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Evaluative Frameworks and Models for Health Information Systems (HIS) and Health Information Technologies (HIT)

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Abstract. Evaluation criteria for health information systems (HIS) and health information technologies (HIT) is broad, diverse and lacks a gold standard approach that could be leveraged, to evaluate clinical systems at various stages of their system development life cycle (SDLC). Without generalizable tools such as frameworks or models, comparative analysis across HIS and HIT is not possible. This paper presents the findings from a scoping review, utilizing the Arksey and O'Malley methodology [1]. The objective of this review is two-fold: 1) to classify models and frameworks published between the years 2010-2020 according to their level of evaluative focus (e.g. micro, meso, macro, multi), 2) to identify the countries where these models and frameworks have been employed for the purpose of evaluation, using the International Medical Informatics Association (IMIA) Represented Regions [3]. The results demonstrated the heterogeneity of evaluation models and frameworks currently used in health informatics and reflected the necessity for more adaptive approaches to HIS and HIT evaluation.

Keywords. Health information system, health information technology, framework, model, evaluation

1. Introduction

Global digitization is advancing at a rapid pace and health information systems (HIS) and health information technologies (HIT) are gaining market prominence. The criticality of readily available, safe and usable technologies in healthcare is becoming increasingly vital. The diversity of the HIS and HIT available in the marketplace, is also reflected in the heterogeneity of evaluation models and frameworks currently used in health informatics. Standardization and cross-cultural instrument validation [2] in the creation of relevant models and frameworks is paramount. Such an approach would ensure that safe, reliable and efficient technological solutions are purchased and implemented appropriately in healthcare settings. The objective of this paper is two-fold: 1) to classify models and frameworks published between the years 2010-2020 according to their level of evaluative focus, 2) to identify the countries where these models and

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frameworks have been employed for the purpose of evaluation of HIS and HIT, using the International Medical Informatics Association (IMIA) Represented Regions [3].

2. Methods

A scoping review following the Arksey and O'Malley methodology [1] was conducted in the EBSCOhost CINAHL®, Web of Science®, IEEE *Xplore*® and PubMed® databases. The keywords utilized were "evaluation AND (framework OR model OR theory)" AND "health information system." Prior to screening the articles, the researchers defined the terms model and framework. This was done to support consistent screening of the articles. Models identified key concepts and their relationships (in the context of systems) and were conceptualized as "the experiences, reflections and insights of scholars and practitioners" [4]. Frameworks were defined as "organizing structures that may be developed into models or theories over time" [4]. Following this, two researchers applied the inclusion and exclusion criteria (Table 1), screened the titles and abstracts of each article using Covidence®. A third researcher resolved the differences of opinions in article selection and then a full text review of all remaining articles was completed. Lastly, a market level analysis was conducted and the data extracted (Table 3) from the articles was categorized according to: country of use, IMIA represented region [3], level of evaluative focus (Table 2).

Table 1. Inclusion and exclusion criteria

Inclusion	Exclusion
English articles	Language other than English
Published between 2010-2020	Published outside of date parameters
Article abstract present	Article abstract absent
HIS or HIT as an intervention with an evaluative component that:	Editorials and literature reviews that lacked an evaluative component that focused on:
a) Used a model or framework to evaluate a technology	a) Clinical or organizational outcomes
b) Developed a model or framework to evaluate a technology	b) Patient risk factors and health conditions
c) Tested a model or framework to evaluate a technology	c) Surgery
	d) Medical devices
	e) Databases or data extracted from a database

Table 2. Definitions for micro, meso, macro and multi-levels of evaluative focus [5-8]

Level of evaluation	Micro	Meso	Macro	Multi
Definition	Evaluation of individual users interacting with technologies.	Users interacting as a team, group or organization using technologies within an organization.	Health system or inter-organizational level interactions using technologies.	Users interacting with and using technologies from micro, meso and macro perspectives.

3. Results

The initial search yielded 363 articles, 78 duplicates were removed, resulting in 285 articles screened for inclusion. From there 215 articles were excluded as they did not meet the inclusion criteria (Table 1), 70 articles were read in full for inclusion and 17

were excluded as they did not satisfy the inclusion criteria. The remaining 53 articles were then reassessed for inclusion and during the data extraction, phase 11 articles were excluded. These articles were excluded as they represented editorials or literature reviews that summarized the state of the literature but did not propose recommendations to address models or frameworks in HIS and HIT. The screening process of the scoping review was iterative and resulted in a final inclusion of 42 articles. As this was a review of existing publicly available literature, an ethics consult was not required. Some limitations of the study include that findings were guided by the search terms and were limited to articles in the English language only, therefore other relevant articles may have been omitted from the review based on this criteria.

Table 3. Categorical findings of market level analysis

Level	Classification	Country of Origin	IMIA Regions [3]
Micro-level	2 Frameworks [10,11] 0 Models	Indonesia [10], Netherlands [10]	Asia Pacific [9], European [10]
Meso-level	9 Frameworks [12-18,22,23] 4 Models [11,19-21]	France [11,15], Germany [12,17], Austria [12], Canada [13], Indonesia [14], Botswana [16], South Africa [18], Argentina [19], Australia [20], Finland [21], India [22], Cyprus [23]	European [11,12,15,17,21, 23], North America [13], Asia Pacific [14,20,22] African Region [16,18] Latin America and the Caribbean [19]
Macro-level	18 Frameworks [24-27,29-31,33-37,39-44] 4 Models [26,28,32,38]	Pakistan [24], Brazil [25], Ireland [26], Tanzania [27], United Kingdom [28,40], Sub-Saharan Africa [29], Somalia [30], Australia [31], India [31], Portugal [32], United States of America [33], France [33,45], Canada [33,44], Cyprus [34], Iran [35,36], Columbia [37], Libya [39], Sweden [40]	Asia Pacific [24], Latin America and the Caribbean [25,37], European [26,28,32-34,40], African Region [27, 29,30,39], Asia Pacific [31], North America [33,44], Middle East and North Africa [31,35,36]
Multi-level	6 Frameworks [45-50] 0 Models	France [45], Canada [50]	European [45], North America [50]

The results of the market level analysis (Table 3) indicated that: 50% of the studies applied a macro-level analysis, 31% utilized a meso-level perspective, 14% used a multi-level approach and 5% assessed HIS and HIT from a micro-level lens. The two articles [10,11] that contextualized HIS and HIT evaluation from a micro-level analysis came from the Asia Pacific and European IMIA represented regions [3], whereas meso and macro-level evaluations were dispersed across many diverse IMIA regions [3]. Of the multi-leveled articles, only two articles [45,50] utilized IMIA regions [3] in their analysis. The remaining four articles represented literature reviews that assessed HIS and HIT but did not specify a country or IMIA represented region [3].

With a collective total of 35 frameworks and eight models, the prominent theme and approach to evaluative design was the framework. However, as evidenced by O'Leary and colleagues [26], a holistic approach utilizing a model and a framework may be a more efficient and effective method. The findings revealed the need for comparability, when assessing HIS and HIT from various perspectives to ensure safety, usability and institutional applicability. However, this field is complex and evaluators must be cognizant of issues that exist in comparing differing nations and jurisdictions. Cultural,

social factors (e.g. language, time period, health literacy) and geographic customs [2] may alter the interpretation of the research questions and the overall success of the evaluation. Moreover, ignoring these diverse factors could impede the integrity and generalizability of frameworks or models, as each consideration may have direct influence on the outputs and approach to data collection.

4. Conclusion

In this scoping review, we have seen a range of models and frameworks that evaluated technology in healthcare settings. As evidenced by the heterogeneity of evaluative design and approaches currently used in health informatics, there is a need for more adaptive methods to HIS and HIT evaluation. To satisfy this critical gap in HIS and HIT assessment, future models and frameworks could be designed to incorporate patient, physician and caregiver journey mapping activities [51]. Additionally, a focus on clinical workflow, human factors (e.g. human information processing capabilities and limitations) and usability engineering could improve the safety and adoption of interactive clinical systems. An appropriate set of criteria (e.g. framework or model) could not only guide HIT implementations but could be leveraged to evaluate clinical systems at various stages of their system development life cycle (SDLC) [52]. As healthcare organizations are highly complex environments, integrating iterative usability testing into HIS and HIT assessment tools may be prudent. Furthermore, designing evaluative schemas from a socio-technical, cognitive [5] and organizational cultural approach may result in more effective HIS and HIT evaluation. Although, dynamic framework and model creation from a holistic and multifactorial lens could be challenging, such an approach may be the only feasible solution to adequately assess the fluid influx of technological innovation in healthcare. A dynamic evaluative approach could ensure that safe and usable technologies are procured and implemented into healthcare settings. Human centric, standardized and generalizable evaluative tools hold tremendous promise for improving healthcare service delivery, patient safety and the global health system.

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