

Megatrends shaping the future of healthcare

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Abstract

Healthcare systems worldwide are increasingly affected by rapidly changing environments and influencing factors. Megatrends encompassing technological, clinical, and business dimensions are integral factors reshaping the healthcare landscape and presenting both opportunities and challenges. The purpose of this paper is to 1) describe the megatrends 2) highlight the implications for healthcare systems, and 3) drive needs for adaptation for healthcare system stakeholders.

To integrate disruptive innovations and build sustainable healthcare systems that meet the diverse needs of all stakeholders, it is crucial to understand these megatrends and their corresponding patterns. Innovative strategies and cross disciplinary collaboration are required to navigate these trends and maximize benefits. Innovation Think Tank (ITT), part of Siemens Healthineers has been actively partnering with global healthcare organizations to address local challenges, share best practices, and drive healthcare innovation. ITT programs and activities, through its innovation methodology and tools, focus on capturing and validating healthcare trends and challenges, while co-creating innovative solutions and harnessing capacity building.

The insights in this paper, gathered from various ITT programs and activities, explore these disruptive megatrends in the areas of healthcare system, technologies, clinical advancements, and business models, while maximizing benefits and minimizing complexity as healthcare systems stand at the intersection of innovation and adaptation.

Keywords: Megatrends, healthcare system, Innovation Think Tank, business models

Introduction

Current challenges

As the world's population grows and healthcare demand rises, the provision of quality health services

for all remains an ongoing challenge. The emphasis on equitable access to high-quality medical care is significant as half of the world's population, or up to 3.5 billion people still lack access to the health care they need [1]. Some of the most prevalent issues observed on a global scale include accessibility and availability of healthcare personnel, financial support for health services, mental well-being, conflict and humanitarian crises, economic hardship, and the widespread dissemination of misinformation [2]. The overall global challenges reveal a fragmented and inequitable healthcare system where socio-economic disparities are frequently growing. To overcome these challenges, disruptive innovations combined with multi-stakeholder engagement can drive the universal transformation of basic healthcare services [3]. Fostering a creative and innovative culture in healthcare organizations to enable stakeholders to identify solutions based on the actual demands of healthcare systems is a key component of responding to emerging difficulties. It is important to understand the current trends within the healthcare system and engage various stakeholders to get real-time feedback to accelerate the implementation of innovation processes.

Healthcare system stakeholders and overall healthcare trends

Stakeholders are individuals, groups, or organizations that have an interest or concern in a particular entity [4]. Healthcare stakeholders play a critical role in the healthcare sector by driving the ongoing development of health-related products, services, research, and initiatives, while also managing healthcare spending. They have a significant influence over the formulation, implementation, assessment, and financing of various healthcare programs. Patients are the most important stakeholders, but healthcare providers, policymakers, researchers, educational institutions, pharmaceutical companies, local governments, health educators, and nutrition professionals all have significant positions as stakeholders in healthcare ventures.

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Disruptive innovation creates significant change in any industry. In healthcare, the focus of new inventions is shifting from disease treatment to wellness and prevention [5]. Improving the consistency and quality of healthcare services in developing countries requires the implementation of digital healthcare technologies and services. However, there may be a need to overcome infrastructure constraints such as lack of or inadequate power supply, difficult access points, or security concerns.

The complex process of disruption has forced the industry to shift from a conventional and predictable business strategy to a more adaptive, flexible, and comparatively complex management approach. The experience and safety of health services are currently being greatly improved by thousands of laboratories, incubators, accelerators, and startups. Hospitals, which have medical expertise, have recently seen startups surpassing their knowledge, forcing them to "step out of their comfort zone" to compete and adapt to the changing needs of healthcare consumers. Three different types of innovations can improve healthcare and reduce costs. One is making healthcare more consumer centric. Another, leveraging technological and clinical advancements to create new products and therapies to improve healthcare. The third, creating new business models, particularly to incorporate various healthcare developments to optimize care delivery [6]. Digital innovation is driving technical trends, reshaping care through telemedicine and AI. Clinical trends focus on precision medicine, while business trends disrupt traditional models with digital startups and value-based care. These megatrends promise improved experiences but also raise concerns, including data security, adaption of clinical practices, and regulatory adjustments, which are discussed in more detail below.

Technical trends

Trends in healthcare are constantly evolving, driven by technological advancements, changing demographics, and evolving consumer expectations. One prominent trend is the increased adoption of telemedicine and digital health solutions, which have become integral to providing remote care, improving patient access, and reducing healthcare costs [7]. The COVID-19 pandemic has accelerated these changes, with a focus on community-driven support models, novel population health monitoring methods, and

widespread public participation in clinical trials [8]. Data analytics and cognitive technologies such as artificial intelligence and robotics are playing a central role in healthcare decision-making, helping providers enhance patient outcomes, streamline operations, and predict disease outbreaks. In addition, there is a growing focus on personalized medicine and genomics, allowing for tailored treatment plans based on an individual's genetic makeup. There is also greater adoption of portable medical systems and wearables, which enable faster diagnoses by providing physicians with real-time information about their patients. Today's technologies and innovations not only improve the patient experience through features such as virtual patient visits and personalization, but also empower patients to take a more active role in their healthcare decisions [9].

Clinical trends

As the healthcare landscape continues to evolve, several clinical trends are shaping its future. Declining fertility rates, increasing life expectancy, and advancements in public health are contributing to an aging population, necessitating an emphasis on geriatric care [10]. Due to the increasing burden of chronic diseases, a transformative shift from disease treatment to prevention is underway. Moreover, the demand for homecare and self-testing kits has increased in recent years. In the wake of the COVID-19 pandemic, virtualization of care services or remote diagnosis is expanding access to care, while mobile clinics and workplace clinics are fostering community well-being.

Irrational use of antibiotics has led to antibiotic resistance, requiring innovations in treatment. Precision medicine, personalized care (e.g., gene therapy), targeted drug delivery, minimally invasive surgery and robotic surgery are contributing to patient-centered care and enhancing the patient experience. Further, predicting diseases based on patient health data by creating a digital twin can empower proactive care.

Business trends

The future of healthcare business trends is characterized by a strategic shift toward supply chain agility, with companies investing heavily to ensure the flexibility and resilience of their operations. At the same time, healthcare organizations are increasingly looking at growth opportunities in

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developing markets, recognizing the untapped potential for healthcare services and products. There is also a focus on collaboration, with a particular emphasis on fostering partnerships with smaller players in the industry. Medical device companies are pivoting away from traditional in-house efforts and instead foreseeing partnerships as the driving force for innovation and faster market penetration [11].

In this highly competitive and specialized sector, new collaborative models and innovative business approaches are emerging that require fresh perspectives on joint projects, strategic investments, and research and development efforts that involve a broader range of partners. In addition, the concept of value-based healthcare is gaining momentum and promises to reshape the industry by emphasizing improved patient outcomes and cost-effectiveness [12]. Together, these trends are shaping the healthcare business landscape and fostering a dynamic and forward-looking environment.

Overall, some of the best practices in healthcare include a focus on mapping patient journeys, leveraging technology for omnichannel patient engagement such as using AI virtual assistants, enabling online appointments, and leveraging data insights from these digital systems. Effective communication is also emphasized to enhance patient understanding, while continuous professional development supports staying current with advancements. These approaches collectively foster a patient-centered culture, improve patient experience and engagement, and optimize operations, resulting in enhanced healthcare outcomes and overall satisfaction [13].

Highlights of Innovation Think Tank work in trend identification

With its global reach and cutting-edge framework for healthcare technology, Innovation Think Tank (ITT) responds to the growing demand from healthcare stakeholders for a self-sustaining innovation infrastructure. The ITT global infrastructure incorporates more than 90 activity locations, including co-creation programs and established labs at Siemens Healthineers (SHS), as well as multiple partner universities and hospitals [14]. By empowering partners to reinvent themselves, ITT helps institutions find customized and innovative solutions to key healthcare challenges.

Material and methods

ITT offers a comprehensive set of methodologies and tools such as ITT Healthcare System Framework (HSF) [15], ITT methodology [14], Disease pathways [16], clinical workflow templates, and knowledge assets from more than 2500 research and development (R&D) projects that not only address the needs of key stakeholders, but also explore the broader landscape of current trends and site-specific challenges. ITT toolsets identify innovative strategies aimed at transforming traditional healthcare delivery methods. To capture and validate trends and challenges across a range of project scopes and location-specific healthcare systems, ITT has developed customizable survey templates using ITT HSF, integrated during co-creation workshops that led to an understanding of the megatrends shaping the future of healthcare. Not only the tools and methods of ITT, but also the engagement, validation and alignment with stakeholders through various panel discussions, ITT event presentations (external ITT exhibition, ITT Summit) and C-level communications led to the collection of healthcare megatrends.

The approach involved brainstorming with a diverse, interdisciplinary team to uncover underlying trends and challenges. This collaborative work provided a clear and more realistic understanding of the healthcare client's needs. Furthermore, the brainstorming session helped team members identify barriers to implementing these trends. As a result, these challenges were strategically placed within the corresponding value streams of the trends. During the trend scouting process, more than 100 variables were initially identified. To streamline the analysis and avoid redundancy, these variables were categorised into interdependent and sub-categorised trends. In this way, ten core trends were identified. As shown in Figure 1, these ten trend categories are highlighted in blue, the trends themselves in green, and the associated challenges in red. These trends are considered to be very helpful in adapting health care to the specific needs of local populations. This can be achieved by improving the adaptability of technology implementation and promoting transparent communication between healthcare providers and the public. Using the ITT methodology in R&D as well as external customer (university, hospital, government) projects has also played a significant role in understanding different healthcare systems and creating specific disease pathways, clinical workflows, and technology roadmaps.

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One such example of ITT co-creation activity is when ITT organized a customized event for Evora University in Portugal with a focus on the challenges of aging, which led to an understanding of Portugal's healthcare system and related trends. The outcome of this program made us understand the megatrends related to aging, which resulted in having more than 50 solution proposals during the event [17]. Similarly, around 175 programs were organized which led to a plethora of trend identification [Table 1]. Moreover, collaborative projects with SHS business lines incorporating numerous customer site visits, expert interviews and surveys, have provided a rich

understanding of the current state of healthcare and a forward-looking perspective.

Using state-of-the-art frameworks and stakeholder engagement, ITT has successfully identified several healthcare trends. These trends cover not only technical and clinical aspects, but also delve into the future outlook of business models, offering a holistic view of how these trends can be harnessed within the healthcare industry. As ITT continues to expand its methodologies and remains at the forefront of healthcare trends, the healthcare sector also anticipates a dynamic and innovative future.

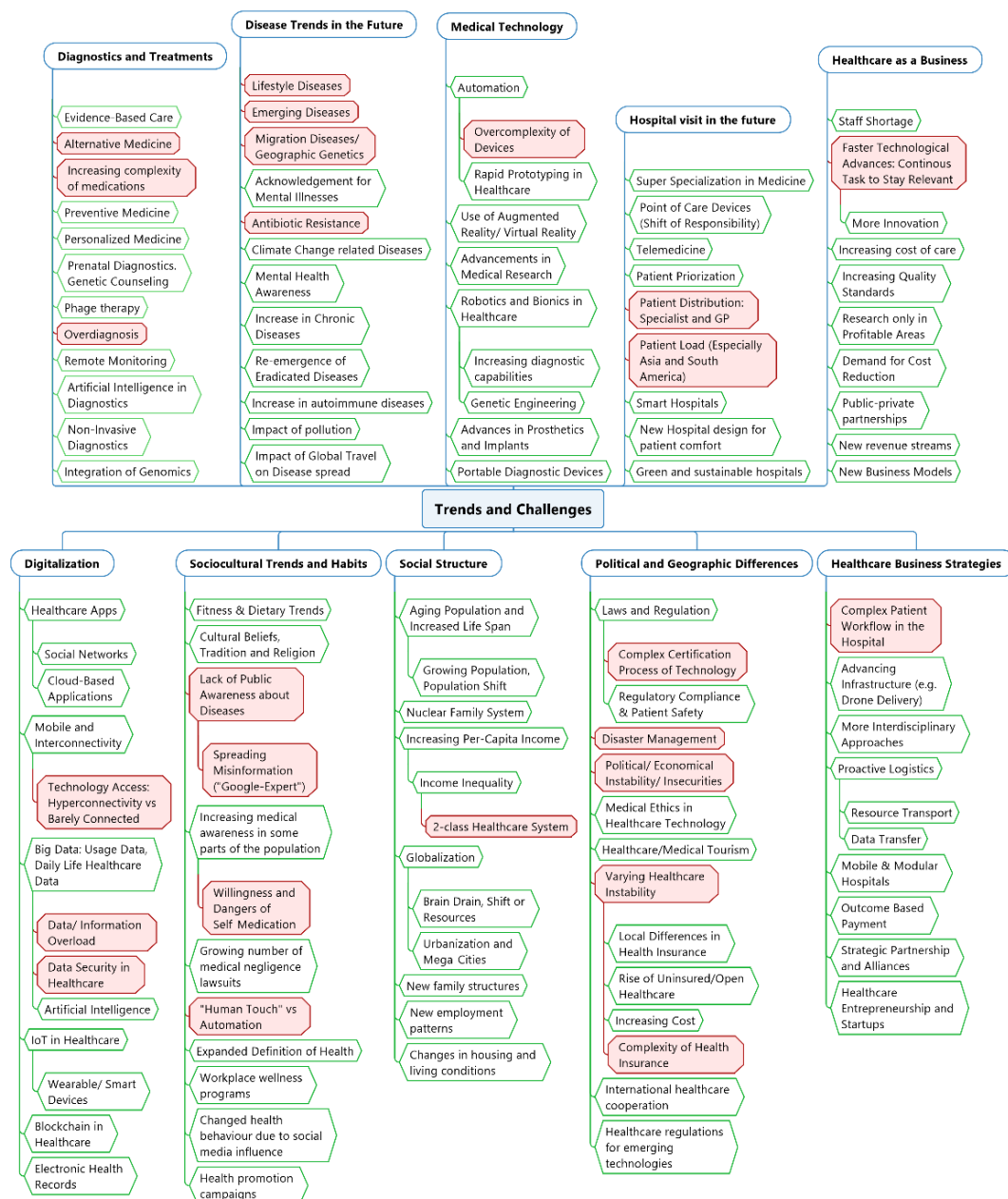


Figure 1: Trends and their implementation challenges in healthcare

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Category	Program Examples	Content analyzed	Impact KPIs # = Number of
ITT Co-creation and Capacity Building program	Future of healthcare focused programs: <ul style="list-style-type: none"> Western University, Ontario, Canada Era's Lucknow Medical College and Hospital, India Emirates Health Services, United Arab Emirates (UAE) Fakeeh University Hospital, UAE Queensland University of Technology, Australia Access to care focused programs: <ul style="list-style-type: none"> Regent business school, South Africa Era's Lucknow Medical College and Hospital, India Western University, Ontario, Canada Siemens Healthineers, Egypt Siemens Healthineers, MEA Universidad Nacional de Colombia Sede Bogotá, Bogotá, Colombia University of South Carolina, United States Other healthcare focused topics: <ul style="list-style-type: none"> Critical care, urology, emergency care, perioperative care: Imperial College London, United Kingdom Active Aging Challenges: Evora university, Portugal Future of Laboratory Diagnostics: Acibadem Healthcare Group etc. 	<ul style="list-style-type: none"> Healthcare Challenges Clinical trends Business model trends Technology trends Institutional challenges Operational efficiency challenges Access to healthcare challenges Regional best practices 	#Regional Healthcare systems analyzed #Trends (Healthcare, Clinical, Technological, Business) #Stakeholder challenges #Best practices #Innovative solution proposals
	Product and portfolio definition projects Technologies and business models which can disrupt healthcare; Disease pathway elaboration; Clinical Workflows, etc.	Customer requirements, disruptive healthcare technologies, stakeholder pain points, new business models	

Table 1: Example of content analyzed for identifying the global trends and challenges in healthcare. The categories and program examples highlight the projects and engagements with various universities based on different healthcare focus areas.

Results

A comprehensive survey was conducted to comprehend trend analysis in various regions worldwide. The survey involved more than 250 participants from diverse backgrounds, including SHS thought leaders, R&D experts, and sales and customer service experts. In addition, healthcare professionals such as radiologists, physicians, surgeons, engineers, researchers, and others participated in the survey to provide their opinions on the impact of various trends in healthcare. The data collected and validated through the survey was structured into the key current trends that will transform healthcare delivery across the globe and the degree of their impact on the global healthcare system.

Healthcare trends

Participants ranked the healthcare trends based on their perceived impact. Figure 2 illustrates a consensus, with over 85% of respondents indicating that data driven health innovation has the greatest impact, and digitalization in healthcare with 74% of respondents believing it has a high impact. Additionally, more than 60% consider the shift from treatment of diseases to prevention, increasing demand for access to care, automation in healthcare operations, and fully integrated care solutions to have high impact from their perspective.

Technology trends

Based on their opinions, participants ranked the technology trends as shown in Figure 3. Big data

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analytics to optimize healthcare operations, AI based services and the use of 3D printing are considered to have the highest impact by more than 65% of respondents. 56% of respondents ranked nanotechnology as a high-impact trend, followed by healthcare apps and Internet of Medical Things (IoMT) in healthcare monitoring, which received nearly equal votes for high and moderate impact.

Clinical trends

Key clinical trends were validated by participants in terms of their level of impact, as illustrated in Figure 4. 86% of respondents voted for intelligent cancer care as a highly impactful trend. More than 70% of respondents consider targeted drug delivery (78%), prediction of diseases based on patient health data

(75%), precision medicine (74%) and increased accuracy in surgery (74%) to be highly impactful.

Business trends

Figure 5 shows the business trends and the level of impact as perceived by respondents. Based on the responses it is evident that majority of the participants ranked cross institutional collaboration as having the highest impact. Additionally, more than 50% of respondents believe that value based healthcare and digital reimbursement have high impact. According to the respondents, public-private partnerships, freemium and business-to-business healthcare startups have relatively high or moderate impact.

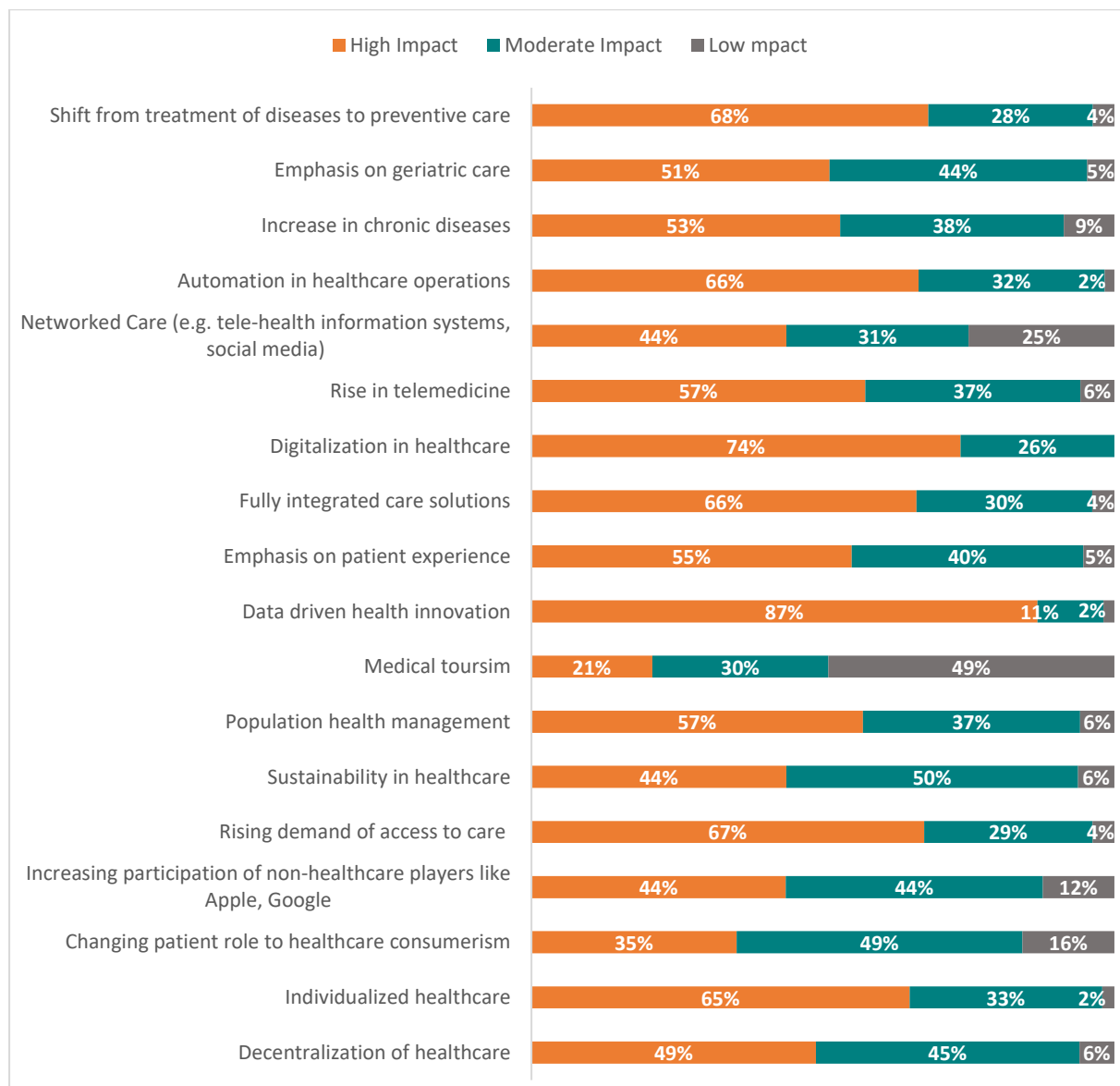


Figure 2: Impact level of overall Healthcare trends

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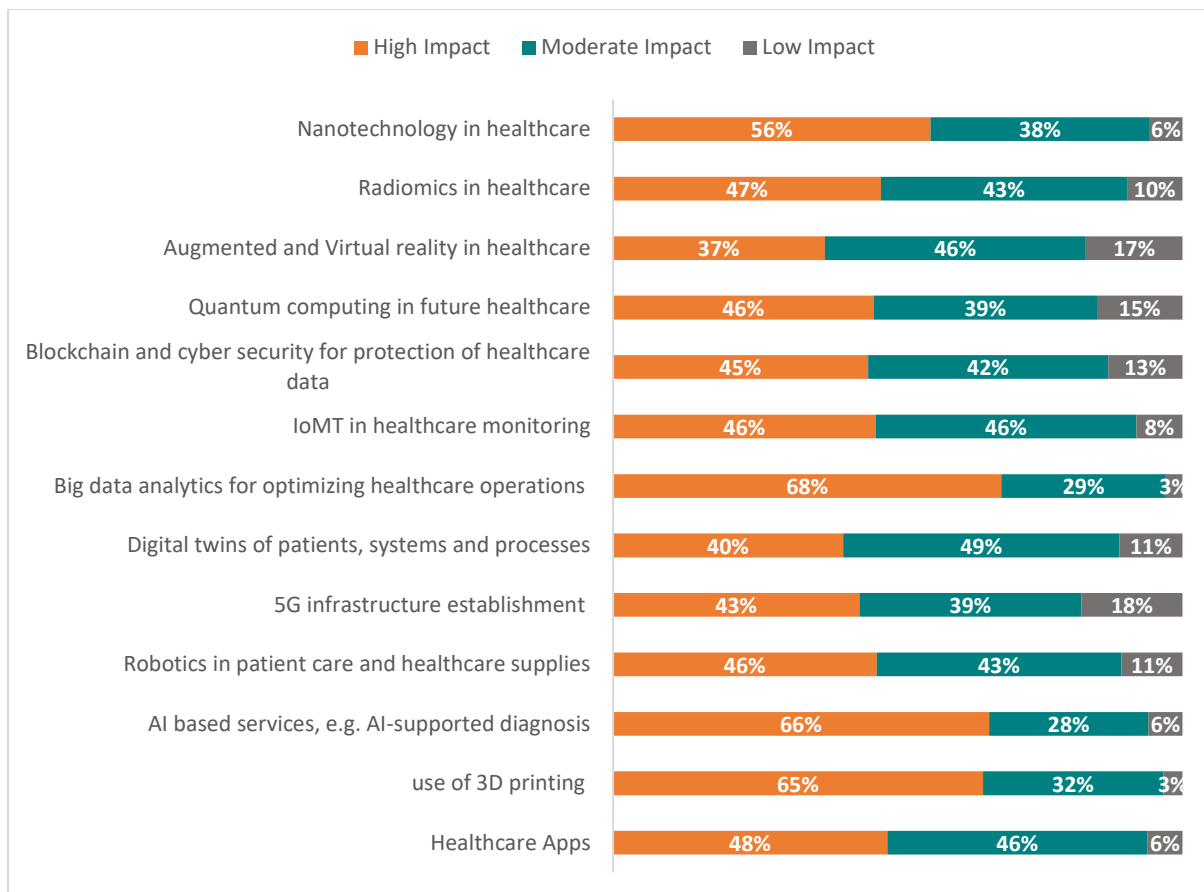


Figure 3: Impact level of Technology trends

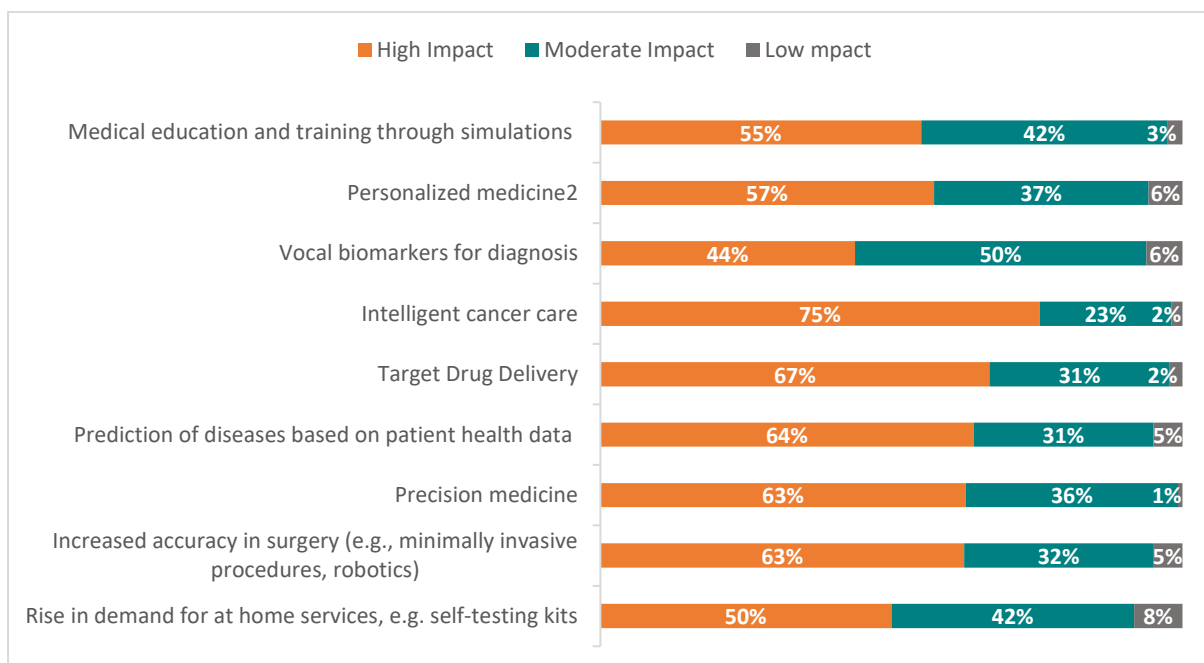


Figure 4: Impact level of Clinical trends

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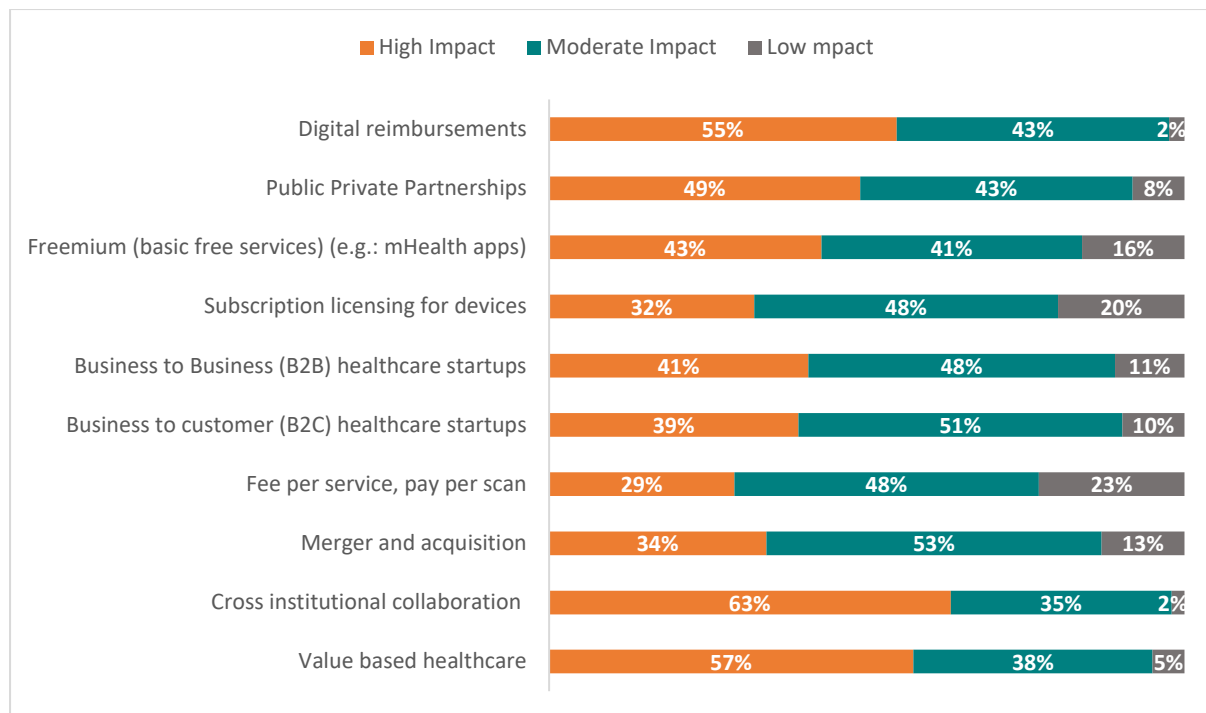


Figure 5: Impact level of Business trends

Discussion

Disruptive trends that are radically changing the way we approach healthcare are driving a huge transformation in the healthcare sector. These megatrends are transforming the healthcare industry, pushing us to innovate and adapt to meet the constantly changing needs of both patients and providers.

A change in the way we view healthcare is at the heart of this transformation. The rise of new technologies and methods is upending established models. Value-based healthcare, telemedicine, personalised medicine, data-driven healthcare, partnerships, and the pursuit of health equity are the main megatrends influencing these changes. For example, data-driven healthcare uses analytics and big data to improve diagnosis, treatment and decision-making, resulting in more accurate and efficient care. Conversely, telemedicine is changing the nature of the doctor-patient relationship by enabling remote access to medical consultations and increasing access to healthcare, particularly in underserved or remote areas. Personalised medicine promises more effective and efficient healthcare by customising therapies based on a patient's genetic composition and medical history. Value-based healthcare encourages providers to deliver the best outcomes for patients by emphasising quality over quantity. A holistic approach to healthcare is fostered

by collaboration among healthcare stakeholders, as several organisations come together to address complex health issues.

The goal of health equity is to ensure that healthcare services are equitable and available to everyone, regardless of socioeconomic background. These tendencies are linked and they are not discrete processes. By utilising technological innovations, expanding access, and ultimately improving health outcomes for both individuals and communities, they are working together to transform healthcare.

It is clear that the healthcare industry will continue to change in reaction to these revolutionary shifts as progress is made. To meet the changing demands of a rapidly expanding market, providers must embrace and adapt to a more dynamic and patient-centric approach to healthcare. Continuing this revolutionary journey, the future of healthcare offers tremendous prospects for improvements in patient experience and healthcare innovations.

Conclusion

Healthcare is in a crucial phase of change, driven by major disruptive trends in technology, clinical and business dimensions. This paper highlights the critical need for healthcare professionals to understand, adapt, and innovate to respond to these altering

trends. The global increase in healthcare challenges and the rise of innovations call for more prevention-based and patient-centered care. Meanwhile, strategies, policies and new business models are reshaping the industry. As ITT continues to identify advanced trends, the healthcare industry looks forward to a dynamic and innovative future, upheld by changing patient experiences and health outcomes.

Author contributions

SH has established and confirmed the paper's framework as well as guided and initiated the paper's context. CW and GA has provided crucial insights and inspirations for the context. CH and EB contributed in finalizing the background of the paper. JV, NN, AG, DH, MM and BA collected the data, analyzed the results, and added content to the whitepaper. All authors contributed to the paper's drafting and approved the final version. The authors do not state any competing interests.

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Disclaimer

The information presented in this paper is not meant to be used as standard recommendation and do not represent associated organizations. The results shown are based on the limited sample size and does not ensure complete accuracy considering the evolving healthcare landscape. Any direct or indirect consequences resulting from using this information are disclaimed by the authors. Large language models were utilized for paraphrasing purposes only.

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