SPECIAL ISSUE PAPER

Identifying Micro-Level Generative Mechanisms of ICT-Enabled Performance Improvement in Resource-Constrained Healthcare Organisations: A Critical Realist Perspective

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Abstract

Healthcare studies in the information and communication technology for development (ICT4D) domain have attempted to understand how technology can be used to support healthcare organisations in developing countries; organisations whose performance is negatively impacted by resource constraints. Current studies – predominantly informed by positivist and interpretivist paradigms – produce analyses and prescriptions designed without an in-depth understanding of the underlying mechanisms influencing performance. The result is limited ability to explain how organisational performance is enabled by ICT.

Critical realism as a philosophy of science provides a deeper ontological and broader epistemological approach that makes it possible to theorise the micro-level mechanisms that hold potential for explaining observed outcomes. The study reported here, informed by the critical realism paradigm, uses interviews, observation and organisational data collected from a single case study to identify the resource optimisation micro-level generative mechanisms that have improved emergency medical services. The study integrates the technological affordances lens to explain ICT-enabled organisational performance. Additionally, the paper proposes and tests an understanding of the Bygstad, Munkvold, and Volkoff stepwise framework as a methodology for doing critical realist research using affordances.

1 | INTRODUCTION

Constrained resources and their relation to organisational performance are ongoing concerns in the domain of development.[1] Irrespective of the sector, whether public, private or non-governmental, organisational under-performance restricts the achievement of development goals (Andrews, 2008; Yadav, 2015). While information and communication technologies (ICTs) are frequently employed to address resource constraints, the people involved in improvement projects frequently lack understanding of the connections between ICTs and organisational performance. Although they may observe one or more connections, they may not perceive the underlying mechanisms that influence those observed connections.

This paper investigates the underlying mechanisms in the context of healthcare in a developing country. Good health is a central development goal, yet lack of healthcare resources reduces its availability and affordability. Healthcare organisations in these contexts face severe problems of not meeting performance targets. While ICTs have been seen as a potential solution, there is a lack of good understanding of the relationship between ICT use and improved healthcare services.

This situation applies to the use of ICT in pre-clinical health services such as emergency medical services (EMS). The primary role of EMS organisations is to provide pre-hospital emergency services to sick and injured patients (Blackwell & Kaufman, 2002; Razzak & Kellermann, 2002).

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[1]We use the term "domain of development" to include development beyond the boundaries of developing countries, as many resource-constraint challenges and ICT-related solutions are equally found in parts of the global North (Gigler, 2004; Nemeth, Wears, Patel, Rosen, & Cook, 2011).

These organisations are complex entities with public EMS organisations consisting of numerous components and stakeholders including service providers, paramedics, patients, and government agencies (MacFarlane & Benn, 2003). These components and stakeholders are intertwined with responsibility and accountability relationships. Accountability plays a vital role in ensuring that diverse stakeholders involved in the provision of emergency services are held accountable and rewarded for their actions (Boyd, Micik, Lambrew, & Romano, 1979; Moore, 1999). Increasingly public EMS organisations are under pressure from stakeholders to provide explanations for variations in service delivery (organisational performance) (LeRouge, Mantzana, & Wilson, 2007).

When assessing performance, managers are often overwhelmed with large volumes of data that make it difficult to decipher the information (Cretikos et al., 2006). Effective accountability requires that relevant data be aggregated (Menon, Lee, & Eldenburg, 2000). Hence, the use of key performance indicators (KPIs) to aggregate data into simplified measures to assess organisational performance (Dahlgaard, Pettersen, & Dahlgaard-Park, 2011). EMS KPIs include effectiveness, efficiency, quality of care and responsiveness (Murphy, Wakai, Walsh, Cummins, & O'Sullivan, 2016). EMS organisations are increasingly dependent on ICT to support operations and management. Hence these EMS KPIs are also used to justify investments in ICTs.

The simplicity of these KPIs contrasts with the real-world complexity of EMS organisations and the internal and external factors that impinge on meeting performance targets (Erkut, Fenske, Kabanuk, Gardiner, & Davis, 2001; Kim & Michelman, 1990). A core problem is that EMS KPIs are designed without an in-depth understanding of the underlying mechanisms that influence organisational performance and hence the underlying causes of performance variations. Thus KPI measurements alone are unable to explain the causes of performance variations or to justify ICT investments because of the lack of understanding of underlying mechanisms.

This paper is therefore guided by the following research question: *what micro-level mechanisms underpin ICT-enabled organisational performance in resource-constrained healthcare organisations?*

With literature in the ICT4D domain, including that on healthcare organisations, being dominated by positivist and interpretivist paradigms, research to date has struggled with this type of question since neither paradigm provides ample insight into causal mechanisms. Therefore, we adopt a critical realist approach, given critical realism's well-known association with mechanisms. In this paper, critical realism assists in identifying mechanisms that impact ICT-enabled emergency medical services in the resource-constrained public healthcare sector of South Africa. Simultaneously, the paper reflects on the methods and utility of critical realism for identifying mechanisms.

The paper is organised as follows: this introduction provides the background, objectives and rationale of the research. The second section explains the critical realist conceptual framework and systematic methodology used. This is supported in the third section by analysis of the South African case study structured according to the steps of the methodology. The paper culminates with conclusions.

2 | RESEARCH DESIGN

The starting point for the critical realist researcher is to observe a given situation and to hypothesise reasons why the observed events occur; the reasons include the mechanisms that generate those events. This contrasts with positivist and interpretivist approaches. A purely positivist stance will deduce that under similar circumstances an identical outcome will be produced. From the interpretivist stance, a theoretical explanation of the current situation will be induced which might apply to a different but similar situation. Whereas the positivist stance strives for objectivity with no agential influence, the interpretivist stance accepts that all observation is subject to the philosophy of the agent. In contrast, critical realism takes a holistic view that provides an alternative path that acknowledges and to some degree incorporates both positivist and interpretivist stances (Bhaskar & Danermark, 2006; see also Heeks & Wall in this special issue).

To accomplish this, critical realism's ontological position incorporates dimensions and domains. Dimensions comprise the transitive dimension (our changing knowledge of phenomena) and the intransitive dimension (enduring phenomena about which we seek to know). Domains are divided into the real (mechanisms that are intransitive), the actual (events generated by mechanisms) and the empirical (observable, experienced events) (Hartwig, 2008). Empirical events are the only elements observed, hence explanatory mechanisms can only be inferred. Critical realism uses the processes of abduction and retroduction to evaluate and select explanatory mechanisms that may combine to produce events which are observed and can be empirically tested in the empirical domain. Underlying this is the belief that events in the actual domain are regulated by mechanisms in the real domain. As the intransitive domains resist the ability of human agents to understand them, the inferred mechanisms are not easily testable through direct observation. A central concern of critical realism is thus how to test identified mechanisms for causal feasibility. One method is based on affordances as proposed by Gibson (1979). We now describe mechanisms and affordances in more detail.

2.1 | Mechanisms

The concept of mechanisms, for which several definitions exist, is fundamental to critical realism (Bhaskar, 2008; Easton, 2010). Bygstad, Munkvold, and Volkoff (2016) emphasise the extensive range of definitions of a mechanism, from self-fulfilling prophecy to an assemblage of entities and activities that together result in semi-regular outcomes. They propose that mechanisms are causal structures that explain relationships between observed events. While mechanisms are not readily testable, they may symbolise causality in and between social and material entities, resulting in the potential for understanding how mechanisms generate actions in the material world (Bygstad et al., 2016). According to Bhaskar

(2008), when a mechanism is postulated, it may "come to be established as real" (p.2), however, it remains independent of the empirical evidence that justifies its existence. Mechanisms are considered generative if they cause events to occur in the actual domain even though they are not observable in the empirical domain and are thus "nothing other than the ways of acting on things" (Bhaskar, 2008, p.3). The ability of generative mechanisms to provide, identify and explain the interactions between entities offers a "rich source of explanatory devices" (Easton, 2010, p.122).

2.2 | Affordances

For a mechanism to be generative and act on things, it must have the capability to function. The potential for action is central to the concept of affordances as defined by Gibson (1979), and thus relevant in introducing the concept of affordances to better understand mechanisms. Affordances are a function of the attributes of, and interaction between, entities, objects and agents (which are typically humans) (Gaver, 1991). An example of affordances is the form of a handle on a door. A vertical bar that can be grasped affords the pulling of the door to open it. On the other hand, a flat panel affords pushing. In this paper, we acknowledge the definition from Volkoff and Strong (2013) of affordances as "the potential for behaviours associated with achieving an immediate concrete outcome and arising from the relation between an object (e.g., an IT artifact) and a goal-oriented actor or actors" (p.823). In accordance with Gibson (2015), we understand behaviour to be the potential for action and not action per se.

When actors (agents) interact with objects, such as technology, they may or may not recognise the affordances of those objects. Gaver (1991) classifies two affordance types on this basis. An obvious affordance is one that is perceived by the agent; while a hidden affordance is not perceived. Hidden affordances may be revealed through use, which leads to learning through discovery, and are then referred to as sequential affordances (*ibid*.).

The idea of sequential affordances of technology fits well with the notion of mechanisms being inferred through the events that emerge in the empirical domain. Similarly, the notion of affordances as potentialities fits well with the critical realist definition of mechanisms. We, therefore, see value in adopting an affordances-based approach for understanding the generative mechanisms associated with technological (e.g. ICT) objects and associated with the interactions between human agents and those objects (cf. Robey, Raymond, & Anderson, 2012).

2.3 | Conceptual Framework

Our overall conceptualisation is summarised in the positioning diagram depicted in Figure 1. At the centre of the diagram is EMS as a critical part of healthcare. As noted above, in the domain of development, healthcare is essential but typically resource-constrained. Consequently, measurement of service delivery is beneficial in maintaining service levels which are best accomplished through sets of KPIs. ICT is purported to support development while assisting healthcare. Nevertheless, ICT may also be a constrained resource. EMS KPIs seldom provide explanations of fluctuations and issues in EMS service delivery because they are created without awareness of the underlying mechanisms that affect that service delivery. We suggest that critical realism has potential to identify underlying mechanisms that may explain these fluctuations, and that those mechanisms may usefully be explored through an affordances lens.

2.4 | Research Methodology

Having outlined the conceptual framework for the paper, we now turn to understanding how best to operationalise that framework. One clear contender is the six-step framework for critical realism analysis outlined by Bygstad et al. (2016), which is particularly relevant because of its incorporation of affordances. Their framework builds on the methodological work of Wynn and Williams (2012) and aims to identify a mechanism that provides the "strongest explanatory power" (Bygstad et al., 2016, p.89) of observed events. Although not explained in graphical terms in the original paper, we have developed a diagrammatic summary, shown in Figure 2, of the six steps derived from Bygstad et al. (2016):
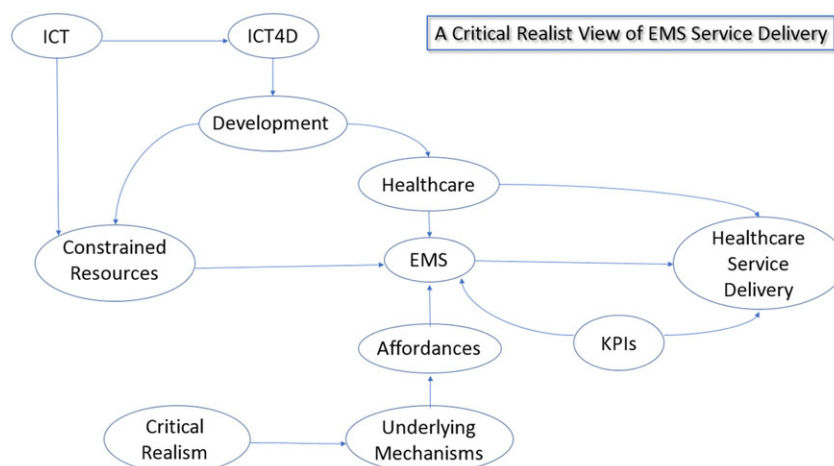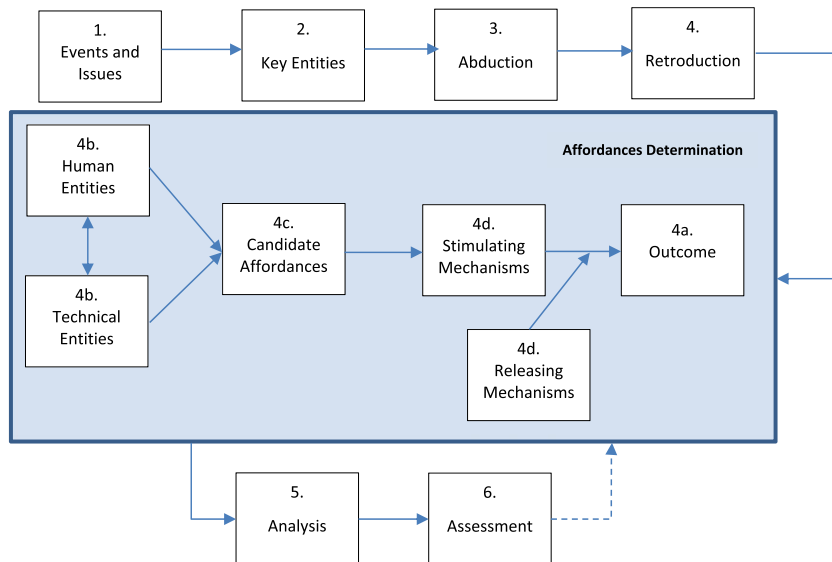

FIGURE 1 Positioning Diagram

FIGURE 2 Stepwise Framework for Critical Realist Analysis (developed from Bygstad et al., 2016)

Step 1. Description of events and issues. Description of the event or observation that the researcher aims to explain.

Step 2. Identification of key entities. This identifies the key entities and their relationships to each other. Fundamental entities may be social or material entities and may form networks with emergent causal power. They can be identified from existing theory or through grounded methods.

Step 3. Abduction is the process of exploring tentative theories that may explain the observed event; existing theory forms the basis for abduction. Nevertheless, the theories used may require modification.

Step 4. Retroduction is the process of identifying candidate mechanisms comprising four parts:

a. Identification of immediate concrete outcomes. Bygstad et al. (2016, p.89) define an immediate concrete outcome as "something that is directly achieved (or could be achieved) through the use of technology, and is related to the realisation of the actor's goals". Concrete outcomes have the potential of using a material entity for achieving social goals. In contrast to the observed outcomes, concrete outcomes only have the potential to be achieved (Volkoff & Strong, 2013).

b. Analysis of the interplay of social and material entities, to identify one or more mechanisms.

c. Identification of candidate affordances as potential behaviour influencers. This may result in multiple candidate affordances, or they may be nested.

d. Identification of stimulating and releasing conditions. Contextual conditions may stimulate or restrain the actualisation of mechanisms while others release constraints (Volkoff & Strong, 2013). Thus, the existence of an affordance as a potential behaviour is insufficient on its own to produce the concrete outcome. It requires a stimulating condition to encourage its use and a releasing condition to overcome restraining conditions.

Step 5. Analysis of the set of affordances and associated mechanisms, and their relationships to each other. They must also be evaluated against potential higher-level mechanisms.

Step 6. Assessment of the explanatory power of the selected mechanisms to identify which mechanism best explains the observed events. The six steps are partly iterative as depicted by the dotted line from Step 6 to the affordances determination box.

2.5 | Research Method and Setting

The research took the form of a single organisation case study. Case studies involve investigating a particular case, event, or incidence (Yin, 2003) with the primary aim of generating explanations of why and how particular events occurred. Furthermore, according to Yin (2013), case studies are appropriate for investigating events in their context in which boundaries are unclear.

The case, labelled "WCEMS", was in a large Western Cape province municipality of South Africa. WCEMS is a public service organisation which provides 24-hour medical response and pre-hospital care services to the public. It is one of the largest EMS services organisations in South Africa responding to more than 515,000 emergency cases per annum. From a social perspective, WCEMS employs approximately 2,000 personnel including ambulance paramedics, call takers, dispatchers and control centre managers. There are six control centres, five of which are in rural areas.

From a material perspective, WCEMS consists of medical emergency response, transport, and ICT systems. Transport also comprises HealthNET, a specialised unit which deals with the transportation of non-emergency patients.

Beginning in late 2013 and going live from early 2014, WCEMS implemented state-of-the-art ICT systems to resolve performance issues in its clinical service delivery and operational computational systems. The purpose was to improve the response times, the quality of services, and clinical outcomes through optimising the use of resources. High priority was placed on monitoring and allocating resources. Centralisation was crucial as each of the six control centres operated independently prior to the implementation of the inter-organisational information system. A primary goal was the enhancing of operational efficiencies throughout the organisation with the expectation of overall organisational performance improvements. Simultaneously, increased investment in infrastructure was undertaken by local government authorities. Although there were indications of improved operational efficiency, the improvements were not initially to the anticipated levels. This led the first author to question what mechanisms were initially constraining organisational performance improvements.

Data collection took place from 2014 to 2016. Four instruments were used to collect data across several levels and functional areas of the organisation: (1) Interviews (2) Observations, (3) Organisational document (policies, procedures, rules, reports) review, and (4) Performance data (performance reports and system data logs) review.

The primary method of data collection was through semi-structured interviews. A purposive qualitative sampling of respondents offered an effective and efficient method of sampling that embodied the phenomenon of interest in its highest variety (Schreier, 2012). This technique allowed the development of richer explanations and the capturing of the complexity of the research phenomenon (Kuzel, 1992). It is well established that interviews are the most common tool used in qualitative studies (Conboy, Fitzgerald, & Mathiassen, 2012; Keutel, Michalik, & Richter, 2014) and of particular value in critical realist research (Archer, 1995; Mingers, 2001). Twenty-five participants were interviewed: six senior managers, five supervisors, two quality analysts, one liaison officer, one trainer, five call takers, and five dispatchers. The rationale behind using interviews was to gain insights into the perceptions, opinions, and issues that exist but are not directly observable to the human eye. A set of open-ended questions were used to guide the interviews (Myers & Newman, 2007). This allowed flexibility for reacting to responses and adaptation of follow-up questions (DiCicco-Bloom & Crabtree, 2006). Where necessary, clarification questions were asked to get a better understanding.

Observations of the human actors in their workspace, their interactions with other actors and their interactions with ICT were also documented. Organisational documents were collected and integrated with the interview data to add any subtle differences in meaning, opinion or attitude that may exist in the source data. Qualitative content analysis techniques guided analysis of the interview data, field notes from the observations, and organisational documents.

3 | FINDINGS AND DISCUSSION

The full timeline of what occurred in WCEMS is shown in Figure 3. An explanation of the contents will be provided in the rest of this section but the timeline itself can be summarised in two main points:

a. New ICT systems went live from early 2014 but did not initially make a difference to organisational performance, as illustrated by the data in Figure 4.

b. Over the course of 2015, organisational performance did improve, as indicated by the data in Figure 5.
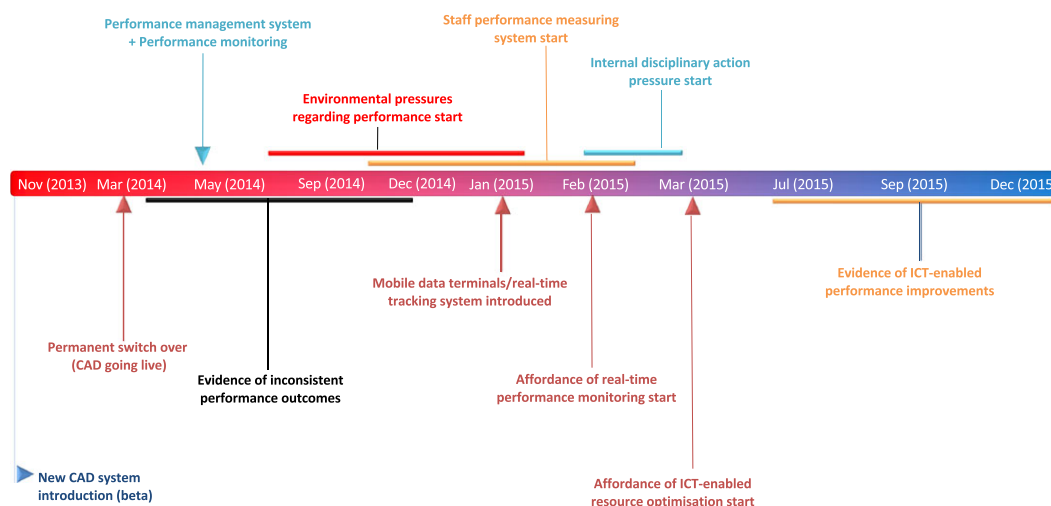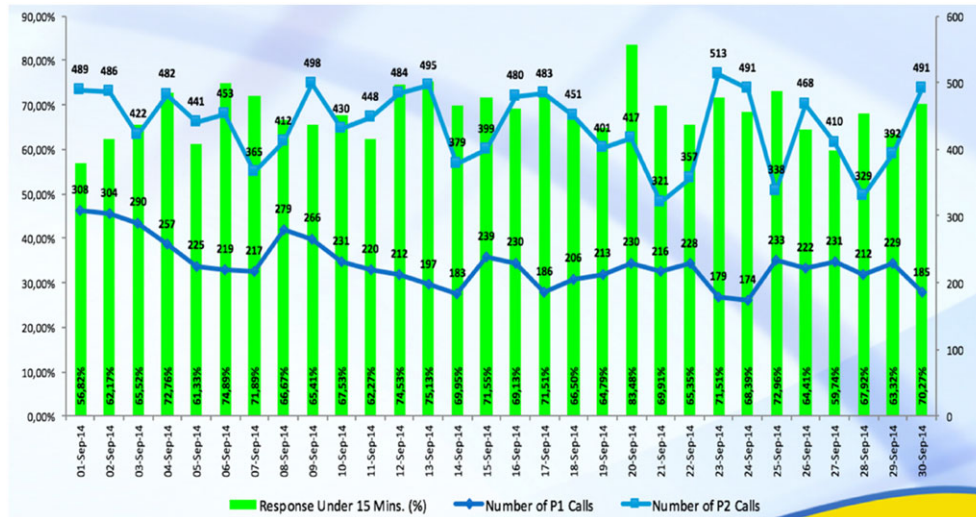

FIGURE 3 WCEMS Case Study Timeline

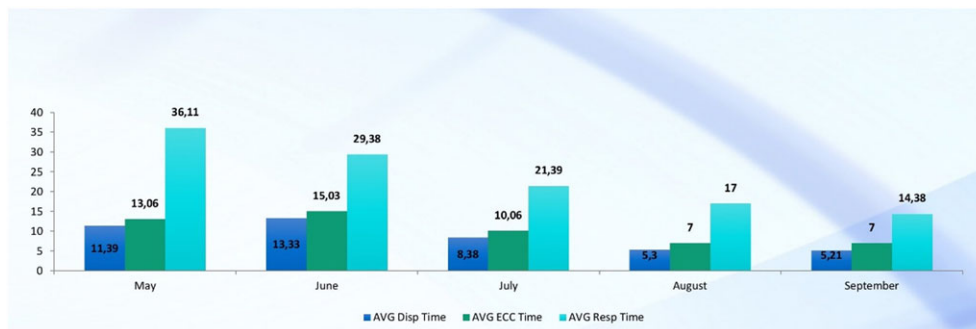**FIGURE 4** Inconsistent Performance Outcomes at WCEMS (September 2014)

FIGURE 5 Improvement in WCEMS Performance Outcomes (May 2015 to September 2015)

The question then arises why this pattern occurred: why did the ICT systems not directly lead to improvement as intended, with that improvement only emerging later on. We will now look to uncover the mechanisms that may explain this using the stepwise framework from Bygstad et al. (2016) as outlined in Figure 2. For the sake of simplicity and clarity, we only present selected mechanisms and their affordances, rather than discussing those mechanisms and affordances that were initially considered but then rejected.

Step 1. Description of Events and Issues

The most important organisational change events were distinguished by their direct role and contribution to the operations of WCEMS and arose from attempts at improving performance. Crucial events were: (1) the implementation of a new call taking and dispatch (CAD) system, (2) the implementation of a performance management system, and (3) the introduction of mobile data terminals and real-time tracking systems. One project manager epitomised the perceived value of these ICT-based systems as well as the need for continuous upgrading of such systems:

> "...We embarked in 2010 for a new CAD application for communication centre, one of the reasons was to get better information, and the main reason was to get any emergency resource quicker to the incident. However, in the year 2010, the technology that existed was inadequate, so in 2013, we had to amend our specifications because of the new technology that came to the market. And one of the reasons why there is more integration is because we had to change some of the requirement specifications after the new technology that came to the market..."

In terms of observed events, the central pattern was that mentioned above: the initial absence but then time-lagged emergence of performance improvement. Resource shortages were key to the historically-poor performance patterns of WCEMS; performance patterns that endured for many months after the initial ICT systems were introduced, as illustrated in Figure 4. For example, on the first day of September 2014 – many months after the first two systems were introduced – only 57% of P1 (priority 1, life-threatening) emergency cases were responded to within the required 15-minute time threshold mandated by the Department of Health in South Africa. Lack of resources required managers to manually organise resources and business processes to optimise the performance of WCEMS; a performance which was not only sub-standard but also continually inconsistent. Performance at the level of individuals was also not being monitored.

Figure 5 shows the improvement in performance outcomes between May 2015 and September 2015. Response times for emergency incidents improved from an average of 36 minutes in May to 14 minutes in September. There was also an improvement in the average time it took

to dispatch ambulances to scenes of emergencies, from 11 to 5 minutes. Finally, as illustrated, the average time to process the emergency incidents that were received by the emergency call centre (ECC) at WCEMS improved from 13 minutes to 7 minutes. Yet these improvements only occurred well over a year after the ICT systems were first operational; and nearly two years after the beta version of the CAD system was first introduced.

Step 2. Identification of Key Entities

From a social perspective, key entities included ambulance paramedics, call takers, dispatchers, and control centre managers. From a material perspective, WCEMS consisted of medical emergency response, transport, and ICT systems. ICT systems included the CAD system and performance management systems with real-time tracking systems and mobile data terminals. A cycle of increased investment and additional personnel made from late 2013 onwards had not initially led to substantially improved KPIs as anticipated. Examination revealed that although adequate technology was available in 2014, it was not utilised efficiently; thereby suggesting a need for further analysis to identify the influential mechanisms causing this shortcoming.

Step 3. Theoretical Re-description (Abduction)

The lack of observed initial improvement led the researchers to posit that it was neither the human nor material agencies alone that were responsible for organisational performance. Borrowing from Leonardi (2011) it was posited that an imbrication was in place that was not at first effective. According to Leonardi (2011, p.150) imbrication refers to "how a human agency approach to technology can usefully incorporate notions of material agency into its explanations of organisational change". Through a process of abduction, it emerged that the technology was not initially conducive to use. While the users were trained in the systems, they saw little benefit in using the systems. To make sense of this situation, it was determined that Gibson's Theory of Affordances (Gibson, 2015) could explain the situation, as per the explanation provided in Section 2. Although actor-network theory and institutional theory were considered, neither fitted the situation. Consequently, the affordances lens was considered appropriate and fitted with the methodological approach of Bygstad et al. (2016).

Step 4. Retroduction: Identification of Candidate Affordances

Retroduction was used to evaluate the inferred mechanisms that may have caused the pattern of events under review. Affordances that could actualise the mechanisms were identified through an iterative approach recognising that the affordances require both stimulation and release. The following steps identified and selected relevant affordances of the entities that could lead to the actualisation of the mechanism.

Step 4a. Identification of Immediate Concrete Outcomes.

The verbalised concrete outcome was the need for increased organisational performance (improved services) with existing resources but, in practice, the outcome was far more unpredictable, as shown by the delay in improvement.

Step 4b. Analysis of the Interplay of Social and Material Entities.

Insight into constraints encountered in imbrication of the social and the material was provided by the interplay between EMS personnel and the ICT systems. With the availability of current data regarding where ambulance crews were and which routes they had taken and with direct communication to ambulance crews, management was able to accurately determine how long response to an emergency incident should take.

Step 4c. Identification of Candidate Affordances.

Two affordances which were only actualised in 2015 – almost a year after initial ICT system "go live" – emerged as central to realising the effective use of ICT in the organisation.

Affordance 1. Real-Time Performance Monitoring.

Real-time performance analytics involved WCEMS managers monitoring KPIs which defined how the organisation was functioning in relation to its resources and against predefined goals set by the Department of Health. Through the real-time monitoring of performance, managers were afforded the necessary information about when, where as well as how the performance of the organisation was unfolding in real time. This was particularly beneficial for the optimisation of resources given that resources (i.e. ambulances) that were not in use by some dispatch boards were immediately transferred or reassigned to the dispatching boards that needed them the most.

> "… Real-time reports have affected performance, in a sense that there are more managerial reports being sent out, [the] managerial interaction between staff and supervisors, especially in the districts, because now everybody is on par. Everybody gets the same

reports at the same time, and this has allowed for supervisors and centre managers to start WhatsApp groups around performance issues. So, everybody is on par [with] what is happening out there. Whereas previously, they were disconnected from the staff on the road, but at the moment they are well in tune with everybody, and they know exactly where the problem areas are which allows them to take some actions when necessary." — *Manager #5*

In 2015, once the affordance of real-time monitoring of performance was enacted, managers were, in turn, able to discover other hidden affordances which enabled them to collaborate more effectively. The visualisation of real-time performance by teams allowed team members to work together by adapting their team members' scheduled activities and assisting struggling team members. This, in turn, enabled a more collaborative working environment. The real-time performance reports displayed on the digital display boards were considered a vital affordance that created a reference point which managers and supervisors made use of for planning and developing strategies for anticipated higher demands of emergency services (for example, the weekends at month ends when monthly wages are paid and violent crime/accident levels rise).

Affordance 2.   ICT-Enabled Resource Optimisation.

The environment in which WCEMS operated was characterised by scarcity of both human and material resources. The resources were often overextended to keep up with increasing and unpredictable non-linear demands of emergency services. Optimisation of resources was a vital affordance of the ICT system for improving performance that took some time to be enacted. The CAD system allowed the identification of the resources in use and determination of how the resources were utilised. Over time, this allowed experienced senior managers to interrogate resource usage to devise strategies that enabled the creative use and optimisation of the resources.

"... From only eleven ambulances allocated to each dispatcher, you have to find ways to manage them accordingly. So, when their demand for emergency cases is very high, we use the CAD system to interrogate which resources are not engaged or used optimally. So, you have to reshuffle the resources around to accommodate everyone." — *Dispatcher #3*

Dispatchers faced challenges of managing the few resources while ensuring that the P1 emergency cases were serviced urgently. Through real-time reports, emergency dispatchers could access reports of ambulances that were positioned in geographical areas that had few emergency cases and reassign them to the busiest geographical areas. Using the CAD system, senior managers could interrogate the system to determine the availability of ambulances with the required equipment that could be dispatched to multiple patients with similar injuries. In this way, the number of unattended emergency cases was reduced, and overall organisational performance was improved. Optimising resource use was thus a critical functional mechanism that directly impacted productivity and enabled higher levels of performance outcomes.

Step 4d.   Identification of Stimulating and Releasing Conditions.

During analysis, the primary stimulation for using the ICT systems was found to be the incentives created by the staff performance measuring system. Although this was insufficient to activate the actual use of the system, two releasing mechanisms manifested, one from external pressure and the other from internal pressure.

3.1 | Stimulating Mechanism: Staff Performance Measuring System

The monitoring of staff performance and the actions of agents was considered a stimulating mechanism; something that only became operational after 2014. It not only enabled but also shaped expected actions, values and practices of agents in relation to individual performance. This created incentives for better individual performance which, in turn, contributed towards the performance of the entire organisation.

"In this organisation, or in the government we have the Staff Performance Measuring System (SPMS). It's only done once a year. The chance of getting [an incentive] is very slim. People have to work hard in order to qualify for a bonus. I am currently working on something. I have assessed a few calls and have identified the excellent performers and the not so good performers, and the really bad performers. I can identify who they are already." — *Quality Assurance Analyst #3*

"... the SPMS, still plays a big role. So, if you do not meet your key performance areas or key performance indicators, you will not get your 13th cheque [i.e. bonus payment]." — *Manager #3*

3.1.1 | Releasing Mechanism - External: Environmental Pressure

External environmental pressure emanated from multiple sources, particularly the government which set out a regulatory framework for EMS which started to exert pressure from late 2014. Standard performance levels were necessary for WCEMS to meet accreditations standards which ensured quality improvement levels defined by government and local and international regulatory bodies. Regulatory frameworks and standards played a fundamental role in shaping performance.

"Performance is how we get assessed. At the moment, the problem is that the way we get assessed is not necessarily reflective of the services we provide. If you look at our main indicators. We look at priority 1 response, under 15 minutes for priority 1 in urban areas and under 40 minutes in rural areas and there are a few other indicators that talk around that. Those two are the main ones that we get judged according to. The single most important is our priority 1 urban response rate, however, if you look at the work we do, that is the least amount of the work we do is responding to priority 1 calls in urban areas. We respond far more to priority 2 calls, we do far more inter-hospital patient transfers, but we do not get measured on that. As a consequence of this pressure, you gear your services rightly or wrongly to achieve the targets that you are measured on. Not necessarily the targets you should be measured on." — *Senior Manager #2*

3.1.2 | Releasing Mechanism - Internal: Disciplinary Action Pressure

Pressure from potential disciplinary action was considered an internal releasing mechanism because, from early 2015, the ICT system provided managers with an affordance to track in real time what was happening both on the ground and regarding performance outcomes.

"It [the ICT system] has also given the agents more accountability, the reason for that is because ambulance paramedics are being tracked with the automated application, whereas in the past they could take the longest route to the hospital. For instance, they could take about 40 minutes to get to the hospital, now with the automated vehicles tracking, AVL, we can see that they've taken the longest route to the hospital and can face disciplinary action from their various district managers." — *Training Manager*

The optimising resources mechanism afforded elimination of wasted time through agents becoming aware of their individual performance. This awareness resulted in their acting in accordance with the rules to avoid disciplinary action.

Step 5. Analysis of the Set of Affordances and Associated Mechanisms

In 2015, two affordances emerged which supported the underlying mechanism for productivity improvement as measured by the performance targets: real-time performance monitoring and ICT-enabled resource optimisation. These were imbricated and self-supporting once the optimisation mechanism was stimulated and released. Optimised ICT resources afforded the operational staff opportunities for real-time monitoring which encouraged quicker response times and improved the allocation of resources.

Step 6. Assessment of Explanatory Power

The underlying mechanism of resource optimisation through affordances provided by real-time performance monitoring and ICT-enabled resource optimisation led to the concrete outcome of organisational productivity improvement. The affordances were observed to be imbricated and sequential with ICT-enabled resource optimisation supporting real-time monitoring which in turn provided data for measuring resource usage. ICT enablement was actualised by humans through stimulating and releasing mechanisms. This led to improved organisational productivity without increasing resources.

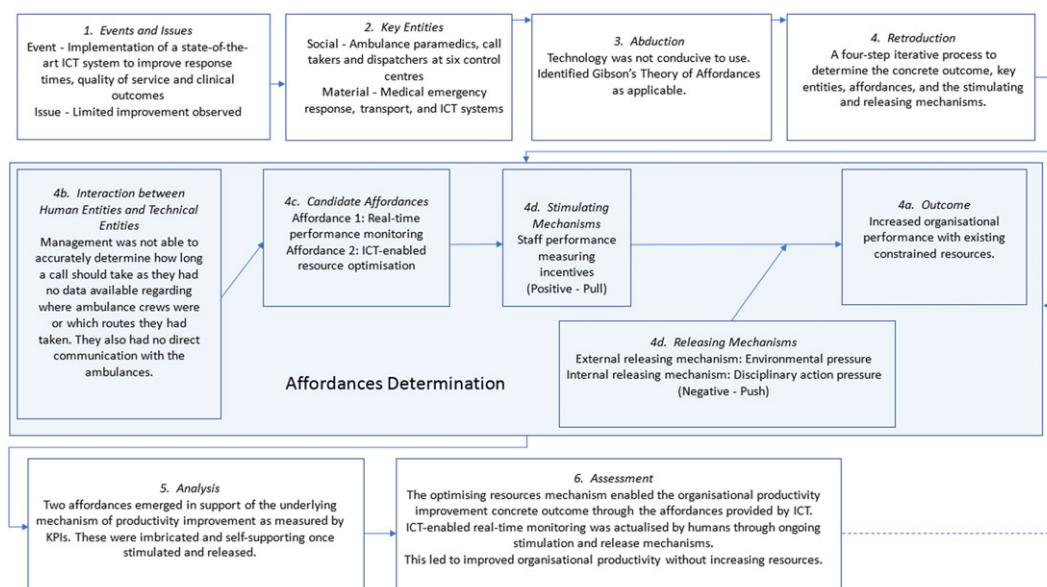A final overview model of the stepwise analysis is shown in Figure 6.

FIGURE 6 Final Model of Findings (following Bygstad et al., 2016)

4 | CONCLUSIONS

Healthcare is an essential domain of development and, hence, for ICT4D. As in the majority of ICT4D settings, a fundamental and persistent issue in healthcare is resource constraints. For a deeper ontological and epistemological understanding of the issue, this study performed a critical realist investigation into underlying mechanisms at work in an emergency medical service operation that was encountering productivity issues. The issue they faced was that productivity fluctuations and resource constraints persisted, even with introduction of ICT-based systems. Hence, we posed the question: *what micro-level mechanisms underpin ICT-enabled organisational performance in resource-constrained healthcare organisations?*

One challenge we faced was that critical realism has a paucity of methodologies. However, Gibson's Theory of Affordances has been suggested as a lens for critical realist research that can provide a deeper understanding of mechanisms and which has inspired the development of the stepwise framework for critical realist analysis by Bygstad et al. (2016). With minor adjustments, their approach was followed in the current study. Our methodological contribution is therefore twofold. Firstly, to make the model more understandable, a diagram of the framework was developed, and secondly, we provide an example of the framework as a suitable analysis mechanism.

Following the stepwise framework, it was observed that the concrete outcome of productivity improvement was achieved by the mechanism of optimising resources through the affordances provided by real-time performance monitoring and ICT-enabled resource optimisation. Specific learning in the case study showed that even though ICT afforded the concrete outcome, this was stimulated by personal interests in the form of incentives related to staff performance monitoring. Nevertheless, the affordance required releasing mechanisms. Two releasing mechanisms, based on applied pressure, externally from the government, and internally through potential disciplinary action, were identified. From our observations, we conclude that reward motivated stimulation whereas actualisation required threats to motivate release. Of note is the ongoing nature of the rewards and threats. Although affordances may continuously encourage use, they do not provide consistent motivation for use.

Future research is indicated to assess if the positing of reward and threat is unique to this case or more general in the actualisation of affordances relating to the use of ICTs in resource-constrained healthcare organisations. Furthermore, research is required to consider the extent to which increasing resources would increase productivity. The corollary of this is an investigation into the point to which current resources can be improved before overuse reduces productivity.

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