TAM specifically to health-care literature and studies.

Different situations require different variations of the TAM and the external variables can be added after an initial beliefs elicitation study, and in so doing, contextualising TAM offers the researcher better predictive power. As a framework for predicting technology acceptance, the TAM remains the most popular model for researchers and continues to be the most “robust parsimonious, and influential in explaining technology adoption behaviour” (Lu *et al.*, 2003; Marangunić and Granić, 2015). This research draws on the TAM model to gauge the acceptance of technology by the CWHs as a potential resource-based KM system for breast cancer care.

In the research framework, the TAM is central to predicting the CWHs use of technology in their current role. The design element of the *App* is reliant on “modality”, the concept that knowledge can be disseminated through two communication channels, visual and auditory.

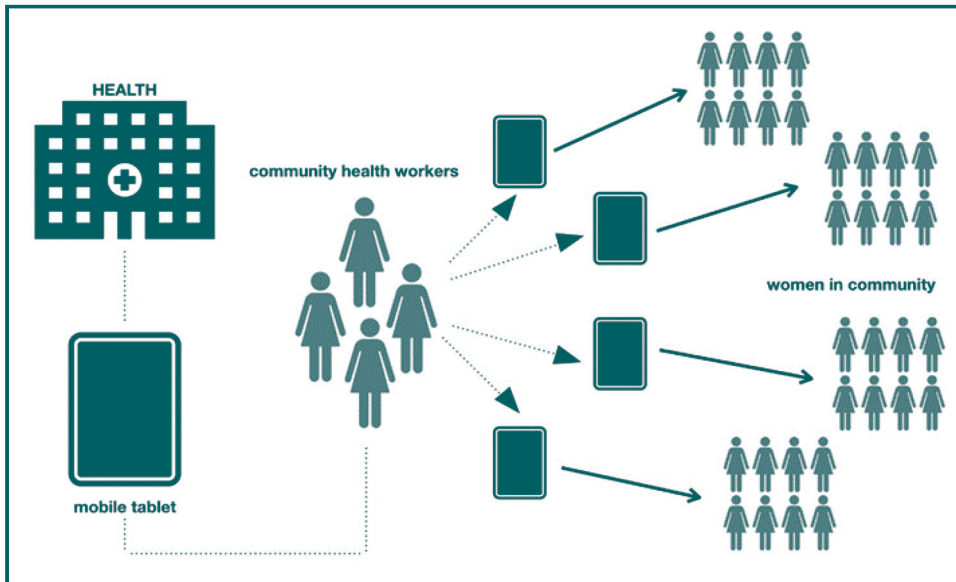
Frontline health-care delivery in India

The majority of India’s population live in rural regions, but Esposito *et al.* (2012) estimate that most of India’s 16,000 hospitals are located in urban areas cultivating insurmountable health-care challenges in rural populations. Globally, there is a collective interest to develop the influence of CHWs as frontline health workers, but research has been limited to their role in matters of women and children’s nutrition (Saprii *et al.*, 2015). ASHAs are CHWs instituted by the MoHFW as a part of the government’s programme [National Rural Health Mission (NRHM), 2012]. The set target of 2,500,000 ASHAs in 10 states by 2012 has fallen short as only 700,000 are currently operational (Fathima *et al.*, 2015). The ASHAs have responsibility for the execution of the community health programme. This includes regular surveys of families to organise pre-school activities, provide health and nutrition education, show pregnant women how to breastfeed, promote family planning and educate parents about child growth and development.

Indian villages are autonomous communities, with little interaction with the central government. A democratically elected village council which represents all major groups (caste or religious) makes most day-to-day decisions. In practice, the support of the council or chief ensures the CHW is effective and accepted within the community, encouraging people to use their services (Hariprasad and Mehrota, 2016; Ramachandran *et al.*, 2010). Their role places them central to the development of a sustainable m-health KM system with the potential to communicate breast cancer awareness knowledge and health care in an emerging economies context (Figure 1). Ownership by the Indian Government to fund the technology could signal a positive trustworthy reputation for India’s MoHFW. Hence, this paper seeks to address the gap in published literature concerned with m-health technology as a KM resource for a health-care organisation to achieve competitive advantage, in an emerging economies context (Modi *et al.*, 2015).

A KM system supported by m-health technology has the opportunity to enhance the skills of non-physicians such as CHWs and empower them to deliver timely and quality frontline health care. However, in an emerging economies context, there are several factors that need to be addressed before implementation including the CHW’s acceptance of technology as a part of their role. Furthermore, the *App* is designed to improve current processes of *knowledge capture* and *codification* and facilitate access to up-to-date breast cancer information. Over the past few decades, the recognition of mobile technology as a powerful communication tool and its ability to provide communities with essential health information have grown (Desouza *et al.*, 2014). However, the acceptance of its sustainability, effectiveness and efficacy in the community needs to be addressed. This study seeks to consider the operator (CHW), their needs and requirements before technical innovation. Table 1 provides a critical overview of the literature addressing KM related to m-health technology as a resource-based advantage in an emerging economies context. This has led to the identification and framing of the research objectives outlined previously.

Figure 1 M-health technology to give resource-based knowledge management advantage, to community health workers in rural communities in India (Authors own design)



Research design

This investigation set out to explore the effectiveness of m-health technology as a KM tool to reduce asymmetry of breast cancer information and operate as a resource-based competitive advantage. To achieve the research objectives, the qualitative data was collected from Gujarat, India, where breast cancer accounts for 31.5% of all cancers in women. Furthermore, the MoHFW (signaller) has public health hospitals, and public-private partnership activities are also present ([Breast Cancer India, 2016](#)). Researchers conducted 20 interviews with frontline medical staff in this geographical location. An interpretative-inductive exploratory methodology follows the directives of [Gioia et al. \(2013\)](#) to imbue qualitative rigor. The methodological strength of this approach is the heterogeneity of CHW's expert opinion collected via semi-structured interviews producing rich qualitative data ([Krueger and Casey, 2014](#)).

Sample and data collection

To explore the feasibility of m-health technology as a KM resource-based advantage, it was important to determine the CHW's socio-cultural understanding of breast cancer and their technological skills base. The characteristics of the CHWs are contained in [Table 2](#). The CHW's culturally determined thought processes, anchored in India's complex historical, religious, ethnic, political and social influences, provided valuable insight ([Usher-Smith et al., 2017](#)). This research design aligns with ethnography where the importance is placed on the thoughts and opinions of the participants about the issues discussed and thereby viewed in the context of their experience ([Hammersley and Atkinson, 2007](#)).

All interviews were conducted in the local dialect, audio recorded and transcribed by the research team using a protocol guide. A semi-structured discussion guide was solely used to facilitate the discussion, when needed, to avoid loss of direction. Given the exploratory nature of this study, the idea was to avoid imposing preconceived frameworks or opinions upon participants, seeking instead to obtain their understanding (of KM and the suitability of the knowledge-resource App) within their own frames of

Table 1 Outline of research addressing knowledge management related to m-health technology as a resource-based advantage in an emerging economies context: conceptualisations, antecedents and consequences

Author(s)	Concept	Definition	KM antecedents	KM consequences
A review of KM in health care (Nicolini <i>et al.</i> , 2008) (Literature review)	Three overarching themes in KM	KM tools and initiatives	Knowledge management in health care: towards 'knowledge-driven' decision-support services (Abidi, 2001) Inflow and outflow of information to benefit KM (Sheffield, 2008) The most important issues in knowledge management (King <i>et al.</i> , 2002) Criteria for KM (Desouza and Awazu, 2006) Knowledge management for superior advantage (Hoffman <i>et al.</i> , 2005) Fewer studies on public-sector themes for professional practice (Massaro <i>et al.</i> , 2015)	Accumulated knowledge can be a source of sustainable competitiveness (Nguyet <i>et al.</i> , 2019) Dynamic capabilities, agility and knowledge management (Pereira <i>et al.</i> , 2019) Technology to facilitate knowledge sharing and knowledge seeking in health (Singh <i>et al.</i> , 2018) Knowledge is a key success factor in achieving competitive advantage (Mehralian <i>et al.</i> , 2018) KM can enable innovation (Papa <i>et al.</i> , 2018) Ascertain skills, capabilities and competencies of employees (Baines and Smith, 2020) Knowledge is a strategic competitive asset for competitive advantage (Jha and Varkkey, 2018)
Dwivedi <i>et al.</i> (2008) (Conceptual)	Designing intelligent health-care organisations with KM and ICT	ICT strategies for health-care KM	M-health KM for frontline workers (Chib, 2010) Mobile health assist treatments (Free <i>et al.</i> , 2013) Mobile phones: the next step toward health-care delivery in rural India (DeSouza <i>et al.</i> , 2014) There is a paucity of literature regarding m-technology to communicate health messages in India (Ramachandran <i>et al.</i> , 2010) Knowledge sharing (Kim <i>et al.</i> , 2012)	Information shapes knowledge, which in turn is a driver of health-related change (WHO, 2016) Need of a new frontline health functionary for non-communicable diseases in India (Gupta <i>et al.</i> , 2017) Technology has emerged as an opportunity for KM (Kalnad <i>et al.</i> , 2017) Resourced-based organisation can improve health-care capabilities (Wang and Byrd, 2017)
Spence, (1973) (Empirical)	Reducing asymmetry of message to achieve perfect information	Signal genuine regard to the social issue may give signaller a positive reputation	Receivers are outsiders who lack information about the organisation in question but would like to receive the information (Spence, 1973) Signal genuine regard KM may yield a positive reputation (Kreps and Wilson, 1982) Quality refers to the ability of the signaller to fulfil the needs or demands (Connelly <i>et al.</i> , 2011)	The importance of receivers responding to signallers about the effectiveness of their signals (Gupta <i>et al.</i> , 2017) Service-centred organisation (Vargo and Lusch, 2017) "Perfect information" (Stiglitz, 2000) A positive perception about a firms' social position can reduce any uncertainty with consumers (Stiglitz, 2000).
Davis, (1989) (Empirical)	Technology acceptance model	PU and PEU model	"TAM the influential and commonly adapted theory for describing an individual's acceptance of information systems" (Bagozzi, 2007) External influences cannot be ignored in assessing technology acceptance (McKechnie <i>et al.</i> , 2006) TAM influential in explaining technology adoption behaviour (Lu <i>et al.</i> , 2003) To gauge the usefulness of technology the access to and quality of health care (Holden and Karsh, 2010) TAM continues to be the most "robust parsimonious, and influential in explaining technology adoption behaviour" (Marangunić and Granić, 2015)	There is a paucity of literature about mobile technology to communicate health messages in India (Ramachandran <i>et al.</i> , 2010) M-health technology can help in the expanding the scope of service delivery, reducing the response time by using trained non-physicians (Bassi <i>et al.</i> , 2016) Workers should update their knowledge and skills to keep up with the changes (Kuciapski, 2017) Adoption of hospital information system among nurses (Barzakar <i>et al.</i> , 2019) Factors affecting nurses' acceptance (Ho <i>et al.</i> , 2020) Integrating behavioural expectation of technology (Maruping <i>et al.</i> , 2017) Technology acceptance among public sector nurses in cancer care (Taipale, 2019)

Table 2 Characteristics of participants in semi-structured interviews

Occupation	Length of service (Years)			Gender	Community responsibility	Place of dissemination
Accredited social health Activist (20)	0-5	5-10	11-15	Female	Women and children's health including anti and post-natal care, ideal weight and nutritional advice	Urban and rural individual homes
Anganwadi workers	12	4	4	Female	Vaccination advice including Malaria and Denge Zika virus	
		Not known			Anti and post-natal care, girl child, children's vaccinations	Rural individual homes

reference (Greenwood *et al.*, 2014). Hence, the questions were mostly open-ended and discovery-oriented to facilitate open discussions and probing, as the research design was inductive and exploratory. Questions were posed to explore their current technical skills level and to predict the usefulness and ease of implementation of introducing technology to their current role.

Coding procedure. The data was analysed using a three-tiered coding system following the Gioia method (Gioia *et al.*, 2013). In the first stage of the analysis, the first researcher independently read and coded the online comments. These comments were organised manually into a set of first-order themes garnered from the verbatim comments of the CHWs. The second stage involved a second-order thematic analysis, whereby the researchers sought to understand links between the data and new emerging themes *knowledge generation, knowledge capture, knowledge codification and knowledge transfer*. This “sensegiving” provided an opportunity for concept development and theory building (Gioia and Chittipeddi, 1991). In the third stage, all the researchers aggregated key themes to provide a set of summative dimensions to the data (Table 3), *m-health technology signals quality health care, m-health technology enables KM and m-health technology embraces local characteristics*. In contrast to other methods for analysis, such as content analysis, the use of the Gioia method approach allowed for alternative theoretical explanations to emerge from the data. The method has been used effectively to understand phenomenon in other health-care studies (Furstenau and Auschra, 2016; Schölmerich *et al.*, 2016). Furthermore, Maas *et al.* (2016) also applied the method to a study of the development of new practice resources.

Findings and discussion

To be able to theorise m-health as a resource-based KM advantage, the findings presented reflect the CHW's responses to the semi-structured interviews. As a result, three propositions support the proposed conceptual framework. This allows for an understanding of the role of technology in KM for frontline health workers in the health-care sector in an emerging economies context. Three aggregate themes emerge explicated from the data: *signalling quality health care, m-health technology-enabled KM and m-health technology embraces local characteristics*. These themes highlight how technology connects and empowers health-care stakeholders, which manifests as a resource-based KM advantage to the MoHFW. To offer a better understanding of the qualitative findings, an illustration of each theme with a selection of extracts from the data is presented in Table 3.

Theme 1. Signalling quality health care

The first goal was to explore the effectiveness of m-health technology as a KM tool, to reduce asymmetry of breast cancer information. The considerable challenges to the MoHFW to fulfil its duty as a health-care provider have been outlined (Fletcher-Brown *et al.*, 2018). The MoHFW's inadequate resourcing of breast cancer KM culminates in a poor reputation to provide an effective and efficient health-care system. For example, the absence of any regular time set aside for training in breast cancer

Table 3 Illustrative coding of key themes related to m-health technology as a knowledge management resource-based advantage in an emerging economies context

First-order themes – from verbatim comments from ASHAs concerning m-health App			Second-order themes	Aggregate themes
<p>"We never received information on breast cancer so if I could find out on the App I would feel comfortable"</p> <p>"I have little knowledge about breast cancer to finding it here would help me"</p> <p>"We had a 10 min talk this month but was not [specifically] on breast cancer knowledge or treatment. If I could find the information on the App I would be happy"</p> <p>"We have CUG [corporate user group] provides free calling/ messaging amongst CUG members"</p> <p>"I would like to learn more technology to help my job where I can keep notes of my visits"</p> <p>"Showing a video is better for understanding and the woman looks similar to them"</p>	<p>"We ASHAs are familiar with technology"</p> <p>"I have mobile phone"</p> <p>"I would like to know more about the App on the tablet and how to find to find information"</p> <p>"This will be useful for training others especially with the help of pictures about the body"</p> <p>"I could take down patient details for the future"</p> <p>"We could help them to visit a doctor if there is any problem and show them where they are located"</p> <p>"They [women] informed about breast cancer signs with the help of pictures on App"</p> <p>"This topic is uncomfortable for them I can now show them information"</p>	<p>"Information on malaria dengue zika virus has been given but never on breast cancer, so this App is useful"</p> <p>"We have never received enough information on this topic [breast cancer] that's why we rarely give out knowledge"</p> <p>"There has been no information on this, whether individually or in community, it would be useful to have"</p> <p>"I have a touch screen phone at home so I am able to enter in information"</p> <p>"Women should be informed about breast cancer at regular intervals with this"</p> <p>"Women are shy in front of their in-laws [no discussion about breast cancer]but if I show pictures this will help with the embarrassment "</p>	<p>Knowledge generation</p>	<p>M-health technology signals quality health care</p>
<p>"If we get any information [on breast cancer] we will spread it in the community"</p> <p>"To give information of breast cancer to women there should be community meetings"</p>	<p>"We can use pictures and sound to show women about the signs, some girls don't read"</p> <p>"Pictures on the tablet provides information, awareness and abnormalities. . . this is useful"</p>	<p>"It is better to talk on this matter when all women are sitting together and chatting"</p> <p>"When [we visit] these women discussion on breast cancer should take place with the help of these images"</p>	<p>Knowledge capture</p> <p>Knowledge codification</p> <p>Knowledge transfer</p>	<p>M-health technology enables KM</p> <p>M-health technology facilitates local characteristics</p>

knowledge suggests that the disease remains at a low priority in public health policy and the reputation of the MoHFW to deliver effective breast health care remains weak. From the sample, AWW did not possess any knowledge about breast cancer in terms of diagnosis or treatment, in either their personal or professional role which suggests a break down in signalling effective information about breast cancer to essential workers.

ASHAs, however, confirmed the need to visit women in their locale because of India's complex cultural values about women in a patriarchal society, "women are not allowed to go out without their husband". This suggests that any *knowledge capture* must be garnered at the point of face-to-face consultation. The functionality of the *App* allows for *knowledge generation* and *knowledge capture* by ASHAs to be efficiently transferred to women in their individual homes. What is also apparent from the interviews is that ASHAs are highly trusted by the leaders of the villages to enter homes where necessary and distribute health-care information.

Cancer as a health-care topic is discussed in monthly reported meetings but nothing “specifically about breast cancer”, and there are no current protocols to report and store the accumulated knowledge. They identify that breast cancer knowledge gathered at the frontline is valuable but not leveraged to its full potential. They acknowledge that the perceived usefulness of the breast cancer knowledge-resource *App* would facilitate temporal research for *knowledge capture* and enable swift *knowledge transfer* to women. Findings, therefore, identify the equipping of ASHAs with an m-health *App* can *generate knowledge* as a resource that signals quality health-care provision and is implicit to reducing the asymmetry of breast cancer information. Furthermore, a knowledge-resource *App* in this research context has the capacity to manage knowledge to benefit each stakeholder in the information flow. We illustrate this by suggesting:

- P1.* Technology-equipped ASHAs send signals of quality breast cancer information to all health-care stakeholders.

Theme 2. M-health technology enables breast cancer KM at the frontline of health care.

The second thrust of this investigation was to examine m-health technology as a resource-based competitive advantage in KM. It is known that knowledge is a key success factor in achieving competitive advantage for an organisation (Mehralian *et al.*, 2018; Nguyet *et al.*, 2019). However, the skills, capabilities and competencies of employees responsible for gathering knowledge must be ascertained before investment in technologies (Baines and Smith, 2020). Hence, we explore the relationship between user (ASHAs), the ease of use and perceived usefulness of the technology to comprehend the levels of resistance to using the *App*. The ASHAs were found to be functional in some areas of technology with scope for improvement in others (Table 3). All used a mobile phone in their personal lives and in their public health role operated “Corporate user group” technology. This facilitates free calling/messaging among CUG members and is provided by many public-sector organisations in India. In all, 16 ASHAs used mobile phones with traditional keyboard functions and 4 ASHAs possessed smartphones which were referred to as “touch screen” phones, which demonstrated a level of competency.

The cognitive constructs of the TAM model are PU and PEU which identify an intention to use the *App* in their role. The ASHAs were vocal in their agreement of the advantages the m-health technology would bring to their work, “If I could find the information on the *App* I would be happy” and “I would like to learn more technology to help my job where I can keep notes of my visits”. The participants showed an overwhelming appetite to learn new technology for personal and professional development. They agreed that the dynamic capabilities of the resource would facilitate agile KM, “I would like to use it in my work because I could take down patient details for use in future appointments”. The gathering and storing of patient information would form a knowledge resource for forward planning workloads and patient care, which illustrates that a resource-based organisation can improve health-care capabilities (Wang and Byrd, 2017).

PU was identified through suggestions for content such as video, animation and images (see Appendix). They also responded with “pictures on the tablet provides information, awareness and abnormalities this is useful”, and they agreed the touch screen function would make the *App* easy to use. In terms of m-health technology, to give a resource-based advantage, this study found the *App* could capture *new* knowledge and *transfer* breast cancer awareness knowledge to patients in the community, “We can use pictures and sound to show women about the signs, some girls don't read”. In addition, the *App* facilitates visualisation of data as an infographic about breast cancer, “The women can be informed about breast cancer signs with the help of pictures” (Table 1). The technology improved the ASHA's self-efficacy, through the access to knowledge and in autonomy of operating the device. Overall, the ASHA's response to embracing new technology is positive and motivated to develop the required skills.

PEU would, therefore, suggest a relationship between design, mobile technology and on-going training to ensure a resource-based KM advantage for the MoHFW. Over time, a CHW's confidence is likely to develop through their dynamic capabilities, agility and KM (Pereira *et al.*, 2019). Over the past few decades, the recognition of mobile technology as a powerful communication tool and its ability to provide communities with essential health information essential have grown (Rahimi *et al.*, 2018). However, the use of mobile technology sustainability, effectiveness and efficacy and the uncertainty of how technology will be accepted in the community is rarely researched. This study, alongside other recent innovations, has used an adapted TAM model, to understand the potential use of knowledge technologies with the training of nurses to deliver patient centred care (Barzekar *et al.*, 2019; Ho *et al.*, 2020; Taipale, 2019). We, therefore, posit:

P2. Knowledge-resource technology improves the quality of breast cancer knowledge management where resources are currently depleted.

Theme 3. M-health technology embraces local characteristics.

ASHAs are pivotal for the effective and efficient outflow and inflow of KM in the community in their role as a mediator of the signaller's message. They are indigenous to the community and comprehend the cultural complexities that present as obstructions to KM. Their insider knowledge accentuates their position to one of privilege and to the nuances of community protocol. In so doing, the knowledge-resource *App* facilitates *knowledge transfer* to Indian women who are most at risk, "Any information [on breast cancer] we will spread it in the community" and "Women are shy in front of their in-laws [no discussion about breast cancer] but if I show pictures this will help with the embarrassment". Their cultural knowledge and nursing skills are integral to overcome societal ignorance about breast health and self-examination. In fact, they use cultural familiarity to their advantage for *knowledge codification*, rather than viewing culture as a barrier to effective knowledge transfer, "When [we visit] these women discussion on breast cancer should take place with the help of these images" and "Showing a video is better for understanding and the woman looks similar to them".

The role of the ASHA is established as an essential facilitator of breast cancer education and empowerment with a potential to normalise breast cancer discourse in the community. In other words, the *App* would be used to disseminate breast care knowledge, "when all women are sitting together and chatting". Therefore, this is an opportunity to stimulate a normalisation of self-examination, "To give information of breast cancer to women there should be community meetings", that opens the potential for engagement and exchange of knowledge, as it enriches the value of the breast health-care knowledge. The *App* technology is adaptive to local characteristics to facilitate a purposive outflow and inflow of breast cancer care knowledge transfer and empower women in sustainable breast cancer knowledge, such as preventative self-examination techniques. Hence, we propose:

P3. Resourced-based knowledge management assists to normalise breast cancer discourse in the community.

This study highlights the importance of the TAM to validate and measure determinates that affect behaviours to better understand the implementation of technology in health care delivered by non-physician health workers. In so doing, the technology acts as a resource-based advantage leading to:

- *generation of breast cancer knowledge* that is acquired from frontline CHWs to increase patient well-being;
- *knowledge capture* helps stakeholders continually scan the abundance of breast cancer knowledge obtained through interactions with women in their communities;
- *knowledge codification of local characteristics* engage women in breast familiarity, awareness and abnormalities through 3D technology and design; and

- *knowledge transfer* with the use of knowledge-resource *App* facilitates a sustainable breast cancer discourse to empower CHWs and Indian women.

Theoretical contributions to knowledge management in the public health-care sector in an emerging economies context

This study extends the scope of research on KM by examining how m-health technology can give a resource-based competitive advantage to the public health service sector in an emerging economies context. We establish three clear original contributions to KM scholarship. First, through analysis of the empirical evidence, we contribute three new propositions: Technology-equipped ASHAs send signals of quality breast cancer information to all health-care stakeholders; knowledge-resource technology improves quality of breast cancer KM where resources are currently depleted; and resource-based KM assists to normalise breast cancer discourse in the community.

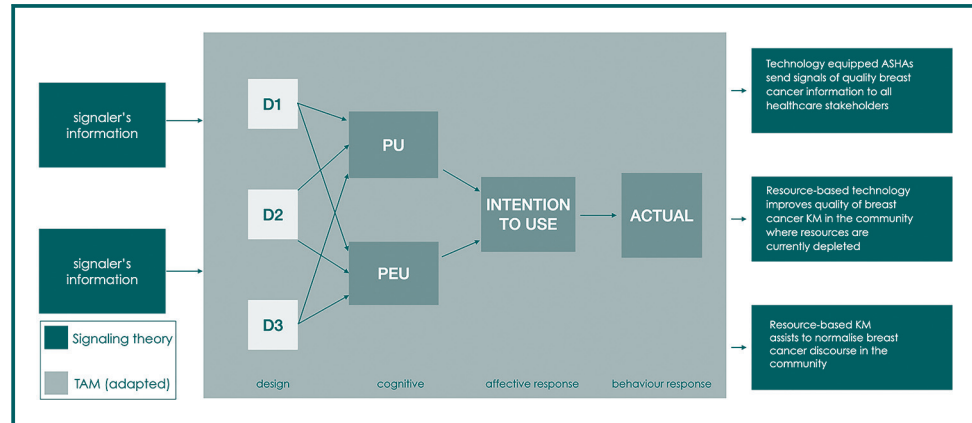
The important question, specifically, is how m-health technology operated by CHWs can *generate knowledge* as a resource for breast cancer and signals quality health-care provision. The public health-care provider is subsequently imbued with an authentic reputation. Additionally, through the lens of the TAM model, we reveal that the CHWs PU and PEU of the m-health technology has the potential for *knowledge capture* from consultations with individual women to standardise quality at the centre of patient care. The accumulation of knowledge can be a source of sustainable competitiveness (Nguyet *et al.*, 2019) which presents m-health technology as an organisational resource-based competitive advantage. Furthermore, our findings illustrate the agility of m-health technology to assist KM. Using exclusive design features, the *App* (in this investigative context) facilitates an adaptive response to local idiosyncrasies via the incorporation of *knowledge codifications* of breast cancer information. Such *knowledge codifications* were found to enable breast cancer discourse with the women at the point of frontline treatment situations. Hence, we show that an innovative m-health *App* operated by frontline workers shapes a sustainable strategy to impact India's breast cancer problem.

Second, we contribute a conceptual framework to illustrate how m-health technologies used by frontline CHWs operate as a resource-based KM advantage in an emerging economies context. Hence, the m-health technology can facilitate a purposive outflow and inflow of breast cancer care knowledge in a manner that can easily be accessed and transferred to others. In so doing, the flow of information at every level reduces the asymmetry of breast cancer information to shape a sustained superior performance in breast cancer health care (Figure 2).

Finally, we contribute specifically to professional health-care management and practice with proposals for implementing the m-health technology and broaden their generalizability with suggestions for its use in other public-sector organisations. Using an integrated model in studying the association between signalling theory and the TAM to effect a resource-based KM advantage is a significant contribution to KM scholarship. Earlier research has separately investigated the impact of each discipline on performance; however, there is a dearth of research looking at how the integration of signalling theory and the TAM affects organisational KM. This research was conducted in an attempt to fill this gap in the literature. The results and arguments presented in the current study promote a better understanding on how KM and m-health activities can facilitate a purposive outflow and inflow of breast cancer care knowledge in a manner that can easily be accessed and transferred to others.

It is noted in literature that knowledge activities disseminated in a firm are strongly affected by the skills, capabilities and competencies of the employees (Baines and Smith, 2020). More specifically, knowledge workers in the knowledge-intensive industries, such as public health service, through their professional knowledge, experience and capabilities play a

Figure 2 An interdisciplinary conceptual model using TAM (author's own)



pivotal role in developing the depth of knowledge transferrable to all stakeholders within a company over time (Mehralian *et al.*, 2018). Therefore, the m-health technology has the potential to increase the value of the relationship with customers by equipping the MoHFW with qualified and knowledgeable human capital who are involved in establishing and maintaining mutually beneficial relationship with women in the community and develop a discourse about breast cancer. Therefore, this study illustrates how knowledge acquired through the m-health technology is a key success factor in achieving sustainable competitive advantage, in breast cancer health care.

Contributions to professional health-care management and practice

This research provides useful insights concerned with implementing m-health KM systems, specifically for frontline health-care professionals in an emerging economies context. This study provides practical implications for not only the managers involved in the MoHFW but also similar public-sector organisations with a poor resourcing arrangements. Particularly, we emphasise the need to focus on understanding the skills and capabilities of frontline workers before developing the resource innovation. This reinforces the need for sector managers to plan ongoing training for the operators of the technology and encourage self-efficacy and the acceptance of technology in their work as a consequence. In so doing, the organisation will benefit from the value derived from the flow of knowledge collected through the implementation of the technology and improve organisational performance.

The main reason that KM is of great interest to managers in the public health-care sector is that knowledge is vital for designing innovative products and services that benefit consumers (Mehralian *et al.*, 2018). In particular, we reveal how the design element of the knowledge-resource *App* has a potential to capture, codify and transfer knowledge through visual and auditory channels, thus rendering it transferable across states and potentially different countries. For example, a knowledge-resource *App* could be designed and operated quickly in times of global pandemic to protect consumers and health-care operations alike.

Furthermore, the results demonstrate how to improve organisational performance by integrating technologies in KM initiatives where few previously existed. Therefore, it might be beneficial for the managers of public-sector organisations to prioritise and place emphasis on KM strategies that encourage innovative mobile technology assets for rapid repayment of capital investment.

Limitations and future research agenda

In consideration of the outlook for health care in emerging economies, this study has answered the call for more robust examination into KM practices and use of m-health by frontline CHWs (Singh *et al.*, 2018). The purpose of this research was to undertake an in-depth inquiry into the application of a knowledge-resource *App* to enhance breast health-care delivery. However, this research paper is investigative in nature and, therefore, does have limitations in terms of its generalisability. First, the analysis has identified three new propositions within this research context: technology equipped ASHAs send signals of quality breast cancer information to all health-care stakeholders; knowledge-resource technology improves the quality of breast cancer KM where resources are currently depleted; and resource-based KM assists to normalise breast cancer discourse in the community. This contribution may be specific to this country context (India) and will, therefore, limit the extent to which these findings may be generalised. We encourage further investigation of a knowledge-resource *App* to enhance breast health-care delivery in other emerging economies contexts, to develop a richer understanding. Furthermore, this study focuses on a single country and it would be useful if a multi-country comparison was undertaken, given the variance in religion, background, cultural and economic structures within emerging economies. Thus, other emerging markets such as Brazil, South Africa, China and Thailand present as future KM research opportunities.

Second, although exploratory data via semi-structured interviews were deemed most appropriate for the purpose of this study, there is scope for future research using quantitative data to enhance the generalizability of the findings between the Western (developed) perspective and emerging economies context. Our sample was limited to only one emerging economy. Future investigations could examine whether the results from the present study apply to other developing or developed countries.

Finally, the study of m-technology in any guise is fast-moving and observations and contributions to theory are frequent. Therefore, while this study has contributed three prevailing propositions of m-technology to KM in the public health-care sector, it is important to encourage academics to undertake a longitudinal study of the adoption of m-health technology by CHWs to assess changes over a specific time period and make further valuable contributions to the body of work on KM.

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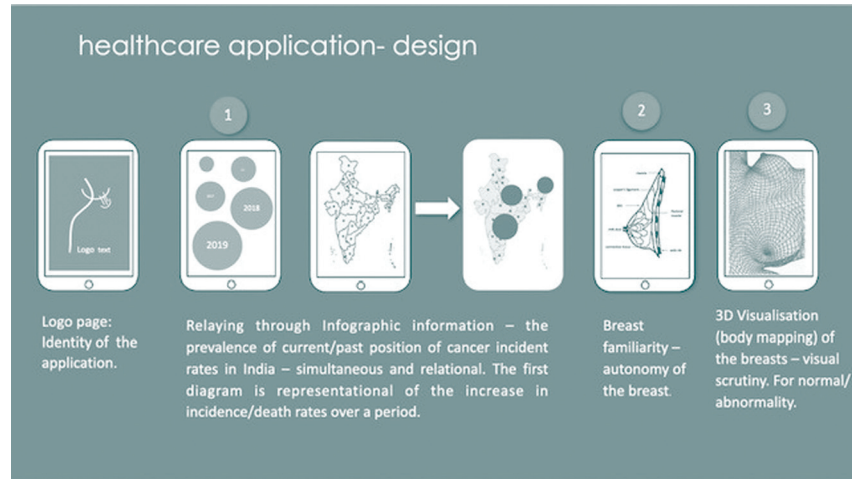
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Appendix



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