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Medical Device as a Service: Systems Thinking, Servitization, and Management Models for Emerging Medical Technologies

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Submitted to the Program of Organizational Dynamics, College of Liberal and Professional Studies in the School of Arts and Sciences in partial fulfillment of the requirements of the Degree of Master of Science in Organizational Dynamics at the University of Pennsylvania
Advisor: Robert Keidel

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Medical Device as a Service: Systems Thinking, Servitization, and Management Models for Emerging Medical Technologies

Abstract

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The premise for this analysis is the thesis that large medical device manufacturers will be forced to shift business models from product-driven manufacturing and sales to service-oriented business. The strategic focus behind this fundamental shift is based on how existing implantable devices are becoming more commoditized and less able to differentiate through product innovation. Fundamentally, product- and service-based businesses operate in different capacities. This paper attempts to understand how the medical device business can successfully adjust, from an operational and cultural perspective, so as to compete in the changing healthcare environment.

Keywords

Servitization, Systems Thinking, Strategic Framework, Medical Device, Med Tech, Healthcare

Comments

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AND MANAGEMENT MODELS FOR EMERGING MEDICAL TECHNOLOGIES

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Philadelphia, Pennsylvania

2020

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AND MANAGEMENT MODELS FOR EMERGING MEDICAL TECHNOLOGIES

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This paper aims to explore the organizational implications where market trends drive the adoption of service-based business models within the medical device industry and, secondarily, to establish frameworks for the execution of new management models. This paper represents an attempt to explore the emerging changes in value-driven deliverables for medical device manufacturers as new medical technologies fundamentally change the way providers and businesses deliver patient care. The research was conducted through interviews with leaders in the medical device industry, combined with examining academic literature related to organizational strategy and structure, to explore the implicit perspectives on the challenges and opportunities related to the shift from product-focused to service-oriented organizations. This is the first research project that specifically explores the impact of medical technology on device manufacturers' business strategy shifting from selling products to selling services.

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1. Structure

1.1 Premise/Hypothesis/Thesis: Sections 2–5

The premise of this research is primarily rooted in the challenges faced by organizations while strategically evolving from a product-oriented business to a service-oriented business and in how simple mental models can be applied to help frame this transition. The medical device sector is an industry subject to incremental innovation on implantable devices and instrumentation, and it is currently experiencing disruption due to the growing popularity of software-based solutions and, in many cases, robotic intervention. The introduction of this research will highlight some of my personal experiences within the industry as well as the background and context of many of these industrial changes. To better frame the issues, this research will highlight the current status of medical device manufacturers' relationships with their customers and how the business is traditionally conducted in a relationship-based and product-driven manner.

Focusing further on my personal experiences, Section 3 will introduce the thesis around the need for servitization within the industry, ultimately calling for a shift from product-focused manufacturing to a strategic service-oriented value chain as medical device companies take on the persona of “med tech” organizations. We will additionally introduce the concept of subject matter experts having vital roles in the suggested shift and further discuss the strategic business needs around digital surgery, where a competitive advantage can be found. Section 4 introduces servitization within the specific context of the medical device industry will further emphasize the need for a differentiated service-focused offering and create a hypothesis around the industry's potential future.

Finally, Section 5 will introduce the concept of geometric thinking, which forms the foundation of this research, and ultimately help reframe some of the suggested solutions. These mental models will continuously be applied throughout the paper to help better visualize complex issues in a more digestible fashion.

1.2 How I Tested It: Sections 6–7

The hypothesis around a need for a service shift in the medical device industry was tested from three perspectives to better understand the options and challenges the organizations will face throughout the transition. First, I drew upon my experience of working with both large and small medical robotics companies, reflecting on the associated clinical experiences and cultural observations. I worked alongside physicians and various industry stakeholders, and these experiences helped shape my growing understanding of how the industry norms are shifting and how organizations can prepare for these new circumstances.

Second, I spoke with stakeholders across the field of healthcare, ranging from the CEOs of startup companies to manufacturing veterans with over 30 years of experience, all of whom qualify as subject matter experts within their field. This helped me gain a better understanding of the industry's current environment and the challenges inherent in adjusting to the digital surgery landscape. These conversations also helped support various aspects of my hypothesis and further clarified many of the frameworks used in this research.

Finally, the literature review examined many of the theories around servitization, systems thinking, and management innovation in a way that allowed my suggested

frameworks to take shape. Much of the literature was able to account specifically for the medical device industry; therefore, it helped create a more immediately actionable playbook for our mental model mapping.

1.3 Conclusions and Their Bases (Data and/or Theory): Sections 8–10

To wrap up the theory with subject matter experts, personal experience, and the literature review, the concluding sections of this research highlights many of the changes suggested as most applicable to the organizational changes necessary in the medical device industry. These sections specifically highlight the concept of systems thinking as a foundational change in both business planning and culture for manufacturers to adopt as a key area in innovative strategic thinking in the digital landscape. This section begins with a look at paradox theory and how the necessary tensions within the concepts of servitization help contribute to an improved structure and systems approach.

The next part of this section will highlight how sales organizations' culture of performance will be dependent on how they train and measure their execution strategies as service-focused technology companies. These concepts are then extended to the new role of the value chain and how both systems thinking and management innovation impact the ways in which value is delivered to the customer.

1.4 Practical Application: Section 11

In conclusion, this research highlights several areas utilizing a variety of mental models to help shape how device manufacturers can begin to frame their transition. From organizational persona to structural design, the final stage of the research will outline simple frameworks that are most applicable to fundamental changes in the key areas of a

business. The conclusion will briefly highlight some of the areas where further research can be pursued as the med tech industry continues to take shape.

2. Introduction

2.1 Facts About the Topic

This paper represents an attempt to explore the emerging changes in value-driven deliverables for medical device manufacturers as new medical technologies (med tech) fundamentally change the way providers and businesses deliver patient care.

This paper aims to explore the organizational implications for management, where market trends drive the adoption of service-based business models within the medical device industry and, secondarily, to create a framework for the execution of new management models.

The premise of this analysis is the thesis that large medical device manufacturers will be forced to shift their business models from product-driven manufacturing and sales to service-oriented business. The strategic focus behind this fundamental shift is based on the premise that existing implantable devices are becoming more and more commoditized and harder to differentiate through product innovation. Moreover, there is significant pricing pressure due to an evolving healthcare environment. Research primarily focused on the transition to service-dominant frameworks has been limited and represents a clear gap in both theory and practice, particularly in the med tech industry, where a rich tradition of product innovation and engineering has built strong cultural norms and expectations (Martinez et al., 2017).

Fundamentally, product- and service-based businesses operate in different capacities. This paper focuses on understanding how medical device businesses can

successfully adjust, from an operational and cultural perspective, so as to compete in the changing healthcare environment. The primary questions proposed are as follows:

1. How do organizations effectively create new cultures and identities?
2. What are the critical organizational strategies in changing from a product-focused business to a service-focused business?
3. How can medical device manufacturers effectively adjust to the market prioritization of new software-based technologies?

The proposed recommendation frameworks are not designed to persuade the reader in favor of any specific industry trend or directly lay out the case for a shift to digital healthcare. Rather, they aim to create a context where leaders and managers can better execute the strategies related to reprioritizing internal business practices. While the fundamental theme of this paper focuses on data and expert opinion to support the shift to digital healthcare, the primary objective is to better understand how management innovation can be effectively implemented in changing business environments.

The addition of a service-focused component offers a profound adjustment to current industry standards and should be highlighted as a critical aspect of this analysis. Technical expertise as a new component of value creation becomes a point of emphasis as technology evolves beyond the simple relationship between the product and the user and requires additional support and expertise. These paradigm shifts fundamentally alter the way device companies will interact with customer and thus, require new modalities of thinking beyond the current standard.

This is the first research project that specifically explores the impact of med tech on device manufacturers' business strategy shifting from selling products to selling services. The underlying data of the medical device industry shows the growth and significant impact of med tech on shaping patient outcomes, including new modalities of imaging, robotics, and diagnosis tools based on artificial intelligence (AI). The results of this analysis will therefore help the reader understand how medical device manufacturers should model alternative positioning strategies (service-based versus product-based) to most effectively influence the structural and strategic initiatives within their growing technology portfolio.

The need for technological intervention in healthcare spans a variety of markets, driven by the growing demand for data-driven decision-making and assisted surgical execution. As much as 70% of all medical errors occur in the diagnostic phase of the patient experience (Royce et al., 2019), and according to Johns Hopkins, roughly 250,000 U.S. citizens die every year due to medical execution mistakes, which is the third leading cause of death behind heart disease and cancer. Some data suggests that upward of 440,000 preventable deaths occur depending on the cause, which ranges from human error to systems failure. More specifically, these are categorized as errors of omission, commission, communication, context, and diagnosis (James, 2013). The cost of these deaths creates an inefficiency of roughly \$36 billion, and they occur even in some of the most common procedures, leading to a clear area for disruption in the robotic and AI/machine learning space built for improved decision-making and surgical consistency (Loftus et al., 2019).

The growing cost of healthcare continues to be a point of economic and political significance around the world. Furthermore, governments are working to reduce healthcare costs in hospitals, which are traditionally the most expensive component of any healthcare system. Lowering the costs of medical devices while also improving patient outcomes have been proven to comprise a significant challenge across all surgical specialties. In spinal surgery specifically, the data shows that upward of 46% of lumbar spinal fusion surgeries result in failure, with over one million procedures performed in the United States alone (Daniell & Osti, 2017). For complex deformity surgeries, the data shows that 37% of patients required reoperation due to mechanical failures; this generated expenses of over \$16 billion in the United States in 2004 alone (Daniell & Osti, 2017; Inoue et al., 2015). Poor outcomes, high costs, and variability across physician diagnosis and treatment are all leading indicators suggesting that the medical device industry is primed for disruption through innovation. This growing role of med tech aligns more clearly with big data to explore a more specific diagnosis and treatment option, with the ability to then potentially automate any surgical intervention. However, healthcare culture poses a challenge in adopting these technologies from the perspective of both reimbursement and physician training.

The current landscape of the medical device industry primarily shows a space where manufacturers produce products and sell them to hospitals. More specifically, device manufacturers develop specific instrumentation or implantable devices that surgeons choose to use for a variety of factors, including clinical effectiveness, comfort,

or simply a relationship with the company and/or its representatives. Purchasing decisions continue to shift in favor of economic buyers with an emphasis on both reducing costs and limiting outcome variance. Governments in the United States, Europe, and China have implemented tax and regulation policies in an effort to encourage local innovation as device pricing continues to experience downward pressure. Medical device manufacturers that have historically relied on product innovation through research and development (R&D) are beginning to see eroding margins, budget restrictions, and reimbursement changes surrounding implantable devices at an accelerated pace (Kapadia et al., 2018).

2.2 Market Observations

Shifting trends toward new value drivers are forcing medical device manufacturers to reimagine their strategic relationships with customers. Devices interconnected with adjacent technology are beginning to present significant opportunities for manufacturers to reshape their value chains and further contribute to outcome-driven deliverables. Variability in both cost and outcome are two of the major pain points in healthcare; for instance, analysis shows that the costs of major joint replacement (orthopedic) and pacemaker-insertion (cardiovascular) implants can range from 5–25% of the episode-of-care-costs, while consumable use in knee-replacement surgeries can vary by more than 230% across major U.S. hospitals (Chadha & Llewellyn, 2019). Regarding the efforts to reduce costs and enhance patient care, growing discussions around identifying solutions that standardize diagnostic and surgical variances are some of the ways both manufacturers and healthcare providers can find

synergies that meet multiple stakeholders' needs. While facing the potential for lower margins, device manufacturers can take strategic advantage of this gap by claiming ownership of the modalities along the healthcare delivery journey. However, this may require new competencies (such as data analysis, digital surgery, or analytics).

Across medical specialties, a growing consensus indicates that innovation in both implantable devices and instrumentation can only go so far; the ways to develop a new orthopedic screw or interventional needle are limited. On the contrary, these new pieces of data-driven technology deliver value to physicians through information sharing or automated intervention. Surgical teams are forced to learn new techniques associated with robotic intervention or data processing, which differ from traditional medical approaches. While an orthopedic screw may not significantly vary between manufacturers, a robotic system capable of interpreting individual patient data and executing surgical procedures based on this data is a new method through which medical device companies can deliver both clinical and economic value. Unlike the current management model, these fundamental changes require an organizational approach different from delivering implants and instruments that surgical teams have been using for years. Companies that fail to recognize and integrate outcome-focused service integration into their value chain risk losing market share to competitors that take advantage of this shift in focus.

This research will focus on exploring these healthcare trends along with the fundamental premise that selling implantable devices requires a different organizational skillset and approach as compared to adding value via servicing robotics or systems to

collect and interpret data. Device manufacturers will require new structures, skillsets, and training techniques to meet the needs of customers and compete with other manufacturers looking for new ways to create value. While some companies are taking steps toward these new trends in technological innovation, device leaders should endeavor to balance the clinical needs for such innovative systems with fundamental business needs to continue selling and innovating their high-margin devices and instrumentation.

The first companies to successfully adopt robotic or AI systems are now showing growth with their implantable devices due to the new synergies with their corresponding surgical systems. For instance, in Q3 2019 Medtronic, the second quarter revenue of \$692 million increased by 5.5% as reported or 3.5% on an organic basis. When combined with the company's sales of enabling technology used in spine surgeries – including robotics, navigation, imaging, and powered surgical instruments that are recognized in their Brain Therapies division – global spine revenue and U.S. spine revenue both grew in the high-single digits on an organic basis (Medtronic 10-K, 2019). In short, the implant becomes less valuable as a growth driver, while value is created for the physician, patient, and hospital in the modality of the implant or instrument used in the procedure.

Other device manufacturers are beginning to recognize the need for patient-focused outcomes in the physician experience of using new technology to supplement the device. Siemens, for instance, has rebranded its healthcare business as “Siemens Healthineers,” with sales of over \$4 billion in 2017. By entering into strategic partnerships with hospitals through innovative service lines, including technology management and consulting, the leaders of the organization attributed the 19% margins to

the unique value-added aspect of their business (Kapadia et al., 2018). Through a partnership agreement with IBM, Siemens, which is traditionally known for its medical imaging expertise, will further venture into population health management to analyze and improve value-based data for hospital systems, a service business drastically different from selling capital imaging equipment.

The *Harvard Business Review* estimates that some form of smart technology will be used in as much as 90% of hospitals and replace as much as 80% of what doctors currently do, from diagnosis to surgical intervention (Longoni & Morewedge, 2019).

“To successfully collect and report meaningful, measurable outcomes data, medical device companies should invest in a digital strategy and technology infrastructure that allows them to clearly link data with the device, consistently define outcomes and increase transparency across healthcare stakeholders. For this to really work, the starting point should be the user experience and corresponding pain points rather than the device, so ‘user-back’ instead of ‘device-forward’ – a perspective that may be new to traditional players, but familiar to technology entrants.” (KPMG International Report, 2018, pp. 1–25)

2.3 Device Representative/Surgeon Relationships Today

Device sales representatives (“sales reps”) are generally accepted figures in the operating room during surgical procedures in varying capacities across specialties, typically preceding the surgeon and surgical staff to ensure all the needed equipment is available and ready. The representative’s responsibilities include ensuring that all the instruments and components are available for the procedure as well as preoperative setup

and verbal guidance throughout the surgery. An intimate knowledge of their implantable products, surgical techniques, and hospital systems is necessary to anticipate any mid-procedure changes or scheduling adjustments to ensure each procedure is carried out efficiently. From the standpoint of tangible deliverables, sales representatives deliver their value through reliability, preparedness, and expertise in their given product (O'Connor et al., 2016).

While the surgeon is the decision maker in the operating room, device representatives work hard to earn trust and maintain strong relationships with their customers to ensure continuity and establish a level of influence. Hospitals ultimately foot the bill for surgical implants, and surgeons generally have a strong say in which of these products will be used – up to 61% of the expense is spent on supplies considered “physician preference items” (Montgomery & Schneller, 2007). Furthermore, orthopedic surgeons have exhibited a tendency to use only one vendor for most of their implants and maintain brand loyalty over an extended period of time (Burns et al., 2009). They also tend to ally more closely with their device representative than the other hospital staff (Korenstein, 2010). For instance, one orthopedic surgeon claimed, “I use [the reps] because they give me good service...I think that the products are all fairly similar” (O'Conner et al., 2016).

The decisions influenced by both representatives and the industry also have implications within the Food and Drug Administration's (FDA) 510(k) approvals, which indicate that implantable devices ruled as “substantially equivalent” to current market products can be implanted without any clinical testing, allowing competing

manufacturers to avoid the significant delays and costs associated with pre-clinical testing and validation. As the discussion around computer-automated decision-making and surgical robotics becomes more prominent, these FDA-related equivalency factors become reliant on the industry to ensure the correct use of these new technologies.

Over time, the medical device industry has become increasingly cost competitive, although brand recognition and the surgeon–representative relationship remain two of the key drivers in the success of sales. Impactful innovation has become a challenge considering the commoditized nature of many implantable devices, allowing for lower-cost alternatives to gain a share through lower prices and innovative business models. The ongoing shift toward cost-conscious hospitals and economic decision-making are restraining the manufacturers’ ability to bring newer or more premium products into hospitals. Considering the commoditized nature of the bulk of these implantable devices, hospitals are willing to settle on fewer vendors and cost-conscious purchasing decisions for a combination of quality, service, and innovation. The device space will continue to see competitors emerge with cost-competitive pricing, forcing hospitals to view most devices in more of a commoditized fashion, with numerous products and few differentiating features.

2.4 Hypothesis: The Shift from Products to Services

The research assumptions are based on both my personal experience as well as trending economic data on growth in the med tech sector. In conjunction with shifts in purchasing decisions and a clear clinical need to further standardize medicine in a more predictable fashion, I have framed this research with the understanding that device

manufacturers will inherently need to reprioritize multiple segments of their business to better meet both clinical and financial needs. The most important assumption is the belief that the modality in which implants are delivered will ultimately become more significant than the implants themselves; recommendations will be made based on this. The new service focus established by med tech companies through complex capital equipment will ultimately become the new value driver for daily interactions with physicians and administrations.

Additional assumptions are seen through the lens of the specific need for management innovation within the industry from both structural and cultural standpoints. While there have been tremendous medical advancements, the industry culture was formed at a time when iterative improvements to both instruments and devices were the markers of success. The industry veterans or companies built on mechanical engineering may face challenges in accepting the new opportunities presented with the shift to service and digitally driven technological demands. The assumption that the industry's role in healthcare will have to be revamped to fit these suggested service models may not be prioritized by many of the current market players.

This research topic is specific to the shift from product sales to digital servicing, but I also hope to make this reflection a clear roadmap of how medical device leaders can contextualize the complexities around reprioritizing strategic approaches to any new value-added activity. In many instances, particularly due to an established culture and the resulting complacency, the concept of "device as a service" may not be seen as a strategy to consider. My assumption is based on my thesis that the medical device industry will be

driven by those companies that are able to deliver value in new ways that go beyond merely manufacturing implants.

Finally, the assumption that med tech will change the industry as a whole is the reason for this paper. I believe the future role of the physician will fit in somewhere between data collection and the interpretation of the patient's diagnosis, where surgical intervention will be systemized and scaled across robotics and imaging to deliver consistent and predictable results. Thus, the variability in diagnoses and surgical skillsets will be significantly minimized.

“The industry itself thinks very linearly. These traditional models for engaging with customers and marketing products creates hurdles and mental blocks. As digital surgery becomes more impactful, we as both individuals as well as organizations need to develop more into sources of value and information to become true trusted advisors. Healthcare is traditionally a very conservative industry and you can see very clearly how manufacturers reflect that same tone. Current organizational models simply haven't evolved to that point effectively just yet.” – Director of Growth, Med Tech (Interview, October 2020)

3. Personal Background and Context

I've developed the phrase "med device as a service" to best describe my personal experience as well as beliefs regarding the ongoing changes in the medical device industry. I used this experience as a catalyst on my journey through the University of Pennsylvania, with two clear goals; first, to build on the educational framework of organizational psychology that I have been exposed to in my professional life, and second, to develop myself into both a divergent thinker and leader in the field of med tech. The idea that the medical device industry will undergo a significant overhaul due to the value created by new robotic and AI systems is an extremely divergent one because of the industry's current culture and approach to systems thinking. While my experience has helped cement my conviction about these ideas, the industry as a whole is slow to adapt.

My journey began on the clinical sales team of an early-stage robotics company whose specialty was spine surgery. The company and its culture had been built and developed by leaders who had prior experience working with the world's most successful surgical robotics company, Intuitive Surgical, whose da Vinci robot is used for a multitude of general surgery procedures. The company generates revenue through three primary buckets: selling robotic systems to hospitals, service contracts for maintenance, and a disposable cost associated with every procedure conducted. With more of a service-focused sales model as compared to most device companies, Intuitive's sales representatives spend time in every procedure, not selling products but aiding the surgeons and staff by ensuring that the procedure goes well. Ultimately, if the system is

being used efficiently to the surgeon's approval, it will be used more; this may promote more sales. Other operating room sales representatives add value by selling and delivering either instruments or implants for the physicians so that the surgical staff has the necessary tools for the operation. While the timeline of these devices is on the shoulder of the representative, the operation, decision-making, and ultimate outcome are still up to the physicians and their staff.

My personal experiences in the operating room with spinal robotic systems have been with both orthopedic and neurosurgical spine physicians. The spine is an extremely competitive area of orthopedics and neurosurgery due to the limited variation of spine implants and the high number of competitors in the field. For the most part, representatives rely on the strength of their relationships with physicians to earn their trust and continue the business arrangement; it is common for physicians to remain loyal to one or two companies. Because of this dynamic, it becomes challenging to earn a surgeon's business or convince them to switch from one company to another, barring significant changes to the innovative or competitive landscape. Despite this, I had the opportunity to gain access to many surgeons because of the new robot, though not without the setbacks inherent in early technological adoption. My job involved planning the spinal procedure with the surgeon, defining the location and sizing of the implants, and directing the robot while the surgeon performed the operation. For this, immense trust and communication were absolutely necessary, to the point where the robot was unable to function without the representative being in the room.

I was granted access to some of the most prestigious facilities and physicians in the world, which was unique for the industry. It sometimes felt as though the added value and reliability our representatives were able to deliver in these surgeries went far beyond those provided by traditional implant representatives. Simply put, we were building a business around our service, similar to what Intuitive Surgical had done in general surgery. While the implant representatives struggled over the pricing and differentiation of their commoditized implants, robotic surgeries were making procedures faster, more predictable, and prone to less revisions. The value-add of a robotic representative was simply a newly created space in the operating room. As varying robotic systems, data collection devices, and AI computers become more integrated into the standard of care, it is clear to me that the commoditization of normal medical devices will be driven by competing device companies' capacity to add value through outcome-driven technology in combination with service-based representation.

Several years later, I have worked for both the largest medical device company in the world and the largest healthcare company in the world; in both, I worked in orthopedic and neurosurgical imaging and robotics. I have built relationships with med tech leaders, ranging from physicians to creators of other technology-driven systems, all over the world; thus, I have gained a highly diversified perspective. While variability certainly exists among different specialties and the technology used, I continue to maintain a strong conviction in my thesis that the future of healthcare will be driven by med tech services as a means to promote implant growth and add value to surgical outcomes. Both my academic and professional experiences have shown me that

generally, the leadership culture of medical device companies will need to significantly alter its current business framework as the focus and expertise remain on developing and selling products. I often pose the following statement: if we are developing devices that do not contribute to improving an outcome, we need to innovate how we do business. Robotics, AI, and data-driven solutions are all worth pursuing.

3.1 Observation of the Experience

Having stepped out of my role in the operating room, part of my experiential analysis is based on objective reflections concerning where the business had started as compared to today's clinical standards. Part of this journey led me to experience multiple innovative iterations, new product launches, a strategic acquisition, and the implementation of the technology in a large organization with a strategic intent. Throughout this experience, the clinical expectations of hospital stakeholders had significantly shifted from the early adopter phase and into an accelerated commercial user base, which had high expectations and little room for error. Both the continued adoption and clinical success of our highly technical robotic system were doubtlessly driven by the expertise the representatives displayed in every procedure and the level of trust they had built with their physician customers. Considering the aggressive scaling efforts, the technology itself would likely have experienced failure without the level of service and support that accompanied each clinical procedure.

Depending on the complexity of the device or equipment used in a procedure, hospitals and manufacturers can evaluate both sides of the equation on a case-by-case basis by looking at the surgeon's reliance on the expert representative. Some industry

leaders may look at such highly technical equipment and suggest that more user-friendly solutions should be made available in an effort to lessen the learning curve for the physicians and staff, facilitating a more autonomous experience. On the other hand, because of the impactful clinical outcomes driven by the use of robotic technology, our company was able to develop a reliance on the representatives for every procedure, creating a significant competitive advantage that others could not replicate. The robotic representatives were able to gain access to surgeons and build trust with them in a much shorter period of time than usual due to the representatives' high level of competence and expertise.

Another salient observation formed from my experience with large, multinational medical device companies is concerned with the internal culture and emphasis on building, scaling, and further developing such digital technologies from the standpoint of customer interaction. Management tends to emphasize the technology's clinical efficacy rather than promote reliance on the representatives to ensure successful outcomes. Furthermore, due to the described disconnect, I have seen a significant variation in physician and representative training, which leads to the conclusion that we may be experiencing a fundamental misunderstanding of what drives the success (or failure) of these digital programs. Often, I have observed just the opposite – poor clinical outcomes due to a poor or inexperienced representative. Regardless, the outcome of the procedure is heavily driven by the competence of the representative, particularly for new adopters of the technology.

“Successful companies have both strong capital salespeople and are backed with a strong clinical team. You can’t be fully product-focused or fully service-focused, there has to be a blend. The best med tech startups have divergent growth strategies – some product and some service – a sliding scale for every product depending on the need. Financially you have to be able to scale the service and product, the real focus needs to be very front-end heavy on people and allowing those individuals to be challenged enough to fully engage.” – Vice President, Surgical Systems (Interview, October 2020)

The larger players in the field are clearly recognizing the need for digital solutions in their business portfolios, but I question whether these companies have a clear idea of what it takes to become successful in digit healthcare. In my experience, company culture and inefficient value chains comprise the dominant train of thought, without a true understanding of how these digital systems will fit into the healthcare ecosystem. Rather than creating organizational strengths around real-time service requirements where true value is created, the digital solutions are simply being added as a new tool within the product portfolio for salespeople and marketers to push as the “next best thing.”

3.2 Who Are the Experts?

Human beings generally have favorable biases toward their own judgements and abilities along with a strong propensity for recognizing a lack of expertise (Burson et al., 2005). Simply put, sometimes, “we don’t know what we don’t know.” We are often guilty of assuming experts in one field are knowledgeable in another, confusing general intelligence with expertise in a specific field, or even confusing factual knowledge with superior insight. Logically, some have made the argument that only true subject matter

experts can successfully recognize other experts in the same field. Therefore, we have mechanisms such as peer-reviewed literature to formulate a consensus among these groups. Because of the shift into a service-oriented digital environment, which is not traditional to medical device manufacturers, we can surmise that currently, device leaders “don’t know what they don’t know” due to lack of experience and expertise in the growing med tech space.

To date, we have seen several companies and relative company acquisitions that have successfully built and incorporated digital capital equipment into their business portfolios. Whether looking at these models as opportunities to learn or simply framing their current experience to develop a more open mindset of acknowledging the unknown, device leaders should take the time to recognize these blind spots to seek growth and expertise.

3.3 Industry Thesis

The thesis of this research is built on the premise that in order to remain competitive, device manufacturers will need to fundamentally shift their current focus from solely selling implants and instruments toward delivering value-added service through robotics, imaging, telemedicine, or other forms of interconnected technology as a means to deliver implants in a more customized way. The medical device industry is in need of more patient-focused solutions, where new technology poses an opportunity for creating more customized and predictable outcomes. While selling medical devices will always remain the ultimate goal of manufacturers, the emerging demand for new systems focused on automation and data will require a different commercial skillset as well as

management innovation. As demands change across healthcare, the culture and focus of device manufacturers should change as well; these have traditionally operated primarily in a capacity where instruments and hardware were the basis of growth and success.

To fully succeed in this new environment, medical device manufacturers will need to expand their role; rather than limit their presence to the operating room at the point of purchase, they should be present throughout the patient journey, from diagnosis to recovery. Direct customer-facing interactions will need to evolve in a manner that provides real-time service at every stage of the user's experience. Real-time response and troubleshooting require interaction with the technology for both pre-clinical and ongoing training so that the stakeholders can ensure the safe and efficient use of the technology.

The *Harvard Business Review* conducted a survey of 270 corporate leaders in strategy, innovation, and R&D roles in large companies in an effort to gauge the most common obstacles to innovation. To highlight the additional burdens faced by medical device leaders outside of shifting market needs, the results of this survey also layered in some of the less overt challenges that larger companies faced internally. The top three challenges were political battles and lack of alignment, cultural issues, and the inability to act on signals crucial to the future of the business (Kirsner, 2018). As we combine these results with the lens of the medical device space and healthcare, the pressure on leaders to adjust business trajectories and build new competencies becomes extremely challenging for all stakeholders, from the providers to the manufacturers themselves.

3.4 Creating New Layers of Value – Med Tech Representatives

A new layer of value is slowly being created in the med tech space, where the most important company representative in the operating room is able to provide real-time consultation, digital expertise, and consistent workflow management of all digital technology to aid the physician and ensure smooth and efficient outcomes. Nowadays, medical device companies' representation in operating rooms is very specific to the nature of each individual company's business needs. Most device manufacturers' representatives are salespeople with the responsibility of providing the required instrumentation and reliable product expertise throughout the procedure when needed. Commoditized pricing pressures place a high reliance on the relationship between the physician and the representative to maintain business.

Emerging software and robotic companies in the medical device space provide slightly different clinical representation, directly reflected in their respective business goals. For instance, Intuitive Surgical has the very specific need to ensure good user experience and system utilization. With no tie to an implantable device, Intuitive's representatives act as real-time experts to ensure the system is being used appropriately and effectively, which, in turn, encourages continued use. A slightly different example involves how some med tech players – such as Brainlab, in Munich, Germany – consider themselves to be software-based companies focused on imaging and data. Their capital equipment is generally comprised of imaging and navigation systems in addition to a highly diversified network of cloud-based computing options for hospitals. With no relationship to a specific implantable device, their software-based business model

requires clinical representation for troubleshooting scenarios and little emphasis on additional sales needs.

The current role of sales representatives remains consistent across specialties, with some variance depending on the procedure, competition within the specialty, and level of complexity involved in the setup and use of the instruments and devices. Regardless of whether they are a direct device salesperson or software-based clinical specialist, the best representatives are known for being highly reliable and knowledgeable and sometimes play a role in consulting on their respective technologies beyond the scope of their service.

The proposed thesis posits that implant companies will need to functionally and culturally shift to the service-oriented business approach to ensure the continued growth of their implantable business. The oft-touted marketing mantra, “service builds value,” will hold true as device manufacturers adopt new forms of digital technology to further enhance and differentiate their outcome-focused solutions. The reliance on digital expertise helps build and develop relationships between the company and hospital stakeholders in an unprecedented manner. The companies with both service-oriented and patient-focused sales force and infrastructure will have an opportunity to differentiate and create unique value beyond the core business of implant sales. As Theodore Levitt said, “Customers attach value to a product in proportion to its perceived ability to help solve their problems or meet their needs. All else is derivative” (*Harvard Business Review*, 1980).

3.5 The Business Moat Opportunity

By providing quality service and integrated systems of hardware and software and by bundling multiple capital expenditures into connected solutions, medical device companies have the opportunity to create an economic “moat” around their business. Currently, manufacturers fight for competitive advantage in a variety of ways but ultimately fall short of sustained long-term success. The differentiator of a moat is the sustainability of the business due to high switching costs, product stickiness, and intangible assets such as relationships or system familiarity. Strong economic moats create environments where competitors have a difficult time persuading customers to switch to a rival offering. Because of the introduction of big data and machine learning in healthcare, the access and use of such information provide just one example of a starting point for companies with regard to engaging with customers on a more integrated level.

3.5.1 High Switching Costs

The switching costs associated with digital health are examined from both economic and clinical standpoints; the main drivers are price, risk, and inconvenience. Major capital purchases or network-wide software integration are not frequent capital expenditures made annually, as budgets typically have built-in room for upgrades or additions over the depreciated lifespan of the system. Once systems are sold and integrated, the opportunity for a competing system to replace the newly acquired technology becomes narrow. Clinically, as hospital staff and physicians are trained and go through the learning curve of adopting new systems and, in some cases, completely new ways of treating patients, the comfort and familiarity with the new software or

capital equipment become ingrained in their daily operations. While the medical device industry is known for having some barriers in this realm with regard to certain implantable devices or instruments, adopting fully integrated robotic systems or AI requires completely new expertise and training.

3.5.2 Stickiness and the Network Effect

Businesses create network effects when users gain more value as the users, data, and streams of technology in the ecosystem increase in number. As companies build more robust pipelines of digital technology, the interconnected nature of each piece of hardware and software builds a significant barrier for competing devices or systems. For example, hospital system networks tied to data management may feed specific patient information to a surgeon who, in turn, is able to determine the most appropriate treatment option. The provided information generates custom patient implants to be used with instrumentation that may only be integrated into a specific robotic system to aid in the procedure. This scenario can continue in any direction depending on the interconnectivity of the company's digital systems, but the main idea is that a robust value chain helps drive efficiency and cost control in the hospital setting.

3.5.3 Intangible Assets

The most important aspect of the digital shift will be the relationships with the industry, both through daily interactions and the brand. The emergence of new modes of treatment and interpretation create a strong gap in healthcare as physicians and hospital systems alike strive to adopt new ways of providing care. Whether the sales representative in the operating room troubleshooting a piece of capital equipment or data

collection centers receiving orders of custom sterile implants, the reliance and relationships on the individual level that support and service new technologies help justify participation and fill the gap as stakeholders go through a generational learning curve. The brands associated with these services and new technologies have the opportunity to create or reinvent an image based on the level of service provided at the point of care and throughout the treatment life cycle. Additionally, med tech presents a strong opportunity for businesses to build a patent portfolio around their respective technologies, which can serve as a strong economic moat.

As robots are sold to hospitals or new machine-learning software is built into the facility, the company selling the package has earned the right to interact with the facility or “be in the room.” Meanwhile, the opportunity for a competitive company to integrate their own systems sometimes becomes blocked or “priced out” of future business. The stronger integration a company has across its technology portfolio, the greater the opportunity to utilize cross-functional synergies in an effort to drive high-margin implants despite the potential for lower costs. In an environment where hospital systems continue to look for ways to limit vendors, the device companies that can provide the most value-add through technology are beginning to earn more business opportunities and ways to block out the competition.

4. Servitization in Medical Devices

“Are you buying the product, the people, or the problem? If you don’t want the people don’t expect to solve the problem.” – Vice President, Surgical Synergies
(Interview, November 2020)

4.1 As a Competitive Advantage

Servitization can be defined as the complex process by which a company shifts or expands from selling products or basic services to delivering customized solutions (Kohtamäki et al., 2020). For any organization, initiating the shift to servitization requires a reshaping of the value chain; for manufacturers, this is traditionally rooted in three main paradigms: (a) vertical integrations of production and delivery to standardize inputs and outputs, (b) superior product development through R&D efforts, and (c) generation of a sustainable market position to strengthen the economies of scale (Bustinza et al., 2015).

As the research indicates, medical device manufacturers have an opportunity to increase differentiation, customer satisfaction, and build “business moats” in an effort to achieve superior competitive advantages and performance through service-driven activities and organizational focus. The proposed efforts to shift to service require manufacturers to create and capture value throughout the life cycle of both the connected products and across the interconnected organizational system as a whole.

Porter and Ketels (2003) point out the opportunity to generate a sustainable competitive advantage by allowing firms to avoid competing on product cost and innovation and by facilitating greater differentiation and increased customer satisfaction. The medical device sales process, largely driven by price and relationships, offers an

increased emphasis on the service opportunity as physicians and hospital systems are already accustomed to daily interactions with the industry and its representatives, who are often relied on as real-time aids during procedures. Furthermore, the growing need for manufacturers to focus on patient- and outcome-driven solutions presents an opportunity for insurance payers to play a greater role in which technologies are best suited to drive the desired results. A variety of studies show results indicating consistent, though nonlinear, positive relationships between service implementation and company performance and long-term profitability, specifically through differentiation and customer satisfaction as outlined earlier (Baines et al., 2009).

In many instances, smaller companies' ability to remain agile while larger companies move slowly is incredibly impactful in the medical device field. Discussing the topic of differentiation and customer satisfaction with a marketer from a larger device manufacturer, an additional layer of insight was obtained, which exhibits growing significance (Figure 2): "Time to market is the new differentiation. Customer satisfaction will always remain an important aspect of our business. We're learning that in order to be successful, we need to be faster to market and make strategic partnerships in an effort to increase our speed. Robotics, for example, will be largely similar pieces of equipment in the future. How do we get to market first and begin collecting the data that will help drive our business?" (Interview, September 2020)

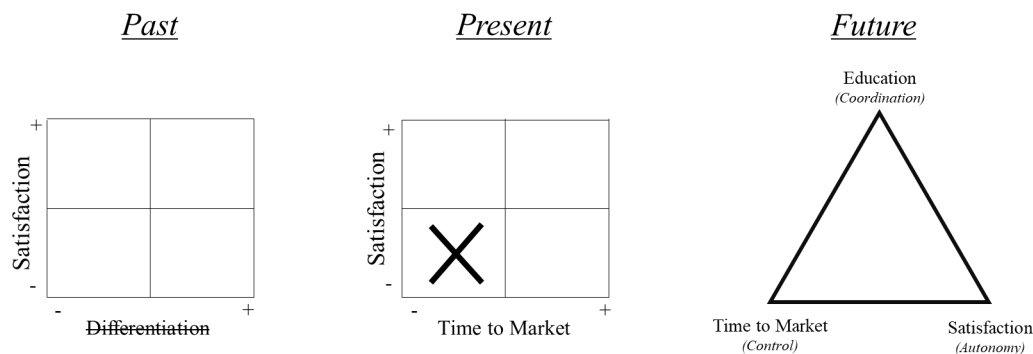


Figure 2. New Strategic Lens

To further outline the economic advantages of service as a competitive advantage, the analysis conducted by Bustinza et al. (2015, pp. 53–59) specifically examined medical device manufacturers to better understand the impact of offering services in addition to traditional products, intending to “better understand the extent to which companies are able to create value by evolving their service strategies into an outcome-based model.”

The results suggest a growing belief in advanced service offerings being the highest revenue driver across the service continuum in addition to a projected increase in revenue across all service offerings within the value chain; there is an understanding that the newly developed capabilities will be the basis for sustained competitive advantage. Interestingly, specific to medical device competitive advantages, there is little evidence to suggest differentiation specifically through service offerings; rather, competitive advantage is likely to be achieved through customer satisfaction, which, in turn, strongly aligns with the need for improved efficiency and patient outcomes (Baines et al., 2009).

Annarelli et al. (2016) introduced the concept of product service systems (PSS) as a model for marketing organizations around combined product and services, often as a result of a shift into servitization through added service to sell products or complete a change in the payment structure of the product. Relative to the content of this research, the most prominent PSS-related shift was outlined by Tukker (2004), who pointed to a results-oriented business servitization model that could potentially exhibit growing promise in healthcare. Schmidt (2016) built on this research to show the increasing importance of PSS in accepting technological innovations but without potential pitfalls along the way. The continued evidence of this in both theory and practice, as outlined by the brief summary of available literature, emphasizes the positive influence the service aspect of medical devices can have on competitive advantage in an increasingly commoditized healthcare industry.

4.2 Customer Perceived Value

The works of Baines et al. (2009) and Raja et al. (2013) conclude that prior literature indicates a reliance on service integration as a “conscious and explicit” strategy for data-driven competitive advantage. Enforcing a service offering to enhance customer value creates a new customer experience, which inherently becomes reliant on the interaction between the customer and the business on a level beyond the use of any single product. The service delivery system gives the company an opportunity to build stronger and more interactive experiences with customers and also facilitates an atmosphere where the experience can be more closely evaluated, thus creating stronger competencies for the organization. Depending on the technology utilized, these medical device companies will

have the chance to accelerate these learnings and create custom solutions, where customer satisfaction and patient outcome can both rapidly improve in shorter periods of time.

“The conversations that my team is having with surgeons is very different than the one’s our implant team has. It’s much less of a relationship and more of a technical deep-dive on exactly what the surgeon wants to achieve. The surgeons respond very well to the coaching and direction we give them, and, in a way, we become a member of their team. They see value in the service we provide because it ultimately makes their lives much easier.” – National Robotics Manager (Interview, September 2020)

As value improves with increased interaction and customized solutions, manufacturers also run risks of bad user experiences or the emotional implications that accompany communication and the reliability of poor interactions with the service aspect of the business. Despite improvements in technology, failure is an unavoidable aspect of any piece of medical equipment throughout its life cycle; it can be caused by user error, which only places further emphasis on an organization’s ability to engage with the customer in an appropriate fashion. Zeelenberg and Pieters (2004) emphasized the negative emotions experienced by customers, which subsequently drive behaviors that may impact the service company, such as negative word of mouth or reluctance to maintain a business relationship.

“In my experience with robotics, the technology is only as good as the coach or person running the system with the surgeon. In the future these people may go away and we may see systems that don’t require a rep’s assistance. In my opinion, the expertise and

experience of the rep is the key to any program being successful and our hospitals adopting our systems. The biggest challenge is finding the experts who can facilitate these procedures and the time it takes to build experience. It's been a challenge to scale.”
– Robotics Clinical Manager (Interview, September 2020)

The influence of emotions on consumer behavior has been shown to stem directly from the specific emotional lens of the customer as opposed to dissatisfaction with the experience itself (Walker, 2018). As we investigate the growing need for a service focus in med tech, note the higher price of poor performance due to the nature of the work. While governing bodies such as the Food and Drug Administration (FDA) enforce adherence to strict medical standards, the possibility of poor user experience remains strong and costly. Vázquez-Casielles et al. (2007) showed that when consumers experience service failure, they tend to immediately look for causation, and attributing a cause can provide a perspective for assessing customer reactions to a failed service. When dealing with poor training or user errors, experience has shown that healthcare providers in highly stressful situations can be quick to blame the service or technology, particularly when the payers and reputation are on the line. Here, the challenge lies in diagnosing the problem and responding to the service failure; if correctly positioned in the value chain, these can be mitigated long before the problem occurs.

“The training team sets the expectations for the surgeons, but the reps have to continue to reinforce those explications throughout the learning curve. These technologies are new techniques for surgeons to utilize and should be coached strictly. If

they aren't having a good experience with our capital systems, why would they use our implants?" – Digital Technologies Regional Manager (Interview, October 2020)

4.3 Market Positioning

“Digital healthcare is a much different mindset for our organization.” – Vice President, Digital Strategy (Interview, November 2020)

Compared to other industries, healthcare occupies a unique position, where much of the value chain is delivered downstream in customer-facing scenarios when aspects of the organization, such as a service branch, begin to amplify those downstream experiences. From the research referenced earlier, it can be deduced that different servitization strategies lead to different outcomes depending on an organization's position in the value chain, where the concept of differentiation is not directly linked to performance in downstream industries such as medical devices; rather, customer satisfaction becomes the leading indicator of a successful strategy (Bains et al., 2015). Because the medical device industry has such a variety of specialties and niche products, the concept of shifting to a service focus can allow manufacturers to continue to innovate and develop at a comfortable pace while allowing the commercial branches of the organization to innovate based on how the customers perceive them. Once systems thinking is integrated into the strategy, new product development can become a feedback loop directly tied into the customer experience with the service organization, where firms have the opportunity to further customize their offerings to capitalize specifically on customer satisfaction.

Downstream customer satisfaction is identified as the key driver for the successful prioritization of service models. The biggest organizational challenge in the digital shift lies in the current downstream sales force structures related to in-house sales representation versus outside distributor-based representation. Choosing between in-house or external sales partnerships is a key strategic decision for device manufacturers for a variety of reasons, particularly in an industry where sales force relationships and an open R&D feedback loop are critical. Often, a device manufacturer or smaller firm can surpass the complexity of developing a commercial organization by partnering with external distributors that have existing links to customers; however, this results in the manufacturer sacrificing the opportunity to directly develop new relationships. The lack of direct contact with the customers can potentially impact upstream product development.

The analysis of a firm's changing downstream market opportunity concludes that an external relationship with a partnering sales organization remains the most valuable and relevant when the two firms continue working together in the same product market, such as orthopedic implants. This subsequently diminishes when the manufacturer enters a new downstream opportunity. The analysis of 545 U.S. medical device manufacturers considers "new markets" to also include innovations such as digital health, where firms have traditionally had more success with sales in-house. However, the research also creates room for opportunities as innovation grows and develops toward the manufacturer's core downstream focus.

Over time, separate and distinct firms can build trust, develop shared norms that dictate acceptable behavior and facilitate coordination, and create routines that enable efficient actions. These features, collectively labeled “relational capital,” facilitate the development and transfer of relationship-specific knowledge across firm boundaries (Poppo & Zenger, 2002) and therefore underpin effective relational governance (Elfenbein & Zenger, 2013; Zaheer & Venkatraman, 1995). Based on past experiences and expectations of continued future exchange, partnering firms make investments in developing knowledge and other assets specific to their relationship.

The focus on market positioning from a downstream perspective certainly makes a tremendous impact in the medical device field but not without the need to focus on building companies more closely related to those that have had success in related software-based industries, such as the enterprise software (SAAS). Med tech organizations should first look internally into their hiring processes and cultural practices in order to correctly position efforts to shift priorities to new potential revenue streams and prepare for future market adjustments. The interviewed subject matter experts are aligned in terms of general cultural and business practices, which may need to evolve as the market becomes more digitally focused.

“Big companies struggle the most with execution when it comes to digital innovations. It’s hard for us to innovate because we don’t know what we don’t know. Smaller digital med tech companies are always future-focused and aspirational, rarely living in the moment. It allows them to move quickly in a generally slower, more conservative healthcare market. Where bigger companies can succeed is with moderate

innovation because they have brand recognition and won't be able to outpace the market. The cultural becomes a challenge when you don't have a true visionary or digital subject matter expert in a leadership position driving the ship.” – Global Commercial Development Director, Robotics (Interview, August 2020)

4.4 Training and Knowledge Development

“Small companies need access; large companies need the skillset. That's just where we are. Our training, the mental state of our field sales force, and the effort they are required to put into learning the complexities of new technology – Is this really doable considering who we are? – Commercial Leader, Orthopedic Manufacturer (Interview, September 2020)

As traditional medical device companies start focusing on service-driven initiatives, new competencies and norms inherently become a critical priority for successfully implementing the necessary organizational changes. While countless research projects demonstrate the importance of specialized knowledge for any successful business or organization, the performances of product and service organizations are impacted very differently depending on turbulent market conditions. Regarding the theoretical groundwork for a “knowledge-based” view of competitive advantage, Schroeder et al. (2002) suggested that knowledge is the key strategic resource, which leads to superior performance, for any organization. The dynamic tensions between knowledge development and the culture of competitiveness as the two key aspects of the knowledge-based view are the drivers that Hult et al. (2007) outlined as the framework

for delivering high levels of performance outcome. As a measurement scale, performance is specifically the evaluation of profit, cost, and growth.

For traditional manufacturing businesses, knowledge management is concerned with making the right knowledge available at the right time (Holsapple et al., 2015). Using knowledge as a dynamic and evolving capability involves processes such as knowledge acquisition, sharing, application, and creation (Lichtenthaler & Lichtenthaler, 2009), which theoretically extends across all businesses and organizations. Looking specifically at the differences between service and product companies, Hult's framework further differentiates between the concepts of knowledge development and competitive cultures and where performance is most impacted.

The research evaluation looks at how these dynamics affect firms during market turbulence, defined here as market disruption through digital innovation. While knowledge development is shown to be linked to superior performance, the reasons are indicated to be due to cumulative experiences and manufacturing performance, where the ability to value, assimilate, and apply knowledge reflects operational know-how and improved results (Pisnao, 1994; Rosenzweig & Roth, 2004). The insights, experience, and skills gathered by a firm's routines and beliefs help contribute to bringing new ideas and opportunities for improving firm performance; however, these insights are specific to product manufactures and fail to account for the assumed shift to service required by medical device manufacturers.

When new markets emerge and demand a shift to service-based models, experience and applied knowledge become a scarce resource for industries that require

new competencies with undefined expectations. Past knowledge may prove to be less useful in newer environments where organizational memory may actually lead to inferior performance (Macau et al., 2016). Because service is an intangible good, knowledge becomes the main input as opposed to manufacturing, where tangible goods and the required materials are the key drivers. Therefore, in the service business, where customer involvement and customization are critical factors of success, Kiano et al. (2010) suggested that human capital is a more important factor as compared to manufactures.

“The biggest lesson learned about commercializing new medical technologies is simple: Sell first and focus on the relationship second. Innovative technology has proven to supersede the relationship, the widgets no longer matter. We’ve had surgeons willing to sever long-standing relationships in favor of the new technology, so credibility is quickly more important than relationships which traditionally drive our industry forward. As a company we’re trying to get away from the knife-fight and change the way our customers make decisions, but it takes time to change the current trajectory our customers have been on for their whole careers.” – Technology Leader (Interview, September 2020)

Service shifts will require new norms and beliefs that may challenge the current thinking of many manufacturers, who rely heavily on knowledge development to improve business processes. The analysis discussed the need for open competitiveness in conjunction with continued knowledge development to avoid being hindered by prior belief systems. Because service businesses are more vulnerable to heterogeneity, variable and non-standard methods may need to become part of the initial learnings as competencies related to customer and technology interactions are developed. New

expectations, norms, and standards will need time to develop and fit into the existing value chains, from both commercial and product development standpoints, despite the high expectations from customers and regulatory bodies.

“It’s all about breaking the precedent; we’ve been extremely disruptive from both professional and commercial educational standpoints and it’s allowed us to gain a significant competitive advantage because we focused our efforts on the people and the business as opposed to just the product. We’ve played a significant role in the commercial sales organization and understand that the technology will do its job. It becomes the clinical or salesperson’s competence that becomes the limiting factor.” – Training Director, Digital (Interview, November 2020)

4.5 Management Implications

“Losing business will not bend on our long-term vision.” – Commercial Leader, Orthopedic Manufacturer (Interview, September 2020)

The referenced literature has established that knowledge development will vary for medical device manufacturers that are shifting their focus toward the service business, where knowledge and information are the main intangible input and output as opposed to traditional product manufacturers, who rely on tangible materials and design. These differences will drive a change in how knowledge is managed and incorporated into the organizational processes to achieve competitive advantages and successful technological implementation. Med tech businesses will have to ask several questions outlined by Andreeva and Kianto (2014) regarding the referenced differences in knowledge

management between product and service businesses and how to implement best practices.

The distinctive differences between products and services are largely dependent on the human capital aspect of the organization that is the primary point of emphasis. The process of knowledge sharing needs to become an efficient driver for organizational, individual, and customer behaviors to help drive strategic decisions and build competitiveness within the newly developed aspects of med tech. Knowledge management focuses on an organization's ability to consciously develop activities and practices around continued knowledge processes in the development phase of any new project. Hansen et al. (1999) suggested that a knowledge management process must have a direct link to organizational strategy, whereas a service-based business mostly relies on human capital to excel. Furthermore, around the suggested links to strategy, they built a framework for the quadrants of focus: organizational design, organizational culture, human resource practices, and management of information and communication technology.

A majority of the organizational literature focuses on culture as the key ingredient for knowledge management, with direct links to the creation and sharing of information (Davenport & Prusak, 1998). History, expectations, and unwritten rules are some of the most common themes when defining a culture, where many of these norms significantly influence communication behaviors. Many of the largest medical device companies at present can be considered very different from the newer and more innovative players who are developing the technologies of the future; innovation, recruiting, and expertise

significantly vary among the new entrants. When some of these companies are acquired as strategic initiatives by larger manufacturers, their cultures clash in a variety of ways.

Beyond the culture, med tech manufacturers also have to look at the other strategic initiatives around servitization, including design, human resources, and information technology, which may vary from the current industry standards. In a service environment where human capital is the main strategic advantage, programs to support knowledge growth and sharing garner a larger focus for each of the three suggested areas of prioritization. Human resourcing and new means of information technology may present opportunities for creating practices around initiatives to help build cross-functional support for servitization as well as for creating programs to build and retain talent, where a reasonable hypothesis would suggest a clear link to success in service businesses. Particularly regarding organizational design, the same process would be needed to ensure a connection to the strategy around service. New structures may present an opportunity to be taken advantage of, which would potentially lend a different perspective to traditional cross-functional structures.

“The key for our brand has to be the unification of our vision. We’re already seeing technology getting to the point where physicians can no longer afford to remain in their current state of practice. We still have a disconnect between our sales force and our strategic vision because the long-term goal for the technology doesn’t necessary move at the same speed as their quarter over quarter initiatives. The reason we can stomach slower growth and development is because these initiatives are being driven at the executive level with the expectation that short-term sacrifice will lead to a longer-term

success. Mid-level management doesn't have to continually sell the idea which gives us all the ability to focus on development and competence." – Commercial Leader, Orthopedic Manufacturer (Interview, September 2020)

5. Geometric Thinking

“Organizations need solutions, not suggestions. Too many suggestions can lead to paralysis by analysis.” – Med Tech Executive (Interview, September 2020)

Reverting back to the fundamental purpose of this research, I seek to exemplify how organizations can frame and simplify strategic decision-making in a manner that becomes customizable and easily digestible across all cross-functions within the organization. While the complexities of such a shift often become a critical challenge for the management, simple frameworks can be shaped to avoid focusing on the content of the problem and instead understand the patterns in the underlying situation. By creating a visual aesthetic of organizational design, we have the ability to more clearly articulate the reasoning behind our decision-making.

Robert Keidel has significantly influenced the simplified geometric approach that will be used to outline and frame the complex problems presented within this thesis. Keidel (2005) focused on expanding traditional mental models of limited strategic decision-making to reframe them into a combination of three weighted principals: control, autonomy, and collaboration. Keidel argued that human organization reflects cognitive organization.

Using insights from Margret Wheathley’s *Leadership and the New Science*, Keidel’s triadic framework is grounded in the idea that similar to nature, organizations are combinations of relationships but with an added layer of intentional design to create a purposeful specification for those relationships. The triadic concept comes to fruition when we break down how humans interact with one another; relationships can be

separate and autonomous with minimal contact – for instance, hierarchical in a boss–subordinate arrangement or collaborative between the two parties. The design problem the framework aims to solve is how to best blend these interactions, which are inherently at odds with one another.

Triangular design persists as a naturally constant pattern that allows organizations to balance and continually rebalance organizational structures across multiple functions. This mostly requires simultaneous tradeoffs between autonomy, control, and cooperation. By paying closer attention to thinking styles and patterns rather than the content, organizations can more clearly define and prioritize the focus of their strategies. The suggested framework therefore allows for a common language to help conceptualize an improved way to perceive, think, and communicate strategic initiatives for change.

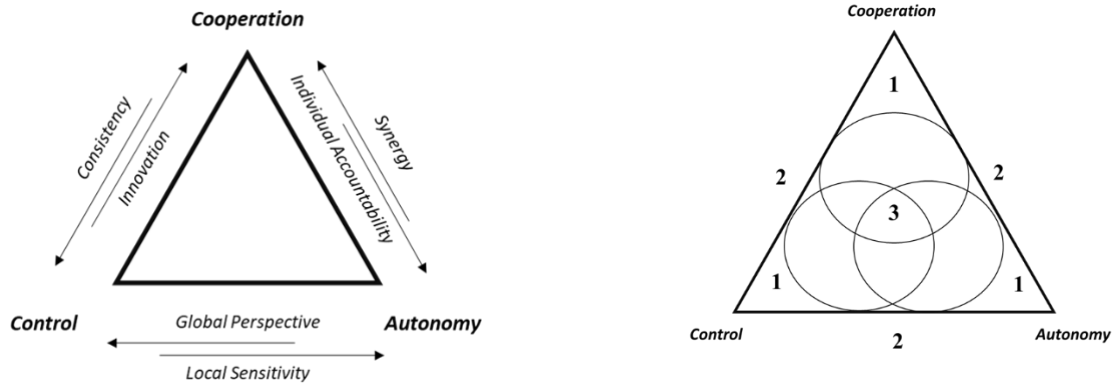


Figure 3. Triangular Thinking

Keidel, R. W. (2010). *The geometry of strategy: Concepts for strategic management*. Routledge.

Management typically falters in three general ways when building an organizational strategy (Figure 3):

1. They may overprioritize one of the three organizational areas of focus, i.e., autonomy, control, or cooperation (one-variable design).
2. They may focus minimally or not at all on the bottom priority (two-variable design).
3. They may operate without any focus or priority (undifferentiated design).

Keidel's model challenges organizations to rethink and recommunicate a new system of thinking to focus on the three key elements of the triangular design, but it has several rules. First, every organization and unit within the organization should prioritize one of the three categories so that very specific and necessary tradeoffs are made. Second, each of these three variables should be appropriately integrated as essential and independent entities. Finally, the focus should be on the variables requiring attention at the given moment regardless of priority, and this should be adjusted over time as necessary (Keidel, 2005).

5.1 Mental Models

While the triadic framework will be the most effective scaffolding model for med tech's management innovation, it is important to highlight the more traditional styles of thinking as these unconscious "geometries of thought" help us understand where we are today and may continue to serve a significant purpose with the correct application. Keidel has created a lens through which we can consciously determine which styles of thinking are needed in any given scenario or determine which decision can be moved into a different style of thinking (Table 1). Rather than define the answer, the questions we ask ourselves will point toward the direction of the strategic framework. The quality of these

questions may inherently lead to a more triadic approach, which ultimately moves along a continuum of more simplified approaches.





| | |
|--|---|
| <p>• Point Thinking (Persona)</p>  <ul style="list-style-type: none"> • Black or White Thinking • Establish Essentials • Non-Negotiables • Rules of Thumb | <p>• Linear (Measurement & Performance)</p>  <ul style="list-style-type: none"> • Shades of Gray Thinking • Provides Yardsticks • Relative Position • Compromises |
| <p>• Angular (2x2 Puzzles)</p>  <ul style="list-style-type: none"> • Black and White Thinking • n x m Metrics • Problems in Two Dimensions • Best of Both World Solutions | <p>• Triangular (Patterns)</p>  <ul style="list-style-type: none"> • Pattern Thinking – Weighted • Structuring Complex Problems • Common Languages • Autonomy, Control, Coordination • Focus on Core Aspects |

Table 1. Mental Models

Keidel, R. W. (2005). *Seeing organizational patterns: A new theory and language of organizational design*. Beard Books.

5.1.1 Point Thinking

Framed within limited options, typically dichotomies, point thinking tends to reduce complex issues to binary tradeoff decisions with an either-or approach. Often, this can become an extremely limiting model, but it serves a clear purpose when defining an organization’s strategic persona. By clearly defining “who we are” or determining non-negotiables, point thinking can become a powerful tool for clarifying not only how an organization will perceive itself but also how it will be perceived by the world.

5.1.2 Linear Thinking

Linear thinking, the next phase beyond point thinking, is linked to linear metrics such as cycle times, R&D spending, or profitability. These processes are linked to

performance – or shades of grey. Keidel further broke down linear thinking into process, outcome, and legacy metrics, which are mostly necessary but often fail when benchmarking incorrect measurement criteria or inappropriately preparing for the future from a talent standpoint.

5.1.3 Angular Thinking

Angular thinking is rooted in the classic business school 2x2 strategic framework and focuses on both the black and white or the best of both worlds. The aim of the 2x2 framework is to create options for complex issues, but it tends to ignore potentially important third variables in the equation. In most 2x2s, one of the quadrants mathematically becomes a non-desirable option (-/-), thus creating a triad of potential solutions (+/-, -/+, +/+). In identifying the areas where organizations can find value in best-of-both-worlds solutions, strategic decisions can move away from emphasizing one area over another and blend efforts into the most appropriate decision.

The challenges with angular thinking, as described above, fail to account for a third option or variable in the equation. Here, the classic “prisoner’s dilemma” is a result of the lacking variables or, perhaps, misses the foresight in the potential failures of the best-of-both-worlds solution (+/+) by reverting to a somewhat point-thinking decision style by committing to a particular quadrant. While the 2x2 is certainly a well-established strategic framework, the lack of flexibility for both long- and short-term implications may be a blind spot as the framework behaves as more of a rigid mechanism as opposed to a flexible organism (triangular).

5.1.4 Triangular Thinking

The triadic approach seeks to explore larger patterns and, according to Keidel's work, is considered to be more deeply based on how the organization itself is designed. Looking specifically at the strategies of competition (cooperation), growth (autonomy), and organization (control), the need to strike a balance on a weighted priority can be constantly shifted and adjusted based on changing environments or broken down into a continuum of sub triads based on varying organizational functions and tradeoffs (Table 2).

| Autonomy | Control | Cooperation |
|---|--|---|
| Baseball Environment Talent Customer Effectiveness Competition Player Separation | American Football Systems Scheme Shareholder Efficiency Conflict Coach Assimilation | Basketball Social/Cultural Culture Employee Intention Collaboration Team Integration |

Table 2. Common Triadic Thinking Frameworks

Keidel, R. W. (2005). *Seeing organizational patterns: A new theory and language of organizational design*. Beard Books.

The triangular approach encompasses the ability to evaluate competition, prioritize core competencies, and reimagine internal structures, or it may help reprioritize a company's value chain (Figure 4). The simplicity of the design provides a perfect framework for facilitating medical device manufacturers' transformation into med tech organizations, as these suggested frameworks are simply a reprioritization rather than an entire organizational overhaul. Most of the major players within the space already possess the resources and capacity to make such adjustments. The triadic framework is a straightforward method to help the management refocus its efforts toward the appropriate strategic direction.

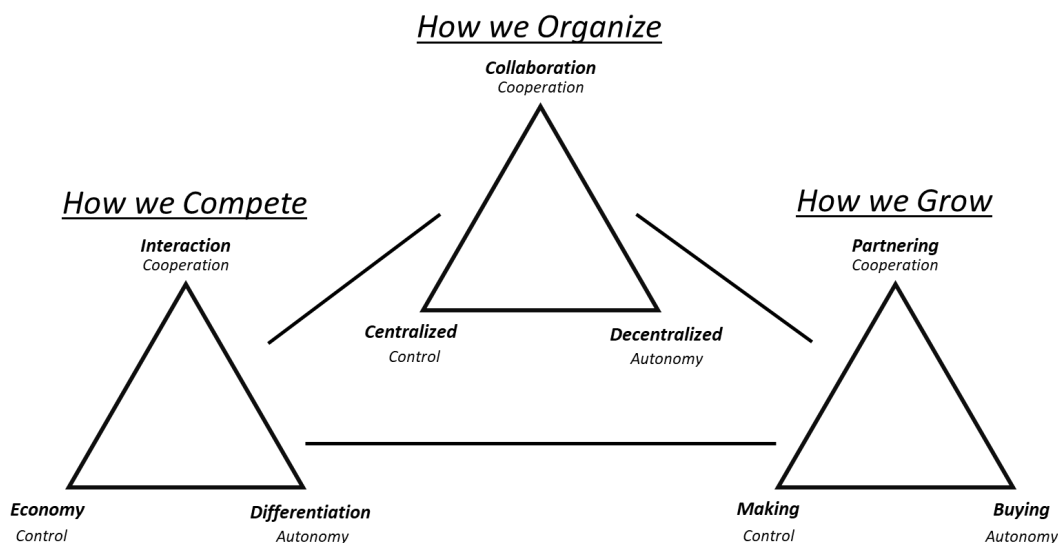


Figure 4. Organizational Triad

Keidel, R. W. (2005). *Seeing organizational patterns: A new theory and language of organizational design*. Beard Books.

5.2 Frameworks for Med Tech

According to the paradox theory, no single or simple solution exists for the challenges faced by many organizations, and when in flux, the organization should address the uncertainty and seek to embrace the “both–and” (angular) solutions where appropriate (Jay, 2013; Lewis, 2000). The paradox theory allows for an alternative view through which organizations can accept these “both–and” strategies without the narrow constraints of a black-and-white “either/or” (point) approach to products and services (Smith et al., 2010). By broadening the horizon through which the related challenges are felt, organizations can implement better coping strategies for complex challenges (Dweck, 2006; Gupta & Govindarajan, 2002).

The key to the paradox theory of servitization lies in the concept of embedded tensions between what is considered to be product logic and what is service logic, where the tension itself becomes an important asset in the equation but also establishes an either-or point-thinking approach. The tension, as noted, should not be seen through the lens of a tradeoff but rather as a mechanism for creating additional factors to help weigh decision-making and for making sense of an issue that seemingly holds two variables. Kowalkowski (2015) developed a third option as a potential trajectory within servitization to create a scenario where the areas of need can be weighed against one another, each important but likely prioritized according to the strategy and organizational environment. Taking a more angular view to servitization, we can expand the service and goods-dominant logic to a ‘best-and’ approach and thus better understand the paradoxical challenge. For service, specifically, the recommended trajectories can be labeled as

availability provider (autonomy), performance provider (cooperation), and industrializer (control); these can be applied to any new medical device service business. In this instance, we parallel availability with autonomy as a function of sales or local responsiveness, performance with cooperation as a means of cumulative learning or knowledge transfer, and industrializer with control to emphasize efficiency, consistency, or the process. In the context of the medical device industry, we are exploring servitization as the integration or re-conception of complex technology – such as robotics, artificial intelligence, imaging, or most outcome-driven systems – as the key value driver for the growing and competitive healthcare industry.

“The new questions we have to ask ourselves are around what value we are specifically trying to create and exactly how are we going to do it. We cannot lose focus that digital solutions are products as well, don’t forget that.” – Vice President, Digital Strategy (Interview, October 2020)

Paradoxes cannot be resolved; thus, organizations must create coping strategies for the weighted tensions between autonomy, coordination, and control. As the literature suggests, the key is to accept, appreciate, make sense of, and cope with the emerging concepts as opposed to choosing narrow paths or dismissing the tensions altogether (Beech et al., 2004). When attempting to create a coping environment to prepare medical device companies to accept the tensions from the product-to-service balance, a focus on both efficiency and effectiveness (angular) should drive the measurement and follow-up as well as reward the practices of the tensions between effectiveness and customization for manufacturers (Kohtamäki, et al., 2020).

As device companies attempt to compete and differentiate, customized delivery methods and patient-impacting systems should, theoretically, negatively impact the initial standardization requirements and thus create a paradoxical tension between customary implant sales and service-rendered assistance or implementation. The tension between customization and efficiency becomes the clearest when device companies have an opportunity to innovate the current organizational frameworks.

5.3 Systems Thinking Concepts

“We don’t want to operate as an individual thirty-billion-dollar company. We want to operate as thirty individual billion-dollar companies.” – Geoff Martha, CEO Medtronic

Substantial research and literature have been published on the failure of companies across all industries to anticipate or adapt to new markets or trends, which often results in missed opportunities for growth or, in many cases, complete collapse. As the healthcare ecosystem is in the early stages of significant change, many disruptive technologies and market demands will drive the blurred distinction between devices and their connected technology information systems as the need for connectivity between the two value drivers continues to grow.

Systems thinking is a framework that strives to understand how various elements are connected to each other within a larger network of individual projects. The tensions present within the paradox of servitization extend to the medical device industry as a whole and have ultimately forged the concepts explored in this thesis.

As mentioned previously, the value of the individual device begins to sink as a standalone item but significantly decreases as the device becomes integrated into a larger ecosystem of data-driven technology. Current systems of manufacturing or strategic technology acquisition tend to focus on black-and-white issues regarding individual solutions and individual problems, creating supply chains, quality systems, strategies, and sales agendas usually within silos. Some companies have the ability to offer a suite of value-added components, but the interconnectivity and data aspects of the value chain did not become significantly important until recently.

Systems thinking takes a holistic approach that focuses on the interconnectivity of the linked assets within a larger system. Traditional value chains typically hold a more linear approach from end-to-end delivery, whereas systems thinking holds a variety of connectivity relative to the overarching goals of a program or organization, facilitating a unique way of managing and delivering simplicity through complex patterns. As opposed to a hierarchical control mechanism, systems thinking encourages both autonomy and cross-functional coordination by considering the structures of organizational patterns related to interactions and organizational dynamics as components of a larger structure at each level of the value chain; this helps anticipate, rather than react to, emerging challenges (Atun, 2012).

Traditional hierarchal organizations tend to develop siloed, narrow-minded business functions, which, in turn, influence decision-making processes. Shifting to angular and triangular thinking requires accountability to strategy, technology, and organization (STO) because it would be impossible to understand one aspect of the

organization without addressing the other two. Every complex organizational decision is invariably based on STO and requires frameworks to create options and direction with the intent of stimulating fresh thinking about organizational principles and choices. The design problem is how to best blend these alternatives (Keidel, 2010).

A commercial leader of an orthopedic device manufacturer discussed the sales force as a component of the system: “We have to challenge ourselves as an organization around developing comfortability for our sales force around new technologies. It’s not just a change in customer behavior that we have to contend with, it’s also our own sales force that needs to change their learning and selling processes. As a leadership team we’ve realized that complex technologies don’t really fit the mold of our company, who we are, and the culture of our products. We’ve found that it’s not that customers don’t want our new technologies, it’s the field team that rejects the offering because of the complexity. We need to design solutions that are simple to use and understood across the entire spectrum of our organization and all the way down to the end user.” (Interview, October 2020)

6. Research Process

The review will be an important component of the overall exploration of the posed questions; it will consider peer-reviewed sources on the subject matter, primarily systems thinking, servitization, cultural development, and sense-mapping. Among these, I will primarily focus on the idea of servitization, which refers to the business transition from a product-based business to a service-based one, both of which possess distinct organizational cultures and structures.

The relevance of this topic is beginning to break ground in the medical device industry across all specialties for a variety of reasons, and it should be considered highly relevant by those familiar with the space. The thesis states that the industry will need time to adjust to these changes. The perspective I am offering is very likely to sound unfamiliar because it is a drastic divergence from the current way of life for both healthcare professionals and the industry. The veteran surgeon or career business leader, accustomed to working in one specific way, may take time to digest the partnership that accompanies the value-add of med tech.

The fact that these thesis topics may take time to develop certainly does not come as a shock as I am aiming to influence how we treat patients in the future while understanding that change takes time and may suffer setbacks. The research I have done fits directly into the literature, specifically with regard to the culture and challenges of changing systemic thinking. When tied together, this perspective will allow medical device manufacturers to evaluate their own perspectives and operations by filling the

gaps specific to med tech culture and recognizing the need for healthcare reform on multiple levels.

I hope to fill the gaps associated with data-driven service business, which has yet to be described in a manner that looks at the value-add of the service rather than at the service as a means of production. My research will demonstrate the competitive advantage a medical device company can gain by appropriately focusing on the service portion of the new med tech aspect of their business and driving the culture away from implant manufacturing as a competitive advantage and differentiator.

6.1 Design

The epistemological viewpoints taken in this research have been highlighted in the introduction to depict the assumptions of an industry shift into service-oriented operations, even though it is a relatively new concept in the medical device industry. Using the literature review of the relevant topics associated with the subject matter expert interviews, this study adopted a conceptually exploratory strategy with qualitative characteristics to propose a strategic framework for the reader.

I conducted structured interviews throughout the summer of 2020, approximately between July and September, to collect the relevant data. I used a questionnaire to determine the company's journey to servitization through the eyes of different informants from business units in two regions. The questionnaire included questions about the definition and value proposition of the service offerings and the descriptions of their company's servitization journey, including the steps and practices for developing

services. Afterward, content analysis, triangulation of the interviewees' insights, and cross-case analysis were used to draw conclusions.

The interview questions were designed to provide a background for the questions posed and create an open-ended atmosphere where I could gain insights that would not be influenced by my thesis statement. The specific samples for these questions were designed to create a variety of viewpoints, from the design to the surgical application. I hoped to pose questions for both current and future scenarios to better understand the road that a medical device leader may travel as well as the lens through which their business needs to function strategically in the future.

A substantial amount of literature exists on the process of creating value through value-added services or through businesses pivoting their strategic focus to structure themselves as service-oriented businesses, but none are specific to the medical device industry in the context of culture, servitization, and systems thinking as opportunities for growth. In 1988, a paper written by Vandermeewe and Rada, titled "Servitization of Business: Adding Value by Adding Services," emerged as the foundation for the concept of servitization as a contextual opportunity. Later literature went on to reimagine the concept of servitization through terms such as bundling, product-driven systems, service packaging, and others, specifically for manufacturing companies; it also redefined the phrase as "going downstream" with customers as opposed to the traditional "upstream" product development (Cassia et al., 2015). To further draw a distinction, Wise and Baumgartner (1999) highlighted how the service value-add is primarily executed at the tail-end of the value chain.

The problem to be solved is rooted in the cultural and structural organizational bottlenecks that will inhibit medical device companies from effectively competing in the quickly advancing healthcare space. Recent literature on the topic of servitization has expanded its scope to explore the implications of the process within organizations along with the structural challenges and best practices. One such area of focus is servitization through the concept of service-dominant (S-D) logic, as observed first by Vargo and Lusch (2004, 2008). The basis for this theoretical approach has guided the proposed solutions outlined within this paper and the continued development of med tech to embrace the outlined strategic concepts (Cassia et al., 2005):

- Service is a fundamental basis of exchange.
- Goods are a distribution mechanism for service provision.
- The customer is always a co-creator of value.
- An enterprise cannot deliver value, only offer value propositions.
- Value is always uniquely and phenomenologically determined by the beneficiary.

The findings of the literary review in conjunction with the triangulation of the subject matter expert interviews indicate a shift in value creation away from the manufacturer's ability to produce new goods and into a realm where value is created and distributed through the customer experience during interaction with representatives and technology at the tail-end of the value chain. The conclusion of this research will address actionable frameworks that medical device leaders can apply within their organizations

through custom and easy-to-understand methods, where the co-creation of value and user experience guides the focus of a firm's strategic choices.

I will function as an action researcher for this analysis. I hope this information will enable a company to strategically refocus its efforts and view its current landscape, both internal and external, through a new lens, providing some perspective on how to successfully compete in the healthcare industry. My hope is that the leadership will understand the impact of advances in med tech on outcome-driven data and clearly define where their company needs to fill gaps to deliver value for stakeholders in the future. The analysis considers the current lack of significant data pointing toward outcome improvement due to robotic interventions but also acknowledges the industry's understanding that these technologies will continue to improve. Device manufacturers have been offered a new way to create value and compete through software and data. The goal of this paper is to create a framework for the execution of these goals.

7. Methods

7.1 Interview Strategy

The research methods included observations and interviews with varying stakeholders across the med tech space. The observations included personal experience in building successful med tech clinical programs alongside hospitals and physicians across the United States and Europe as well as my internal corporate experiences working with both large and small medical device manufacturers. With regard to the emergence of robotics and AI in healthcare, I possess extensive experience due to both the infancy of the field and its narrow focus; in fact, I would consider myself a subject matter expert. Furthermore, I interviewed surgeons, physician assistants, hospital administration staff, device representatives, corporate leaders from successful med tech companies and major players stepping into the space, and general experts in med tech across multiple specialties, thus developing a well-rounded perspective on the subject matter.

The interview method used in this study was based on the methodology for qualitative research specific to subject matter experts as described by Arena et al. (1991). The interviews collected data pertaining to the participants' reactions to and experiences of the changing healthcare environment. They also explored the perceptions of how organizations and hospitals can participate in the paradigm shift to digital strategies. The interviews began by providing the subject matter experts with a context for the discussion to help create a sampling of the upcoming direction of the interview process. In each case, the participants were readily able to relate their personal experiences within the industry and articulate clear expectations of their own organization's willingness to

participate in the changing med tech environment. A few general questions were used to prompt the conversation's validity regarding the changing needs in the healthcare landscape to create a sense of alignment, being mindful not to direct the participant's opinions in any particular direction. The rest of the conversation involved obtaining their perceptions of the perceived changes needed and the unique challenges their own stakeholders will need to recognize.

Using previously explored frameworks for perceived value creation (Wash et al., 2014), the foundation for the interviews was built on the four fundamental dimensions of value: quality, emotional, price, and social. This framework was used to generate lines of questioning that would create an open space for participants to expand their thoughts with an open-ended reference to help connect past experiences with future possibilities. While the concepts of servitization were new to some of the participants, the questioning value framework allowed them to quickly build mental maps and further articulate their ideas.

Throughout the interviews, the participants were encouraged to expand their participation and perceptions of digital technologies in medicine, which provided valuable cognitive data regarding their own sense-making of the proposed industry changes. The in-depth discussion about feelings, attitudes, and strategic challenges with each participant provided valuable insights that often conflicted with the varying viewpoints from the literature as well as other participants' perceptions. The collected data suggests the clarity of the concepts described and the action steps needed maintain consistency at a high level, but it provides very little consolidation at the organizational execution level.

7.2 Interview Selection – Subject Matter Experts

To add color and validation to the ongoing trends in healthcare, the research will engage in interviews with a variety of subject matter experts in the fields of both medical devices and med tech in order to gain experiential insight. Subject matter experts are defined as individuals with specialized experience or in-depth knowledge related to a subject; this is critical for successful technology adoption in healthcare. Furthermore, as defined by Suchman (1995), the interviewees were subjectively filtered to maintain pragmatic, moral, and cognitive legitimacy. The interviewed experts included a variety of individuals in businesses that have yet to engage with or adopt technology into their strategic focus as well as members of businesses related to culture and servitization but not healthcare. These divergent views created a space for discussion and engagement in an effort to challenge any bias the research may hold toward a particular plan of action.

While subject matter experts should always be questioned with a significant level of challenge, emphasis was placed on the experiential component of the analysis with a greater level of acceptance, considering the limited number of subject matter experts in this field who have had the opportunity to execute successful strategies in the new med tech space. Less emphasis was placed on industry veterans who proved slow to adopt technology-driven strategies. Macdonald (1995) argued that organizational change must be dependent on new information coming from an outside source or agent, with challenges coming from internal acceptance and the credibility of the suggested changes. Macdonald claimed that many will be biased in favor of the “not-invented-here” syndrome. The cultures of the medical device organizations most applicable to this

research should accept new ideas or new ways of looking at problems and have the self-awareness and vulnerability to embrace new perspectives.

7.3 Findings

The results of the interviews and literary reviews support the premise that significant managerial implications will ensue from the demand for a shift to service-based frameworks as an alternative positioning strategy in the medical device industry. The thesis fundamentally argues that the transition to service has been quickly shifting device manufacturers away from product-focused arenas into an arena where experience-oriented and outcome-oriented services will drive multiple levers of value in the healthcare industry. The interviews indicated some of the needs to capitalize on these shifts, spanning from survival to market leadership, but the concept that the business must build frameworks and processes remained consistent across the participants.

Regarding the research conducted on the transition into service business, the interviews aligned with the common understanding that such a fundamental shift in the business poses challenges beyond the framework and execution and within the culture and mindset of the company's internal functions.

8. Systems Thinking Models

8.1 Service as Co-Creation

Vandermerwe and Rada (1998) frame servitization as an organizational change process via which new streams of revenue are generated through the provision of services associated with a firm's traditional goods. As medical device manufacturers move toward servitization, there is a decline in the linear thinking concept of goods-dominant (G-D) logic, both strategically and in application. In G-D logic, the value output is manufactured by the firm and distributed to the market, where the roles of producers and consumers are fairly distinct. As firms move toward servitization, there is a need for an alternative strategy of value creation that is built in S-D logic. The roles of producers and consumers will become much less distinct, meaning the input and output data necessary for value creation requires the integration of resources and competencies to deliver smarter and more customized solutions in the med tech space.

The process of servitization aims to collaboratively create value via mutual exchange, while the concept of service systems is centered around the triad of participants, processes, and resources, which interact to deliver outputs (Vargo et al., 2008). A service system's function is to make use of its own resources and those of others to improve its own and others' circumstances (Spohrer et al., 2008). Current medical device practices focused on production processes aim to deliver goods, where the pricing strategies deliver value based on the company's market position. Conceptually, maximum efficiency leads to maximized profitability. In such scenarios, standardization and economies of scale are the key levers that help achieve economic initiatives.

Servitization will fundamentally challenge these general manufacturing foundations as economies of scale and efficiencies become notably less critical factors from an output standpoint. This is because the co-creation of value is now delivered through customized user experiences, making customer input a new aspect of the value creation equation. According to Vargo et al. (2006), when goods are involved, they are tools for delivery and application of resources.

The servitization shift from G-D logic to S-D logic demands a change in the basis of exchange. While manufacturers using G-D rely on the exchange of goods as value, S-D logic creates value through the co-creation and exchange of knowledge and skills. Through this lens, co-creation through the combined efforts of firms, employees, customers, governments, third-party organizations, and any other entity can be customized and determined by the beneficiary, or the customer, of the transaction. According to Vargo and Lusch, “There is no value until the offering is used—experience and perception are essential to value determination” (2006, p. 44). Alternatively, as noted earlier, we can equate this statement to a focus on customer satisfaction as we connect it specifically with the needs of med tech.

The medical device industry demands customized solutions via digital experiences, robotic integration, and value propositions based on both clinical and economic needs. The concept of co-creation remains attractive as we look at these opportunities within the area of solutions (outputs) relative to specific user needs (inputs). As Beinhocker (2006) outlined in an HBS Press article, the value depends on the capabilities of a system to survive and accomplish other goals within its environment.

Appropriately utilizing the service system of an outside subsystem would mean incorporating improved capabilities. Thus, “value-in-use can be defined as a system improvement within a particular environment” (Beinhocker, 2006).

| Medical Device Organizations | | |
|----------------------------------|--|---|
| | G-D Logic | S-D Logic |
| Value Driver | Value-in-exchange | Value-in-use or value-in-context |
| Creator of Value | Firm, often with input from firms in a supply chain | Firm, network partners, and customers |
| Process of Value Creation | Firms embed value in "goods" or "services"; value is 'added' by enhancing or increasing attributes, product innovation | Firms propose value through market offerings, customers continue value-creation process through use, customized system solutions and experience |
| Purpose of Value | Increase wealth for the firm | Increase adaptability, survivability, and system connectivity through service (applied knowledge and skills) of others |
| Measurement of Value | Amount of nominal value, price received in exchange | The adaptability and survivability of the beneficiary system |
| Resources Used | Primarily operational resources | Primarily operant resources, sometimes transferred by embedding them in operant resource-goods |
| Role of Firm | Produce and distribute Value | Propose and co-create value, provide service |
| Role of Goods | Units of output, priced to embed value | Vehicle for operant resources, enables access to benefits of firm competences |
| Role of Customers | To 'use up' or 'destroy' value created by the firm | Co-Create value through the integration of firm-provided resources and other private and public resources |

Table 3. Goods Dominant Logic via Servitization

Vargo, S. L., & Lusch, R. F. (2006). Service-dominant logic: What it is, what it is not, what it might be. In *The service-dominant logic of marketing: Dialog, debate, and directions* (pp. 43–56). M. E. Sharpe, Inc.

9. Performance Culture

“Success is not about launching the perfect technology but rather, are we driving the right culture to change?” – Vice President, Digital Strategy (Interview, October 2020)

9.1 How to Compete

A majority of this analysis has driven the idea of service as a competitive differentiator focused on customer experience and satisfaction, along with the underlying causation of improved outcomes and more efficient surgical experiences. Though the shift to service at a systems organizational level may present unique challenges, the medical device space presents itself as a uniquely positioned field due to many of the current corporate structures relying on a service-like representation and customer relationships to drive business. Purely from a manufacturing standpoint, organizations will need to look beyond these established norms and create a systematic approach throughout their value chain to ensure that a sustainable competitive advantage is thoroughly adopted and established.

McKinsey laid out an argument (Chadha and Llewellyn, 2019) for the pure value play in medical devices, arguing that there is a growing demand for “good enough” products that are competitively priced and, for the purposes of our analysis, commoditized. With the med tech sector growing, slow adaptors and laggards will continue to play a role within the customer pipeline, especially in the international landscape. Identifying this area of basic competition is important because it inherently creates an opposite space in the market for med tech organizations to innovate.

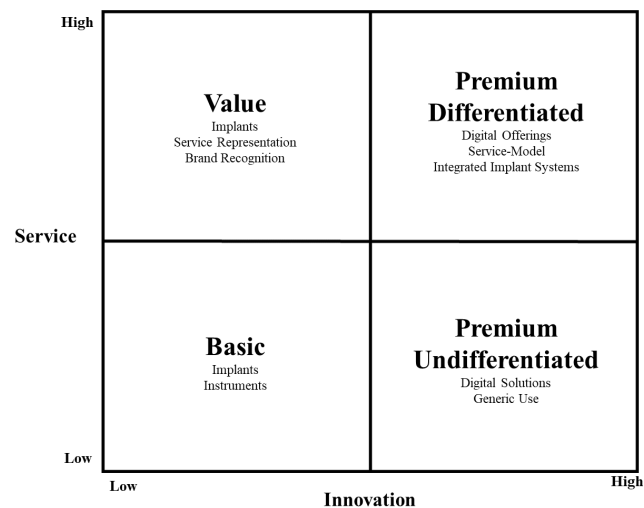


Figure 5. Premium Differentiated 2x2
Chadha, S., & Llewellyn, C. (2019, June 5). *Solutions and services in medical devices: White space or white elephants?* McKinsey & Company

The “basic” segment of the market in the above graph has a direct correlation with the maturing commoditized segments of medical devices; many of the implants and instruments were previously referenced as common use and requiring minimal innovation. These products are typically offered to value-oriented customers who tend to adopt innovation slowly or perhaps operate in an environment with a highly cost-conscious balance sheet. These environments often have little room for premium offerings regardless of the clinical advantage or benefits that a new and innovative technology may be able to bring to the organization. The products in the basic category typically offer minimal service and compete purely on the basis of price.

The “premium differentiated” quadrant is the area where med tech makes the highest impact (Figure 6). Here, it can introduce highly sophisticated digital and software-based solutions that help drive outcomes and efficiencies but are not necessarily specific to any implantable devices where profit margins are made. The products and

services in this quadrant tend to focus on outcomes and efficiencies and are supported by service models with frequent touchpoints with company representation. While these premium offerings can command higher price points in terms of compatibility with integrated implant systems, the general business model around new digital offerings is likely to command unique business models to capture the full value of the offering.

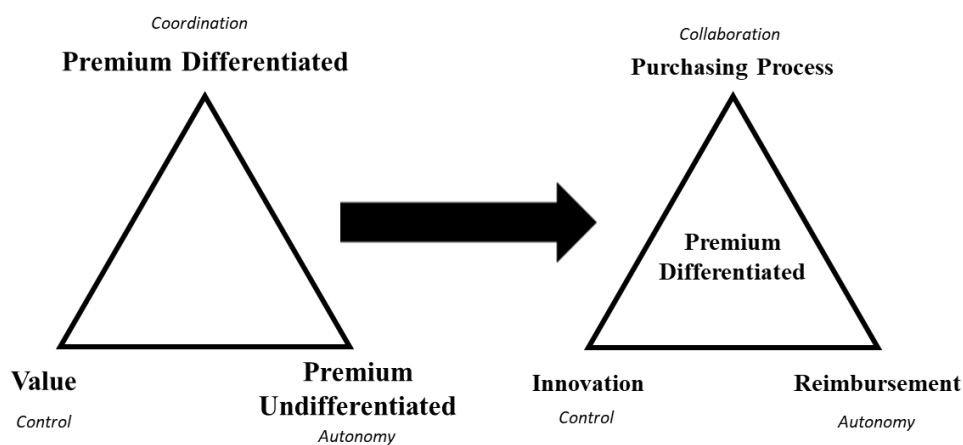


Figure 6. Premium Differentiated Triad

Regarding the scope of med tech as an area ripe for innovation through servitization, the above framework (Figure 7) is an example of the ways in which device companies can begin to reprioritize areas of the business where competencies need to be established and resources may be reallocated. From a strategic standpoint, the aforementioned example allows for a simplified way to weigh current standards with future directions and develop clearer decisions at each level of the value chain. Each level may require its own strategic framework built on the shifting focus of larger organizational initiatives.

In the example below (Table 4), I use the model built in 2013's *Ten Types of Innovation: The Building Blocks of Breakthroughs* (Euchner, 2014) to address the areas of experience that help frame the shift to service in med tech, where customer satisfaction is a key area of value. The provided linear framework may help organizations better understand the current versus future competencies that need to be reprioritized to efficiently meet their strategic objectives.

| Profit Model | Network | Structure | Process | Product Performance | Product System | Service | Channel | Brand | Customer Engagement |
|---|---------|--|---------|---|----------------|---|---------|---|---------------------|
| CONFIGURATION | | | | OFFERING | | EXPERIENCE | | | |
| PROFIT MODEL The way in which you make money <i>For example, how Netflix turned the video rental industry on its head by implementing a subscription model</i> | | STRUCTURE Alignment of your talent and assets <i>For example, how Whole Foods has built a robust feedback system for internal teams</i> | | PRODUCT PERFORMANCE Distinguishing features and functionality <i>For example, how OXO Good Grips cost a premium but its "universal design" has a loyal following</i> | | SERVICE Support and enhancements that surround your offerings <i>For example, how "Deliver WOW through service" is Zappos' #1 internal core value</i> | | BRAND Representation of your offerings and business <i>For example, how Virgin extends its brand into sectors ranging from soft drinks to space travel</i> | |
| NETWORK Connections with others to create value <i>For example, how Target works with renowned external designers to differentiate itself</i> | | PROCESS Signature or superior methods for doing your work <i>For example, how Zara's "fast fashion" strategy moves its clothing from sketch to shelf in record time</i> | | PRODUCT SYSTEM Complementary products and services <i>For example, how Nike+ parlayed shoes, sensors, apps and devices into a sport lifestyle suite</i> | | CHANNEL How your offerings are delivered to customers and users <i>For example, how Nespresso locks in customers with its useful members only club</i> | | CUSTOMER ENGAGEMENT Distinctive interactions you foster <i>For example, how Wii's experience draws more from the interactions in the room than on-screen</i> | |

Table 4. Ten Types of Innovation
 Euchner, J. (2014). *Ten Types of Innovation: The Discipline of Building Breakthroughs*. *Research-technology Management*, 57, 60.

10. Organizational Structure

“How will technology change the way we create value? It’s not necessarily entirely clear. The hardest thing we’ll face is our business’ lack of a big return at the start. How we collect data and turn the information into actionable insights will take time to generate. As a leadership team, we must remain patient and financially disciplined.” – Vice President, Digital Strategy (Interview, November 2020)

10.1 Value Chain

When I spoke to an orthopedic product director about customer satisfaction, it quickly became clear that the need for differentiation will always remain relevant but be increasingly harder to rely on in the current environment: “From a pure product perspective, we’ve differentiated by creating options for surgeons. If you look across our or our competitor’s portfolios, we’ll generally have similar offerings, but each company has a few little things that the others don’t. I think for our newest product launches we’ve focused on providing as many options as possible which eliminates the anxiety before the procedure. In a lot of ways, the customer satisfaction comes through the lowered anxiety before the case – not during or after – because our customers know they’ll have everything they need heading into surgery.” (Interview, July 2020).

The aforementioned insight blends well with the direction that the med tech industry is taking, as preoperative analysis and decision-making are important pieces of the puzzle that healthcare will continue to solve. Point thinking may create a dichotomy, implying that organizations are either manufacturers or med tech companies. Both highlight varying skills, capabilities, and characteristics, but they do little to help develop

a scaffolding that can allow organizations to weigh and prioritize the necessary aspects of control, autonomy, and cooperation required to make the most efficient transition.

Essentially, manufacturers currently hold a heavy upstream focus on control as they pour resources into product offerings and iterative development around manufacturing and engineering efforts. Conversely, the downstream customer interaction in the operating room tends to be more of an autonomous interaction as sales representatives rely heavily on relationships and customers retain satisfaction through complete portfolio offerings, only to use those instruments and products as they see fit.

The introduction of product service systems as the collaborative arm of value chain innovation allows manufacturers to emphasize the combination of product and service. From a structural standpoint, the ability to create new categories of responsibility serving cross-functional needs has created clearer synergies and a more impactful adoption curve for several subject matter experts who are currently successfully implementing digital technologies in traditional business models:

“We’ve look at our training team as part of the commercial sales organization as opposed to being a component of the operational side of the business, we see ourselves as the ‘secret sales force.’ We gain the most customer satisfaction through our reps who manage our robots, we hear it all the time from our surgeons. What makes the difference is the people and the support and our surgeons need to completely rely on the competency of our team, our people have a level of expertise that our competitors do not. There’s a huge opportunity for traditional manufacturers to disrupt the industry from an educational standpoint.” – Training Director, Robotics (Interview, November 2020)

Additionally, multiple subject matter experts mentioned similar new categories with cross-functional responsibility to evolve away from the traditional hierarchical model. Often, they mentioned how these positions facilitated a much clearer feedback loop for the business: “We created a new layer between marketing and sales responsible for strategy creation, content marketing, and a capital sales quota. It’s allowed our business to be informed on a much clearer level by creating a new layer between our internal and external teams. People want to experience a ‘buyer’s journey,’ and this added layer helps our business understand where our customer’s needs and desires already exists. From there, we create a story around our offering.” – Director of Growth, Med Tech (Interview, November 2020)

Building a new organizational structure to manage the requirements of a new digital servitization strategy has been a point of tension for companies that have acquired and implemented such programs. A part of the long-term executive vision and support allows for these challenges to be met with acceptance and, in some instances, may lead to a misunderstanding of the level of competency required to manage the newly acquired technology. As noted by Bustinza et al. (2015), “service innovation requires comprehensive organizational transformation.”

10.2 Relational Governance

I have outlined the need for a paradigm shift at the point of care for device manufacturers as competitive advantage is currently gained at the end of the value chain, where surgeons interact with finished goods and company representation. Furthermore, as the need for digital intervention increases, so will the value chain’s demand to deliver

solutions beyond the operating room and through the patient's journey of care.

Reiterating the discussion from Section 10.1 that specifically examines the current value chain, the work of Chatterji et al. (2015) focuses directly on sales force strategies in the U.S. medical device industry and the implications of launching innovations into new markets. They found that the concept of relational capital allows organizations to facilitate economic exchange and relationship development with outside partners over time through knowledge transfer, resource investment, and coordinated activities. It also impacts boundary decisions as product portfolios and market demands change. Thus, Chatterji et al. (2015) ask questions about the effects of preexisting relationships between firms' impacts on future decisions to integrate sales activities as product portfolios evolve.

In this example, relational capital is comprised of three main elements: shared trust (cooperation), routines (control), and norms (autonomy). The repeated exchange of these elements among groups helps develop interfirm relationships, the core of which creates coordinated activity, behavior management, and structured facilitation in the absence of a centralized process. As organizations improve relational governance with outside firms, the market for innovation should evolve as well, but this can be impacted by the shift to a "sell-first" mentality that the digital component of med tech demands. This is particularly evident in areas where manufacturers work with sales distributor firms or other third-party external organizations.

"Education has to become a part of the commercial business strategy, not a secondary operation. We've used it successfully as a sales tool, especially with outside

partners who've used their acquired expertise to fuel earning potential and use the technology as a driver that leads to other products.” – Training Director, Robotics (Interview, November 2020)

In terms of how organizations can evolve to prepare for the servitization shift, the training pipeline is an example of an area ripe for innovation – from both commercial and structural standpoints – that has the opportunity to make a significant impact.

“Be a disrupter internally, not just through the product. It's a people-first mentality at all times. Larger firms can learn a lot from some of these smaller startup companies when it comes to utilizing training with the commercial side of the business. Innovation is really hard, especially with robotics, software, and all the non-traditional tools the market is asking surgeons to adopt. People and expertise will make up the difference where the product is lacking – add more resources to your people. Let the training teams drive the culture and lead the change.” – Training Director, Robotics (Interview, November 2020)

11. Innovating Med Tech Models

11.1 Persona: Hardware to Software

The concept of point thinking holds its own limitations but plays a significant role where organizations can commit to a persona and culture to shape the future of its business. Throughout this research, I have reviewed the strategies and challenges utilized and faced, respectively, by medical device manufacturers in the face of the growing need to shift to a med tech company. Here lies a great opportunity to take advantage of the industry-driven dichotomy and commit to an identity shift where organizational culture will play a critical role in how organizations attract talent and shape business offerings to align with a clear vision.

The commitment to “med tech” signals to the cross-functional stakeholders a change in attitude and beliefs. These signals are becoming growingly critical throughout the hierarchy of the leadership chain, as interviews with subject matter experts have outlined the critical role a top-driven approach plays when building new business models. The role leadership plays in the shift to digital sets the tone for the organization’s cultural commitment to the future of healthcare; moreover, its implications are felt in the investment strategies and management structures.

New business models will fundamentally alter the way traditional manufacturers operate financially, so accepting change and remaining agile will continue to require significant top-level support to remain committed to a longer-term vision. Organizations will face challenges in shifting their persona without the support of leadership with subject matter expertise or significant experience as the lack of context may cause

standard leaders to misjudge or develop a misguided understanding of the commitment needed to evolve the business.

An additional component plays a significant role when looking at organizational structures in the context of the internal or external functional dichotomies that many organizations possess. While this view may not be specific to the medical device industry, organizational structure can play a key role in the necessary feedback loop that manufacturers will need as they shift to a digital and servitized value chain. The suggested model does not point to a new way of thinking about the internal or external dichotomy; instead, it challenges organizations to completely eliminate such mental frameworks through restructuring. While certain functions may certainly remain primarily focused inward (R&D) and others may consistently remain customer-facing (sales), the value chain should evolve in a way that is driven by new roles having cross-functional responsibilities as the new go-betweens for these separate business units. The constant feedback loop should allow for more consistency regarding clear and timely decision-making about market initiatives and potentially make a meaningful impact on point-of-care customer satisfaction.

11.2 Measuring Opportunities

The way in which med tech companies measure success and opportunities on a linear scale is one of the more meaningful business model shifts that the interviews have uncovered. The acceptance of short-term loss or slow adoption rates are common themes among many of the subject matter experts' questions regarding the topic, each of which mention a commitment to financial discipline and long-term vision. It has become

abundantly clear that future business models based on data collection and utilization are going to be one of the most important changes in the industry, but the revenue models and relationship with payers remain unclear. Nonetheless, the vision of the med tech space has a persona. However, the existing mental models on the linear nature of measuring success may require a paradigm shift.

“Looking at our M&A strategies to acquire new technologies we typically focus on incremental revenue for any given project. Here is where we’ll need the biggest financial culture change and the most strategic alignment. We have to learn that digital surgery in many ways is more about revenue downside protection as opposed to upside opportunity to gain share. Revenue loss avoidance is not traditionally in our base case financial models. How do we measure productivity gains? How do we quantify value? Although these digital investments may take time to come to fruition, they create disadvantages for our competition, have the opportunities to reduce our costs elsewhere in the value chain, and allow us to improve customer loyalty.” – Vice President, Digital Solutions (Interview, September 2020)

With a systems thinking approach, looking at the independent project’s expected net present value (eNPV) may require a shift in approach as the interconnectivity of the integrated parts will be much more valuable as an ecosystem. Having the ability to tie in multiple projects to a larger system, eNPV may serve as an appropriate shift when improving switching costs and data collection. These can then become valuable drivers of customer retention. While each organization will have unique ways of allocating capital,

recognizing a new way to measure both opportunities and success in a linear framework poses a new challenge for business leaders intending to create a financial paradigm shift.

11.3 Challenging Organizational Norms

The “Icarus paradox” or “paradox of performance” refers to an organizational tension focused on a company’s past successes as the main factor in the persistence of a strategic action plan that focuses on old strategies. In other words, businesses often fail after periods of abrupt success when they simply follow the same pathways that facilitated the initial success. For instance, only 19 of the Fortune 100 companies in 1966 are still on the list today. As Miller (1990) explained, success can lead to converging ideologies; this eliminates awareness and the important forces of tension and divergence and creates a defensive mindset regarding those who have relied on past success.

The process of challenging organizational norms impacts the mechanism of top-down hierarchical control and seeks to structure complex problems as puzzles with a blend of alternative options. Angular and triangular cognitive methods help balance organizational control with additional autonomy and coordination in an effort to create common languages and simplify complex issues. The move toward angular and triangular frameworks provides an avenue to connect high-level organizational principles with industry- or function-specific knowledge, allowing thinking patterns and decision-making to become richer and more inclusive (Keidel, 2010).

Both similarity and difference are rooted in autonomy, control, and coordination, allowing triangular patterns to form in ways that clarify a variety of concepts or blended organizational initiatives. Tying in systems thinking and servitization, the need to move

beyond point and linear cognitive methods becomes apparent when medical device manufacturers continue to add new layers of complexity to their environment both internally and externally.

11.4 New Layers – Systems Thinking Structures

“Positions with both internal and external responsibility are the people who not only understand the problems from both sides of the business but also know how to solve them.” – Director of Growth, Med Tech (Interview, October 2020)

The biggest opportunities to innovate from a structural perspective lie within the cross-functional responsibilities rooted in a systems thinking approach. Many of today’s corporate structures operate within a hierarchical framework and tend to reflect these linear themes upon evaluation of the traditional value chain. In many ways, medical device companies are reflective of the same customary conservative healthcare industry standards, and as we shift to servitization, they may struggle to adjust to the quickly changing environment of digital surgery. From the dichotomies of functional roles (marketing versus R&D) to stack-ranking eNPV projects to allocate capital, adding third dimensions between business units presents an opportunity to reshape how a business interacts cross-functionally. In an effort to begin the process of creating a systems-focused organization. While every organization will be different, the concept of adding additional layers to link functions becomes an important piece of systems development.

New organizational layers eliminate the traditional linear approach and facilitate feedback loops between cross-functional units, creating a communication system with the chance to make broader impacts on the business. As in the case of eliminating the

internal–external dichotomies, certain functions also play a role in becoming essential components of the new business design. The key to effectively implementing these additional layers is that the new leadership positions hold significant responsibility and hyper focus on coordination between the functional units.

Typical marketers tend to be engineers, salespeople, or pure marketers and as an example, a director of ‘growth’ may bear responsibility for both sales *and* marketing. By adding a capital sales quota, we create a formula to help improve the product’s story, better understand forecasting, and enabling us to understand the customer’s journey more clearly to effectively build partnerships. In another example looking at the responsibilities for a director of training, the training team is not typically brought into the commercial business as a critical aspect of the sales journey. Setting customer expectations, gaining critical feedback, and subject matter expertise help bridge the gap with R&D in a much more efficient manner and seemingly eliminate the internal or external dichotomy. In this training example, the cross responsibility to both sales and R&D becomes critical to servitization. Finally, a director of ‘user experience’ may play a role as marketer, understanding the product through the eyes of the customer, and understands market needs while simultaneously playing a role critical to the R&D team, working directly with engineers to create realistic products with more efficiency. As a function of nature, these new layers create additional triads where middle managers can operate with a clearer feedback loop. Some of these functions may shift depending on the organization, but the central idea is that a much clearer systems approach is being created as we add responsibility to new layers.

Because these feedback loops create a systems thinking organization, managing projects throughout an ongoing life cycle significantly changes through enhanced collaboration. These structures can also impact eNPV, which will dictate project prioritization. While the feedback loop is constant and efficient, the business can more critically evaluate the whole interconnected program which inherently becomes an important aspect of digital business within healthcare. Furthermore, the concept of servitization becomes an embedded aspect of the organization as these layers are integrated into the feedback loop of the business. This helps shift the culture toward a user-experience with an enhanced focus on patient outcomes and system improvement.

11.5 Final Thoughts: Finding Triads

The emphasis of this paper outlines the need for an expansion of the current mental frameworks focused around linear and angular thinking and adds the component of service (cooperation) to the already established roles of provider (autonomy) and technology (control) to more clearly frame the challenges of servitization. By using the triadic framework where possible, med tech organizations will have the ability to more clearly focus time and resources in areas of need and better understand the complexities of both internal and external factors that will impact a quickly growing technology market.

This research taps into a broad spectrum of opportunities for medical device manufacturers to rethink and reshape their organizational abilities to better serve the needs of a fast-changing industry. The highlighted information has sought to answer questions related specifically to culture and identity, the shift to servitization, and the

prioritization of systems thinking approaches. While these questions may remain uniquely positioned for each business to answer on their own, I have built a strategic framework to help facilitate the process. Much of the existing research points to the need for structural changes, expanding mental models, and most importantly, recognizing the need for constant change.

As we stand today, surgeons and other healthcare providers know manufacturers and their products very well, which bestows on them subject matter expertise and control over clinical decisions and execution. New technology seemingly places this expertise in the manufacturer's hands instead, giving a business more control over its position in the market as well as interactions with customers. Considering the power of knowledge, one of the biggest and most important aspects of med tech companies will prove to be the level of training and development as both a means to create value and improve customer satisfaction. The suggested structural changes will provide valuable frameworks to implement these ideas, which will then trickle down to impact the culture, time to market, and communication. They will also create businesses that can partner with providers in a way that improves the lives of people around the world.

Further research can be done to better evaluate the impact of servitization in specific healthcare sectors, including telehealth and pharmaceuticals. While this analysis was a first look at the newly emerging and growing needs of med tech, its successes and failures will certainly help guide more specific research as we evaluate the impact on culture and the overall effect providers experience as decision-making continues to become democratized. Extensive research can be conducted on insurance companies'

adoption of software-enabled decision-making and how these changes can impact the cost of care. Finally, research can further explore how the shift to servitization impacts the medical sales world. One can assume that the sales professional will also need to adjust and become more of an SME in terms of technology and processes as opposed to products or devices. These impacts will drive the way manufacturers interact and form relationships with customers, most of which already drive today's business.

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