

# A Scoping Review of Digital Health Innovation Ecosystems in Developed and Developing Countries

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**Abstract:** Digital health innovation ecosystems describe the need to incorporate the components of digital health, innovation and digital ecosystems in administering healthcare services. Reviewing the evidence of digital health, innovation and digital ecosystems in both developed and developing countries is therefore crucial in determining the feasibility of implementing a digital health innovation ecosystem. The purpose of this paper was to present the results of a scoping review aimed at identifying the scope and range of digital health, innovation and digital ecosystems literature in developed and developing countries and propose guidelines for implementing digital health innovation ecosystems. The findings of the scoping review reveal that studies on digital health, innovation and digital ecosystems have been conducted in developed and developing countries, providing useful insights on the feasibility of implementing a digital health innovation ecosystem in both developed and developing countries. Guidelines for implementing a digital health innovation ecosystem were also proposed. The findings of the scoping review as well as the guidelines proposed in this study will inform healthcare policy makers in developed and developing countries.

**Keywords:** Digital health, innovation, digital ecosystems, scoping review.

## 1. Introduction

Digital health innovation ecosystems is an emerging topic in literature [1] [2] [3], which suggests the need to incorporate the components of digital health, innovation and digital ecosystems in administering healthcare services [2] [3]. Iyawa et al. [2] define a digital health innovation ecosystem as a “network of digital health communities consisting of interconnected, interrelated and interdependent digital health species, including healthcare stakeholders, healthcare institutions and digital healthcare devices situated in a digital health environment, who adopt the best-demonstrated practices that have been proven to be successful, and implementation of those practices through the use of information and communication technologies to monitor and improve the wellbeing and health of patients, to empower patients in the management of their health and that of their families”.

Being an emerging field, the current literature on digital health innovation ecosystems focuses on concepts and descriptions [2] [3] and the need for a digital health innovation ecosystem [1]. Despite the conceptualization of a digital health innovation ecosystem for the South African context [1], the scope and range of literature on digital health, innovation and digital ecosystems in both developed and developing countries is not known. According to Iyawa et al. [3], digital health, innovation and digital ecosystems are the building blocks for a digital health innovation ecosystem. Identifying the scope and range of literature on digital health, innovation and digital ecosystems is therefore crucial in

determining the feasibility of implementing a digital health innovation ecosystem in developed and developing countries.

The purpose of this study was to provide the results of a scoping review aimed at identifying the scope and range of literature on digital health, innovation and digital ecosystems in developed and developing countries and propose guidelines for implementing digital health innovation ecosystems for policy makers in healthcare.

### *1.1 Significance of the study*

Developed and developing countries have lessons to learn from each other with regards to healthcare and the use of Information and Communication Technology (ICT) in healthcare. For example, Syed et al. [4] explain that the successes of m-health implementations in developing countries can serve as lessons developed countries can adopt. Developed and developing countries can benefit from the example of Ethiopia, which adapted a unique approach towards providing care for chronically ill patients [5]. Mamo et al. [5] further explain that despite scarce resources in this setting, trained nurses in rural communities can assist in the care of chronically ill patients. Conversely, these lessons can be facilitated when relevant stakeholders are “interconnected” as indicated by Iyawa et al. [2]. Relevant stakeholders in a digital health innovation ecosystem should rely on each other to share ideas [3]. This is why open innovation in the ecosystem is important.

To tackle world health challenges such as child mortality and maternal mortality and to “combat HIV/AIDs, malaria and other diseases” as highlighted in the United Nations (UN) [6] report, countries should adapt the “best-demonstrated practices” [2], while using the available resources in their reach. However, these best-demonstrated practices cannot be practised without the use of ICTs, as the use of ICTs in healthcare has proven to be beneficial [7] [8]. ICTs could refer to digital health technologies such as m-health, e-health, health and wellness apps and wearable sensors [2]. For example, m-health technologies are being used in the provision of healthcare services for pregnant women in developing countries [9] [10] [11] and have been shown to have an impact in developing countries [12].

Furthermore, to meet the healthcare challenges highlighted in the UN [6] report, patients need to take an active role by being involved in the management of their health. These active roles can be facilitated by digital health technologies such as m-health, wearable sensors and wireless computing, social media, health 2.0/medicine 2.0, health and medical platforms, health and wellness apps and self-tracking (the quantified self) [2]. The definition of digital health innovation ecosystems [2] therefore proposes the concepts needed to tackle outstanding health related goals of the Millennium Development Goals. The implementation of a digital health innovation ecosystem is therefore important in meeting the healthcare needs in both developed and developing countries.

The remainder of this paper is structured as follows: Section 2 outlines the objectives of the study; the methodology is represented in Section 3. Section 4 presents the findings of the study, with a discussion of the findings in Section 5. Conclusions, limitations and future work are presented in Section 6.

## **2. Objectives**

The objectives of this study were to:

1. Identify the scope and range of literature on digital health, innovation and digital ecosystems in developed and developing countries.
2. Compare the findings of digital health, innovation and digital ecosystems in developed and developing countries.
3. Identify research gaps in literature regarding digital health, innovation and digital ecosystems in developed and developing countries.

4. Propose guidelines for implementing digital health innovation ecosystems for policy makers in healthcare.

### **3. Methodology**

#### *3.1 Search strategy*

A scoping review was conducted on ACM digital library, IEEE Xplore, Scopus and ScienceDirect to find relevant publications on digital health, innovation and digital ecosystems in developed and developing countries. PubMed was also used to find relevant publications on digital health. Harzing's Publish or Perish software was also used to identify highly cited studies which were not indexed in the databases. To access other relevant publications on digital health, innovation and digital ecosystems, a manual search was conducted using the Google search engine. The search period was from 2006 to 2016.

#### *3.2 Inclusion and exclusion criteria*

Only studies published in English were included. Studies referring to specific countries identified as either developed or developing, as recommended by the World Bank [13], were included. Studies in the digital health, innovation and digital ecosystems domain were included.

#### *3.3 Data synthesis and analysis*

There were 123 publications on digital health, 51 publications on innovation and 13 publications on digital ecosystems that met the inclusion criteria. The findings were categorised into themes, based on two groups, developed and developing countries. In total, 187 publications met the inclusion criteria.

### **4. Results**

#### *4.1 Findings on digital health in developed countries*

Studies in the British, Scottish and Northern Irish contexts were grouped under the United Kingdom. The findings from selected literature on digital health in developed countries identified 29 developed countries: United Kingdom (n=14); United States (n=12); Estonia (n=11); Finland (n=9); the Netherlands (n=7); Denmark (n=6); Australia (n=6); Sweden (n=4); Canada (n=4); Italy (n=4); Spain (n=4); Norway (n=4); France (n=3); Slovak Republic (n=3); Switzerland (n=3); Belgium (n=2); Austria (n=2); Czech Republic (n=2); Poland (n=2); United Arab Emirates (n=2); Germany (n=2). Ireland, Croatia, Cyprus, Greece, Latvia, Portugal, Chile and Slovakia all had (n=1) with some studies describing digital health in more than one context.

Studies on digital health in the context of developed countries were categorised under different themes: electronic health records (EHRs), privacy and security, self-management and self-tracking apps, gamification, digital health, health and wellness apps, e-prescription, wireless sensors, e-health, telemedicine/telehealth, health data exchange, internet, electronic medical records (EMRs), social media, cloud computing, health information technology, m-health, interoperability, information systems and public health surveillance.

#### *4.2 Findings on digital health in developing countries*

The findings from selected literature on digital health in developing countries identified 34 developing countries: South Africa (n=16); Nigeria (n=11); Kenya (n=6); Tanzania (n=5); Bangladesh (n=4); India (n=4); Romania (n=3); Uganda (n=3); China (n=3); Hungary (n=2); Bulgaria (n=2); Malawi (n=2); Saudi Arabia (n=2); Ethiopia (n=2); Namibia (n=2). Jordan, Pakistan, Argentina, Brazil, Colombia, Costa Rica, Ecuador, Mexico, Panama,

Peru, Dominican Republic, Turkey, Taiwan, Indonesia, Swaziland, Sudan, Mali, Cameroon and Burkina Faso all had (n=1) with some studies describing digital health in more than one context.

Studies on digital health discussed in the context of developing countries were categorised under different themes: privacy and security, digital health, e-prescription, e-health, EMRs, EHRs, information systems, telemedicine, cloud computing, m-health, social media, internet and public health surveillance.

#### *4.3 Findings on innovation in developed countries*

Studies in the British, Scottish and Northern Irish contexts were grouped under the United Kingdom. The findings from selected literature on innovation in developed countries identified 15 developed countries, Finland (n=12); Australia (n=4); Estonia (n=11); United States (n=4); United Kingdom (n=2). New Zealand, the Netherlands, Germany, Spain, Sweden, Italy, Ireland, France, Switzerland and Canada all had (n=1) with some studies describing innovation in more than one context.

Studies on innovation discussed in developed countries were categorised under different themes: increasing innovation by collaboration, innovation through learning, Triple Helix systems, technology innovation, innovation spaces and living labs, process and product innovation, organisational and marketing innovation, healthcare innovation, open innovation, intellectual property rights, user innovation and Quadruple Helix systems.

#### *4.4 Findings on innovation in developing countries*

The findings from selected literature on innovation in developing countries identified 24 developing countries, South Africa (n=9); Nigeria (n=7); Kenya (n=6); Tanzania (n=4); Uganda (n=4); Namibia (n=3); Rwanda, Ghana, Cameroon, Zambia, Angola, Botswana, Malawi, Mauritius, Mozambique, Swaziland, Lesotho, Argentina, Uruguay, Colombia, Peru, India, Canary Islands and Mexico all had (n=1) with some studies describing innovation in more than one context.

Studies on innovation discussed in the context of developing countries were categorised under different themes: increasing innovation by collaboration, technology innovation, organisational and marketing innovation, influence of government ownership, innovation spaces and living labs, product and process innovation, open innovation, intellectual property rights and Triple Helix systems.

#### *4.5 Findings on digital ecosystems in developed countries*

The findings from selected literature on digital ecosystems in developed countries identified 5 developed countries: Australia (n=3); Finland (n=2). Ireland, the United Kingdom and Italy all had (n=1) with some studies describing digital ecosystems in more than one context.

Studies on digital ecosystems discussed in the context of developing countries were categorised under different themes: implementing digital ecosystems, trust and interoperability.

#### *4.6 Findings on digital ecosystems in developing countries*

The findings from selected literature on digital ecosystems in developing countries identified 6 developing countries, South Africa (n=2). India, China, Brazil, Malaysia and Hungary all had (n=1) with some studies describing digital ecosystems in more than one context.

Studies on digital ecosystems discussed in the context of developing countries were categorised under different themes: implementing digital ecosystems, interoperability, challenges and trust.

## 5. Discussion

### 5.1 Comparison of digital health, innovation and digital ecosystems in developed and developing countries

The findings of the scoping review for digital health revealed that different issues on digital health have been discussed in both developed and developing countries. While there is evidence of digital health in developing countries [14] [15], the literature revealed that studies on self-management and self-tracking apps [16], gamification [17], health and wellness apps [18], wireless sensors [19][20], health data exchange [21], health information and technology [22] and interoperability [23] were more prevalent in developed countries, compared to developing countries. This could be that there is less research publications emanating from developing countries in these areas. The findings also revealed that studies on m-health are prevalent in developed [24] and developing countries [14] [15]. This could be as a result of mobile devices being widely used in both developed and developing countries.

In general, both developed and developing countries have rich literature on digital health. However, there is a research gap in the areas of genomics and health analytics in specific contexts. Table 1 highlights the differences in themes found in developed and developing countries.

*Table 1: Comparison of themes on digital health identified in developed and developing countries from selected literature*

<b>Components of digital health identified</b>	<b>Developed countries</b>	<b>Developing countries</b>
EHRs	✓	✓
Privacy and security	✓	✓
Digital health	✓	✓
Cloud computing	✓	✓
E-prescription	✓	✓
E-health	✓	✓
Telemedicine/telehealth	✓	✓
Internet	✓	✓
EMRs	✓	✓
Social media	✓	✓
M-health	✓	✓
Public health surveillance	✓	✓
Information systems	✓	✓
Self-management and self-tracking apps	✓	×
Gamification	✓	×
Health and wellness apps	✓	×
Wireless sensors	✓	×
Health data exchange	✓	×
Health information technology	✓	×
Interoperability	✓	×

The scoping review identified studies on innovation in both developed and developing countries. The results from the selected literature suggest that innovation spaces and living labs have been facilitated in developed and developing countries [25] [26]. Studies on healthcare innovation were also identified in developed countries [27] [28].

In general, for developing countries, there should be more research on Quadruple Helix systems. Literature on open innovation, Triple Helix systems, technology innovation, process and product innovation, intellectual property rights, innovation spaces and living labs, organisational and marketing innovation, and innovation by collaboration were identified in both developed and developing countries. Table 2 highlights the differences in themes on innovation found in developed and developing countries.

*Table 2: Comparison of themes on innovation identified in developed and developing countries from selected literature*

<b>Components of innovation identified</b>	<b>Developed countries</b>	<b>Developing countries</b>
Increasing innovation by collaboration	✓	✓
Innovation through learning	✓	×
Triple Helix systems	✓	✓
Technology innovation	✓	✓
Process and product innovation	✓	✓
Healthcare innovation	✓	×
Open innovation	✓	✓
Intellectual property rights	✓	✓
Organisational and marketing innovation	✓	✓
User innovation	✓	×
Influence of government ownership	×	✓
Innovation spaces and living labs	✓	✓
Quadruple Helix systems	✓	×

The findings of the scoping review for digital ecosystems reveal that digital ecosystems have been discussed in both developed and developing contexts. While actual implementations of digital ecosystems have been recorded in both developed [29] [30] and developing countries [31][32], studies on digital ecosystems in developed countries focus on the theoretical aspects of digital ecosystems, which describe digital ecosystems [29][33], the need to implement digital ecosystems [29] and technologies needed to implement a digital ecosystem [34]. Trust and interoperability seem to be a consistent topic of discussion of digital ecosystems studies in both developed and developing countries [35] [32] [36]. Challenges of implementing a digital ecosystem have been described in developing countries [32].

In general, more research is needed on digital ecosystems referring to developed and developing contexts. This could be as a result of digital ecosystems being an emerging concept and as a result, might take a while to adopt in some developed and developing countries. Table 3 highlights the differences in themes found on digital ecosystems in developed and developing countries



Table 3: Comparison of themes on digital ecosystems identified in developed and developing countries from selected literature

Components of digital ecosystems identified	Developed countries	Developing countries
Implementing digital ecosystems	✓	✓
Trust	✓	✓
Interoperability	✓	✓
Challenges	×	✓

Despite a limited number of studies in some areas of digital health, innovation and digital ecosystems in developed and developing countries, the findings of the study reveal that there is evidence of digital health, innovation and digital ecosystems literature in both developed and developing countries. This implies that the basic building blocks of a digital health innovation ecosystem as described by Iyawa et al. [2] which consists of digital health, innovation and digital ecosystems, have been established in developed and developing countries and it is therefore feasible to implement digital health innovation ecosystems in both developed and developing countries.

### 5.2 Proposed guidelines for implementing digital health innovation ecosystems

Guidelines for implementing health information systems and other ecosystems have been proposed [37] [38] [39] [40] [41] [42] [43]. The guidelines discussed in these studies were also adapted in developing the guidelines for implementing digital health innovation ecosystems proposed in this study. The guidelines for implementing digital health innovation ecosystems are highlighted in Table 4. The guidelines presented in Table 4 could assist healthcare policy makers in implementing a digital health innovation ecosystem.

Table 4: Guidelines for implementing a digital health innovation ecosystem

Guidelines	Approach
<b>Guideline 1:</b> Identifying stakeholders and their role in the ecosystem [37] [38] [39] [43]	Identify individuals and organisations who will undertake activities in the digital health innovation ecosystem relevant to a particular context. There should be formal documentation of the set goals that will be achieved by stakeholders in the digital health innovation ecosystem at an early stage.
<b>Guideline 2:</b> Connecting international through local [40] [39]	There should be identification of international stakeholders who will participate in the digital health innovation ecosystem. There should be strategies and policies put in place on how international stakeholders can connect to the digital health innovation ecosystem.
<b>Guideline 3:</b> Organising requirements [41]	When implementing a digital health innovation ecosystem in a country, it is important for stakeholders in the country to select the important digital health, innovation and digital ecosystems components rather than implementing all the components, which might not be relevant to every country's context. For example, m-health might be appropriate in some contexts and inappropriate in other contexts. Similarly, open innovation might be relevant in some contexts and irrelevant in other contexts. Therefore, it is important to select the components that are most relevant to a context. Once the components have been identified, the relevant components can then be implemented.
<b>Guideline 4:</b> Defining the operational environment [41]	There should be an architecture that describes the structure for implementation unique to a particular context. The technologies to be deployed in the platform should adapt to the architecture of a particular context.

<b>Guideline 5:</b> Aligning the existing healthcare applications with the new digital health applications [41]	There should be strategies in place for the integration of existing applications with the new applications to ensure that there is continuity of workflows with existing healthcare applications. There should be structured planning to ensure that existing infrastructure is reviewed for integration with new digital health technologies.
<b>Guideline 5:</b> Reviewing and monitoring [40] [42]	Stakeholders must set up strategies to ensure that review and monitoring take place. Reviews can be carried out at specific times agreed by the stakeholders. There should also be a standard for monitoring activities in the digital health innovation ecosystem.

## 6. Conclusions

In conclusion, this paper provided the results of a scoping review that aimed at identifying the scope and range of literature on digital health, innovation and digital ecosystems in developed and developing countries. The study identified the scope and range of literature on digital health, innovation and digital ecosystems in developed and developing countries. Different themes on digital health, innovation and digital ecosystems in developed and developing countries emerged from the selected literature. The study also compared and identified research gaps on digital health, innovation and digital ecosystems in developed and developing countries. The themes identified in this study provide evidence that can be used to determine the feasibility of implementing digital health innovation ecosystems in different contexts and guide future research on digital health, innovation and digital ecosystems in developed and developing countries. Guidelines for implementing a digital health innovation ecosystem were proposed which can be adapted by policy makers in healthcare in developed and developing countries. The findings of this study will inform policy makers in healthcare in developed and developing countries about what has been established in terms of digital health, innovation and digital ecosystems and what needs to be implemented and established in developed and developing countries.

Based on the way the search was conducted, relevant publications on digital health, innovation and digital ecosystems in developed and developing countries might have been excluded and therefore constitute a major limitation to the findings of the study. Future work would be to implement digital health innovation ecosystems in developed and developing countries.

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