

# A Disciplined Innovation Approach to Health Technology Solutions

Noel Carroll<sup>1</sup> and Ita Richardson<sup>1,2</sup>

<sup>1</sup>ARCH- Applied Research for Connected Health Technology Centre, University of Limerick, Limerick, Ireland

<sup>2</sup>Lero- The Irish Software Research Centre, University of Limerick, Limerick, Ireland

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**Abstract:** Despite the potential of innovation-driven healthcare technology services to increase the quality, accessibility and quality of care, the realization and success of such promise has yet to be achieved. This prompted us to explore the barriers towards success for healthcare software companies and examine what frameworks are employed across industry to support their growth in the digital healthcare market. As part of a three-phase study, this article reports on the first phase – to synthesize the literature on the readiness factors for healthcare technology companies. The findings of this research will guide our second phase of this research in surveying industry healthcare software companies. In so doing, we can establish readiness factors for healthcare software companies with a view to offering a more structured and disciplined approach to healthcare innovation.

## 1 INTRODUCTION

We often learn how small and medium-sized enterprises (SMEs) across the national and international service sector must consistently and continuously innovate and adapt to ensure their survival (Gebauer et al. 2012). It is a matter of ‘survival of the fittest’ to evolve with the dynamic external environment. To do so successfully largely depends on the SME’s service innovation capability and competences to deploy resources and improve services. This is a challenge particularly in a healthcare context since technology advancements continue to rapidly grow while concerns around healthcare device safety and regulation continue to surface and challenge innovation (Carroll and Richardson, 2016). Thus, pertinent questions need to be asked such as, *how can an organization continuously evolve and offer a new service to meet healthcare needs? Where does the added capability and competencies come from to do so?* From our experience, two key factors here are to 1) identify the unmet healthcare needs and 2) examine how or where the capabilities will come from to address those needs.

We often learn about the growing success of companies breaking new ground in healthcare innovation and dominating market leadership (Carroll, 2016). While, this is very much welcome

across the healthcare sector, little is known about why companies, particularly software companies, fail to achieve their business objectives in reaching new markets (Kellermann and Jones, 2013). Thus, uncovering both why companies fail and what we can do to reduce such occurrences, drew our attention towards the concepts of *evaluation, organizational readiness* and *capability maturity* to establish a more disciplined view of healthcare technology innovation. Technology has contributed towards a shift within healthcare practice which highlights the growing reliance and trust we now place on software to support healthcare decisions. However, unlike some sectors, for example business, failure to correctly align healthcare needs with software requirements can have devastating consequences on people’s health – potentially fatal.

## 2 TOWARDS DISCIPLINED INNOVATION

In recent years, the concept of ‘*Disciplined Entrepreneurship*’<sup>1</sup> was coined at MIT and offers a comprehensive step-by-step approach to creating solutions. It focuses on the iterative process towards a final solution to meet users’ needs. Aulet (2013)

<sup>1</sup> <http://disciplinedentrepreneurship.com/>

attempts to move away from an abstract view of entrepreneurship and proposes a toolkit to guide innovation. This provides a rich insight on entrepreneurship as a skillset. The toolkit provides 24 steps that is described as disciplined entrepreneurship and is a practical step-by-step process to channel the innovation and maximize the chances of success and ultimate impact. Such a formal process is considered beneficial to focus the innovation process. We previously explored how a similar approach could be achieved in a software engineering and healthcare innovation context (Carroll and Richardson, 2016). In this research we employed Design Thinking with a view to aligning healthcare innovation and software requirements and address customer pain points using the *Connected Health Innovation Framework* to a) support software developers in clearly identifying healthcare requirements and b) extend and enrich traditional software requirements gathering techniques. However, we have identified that there is a need to take this a step further and move towards establishing measures of innovation in order to assess risk and the capability to deliver an innovative solution within a process flow. We describe this as ‘disciplined innovation’.

### 3 PROBLEM STATEMENT

By services, we often refer to an intangible product, for example, banking, consultancy, healthcare, education and software development. Thus, the service economy is vital across the globe. For the purposes of this paper, we focus on healthcare and software development as an exemplar to support SMEs, i.e. the ‘health-tech’ market. Yet, despite the significance placed on the service sector, there is a lack of practical measurement or management tools for innovation. Such a gap in literature and practice ensures that the promise of health-tech innovation is never fully realized across SMEs (Kohler et al. 2013). In an attempt to identify a tool to support technology companies to guide SMEs to improve their healthcare innovations, the authors are continuously faced with the need to restart the innovation evaluation process for each company.

In this paper, we propose a decision support tool that will guide organizations to self-assess their current organizational operations. Such a tool would support organizational management practice. It would provides us with a real opportunity to establish a framework to guide organizations through the evolutionary dimensions of healthcare

technology innovation.

In a recent article, Christensen et al. (2016) suggest that, “*business model innovation is crowded*” which is driving companies to mount both offensive and defensive initiatives involving new business models. Identifying innovation attributes allows us to have greater control of the innovation flow process and develop predictable business models to drive decision-making tasks, measured performance and accommodate for an efficient innovation process flow. This becomes the primary motivation to introduce a ‘disciplined innovation’ model.

### 4 HEALTHCARE INNOVATION CAPABILITIES

Healthcare service environments become increasingly complex when technology is implemented to execute specific clinical, technical and business processes to deliver care. This ultimately adds to the complexity of a service environment, making it one of the most difficult environments in which to examine and manage service capabilities. Capabilities are complex, structured, and multi-dimensional. They may be described as fundamental determinants resource utilization to support and sustain organizational performance (Teece, 2009). Managing process maturity has been well documented throughout the business and IT literature. Little research in this area is carried out within a health-tech domain.

In IT management, maturity models play an important and influential role in organizational change (Becker et al., 2009). The availability of service and innovation capabilities has motivated us to review how we conceptualize the health-tech service environment. The success of innovation often relies on a number of contributing factors. For example, according to Birkinshaw et al. (2011, p. 3) the following “conditions” contribute towards sustained innovation: (1) *shared understanding*: cultural understanding of organizational behaviour; (2) *alignment*: aligning systems and processes to achieve desired performance metrics; (3) *tools*: training, concepts, and techniques to innovate; (4) *diversity*: optimizing external influences and insights to offer solutions within a particular domain; (5) *interaction*: establishing platforms to exchange ideas and build networks; and (6) *slack*: providing opportunities to access additional resources to develop ideas. These conditions contribute towards organizations overall competencies and capabilities.

## 5 CAPABILITY MATURITY MODELS

The ultimate goal of an organizational capability is to contribute towards some form of value, e.g. improved healthcare and increased profits. There are a very large number of variables that are dependent on the context and industry which determine the important role capabilities play in value creation. At an abstract level we may identify the attributes of a capability to include (Carroll and Helfert, 2015) value creation, outcome focused, measurable, and maturity driven process. Within an innovation environment, capabilities need to be dynamic. Dynamic capabilities are considered the source of competitive advantage. Teece and Pisano (1994) identify two key aspects in harnessing competitive advantage through dynamic capabilities that may apply to a service innovation environment:

- (1) The shifting character of the environment, e.g. healthcare needs;
- (2) The importance of strategic management in agility, adaptability and reconfiguring internal resources to meet external demands.

Winter (2003, pp. 4-5) suggests, “*dynamic capabilities typically involve long-term commitments to specialised resources [...] [and] [...] there must be an ecological demand for the costs of the capability and the use that is actually made for it*”. Managing dynamic capabilities requires some form of structure and models – for example, the capability maturity model (CMM) (Paulk, 1995). The CMM assumes progress is made in distinct stages and capture capability maturity at a given time (moving through five progressive stages - initial, repeatable, defined, managed, optimized).

The results of this assessment process supports the organization to position themselves against defined best practices while identifying areas of weakness to drive change (Becker et al., 2009; Carroll and Helfert, 2015). However, existing maturity models tend to focus on large organizations (Blommerde and Lynch, 2016, p.2) and are “*too broad to account for the specificities of service SMEs and fail to reflect their unique characteristics*”. We set out to address this gap in a health-tech context.

### 5.1 Health-tech Innovation

Focusing on singular innovation is considered a thing of the past, i.e. developing one solution and forever reaping the rewards. Organizations must continuously innovate and demonstrate their

dynamic capabilities to execute effective innovation capability (Blommerde and Lynch, 2016). Blommerde and Lynch (2016, p.2) suggest, “*SMEs are unaware of their service innovation capability or how to improve their innovative maturity mode*”. Thus, some form of innovation measurement is required to support SMEs.

Blommerde and Lynch (2016) present the key dimensions of service innovation capability which link to all five stages of capability maturity model using a ‘Service Innovation Capability Maturity Index’, namely focusing on 1) user involvement; 2) knowledge management; 3) strategizing and 4) networking. In addition, and with a view to focusing on the measurement of innovation, Kohler et al. (2013) introduce a Service Innovation Model that comprises of four layers. From their description, they explain that the top layer (innovation capabilities) is connected with service innovation capability indicators, which are captured in the second layer. Each capability is associated with an indicator that quantitatively captures the implementation of the innovation capability in the company.

Performance is a key factor in innovation and new terms have been introduced over the last decade such as ‘disruptive innovation’. While the concept of disruptive innovation stems new terms such as ‘value network’ which may be described as “*the context within which a firm identifies and responds to customers’ needs, solves problems, procures input, reacts to competitors and strives for profit*” (Christensen, 1997; p. 31), we need a systematic approach to manage the innovation process.

In the Service Innovation Model, the indicators are a core focus for the assessment and monitoring of the service innovation capabilities. The indicators are described by Kohler et al. (2013; p. 1350) as being quantitative representation of the innovation capabilities. The indicators are connected to a set of asset categories within sets of assets and assessed on a numerical scale. These assets are categorized into assets, i.e. human, financial, physical, intellectual property rights, information and information technology, and relationship assets. There is also a similar outlook on the dynamic nature of innovation. For example, den Hertog et al. (2010) suggests there are dynamic service innovation capabilities that successful service innovators outperform their competitors in some of the following:

1. Signaling user needs and technological options;
2. Conceptualizing;
3. (Un)bundling;
4. Coproducing and orchestrating;

## 5. Scaling and stretching.

Thus, we have identified that there is a natural evolutionary process in the innovation process. This process requires an organization to move between specific maturity stages of innovation. Maturity phases are well documented throughout the literature in CMM but may need to be tailored within an innovation context and more specifically, within a health-tech context. For example, Carroll and Helfert (2015) explain how the traditional view of the organizational environment raises concerns regarding the mismatch in the methods used to assess business value and understanding service process maturity. They demonstrate this by unpacking the nature of service capabilities that allows us to understand the primary components of value co-creation and their contribution towards service maturity within an innovation environment to access organizational readiness. This offers a suitable lens to view a disciplined approach to innovation that can be easily adopted by SMEs in health-tech. We also need to examine how organizational readiness aligns with innovation capabilities.

### 5.2 Organizational Readiness

Throughout the literature, organizational readiness is often associated with organizational change management (OCM) (Armenakis et al. 1993; Weiner, 2009). Change is a critical factor for organizational readiness and is a multi-level, multi-faceted construct which healthcare technologies often face to introduce technology innovation. In most cases, such change refers to organizational members' shared resolve to commit towards a change in practice and a collective ability to improve organizational performance. Thus, organizational readiness for change varies as a function of how much organizational members value the change, e.g. within a hospital context.

Value of change must be weighted up against the risk (e.g. cost and investment of resources) associated with innovation. According to Weiner (2009) there are three key determinants of change implementation capability: task demands, resource availability, and situational factors. We argue that *innovation capabilities* are a fourth key determinant of organizational readiness – which needs to be calculated to assess the impact of innovation on organizational readiness. We explain that innovation is the process of introducing new ideas, devices, or methods to bring about some change.

We can begin to uncover the key enablers of innovation by taking a holistic view of change and

integrate this with business activity rather than isolated processes. This enables us to develop an innovation model and identify the guiding principles that are grounded in organizational experience – documented throughout literature (phase 1 of our research, as presented in this paper) and captured by surveying industry experiences (phase 2 of our research, future work). Weiner (2009) describes how organizational readiness is “*considered a critical precursor to the successful implementation of complex changes in healthcare settings*”. Weiner also cautions “*most publicly available instruments for measuring organizational readiness for change exhibit limited evidence of reliability or validity*” – hence the motivation for this research.

In the case of healthcare software companies, innovation drives organizational changes to meet new market demands. To ensure that innovation can be successful, metrics must be established to drive such change. Thus, OCM may be described as an approach to transition an organization from their current state to a new desired state. This involves the integration and alignment of people, processes, culture and strategy to innovate.

Before OCM can be successfully implemented, managers must clearly evaluate readiness for change. Armenakis et al. (1993) describes readiness in terms of the organizational members' beliefs, attitudes, and intentions. Thus, there are critical elements of change agents and social dynamics that influence organizational readiness process which may contribute towards the success of healthcare software innovation. Identifying and measuring these elements provides a benchmark on the current organizational state compares with their ideal state to derisk healthcare software innovation. We capture all of these factors of CMM and OCM to present our *Disciplined Innovation Model* for health-tech SMEs.

## 6 DISCIPLINED INNOVATION

Migrating from the current state to the future state of an organization requires a number of key stages to embrace an innovation culture to drive a specific strategy and improve their competitiveness. This enables organizational performance to achieve the desired business goals. Therefore, innovation is not a soft or vague construct, but rather, a critical process to drive organizational performance. Why then is the process of innovation less defined in terms of organizational readiness and process flow measurement? Where are the formal process models to guide SMEs through the innovation process to

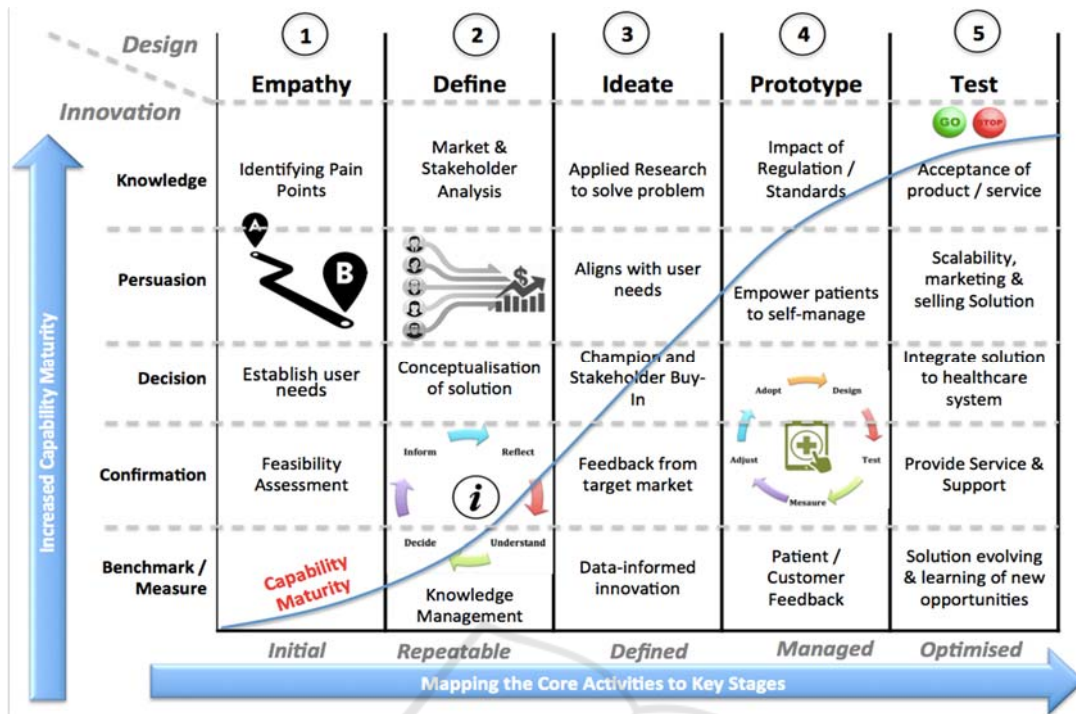


Figure 1: Disciplined Innovation Model.

derisk health-tech initiatives? To begin to address such questions, we need to ask: *Why does a company need to build a new solution, evolve an existing solution to maximize performance? How does a strategy cater for such change? What specific function(s) of the organization must change to ensure innovation is successful? Are there any specific guiding principles to derisk the innovation process?*

Innovation is often linked with creativity and the ability to design solutions for unmet needs in the marketplace. However, it remains unclear whether we can measure innovativeness within organizational readiness. Some attempts were made to measure innovation, open innovation and technological diffusion. For example, Jalles (2010) examines alternative variables such as technological progress (using patents and a Intellectual Property Rights Index) to explain different growth rates of income. In addition, Narayana (2005) suggests the need to measure innovation using a CMM to determine a particular strategic route and whether organizations need to learn of the innovation management process.

### 6.1 Disciplined Innovation Model

Figure 1 illustrates the initial *Disciplined Innovation Model*. It is influenced by:

1. *The key phases of innovation:* knowledge,

- persuasion, decision, and conformation;
2. *Design Thinking stages:* empathy, define, ideate, prototype, and test;
3. *CMM stages:* initial, repeatable, defined, managed, and optimized.

We also include the need to benchmark each phase to measure the capability maturity as a solution matures through each stage. This captures the essence of our initial development of the *Disciplined Innovation Model* and we have identified the need to establish specific metrics for each stage of the model. As the performance demanded by the customers of a value network increases over time so does the performance provided within a technological paradigm. Within a healthcare technology market, this could include a new set of performance value attributes that are now more relevant than the current paradigm to address healthcare needs.

While there is a strong body of knowledge on innovation as a method of competitive differentiation and as a way to create customer value, less attention has been devoted to developing a measure of innovation (Dobni, 2008). Dobni (2008) identifies innovation culture as an important factor to measure and identifies seven factors: innovation propensity, organizational constituency, organizational learning, creativity and empowerment, market orientation,

value orientation, and implementation context. However, more emphasis needs to be placed on the innovation flow process to support how we can support the innovation process.

## 7 DISCUSSION & CONCLUSION

By embedding data analytics into innovation, organizations can unlock new opportunities if guided through a disciplined process. In healthcare, this can build empathy for users and pave the way to improved experiences to deliver truly user-centered services and improved connectivity of services. We identify that despite the potential of innovation-driven healthcare technology services to increase the quality, accessibility and quality of care, the realization and success of such promise has yet to be achieved.

To address this, we present the initial *Disciplined Innovation Model* as a means to establish a self-assessment toolkit for SMEs to support the advancement of healthcare technology innovations and determine whether they are ready for scaling up their services and targeting innovation opportunities. We also identify the need to evaluate healthcare innovation from a healthcare practitioners perspective (O'Leary et al. 2014) as part of our future research.

While we introduce the initial version of this model, as part of our future research we plan to build on this by identifying specific metrics through industry collaboration and piloting the model through an iterative proves across a number of health-tech SMEs. We anticipate that this model could be tailored to fit other sectors to support SMEs though a disciplined innovation process. We will firstly focus on validating this work with health-tech SME's.

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## REFERENCES

- Armenakis, A. A., Harris, S. G., & Mossholder, K. W. (1993). Creating readiness for organizational change. *Human relations*, 46(6), 681-703.
- Aulet, B. (2013). *Disciplined entrepreneurship: 24 steps to a successful startup*. John Wiley & Sons.
- Becker, J., Knackstedt, R., & Pöppelbuß, D. W. I. J. (2009). Developing maturity models for IT management. *Business & Information Systems Engineering*, 1(3), 213-222.
- Birkinshaw, J., Bouquet, C. and Barsoux, J.L. (2011), "The 5 myths of innovation", *MIT Sloan Management Review*, Vol. 52 No. 2, pp. 43-50.
- Blommerde, T., & Lynch, P. (2016). A Maturity Matrix for Assessing Service Innovation Capability. In: *Irish Academy of Management Conference 2016*, 31 August - 2 September, UCD, Dublin.
- Carroll, N. (2016). Key Success Factors for Smart and Connected Health Software Solutions, *Computer*, Vol. 49, No. 11, pp. 32-38.
- Carroll, N., & Helfert, M. (2015). Service capabilities within open innovation: Revisiting the applicability of capability maturity models. *Journal of Enterprise Information Management*, 28(2), 275-303.
- Carroll, N., & Richardson, I. (2016). Software-as-a-Medical Device: Demystifying Connected Health Regulations. *Journal of Systems and Information Technology*, 18(2), pp.186-215.
- Christensen, C.M. (1997). *The Innovators Dilemma: when new technologies cause great firms to fail*, Harvard Business School Press, Boston, Massachusetts.
- Christensen, C.M., Bartman, T., van Bever, D., Strategy, D. and Strategy, E., (2016). *The Hard Truth About Business Model Innovation*. MIT Sloan: Fall, Research Feature September 13.
- den Hertog, P., van der Aa, W., & de Jong, M. W. (2010). Capabilities for managing service innovation: towards a conceptual framework. *Journal of Service Management*, 21(4), 490-514.
- Dobni, C. B. (2008). Measuring innovation culture in organizations: The development of a generalized innovation culture construct using exploratory factor analysis. *European Journal of Innovation Management*, 11(4), 539-559.
- Gebauer, H., Paiola, M. and Edvardsson, B. (2012) 'A capability perspective on service business development in small and medium-sized suppliers', *Scandinavian Journal of Management*, Vol. 28, No. 4, pp. 321-339.
- Jalles, J. T. (2010). How to measure innovation? New evidence of the technology-growth linkage. *Research in Economics*, 64(2), 81-96.
- Kellermann, A. L., & Jones, S. S. (2013). What it will take to achieve the as-yet-unfulfilled promises of health information technology. *Health Affairs*, 32(1), 63-68. Chicago.
- Kohler, M., Feldmann, N., Habryn, F. and Satzger, G. (2013) 'Service Innovation Analytics: Towards Assessment and Monitoring of Innovation Capabilities in Service Firms', 46th International Conference on

- System Sciences (HICSS), 7-10 January, Hawaii.
- O'Leary, P., Carroll, N., & Richardson, I. (2014). The Practitioner's Perspective on Clinical Pathway Support Systems. In IEEE International Conference on Healthcare Informatics (ICHI), (pp. 194-201). IEEE.
- Paulk, M. C. (1995). The capability maturity model: Guidelines for improving the software process. Addison-Wesley Professional.
- Narayana, M. G. P. L. (2005). A framework approach to measure innovation maturity. In Proceedings. 2005 IEEE International Engineering Management Conference, 2005. (Vol. 2, pp. 765-769). IEEE.
- Teece, D.J. (2009), Dynamic Capabilities and Strategic Management: Organizing for Innovation and Growth, Oxford University Press.
- Weiner, B.J., (2009). A theory of organizational readiness for change. Implementation Science, 4(1), p.1. Vancouver.
- Winter, S.G. (2003), "Understanding dynamic capabilities", Strategic Management Journal, Vol. 24 No. 10, pp. 991-995.

