

# Key Success Factors for Smart and Connected Health Software Solutions

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*Healthcare delivery is being transformed by technology that personalizes, tracks, and manages patient information across devices. Smart and connected health will develop safer and more effective, efficient, equitable, and user-centered services through pervasive computing innovations.*

**S**ocietal and demographic changes, coupled with economic challenges, are transforming how we deliver healthcare in our communities. Due to growing populations and medical advances, healthcare demands will inevitably outgrow medical professionals' capabilities to deliver safe, quality care in a timely manner. These factors have given rise to smart and connected health (SCH), a comprehensive sociotechnical model for managing healthcare through software solutions.

According to Gondy Leroy and her colleagues, technological advances in healthcare have encouraged the development of new technologies that drive connectivity across the healthcare sector—apps, gadgets, and systems that personalize, track, and manage care using just-in-time information exchanged through various patient and community connections.<sup>1</sup> This paradigm shift heavily emphasizes the process of software development in supporting SCH innovation. It has also contributed to a shift in healthcare practice, highlighting our growing

reliance on and trust in software to support healthcare decisions. However, failure to correctly align software with healthcare needs can have serious—and potentially fatal—consequences.

## **MY RESEARCH**

As an experienced researcher in applied SCH solutions and healthcare innovation, I'm often asked by industry professionals which reoccurring and emerging factors contribute to the success of SCH software innovations. To explore this question, I conducted a series of semi-structured interviews with 10 experts, including applied researchers, consultants, academics, and industry partners. Many of the participants have also been involved in national and international research projects and case studies. Drawing on these interviews and case study synopses, I synthesize here my findings regarding the key success factors (KSFs) for SCH software innovations.

Collaborating with healthcare institutions and companies over the years has allowed me to develop rich

insights into and strong empathy for healthcare professionals and customers. These groups often cite the barriers and requirements involved in validating the problem–solution fit required for successful SCH innovations. This convinced me that I needed to identify the key ingredients of a practical yet innovative solution that maps healthcare and software needs while identifying technology’s opportunities and mitigating its potential risks.<sup>2</sup>

My research, guided by design thinking,<sup>3</sup> yielded novel outcomes that successfully support the ability to innovatively bridge healthcare needs and software requirements. Design thinking is a human-centered, prototype-driven process that can be applied to any product, service, or business design.<sup>4</sup> It not only guided my identification of reemerging SCH success factors but also uncovered deeper insights on how to align healthcare needs with software requirements to address customers’ pain points. In the context of SCH, a pain point is a real or perceived problem that causes discomfort, annoyance, embarrassment, or frustration and impacts a person’s well-being.

To successfully launch a new SCH software solution, we must map the KSFs of healthcare software companies to guide their system analysts, designers, and software developers in addressing pain points.

## WHY SMART AND CONNECTED HEALTH?

Over the past decade, software companies have increasingly focused on healthcare, yet medical errors are still inevitable because of the fragmented nature of medical information. However, there is growing interest in identifying methods that will transform healthcare from, for example, moving

away from reactive care to proactive and preventive interventions and from clinic- to citizen-centered practices by empowering people through greater access to healthcare information.

SCH is supported by an interoperable digital infrastructure that facilitates the exchange of data and knowledge. It optimizes the use of rich and real-time data sources to support evidence-based health and wellness decisions. Thus, through the use of software tools and technologies, SCH extends healthcare services and processes beyond traditional healthcare boundaries, delivering more convenient and personalized healthcare services. SCH empowers individuals to manage their own health and treatment plans, often facilitated by integrated intelligent systems (for example, wearables) that monitor and support the maintenance of a desired health status.

SCH’s ultimate goal is to develop safer and more effective, efficient, equitable, and user-centered health and wellness services through pervasive computing innovations. Thus, SCH software innovation contributes to the coverage and quality of healthcare services, improved health outcomes, reduced costs, and improved quality of life. Improved decision-making tools can increase the likelihood of saving lives, reducing costs, and ensuring a better quality of life before, during, and after treatment.

## WHY KEY SUCCESS FACTORS?

CEOs often ask, “Within an SCH context, what worked well in the past and how do we incorporate this into our product/service design and development process?” Adopting KSFs requires a process with top-down

support from management to champion new innovation and bottom-up participation from staff to develop healthcare software solutions.

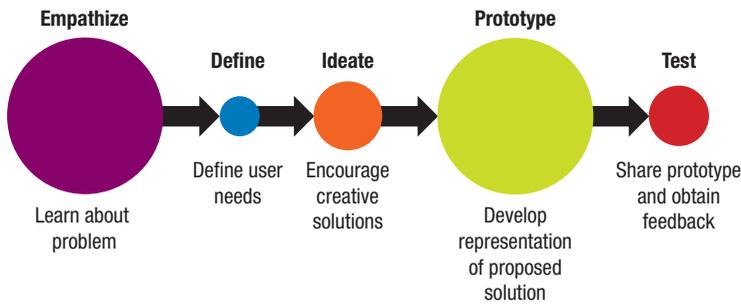
KSFs are those functions, activities, or business practices—typically influenced by the market and defined and viewed by end users—that are critical to sustaining the technology provider–user relationship. Thus, KSFs can act as a scaffold to guide software development and result in value co-creation through software skills, processes, and systems. Organizations can develop KSFs in terms of the core competencies and capabilities that extend internal activities and improve practices and quality functions. Aligning these competencies with the KSFs increases the value and success of both the relationship and the healthcare software product/service value proposition—to both the organization’s and users’ benefit. In essence, adopting KSFs makes the software innovation lifecycle for SCH solutions less risky.

## DESIGN THINKING

Design thinking is a formal process that captures pain points and influences the design and development of end products and services. This technique was extremely useful in guiding my research on the identification of healthcare needs and how they align with software requirements.<sup>6</sup> Such guidance is vital because healthcare software has much at stake, most notably patient safety. Design thinking moves beyond the gathering of software requirements and is not constrained by preconceptions of isolated software solutions.<sup>5</sup> As Figure 1 shows, design thinking has five key phases:

- ▶ empathizing with users to fully understand their experiences,

## SMART HEALTH AND WELL-BEING



**FIGURE 1.** The five phases of design thinking.<sup>6</sup> This process helped identify factors leading to successful smart and connected health innovations and uncovered ways to better align healthcare needs with software requirements.

- › defining a wide variety of possible SCH software solutions,
- › ideating creative SCH solutions,
- › prototyping ideas into tangible form, and
- › testing to refine and examine the effect of SCH solutions.

This process fosters a learning life-cycle about solutions and carefully bridges our understanding of healthcare needs with the software design process. It also helps identify reoccurring themes that contribute to SCH software's success. Stanford University's d.school's (Institute of Design) design-thinking method, which is applied to SCH innovation in Table 1, is one simple, effective model.

The fascinating, sometimes meandering process of initiating a healthcare solution all the way through to testing the product and launching it into the market is influenced by many factors. Through the "stories of individuals," we can identify key lessons learned for guiding software innovation and use these to determine the KSFs.

### MY RESULTS

Drawing on my research, I present the 10 KSFs that organizations should incorporate during SCH innovation development to ensure marketplace success.

### Innovation champions

Improving current healthcare practices requires a sustainable healthcare innovation culture that truly empowers staff members to instigate changes.

Such changes must have remarkable, rather than incremental, effects on healthcare to differentiate an organization from its competitors. Every project needs an innovation champion and a clinical champion, both of whom are bold, creative, and willing to push the boundaries to redefine healthcare. Therefore, one KSF is having innovation champions with the innate ability to identify SCH opportunities while understanding the impact of misaligning healthcare needs with software requirements.

Innovation champions play a key role during the empathize phase and are tasked with securing buy-in from the key decision makers who will execute and lead SCH solutions. Innovation champions are typically familiar with using empathy mapping to uncover what people think, feel, see, say, do, and hear and to identify core healthcare pain points. Innovation champions must also collaborate with clinical champions, usually consultants, who can implement and test proposed changes in a healthcare context. Innovation champions must adhere to feasible timeframes for delivering safe, high-quality software solutions. They are also key to influencing the political will to implement SCH solutions despite institutional and personnel resistance. Organizations should encourage idea generation among their staff, such as through an internal innovation program, to ensure that staff have the opportunity to share their ideas and champion change using SCH innovation.

### Clear definition of success

To achieve healthcare goals using SCH solutions, organizations must communicate what "success" means (both internally and externally) and establish clear objectives. All staff members must understand what the end game is so that they can contribute to its achievement. This is a KSF because it encourages staff, particularly analysts and developers, to prioritize software requirements while targeting lucrative markets. In fact, the design thinking's empathize phase allows software developers to inform, reflect, understand, and decide on appropriate software development actions as co-defined by innovation champions and management. Typically, systems analysts would clearly define the healthcare problem of interest and then align their software processes with their definition of success. However, all employees must support an SCH innovation vision and the organization's short-, medium-, and long-term software-development strategies. One research participant, a software developer, explained that their organization uses the following—adapted from Robert Charette's<sup>8</sup> "why software fails" list—as a checklist of SCH "success requirements":

- › realistic and articulated project goals;
- › accurate estimates of needed resources;
- › well-defined system requirements;
- › good reporting of the project's status;
- › managed risks;
- › good communication among customers, developers, and users;
- › use of mature technology;

**TABLE 1.** Stanford d.school’s design-thinking process applied to smart and connected health (SCH) software solutions.

Design-thinking phase	Description	Contribution to SCH success
Empathize	Close collaboration with end users, patients, software developers, and management teams identifies the key healthcare problems and needs (“pain points”). This is achieved by observing, engaging with, and earning the trust of patients to learn about their experiences.	Supports innovation champions with ethnography skills, who can be sympathetic to patient needs and achieve rich insights by prompting deeper questions about patients’ day-to-day experiences, for example, about taking a medication.
Define	Having gathered information on the core pain points, it is important to define these issues by contextualizing and synthesizing user needs; that is, clearly defining the problem and the associated needs.	Defines users’ priorities in terms of healthcare needs, which influence the SCH software and system design process, and defines success (that is, addressing users’ needs). For example, we might learn that patients experience social isolation, forgetfulness, and poor eyesight and need medication reminders.
Ideate	Software engineers generate new solution ideas by creating and prototyping low-resolution software prototypes through a sprint software-development cycle.	Takes action to develop and adopt human-centric software solutions that address patient needs; generates ideas around a theme, for example, a medication homecare assistant software solution.
Prototype	The development of software solutions with healthcare technology providers commences by ensuring software developers are clear on the product goal, identifying key factors to be tested, and monitoring patient feedback.	Develops an SCH solution within the sprint software-development cycle by collecting meaningful feedback in the testing phase. The feedback should provide a representative snapshot of the market reaction to the product. Examples include conceptualizing included features, such as machine learning, face recognition, personal healthcare assistant robots, and so on.
Test	The solution must be tested against the key healthcare needs by continuously observing and refining the prototype, learning about the user experience, and comparing multiple prototypes to reveal possible suppressed healthcare needs.	Refrains from explaining the SCH prototype to users, allowing them to interpret its functionality; tests the prototype’s usability and usefulness, often prompting the need to address questions and concerns (for example, feedback might include that a personal assistant prototype offers a companion and greater sense of a security—which reduces social isolation—and provides friendly reminders that improve medicine adherence and quality of care).

- › ability to handle the project’s complexity;
- › great development practices;
- › good project management;
- › management of stakeholder politics; and
- › management of commercial pressures.

Identifying what could contribute to software failure can be incorporated into organizations’ success definition and helps avoid the pitfalls associated with bringing SCH products to market.

### Human-centric healthcare needs and software adoption

This KSF borrows techniques from design thinking’s ideate phase and biodesign research’s problem–need–solution approach.<sup>7</sup> It enables system analysts to immerse themselves in

patients’ lives and more deeply understand their healthcare needs. This removes the threat of technologists making assumptions about or guessing what patients need. It also supports organizations’ software innovation developments and reduces the risks associated with developing products unfit for market.

Rather than one-size-fits-all technology solutions, particular focus should be placed on the use, usability, and usefulness of SCH and fit-for-purpose solutions in relation to the target market’s healthcare needs. Therefore, SCH solutions must address real-world healthcare needs and be informed and validated through research rather than just assuming that the market will embrace the solutions. The empathize phase achieves this by investigating

whether an SCH solution meets the end users’ cultural needs and facilitates smoother software adoption. By addressing human-centric needs and software adoption, organizations can maximize their coverage and the quality of their healthcare software and services.

### Knowledge of healthcare end users

This KSF targets the need to identify and understand those who are willing to pay for SCH software products and services, including healthcare institutions, healthcare professionals, caregivers, family members, and governments. The users ultimately co-create an SCH innovation’s healthcare value. SCH users might interact with stakeholders who monitor wellness and contribute to patient treatment

by supporting the health workforce, tracking diseases, and monitoring public health through various software solutions. In addition, healthcare providers (HCPs) might play dual roles—as end users of the software solutions and as technology advocates recommending new software solutions to patients or healthcare institutions.

Therefore, certain core, intangible HCP views, attitudes, perceptions, and interactions (including cognitions and emotions) are critical to a healthcare software innovation's success. Adopt-

development must be efficient and reliable to achieve the organization's vision of success.

A well-documented, transparent project management plan must be established. This plan must clearly identify key resources and software quality milestones to avoid loosely managed and unfocused development. A daily scrum meeting can ensure that the entire team is aware of operational developments and potential challenges within the organization. Specific governance protocols and

SCH software solutions through various sprint software developments. In most cases, value co-creation clearly and compellingly supported with data such as behavioral changes or clinical data is required for a software solution's value realization and wider adoption.

This process enables users to undertake specific tasks on multiple devices and experience single-point healthcare interactions. It also allows the organization to observe and understand how value is unlocked from the users' perspective. Much of this is achieved through extensive research that ideally proves the benefits of a specific SCH solution. More important, value is most often realized through improved health outcomes, reduced costs, and improved quality of life. Measuring value requires both quantitative (for example, a health value scorecard) and qualitative data (for example, patient satisfaction ratings). An organization can continue to improve software by creating new healthcare experiences and applying feedback throughout the innovation lifecycle.

**SMART AND CONNECTED HEALTH IS  
A COMPREHENSIVE SOCIOTECHNICAL  
MODEL FOR MANAGING HEALTHCARE  
THROUGH SOFTWARE SOLUTIONS.**

ing a multistakeholder engagement tool that ensures collaboration before, during, and after the software development lifecycle is extremely useful. Developing the software solution is only half the battle—marketing it to the right audience directly affects the organization's success and the solution's widespread adoption.

### **Software team and healthcare project management**

Much of a solution's success hinges on the software team and coordinated healthcare project-management activities. For example, motivating a software team to deliver a high-quality solution on time is critical. This KSF thus encapsulates the transition from healthcare needs to innovative software solutions. Both the software product and the team supporting its

adherence policies must be defined and documented to avoid deviating from what was originally agreed upon with the innovation champions and other key stakeholders. The development team must be compliant through timely reporting (regular, concise, and frequently reviewed) and regular training to ensure quality standards are maintained. Because poor management can have potentially devastating health consequences, SCH project management necessarily differs from software development for non-critical evolving systems.

### **Evidence-based healthcare value co-creation**

Value co-creation is critical to success and builds trust within the marketplace. This process involves testing and demonstrating the value derived from

### **Infrastructure and interoperability**

Offering a safe and secure SCH software solution to users is a KSF that ensures that users avail of proper technical infrastructures, which is a key concern for HCPs and end users, particularly regarding data privacy and security. The testing phase informs systems analysts of the infrastructure and interoperability requirements for the proposed SCH solution. Interoperability requirements include whether systems need to be connected or are ready for emerging paradigms, such as the Internet of Things.

In addition, because most services are available online and generate real-time analytics, sufficient

attention must be paid to API scalability and tethering problems. If existing solutions are in place, the new SCH software solution must seamlessly integrate with these systems without jeopardizing the quality and safety of healthcare services. Quality and trust marks can be introduced to demonstrate that organizations meet high-quality software standards.

### **Software as a medical device (regulation and standards)**

There are growing concerns among SCH organizations regarding intertwining healthcare, technology, and medical device regulations and standards. During the early prototype phase, organizations must consider their solutions' classification in terms of intended use and categorization as software as a medical device.<sup>9</sup> User and organizational concerns often focus on data security, ownership, and accuracy; user questions often include, "Where is my data?," "Who owns my data?," and "Can I trust this device?" Thus, assuring users that their data is secure and encrypted and can be safely transferred and stored is of vital importance, particularly in relation to healthcare and well-being decision-making tasks.

In addition, policies should govern how solution features are incorporated into the final product; that is, linking back to empathy and enabling decision makers to formalize new protocols and policies that ease implementation and adoption. Regulations and standards should not be viewed as hurdles that hamper SCH innovation. Rather, organizations should view regulations and standards as "rules of the game" that ensure their compliance so that they can focus on the innovation strategy. Using regulations and standards to

guide the SCH innovation cycle also conserves resources by ensuring compliance at an early stage. In most cases, a product's compliance with medical device regulations gives the organization a competitive advantage in the crowded wellness marketplace.

### **From smart and connected health data analytics to knowledge**

Healthcare data analytics has two core functions. First, from an organizational perspective, the technology provider must manage data to ensure that the software solution meets users' requirements, improves the quality and safety of care, and empowers people to manage their own care and well-being. Second, the data captured by various SCH software solutions must be accurate and calibrated to be meaningful to users. Failure to provide these two key functions will reduce the SCH software solutions' value proposition and customer retention rates.

User health self-management is an emerging—and necessary—feature of modern healthcare and wellness services. Therefore, it is important to clearly indicate who manages information—for example, whether a company will develop specific algorithms to mine data and generate diagnostic or predictive analytics—and how the data will be presented so as to be meaningful yet not cause information overload on smaller devices. Thus, as part of the much-hyped data-analytics field, data management and quality control are critical in SCH and the software market share. It is important for organizations to strike the right balance between capturing the required data and educating end users on their health status or progress. This also unlocks new knowledge and value from healthcare data,

which strengthens cross-fertilization between research and industry to accelerate future innovations.

### **Software-driven educational experience**

The final KSF is providing software-driven educational experiences. Internally, it is vital that organizations learn how their solution influences behavioral change in patients. Organizations must also encourage the key stakeholders involved in the software solution's execution to identify what worked well so that they can improve and evolve their software product/service development lifecycle and enhance their market opportunity analyses. Externally, it is critical that users learn how to empower themselves by using the SCH solution. Organizations must also try to ensure that users buy into future software products. Similar to social media, organizations need to identify methods that encourage users to embrace SCH as part of their everyday lives. The users' healthcare learning experience can take them on a journey of discovery to co-create value. This is critical if users are to manage their own healthcare and understand their progress with lifestyle interventions or treatments. Positive educational experiences also encourage users to promote the product in the marketplace.

**S**oftware innovation is poised to transform our access to and participation in our own healthcare and well-being. This challenge is being shaped by associated transformations to what it means to be healthy and to how we make informed healthcare choices. SCH software solutions are facilitating these transformations.

## ABOUT THE AUTHOR

**NOEL CARROLL** is a research fellow at the Applied Research for Connected Health Technology Centre, University of Limerick. His research interests include healthcare software systems and innovation management, particularly techniques to assess and visualize technology's influence on healthcare service networks and novel methods to effectively communicate healthcare service process change. Carroll received a PhD in computer science from the University of Limerick. Contact him at noel.carroll@lero.ie.

However, healthcare is a complex field and, as most software practitioners are aware, software can fail!

The mismatch between healthcare needs and software solutions presents significant risks to healthcare as a result of “improper or unsafe use of technology.”<sup>10</sup> My research helps address this by supporting SCH software development and evaluating the benefits of healthcare technology.<sup>11</sup> Organizations should incorporate the 10 KSFs to successfully address healthcare needs and introduce software solutions to the market. The clinical and commercial advantages of such an outcome-led design process turn directly into customer benefits.

This work has three clear implications for the SCH community:

- › *Practical*: the 10 KSFs provide a roadmap or “scaffold” for software companies.
- › *Theoretical*: this work bridges the interdisciplinary nature of SCH by explaining the benefits of adopting techniques such as design thinking.
- › *Educational*: this research offers rich insight on how practitioners

and academics can adopt a more informed view of SCH innovation throughout the software development process.

In the future, I plan to develop specific metrics for the KSFs as well as methods of incorporating them into the maturity phases of innovation. Doing so will allow organizations to assess their readiness to develop a new product, evaluate which skills need additional focus or training, and decide which elements of the SCH solution should be outsourced. 

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