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Published in:
Digital Personalized Health and Medicine

DOI:
10.3233/SHTI200252

Published: 16/06/2020

Document Version
Publisher’s PDF, also known as Version of record

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Please cite the original version:
Value Mechanisms in the Implementation of Intelligent Patient Flow Management System – A Multiple Case Study

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Abstract. The purpose of this study was to investigate the value mechanisms in implementing a digital health intervention (DHI) in different contexts and countries. We utilized realist evaluation and the CIMO logic (Context, Intervention, Mechanism, Outcome) to analyze the mechanisms explaining the value capture of Klinik Pro, an Intelligent Patient Flow Management system (IPFM), which is a DHI for seeking of treatment and triage purposes. The study was conducted as a multiple case study using semi-structured interviews to research four market expansions in three countries. In total, seven healthcare mechanisms were discovered: co-creation, proper competence level, coordination, evidence-based medicine, integration, proper timing, demand management. The first four mechanisms were the same in all cases. CIMO framework proved to be useful in the value formulation of the IPFM.

Keywords. Digital Health Intervention, Value-Based Healthcare, CIMO

1. Introduction

There are increasing investments into digital health interventions (DHIs), but the value capture of these solutions is difficult to measure due to the complexity of the interventions and their implementation areas [1-2]. In particular, the mechanisms through which the outcomes of the DHI are achieved are often elusive, because there is insufficient understanding of the dynamics between the implementation context and the activated value mechanisms in healthcare. Thus, this study focuses on expanding knowledge on how to discover the mechanisms that explain the value formulation of DHIs. The approach used for this is the CIMO logic, which stands for Context, Intervention, Mechanism, and Outcome [3]. As an approach emerging from design science, CIMO can be used to structure the logic of outcomes and dynamics of an intervention when implemented in a given context [4]. Value in healthcare in this study is understood as the health outcomes achieved per resources used, i.e. a relation [5].

The studied DHI in this research was an Artificial Intelligence based intervention by a Finnish health technology company, Klinik Healthcare Solutions Oy. Their DHI,
called Klinik Pro, is an Intelligent Patient Flow Management system (IPFM) that supports efficient seeking of treatment and triage. Patients report their symptoms online to the IPFM, which then utilizes AI to analyze the level of urgency and suggesting an initial differential of diagnoses. This information is then directed to healthcare professionals to perform further actions (Figure 1).

![Klinik Pro online user interface for patients](image)

**Figure 1.** An example of a setup and functionalities of Klinik Pro (the IPFM)

The real-time empirical setting of this study was formed when in 2019 the company was simultaneously expanding its operations in four instances enabling international comparisons: one in Mexico, one in Portugal and two in Finland. These four contexts were analyzed using the CIMO logic and following [6]. By collecting data regarding the intervention, contextual environments, and expected outcomes of the IPFM, our aim was to deduce which value mechanisms are activated in the implementation of the IPFM. The main research question was: **RQ1:** How to discover the mechanisms through which digital health intervention accomplishes value? As a sub question we asked: **RQ1.1:** How does the implementation context modify the activation of the mechanisms?

2. Data and Methods

The research design followed the principles of design science and service engineering. Due to utilizing the CIMO logic in our empirical cases, the study also followed the principles of theory elaboration model [7] as well as grounded theory [8]. The study was performed as a multiple case study with one unit of analysis: the seeking of treatment and triage process within the primary care unit in each case (Table 1).

<table>
<thead>
<tr>
<th>Context</th>
<th>Targeted healthcare system</th>
<th>Main example of IPFM’s expected outcomes</th>
<th>Market phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large city in Finland</td>
<td>Public primary care</td>
<td>Reduce nurses’ stress levels</td>
<td>In Production</td>
</tr>
<tr>
<td>National association in Finland</td>
<td>Public primary care</td>
<td>More efficient handling of patient flows</td>
<td>Piloting / Pre-production</td>
</tr>
<tr>
<td>Large city in Mexico</td>
<td>Public and private primary care</td>
<td>Create a system to manage electronic health records</td>
<td>Pre-market</td>
</tr>
</tbody>
</table>

Table 1. Case descriptions.
We gathered data by conducting ten semi-structured interviews following the structure of the CIMO-configuration. The interviews took place during spring 2019 and were targeted on a diverse group of stakeholders within each market expansion including healthcare professionals, investors, managers, and IT experts (Table 2).

Table 2. List of informants.

<table>
<thead>
<tr>
<th>Organization type</th>
<th>Description of the organization</th>
<th>Informant role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health technology company</td>
<td>Klinik Healthcare Solutions</td>
<td>Chief Medical Officer</td>
</tr>
<tr>
<td>Primary care unit</td>
<td>Finnish medical center</td>
<td>Chief Physician</td>
</tr>
<tr>
<td>Primary care unit</td>
<td>Finnish medical center</td>
<td>Assistant Head Nurse</td>
</tr>
<tr>
<td>Primary care unit</td>
<td>Portuguese medical center</td>
<td>Managing Physician</td>
</tr>
<tr>
<td>Primary care unit</td>
<td>Portuguese medical center</td>
<td>Physician Intern</td>
</tr>
<tr>
<td>Primary care unit</td>
<td>Finnish medical center</td>
<td>Manager of Health Services</td>
</tr>
<tr>
<td>Primary care unit</td>
<td>Finnish medical center</td>
<td>ICT Service Coordinator</td>
</tr>
<tr>
<td>Venture capital</td>
<td>Healthcare VC company</td>
<td>CEO</td>
</tr>
<tr>
<td>Primary care unit</td>
<td>National healthcare association</td>
<td>CIO</td>
</tr>
<tr>
<td>Primary care unit</td>
<td>Mexican medical center</td>
<td>MD, CEO</td>
</tr>
</tbody>
</table>

3. Results

The activation of healthcare mechanisms relies not only on the dynamics of the intervention and its implementation, but also on the prerequisites of purposeful action. In all cases the informants considered the IPFM to improve the precision of information, break time and location boundaries, and enable inexpensive data collection from patients. However, there were differences in implementations as in Mexico the existing IT infrastructure could hinder proper use of the IPFM, whereas in Portugal the informants considered the decentralization of patient information to cause challenges. Considering the prerequisites for purposeful action, all informants considered the IPFM to provide improvements in the control information among healthcare professionals to make decisions that are more justified. Furthermore, the motivation to use the IPFM was perceived to be good in all cases. Finally, a few informants considered the IPFM to create new capabilities such as inventing new ways to plan clinical pathways utilizing the analysis performed by the IPFM’s AI.

Four healthcare mechanisms were discovered in all cases. First, co-creation is a mechanism that is inherently active in the IPFM due to engaging both patients and healthcare professionals in using the IPFM. Second, all informants perceived the IPFM to activate the proper competence level mechanism that allows the utilization of the lowest sufficient resource in each operation leading ultimately to cost savings. Third, the IPFM was considered to activate the coordination mechanism due to improved control information. Finally, as the IPFM’s AI performs the conditional analysis of the patients based on the most relevant scientific findings, the evidence-based medicine was the fourth mechanism active in all cases.

Besides the aforementioned four healthcare mechanisms, the Finnish informants considered the IPFM to support integration mechanism that results in more coherent and consistent knowledge of patients’ conditions. This was not considered active by the informants in the case of Mexico due to issues in the pre-existing IT infrastructure. Moreover, integration was also not considered to be activated in Portugal due to decentralized implementation. Besides integration, proper timing, a mechanism to
route and schedule patients effectively, was considered to be active in the Finnish cases. However, it was not seen activated in Mexico or Portugal due to same reasons as with integration. Finally, the seventh healthcare mechanism considered to be somewhat present in all cases was demand management. As the IPFM acts as an additional channel to seek treatment, all informants considered the possibility of the IPFM supporting efficient contacting of patients. However, in all cases it was also elaborated that this additional channel might result in overcapacity problems as patients might utilize multiple channels while seeking treatment. Thereby, the demand management mechanism was considered less relevant for all cases.

Generally, the mechanisms in each case were perceived to be very similar despite the contextual differences. In spite of the similarities, the varying intentions and priorities to utilize the IPFM among the stakeholders result in diverse outcomes responding to the actual problems the IPFM aims to solve. Thus, the same DHI can be used for very different purposes.

4. Discussion and Conclusions

By analyzing and comparing the cases, it is possible to discover patterns in the IPFM’s functionality to understand its value formulation on a more general level. In short, the IPFM’s ability to function correctly relies on the co-creation mechanisms to engage patients to report their symptoms to a digital system. Consequently, the practices regarding triage (e.g., whether it even exists) and the existing IT-infrastructure are the critical factors. Any issues with these factors result in uncertain activation of any healthcare mechanisms.

Depending on the willingness of actors, the IPFM produces a more precise understanding of the patient’s condition, which forms a foundation for a better access, planning, and implementation of treatment. IPFM improves not only the knowledge of the patient and healthcare professionals but also enables optimization of resources, thus potentially leading to costs savings, enhanced productivity, and improved quality of care. Consequently, more effort can be allocated to actual patient care tasks. This is the kind of value that decision-makers appear to be looking for. Additionally, IPFM could even provide new competences for its users. However, a critical factor in realizing all the mechanisms rely on the users’ adaptability and willingness to use the IPFM in the first place. Figure 2 illustrates this value formulation process of Klinik Pro (IPFM) on a general level. The purple color indicates patient while the red color refers to healthcare professionals. The IPFM and its activity is described with gray. Healthcare mechanisms are illustrated with blue while the outcomes are highlighted with green. The arrows indicate the interdependent relationships between the factors.

There are certain limitations in this research that need to be taken into account. First, this study concentrates merely on DHIs directed to triage and seeking of treatment, i.e. IPFM solutions. Second, the patients, the most important stakeholder group, were not studied, thus making patient perspective vital to study in future studies. Third, although being a multiple case study, the number of interviews in total was limited.

Despite these limitations, this study provides new insights into discovering the mechanisms of DHI value by examining the interdependent relationships between the intervention, its context, and its expected outcomes. Furthermore, this study supports the customers of the health technology companies (e.g. medical centers) to understand
the value formulation of similar DHIs as the IPFM, improving managerial decision-making. With this information, it is possible to concentrate on activities to maximize value capture while also detecting unnecessary activities.

![Figure 2. Value Formulation of Klinik Pro (the IPFM)](image)

References


