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Medical Informatics in the Digital Personalized Health and Medicine Era: A SWOT Analysis and Actionable Strategies

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Abstract. With the rapid proliferation of digital health technologies, the role of medical informatics in advancing personalized healthcare and wellbeing is emphasized. To examine the readiness of medical informatics for fostering digital health moving forward, a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis was performed. As a result, actionable strategies have been identified to maximize the benefits of medical informatics and overcoming the faced challenges in the digital health era.

Keywords. Digital health, medical informatics, strategic planning, SWOT

1. Introduction

The movement from "eHealth" to "Digital Health" emphasizes on providing people-centred and integrated health services utilizing the technological advances, such as mobile health (mHealth), Internet of Things (IoTs), Artificial Intelligence (AI), big data analytics, cloud computing, blockchain, etc. [1].

Medical Informatics or Biomedical and Health Informatics (BMHI) has become an established scientific-multidisciplinary discipline involving computer, cognitive and social sciences [2]. BMHI utilizes health information technologies to provide the optimal use of information for improving individual health, healthcare, public health and biomedical research.

The goal of this paper is to analyze the strengths, weaknesses, opportunities and threats (SWOT) of the current status of the BMHI field. Consequently, actionable strategies are identified to leverage the anticipated potential of BMHI for the Digital Health (DH) era.

2. SWOT analysis and actionable strategies

SWOT analysis is one of the world's most widely used methods for strategic planning [3]. This paper uses this instrument to match the strengths and weaknesses of the BMHI field with opportunities and threats of DH. The SWOT analysis has been performed

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based on the review of literature, industry reports and initiatives of the global health agencies.

To identify the potential tactical strategies for maximizing the benefits of BMHI for the DH era, an extended "variant" version of the SWOT-named the Threats, Opportunities, Weaknesses and Strengths (TOWS) analysis was conducted [3]. Figure 1 depicts how to develop actionable strategies through the TOWS analysis.

Figure 1 TOWS analysis and actionable strategies

3. Medical informatics strengths and limitations

The BMHI domain has a broad scope with the full range of knowledge (research) and practice (applications) [4] covering several sub-disciplines, mainly: bioinformatics, imaging informatics, clinical informatics and public health informatics. Additionally, there are two rapidly growing domains within the BMHI field, namely: 1) Consumer Health Informatics (CHI) that addresses consumers' articulated needs with managing their health concerns [4,5], and 2) Global Health Informatics (GHI) that focuses on empowering people to use appropriate technology, aligning with a global perspective of healthcare provision to all [6].

The main limitations of scaling up the eHealth initiatives and reaching the desired impact are [6]: 1) limited interoperability with legacy systems at national scale, 2) lack of evidence regarding the eHealth impact on health system performance and individual health, 3) lack of regulatory framework concerning data privacy and security, and 4) the insufficient use of large sets of data, i.e., converting data into health intelligence. On the other hand, the main barrier that hinders CHI [4,5] is the misalignment between the used technology and the users' socio-technical environment. This can significantly impact the technology utilization, endorsement by healthcare providers and users' empowerment.

4. Digital personalized health and medicine opportunities and challenges

The DH domain is considered as a key enabler of the personalized, preventive, predictive, participative, and precision (5P) medicine through leveraging the vision of providing equitable and person-centred care [5]. Consequently, DH has been attracting great interest of all stakeholders, including academic researchers, consumers, global health agencies, healthcare industry, policymakers and others. Recent studies covered different aspects of the DH domain, for example, industry and academic reviews of the DH technical trends [1], the World Health Organization (WHO) 's practical guide for monitoring and evaluating digital health interventions as well as the draft version of the global strategy on digital health 2020-2024 [7], Stanford medicine's

report on the democratization of healthcare [8], Johns Hopkins' roadmap for digital health validation [9], and a framework for assessing the impact of connected health services [10]. At the regulatory level, the Integrating Healthcare Enterprise (IHE)-Europe published its perspective in understanding and adopting the General Data Protection Regulations (GDPR) [11]. Additionally, a vision of how the GDPR supports healthcare transformation is described in [12].

Nevertheless, the main challenge facing the DH market [5,13] is that it is like "wild west" because most of the applications are neither based on the evidence of effectiveness nor adopting existing technical standards. Furthermore, most of the DH applications are mainly technology-driven as "one-size fits all" that may lead to harmful use. At the integration level [5,13], there is a lack of interoperability between user-generated data and health records in addition to an inadequate or fragmented legal frameworks, especially in the area of privacy and data security. Moreover, there is a mandate to address the DH from the socio-technical and organizational perspectives [1] in the context of change management, user engagement, information governance, workforce capacity, citizen empowerment, regulations, business models, etc.

5. Medical Informatics and digital health TOWS analysis

Table 1 summarizes the results of the SWOT analysis and their translation into TOWS analysis and actionable strategies.

6. Medical Informatics and digital health actionable strategies

As listed in Table 1, the actionable strategies can be categorized as follows:

The SO actionable strategies aim to *shape the BMHI research and education* for the DH era utilizing the advances in science and technology. This also matches with the proposed research agenda described in [2].

The WO actionable strategies aim to *build interdisciplinary partnerships and collaborations* to tackle the pressing challenges in aligning the BMHI field with future trends in medicine and DH technologies.

The ST actionable strategies aim to *leverage the role of the BMHI associations in building the ecosystem for DH connected health* with all involved stakeholders, including researchers, consumers, global health agencies, DH industry, standard development organizations, policymakers and others.

The WT actionable strategies aim *to roadmap an integrated future for BMHI and DH* at technical, environmental and organizational levels. This requires interdisciplinary teamwork of healthcare providers, informaticians, data scientists, systems developers, consumers, and experts in behavioural science, law, human-computer interaction, business modelling, and change management.

Table 1. BMHI and DH TOWS analysis and corresponding actionable strategies

	BMHI Strengths (S) **S1** Breadth and diversity of BMHI subcategories **S2** Wide scale of BMHI methods, tools and applications **S3** Consumer Health Informatics articulates the user-centric approach **S4** Global Health Informatics focuses on improving healthcare systems and outcomes	**BMHI Weaknesses (W)** **W1** Too many overlapping standards hinder interoperability **W2** misalignment between the used technology and the "real world" socio-technical environment **W3** Limited large-scale evidence **W4** Limited convergence of data into health intelligence at national and global scales
DH Opportunities (O) **O1** Wide scale of technological innovation in big data analytics, cloud computing, AI, wearable devices, IoT, blockchain, etc. **O2** Future trends in medicine: personalized, pervasive, predictive, preventive, participatory, precise, preemptive, and patient-centralized (8P medicine) **O3** The WHO global health initiatives for digital health, universal health coverage, democratization of data, evidence for all, sustainable development goals, etc. **O4** Great interest of the BMHI community (academia, industry and associations) worldwide in digital healthcare transformation	**SO actionable strategies:** **SO1** Strengthen the BMHI discipline with new trends in medicine and technology (S1, O1, O2) **SO2** Establish strong partnerships for international collaborative research programs and initiatives (S1-S4, O1-O4) **SO3** Align the BMHI education and research programs with the WHO global health initiatives (S3, S4, O3) **SO4** Leverage the strengths of the BMHI national and international associations in developing and updating the BMHI competencies frameworks (in regular basis)- that are intended for curriculum development, accreditation and workforce certification (S1, O4)	**WO actionable strategies:** **WO1** Take the initiative (by the international standards organizations) to coordinate their efforts in improving the existing BMHI standards and resolving the interoperability gaps (W1, O1, O2, O4) **WO2** Adopt socio-technical systems theory to support a better understanding of end-user performance (W2, O1, O2, O4) **WO3** Adopt the WHO guidelines on DH interventions and corresponding frameworks for DH monitoring and evaluation (W3, O1-O4) **WO4** Establish international scale research programs (that adopt new methodological or technical approaches) to advance interdisciplinary understanding (W4, O1-O4)
DH Threats (T): **T1** Rapid pace of technology-driven applications (as one size fits all) **T2** Lack of international regulatory frameworks for DH testing, validation, safety, and data privacy and security **T3** Lack of interoperability standards for user-generated data **T4** Low acceptance and adoption of DH	**ST actionable strategies:** *Leverage the role of the BMHI associations to:* **ST1** Engage all stakeholders in designing national DH connected health services and the corresponding consumers' empowerment programs (S1, S2, T1, T4) **ST2** Establish multidisciplinary taskforce to validate the current initiatives of DH regulatory frameworks in addition to technical working-groups to resolve the interoperability gaps with standards development organizations (S1-S4, T2, T3) **ST3** Develop a specialized competencies framework for implementing and monitoring the DH regulatory framework (S1,T2) **ST4** Develop a collaborative online platform for sharing best practices and lessons learned in overcoming the DH challenges across the associations' members (S1-S4, T2, T3, T4)	**WT actionable strategies:** *Overcome weaknesses by making them strengths (move toward SO strategy)* *Leverage the role of the BMHI associations to:* **WT1** Develop a specialized competencies framework for DH open data and science (W1, W3, W4, T1, T3) **WT2** Build a multidimensional collaborative team to develop a roadmap for interdisciplinary understanding of the DH socio-technical and organizational environment (W2, T2, T4) **WT3** Develop a collaborative online platform for open innovation to tackle the DH challenges (W3, W4, T1, T4) **WT4** Utilize change management concepts to 1) tackle the unpredict-table and complex interactions be-tween the people and DH technology, 2) strengthen user engagement (W2, T2, T4)

7. Conclusion

Medical informatics is expected to play a pivotal role in the transformation of digital "personalized" healthcare and medicine. To achieve this goal, the described actionable strategies support paving the way of the BMHI field towards the DH era, through 1) enriching the BMHI research and education agenda with emerging DH technologies, WHO initiatives and medicine trends, 2) strengthening the role of the BMHI associations in building the ecosystem of digitally connected health, and 3) road-mapping an integrated interdisciplinary future of BMHI and DH at socio-technical and organizational levels. Thus, realizing the BMHI aim in advancing science and improving healthcare outcomes.

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