Ethical Framework of Digital Technology, Artificial Intelligence, and Health Equity

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Received: *November 9, 2021* ***Revised:*** *January 2, 2022* ***Accepted:*** *February 4, 2022*

Abstract

Healthcare is evident in the extensive use of digital technology and artificial intelligence (AI). Although one aim of technological development and application is to promote health equity, it can at the same time increase health disparities. An ethical framework is needed to analyze issues arising in the effort to promote health equity through digital technology and AI. Based on an analysis of ethical principles for the promotion of health equity, this research article aims to synthesize an ethical framework for analyzing issues related to the promotion of health equity through digital technology and AI. Results of the study showed a synthesized framework that comprises two main groups of ethical principles: general principles and principles of management. The latter is meant to serve the implementation of the former. The general principles comprise four core principles: Human Dignity, Justice, Non-maleficence, and Beneficence, covering major principles and minor principles. For example, the core principle of Human Dignity includes three major principles (Non-humanization, Privacy, and Autonomy), and two minor principles (Explicability and Transparency). Other core principles have their relevant major and minor principles. The principles of management can be categorized according to their goals to serve different core principles. An illustration of applying the ethical framework is offered through the analysis and categorization of issues solicited from experts in multidisciplinary workshops on digital technology, AI, and health equity.

Keywords: Ethical framework, Ethical principle, Digital technology, Artificial intelligence, Health equity

Background and significance of the study

Based on a widely-held view that technological advancement can contribute to the promotion of health equity, new technology and technological innovations are developed and applied in medicine and healthcare to reduce health disparities and promote access to healthcare. In 2015, the World Federation of Public Health Associations (WFPHA) surveyed

of 85 members of the Public Health Association (PHA) to gather information on their use of digital technology to promote health equity. Results showed that various digital tools and technologies were used, for instance, in websites, social media, distancing-online meetings, smartphone apps, gamification, and crowdsourcing. Purposes included staff communication, health information dissemination, good practices and policies among healthcare professionals, stakeholders and the public. They also aimed to mobilize and implement government policies and projects (Chauvin et al., 2016).

Likewise, many countries turn to eHealth to promote health equity. A study shows that eHealth empowered patients, ensured patient safety, improved communication between healthcare professionals and patients, promoted access to health information and increased chronic disease management and prevention effectiveness. Moreover, through eHealth, medical experts and specialists became more accessible for patient treatment and training of healthcare professionals. It made the medical and healthcare systems more effective (Moghaddasi et al., 2017).

However, academics and researchers know that the widely-held view mentioned above is not always accurate. Despite huge benefits from digital technology, there is no warrant that it will always lead to health equity. For instance, new digital technology and tools may require new hardware or software that is not accessible or affordable for some groups of people or communities. Worse still, new technology and tools may make obsolete and unavailable those that are affordable and being used among underprivileged groups or communities. In addition, the commercial aim of technology producers leads to limited access or even exclusion of poor consumers (Fong & Harris, 2015). From there, it is evident that the use of technology in itself excludes those who have no technological access. Therefore, instead of health equity, it promotes health disparities differently. The inaccessibility may be due to age, education, income, and infrastructure. It can be because of linguistic and cultural barriers. Patients can be illiterate or have literacy in languages other than that used in technology. Technological discrimination may also come from excluding persons with disabilities in technological design (Moghaddasi et al., 2017).

Significantly, in the past decades, cutting-edge technology, especially the highly sophisticated ones like artificial intelligence (AI),[1] has had crucial roles in almost every sector of society, including healthcare and medicine. Organizations in different sectors use AI technologies, mainly for marketing and financial goals, without clearly understanding the back-end of their sophisticated processes. As a result, they may overlook the fact that decision-making and action executed by AI can produce or perpetuate social biases based on sex, gender, ethnicity, and religion. This concern also raises the question of AI and social inequity.

[1] In this context, the word "artificial intelligence" is the common usage applied in the news, media, and industrial sector. It is typically equivalent to machine learning, deep learning techniques, as the technological system that can learn from the vast and complex database to process, predict, and make a precise decision, for example, medical diagnosis with image processing.

Promoting health equity through digital technology and AI is a new research area in Thailand. Relevant organizations, such as Health Systems Research Institute (HSRI), need research agendas to explore and understand its advantages and limitations to design policies and plans to support the implementation of and prevent problems from the effort toward health equity through digital technology and AI. An ethical framework is required to assist the research agenda-setting. Although there exists the Thailand AI Ethics Guideline was developed by the Office of the National Digital Economy and Society Commission, Ministry of Digital Economy and Society, it was designed for AI governance in general and, therefore, cannot adequately provide a foundation for developing an ethical framework to serve the analysis of issues related to digital technology, AI, and health equity. Therefore, this research aims to develop a context-specific ethical framework to support an analysis that can provide an overview of different elements in ethical issues in the context of AI applications in medicine and health care. These elements can provide a basis for further developing research agendas to support policy and direction setting.

This article includes six parts: 1) Background and significance of the study, 2) Objective of the study, 3) The method of the study, 4) Result, 5) Example of applying the ethical framework in digital technology, AI, and health equity, and 6) Discussion and suggestion.

Objectives of the study

2.1 To analyze ethical principles for the promotion of health equity through digital technology and AI

2.2 To synthesize the ethical framework for analyzing issues related to the promotion of health equity through digital technology and AI

The method of the study

This article presents findings that are part of the research project "Artificial Intelligence and Health and Social Equity," which collected qualitative data from relevant documents and expert opinions solicited in multi-disciplinary workshops attended by academics, researchers, and experts from the fields of humanities, social sciences, medicine, healthcare, and computer science. The presented findings are from the documentary study, in which related documents were surveyed by keyword searches such as digital technology, AI, medicine, healthcare, ethics, laws, and health equity. They were selected based on two considerations. First, the documents were comprehensive. That is, they were based on meta-analyses or reviews of existing literature. Second, the documents covered all of the keywords related to this study. From the selected documents, content analysis was used to analyze and categorize ethical principles. They were then synthesized to form an ethical framework for consideration of issues related to digital technology, AI, and health equity. The data's validity and reliability were ensured through the continuous critical review and comparative analysis of the data and expert feedback. In section 4, the resulting framework is presented while, in section 5, examples are presented of its application to analyze issues obtained from the multi-disciplinary workshops.

Result

Health equity is an ethical concept that addresses social justice in the context of healthcare. The notion of health equity is based on distributive justice, that is, fair allocation of healthcare resources (Braveman & Gruskin, 2003, p. 255). A focus is drawn to the concept of equity after social determinants of health are addressed instead of diseases and illness when health issues are analyzed. It is important to note that there is a difference between health equity and health equality. While the latter focuses on similar healthcare resources (such as access to primary healthcare and medical services) or equal living conditions, the former aims to eliminate unnecessary or avoidable causes of health disparities. These causes include, for instance, social discrimination (Fee & Gonzalez, 2017, pp. 149-151).

As mentioned above, the concept of health equity is ethical. It involves how we think about health base on social determinants of health. To consider these factors to improve health equity, stakeholders from the policy to the practical level need an appropriate ethical framework (DeCamp et al., 2020, p. 2743). For this reason, we explored relevant ethical principles. We synthesized them to offer an ethical framework in analyzing and classifying issues related to digital technology, AI, and health equity. Documents obtained from keyword searches were selected for comprehensiveness and encompassing all the keywords such as digital technology, AI, medicine, healthcare, ethics, laws, and health equity. These papers include Floridi and Cowls (2019), Royakkers et al. (2018), Meskó and Görög (2020), Gasser et al. (2020), Morley et al. (2020), Gerke et al. (2020).

Floridi and Cowls (2019) reviewed and critically analyzed six high-profile ethical frameworks such as the Asilomar AI Principles, the Montreal Declaration for Responsible AI, and the UK House of Boards Artificial Intelligence Committee to offer a universal ethical framework. They then offered a unified ethical framework comprising five core principles: beneficence, non-maleficence, autonomy, justice, and explicability. In comparison to Floridi & Cowls (2019)'s principle-oriented approach, Royakkers et al. (2018) focused on general ethical issues and challenges of AI applications, which were extensively reviewed and categorized under six ethical principles, namely, privacy, autonomy, safety and, security, the balance of power, human dignity, and justice.

Meskó and Görög (2020), Gasser et al. (2020), Morley et al. (2020), Gerke et al. (2020) widely explored ethical principles and challenges of AI applications in the context of medicine and health care. Different ethical frameworks were presented to explain and manage these issues and challenges. For example, Morley et al. (2020) used the epistemic, normative, and overarching categories to classify ethical concerns, while Gerke et al. (2020) applied a framework covering the categories of informed consent to use, safety and, transparency, algorithmic fairness and biases, and data privacy. Gasser et al. (2020) categorized ethical issues and offered layers of ethical principles to deal with them. The first layer includes six general AI ethical principles: autonomy, beneficence, justice, non-maleficence, privacy, and solidarity. In response to the context of health care, these principles were translated into ethical principles

in the second layer, including consent and voluntariness, transparency, scientific validity, and public benefit.

A critical review of these works showed that it was necessary to analyze and synthesize the principles presented therein to formulate a comprehensive ethical framework. There are two main reasons. First, although the principles found in these documents are overlapped, no single document contains all of the principles. Second, in these documents, general ethical principles and principles of ethics management are not always clearly distinguished. Because of these two reasons, analysis and synthesis were conducted to form an ethical framework that covers all of the principles categorized into the general and management principles.

As mentioned above, ethical principles can be divided into two main groups: the general principles and the principles for management. The latter is connected to the former since the principles for management are meant to serve the general principles. Furthermore, the analysis showed that general principles comprise core principles, major principles, and minor principles. In what follows, the results of the analysis and synthesis are presented. Since it is indicated that the principles are derived from the selected documents, references are omitted in order to offer a neat presentation.

General principles

Ethical principles that were found to be general principles were derived from the selected documents-and re-categorized and re-organized into core principles, major principles, and minor principles. The results are as follows. The general principles comprise four core principles: *Human Dignity, Justice, Non-maleficence, and Beneficence*.

First, the core principle of *Human Dignity* requires respect for the person, her worth, and individuality. To realize this principle, three major principles have to be followed:

(1) *Non-dehumanization*: avoid objectifying human beings and ignore their desires or purposes.

(2) *Privacy*: respect personal data to allow individuals to be in control of their private data and maintain autonomy.

(3) *Autonomy*: respect persons' choices and decisions.

Accordingly, two minor principles are presented to assist persons' decision-making in supporting these three major principles.

a) *Explicability*: provide users of digital technology and AI with information that enables them to understand underlying mechanisms and databases, and decide whether or not to use or trust the products.

b) *Transparency*: disclose significant information about digital technology and AI, especially concerning data privacy policy and sources of training data.

The second core principle of *Justice* is about the fair distribution of benefits and burdens. This principle includes major principles as follows:

(1) *Solidarity*: equally allocate benefits and burdens to social members.

(2) *Diversity*: develop technology and AI with respect for diversities.

(3) *Fairness and Non-discrimination*: treat people equally, avoid discrimination against, and unfairly burden particular groups of people.

(4) *Accountability*: determine persons in the policy and practical level to allow identification of those to be punished, pay compensation, or offer solutions when problems arise.

The third core principle of *Non-maleficence* holds that no harm, damage, or even unnecessary inconvenience should be caused to persons. This core principle includes two major principles as follows:

(1) *Privacy*: avoid causing harm or damages from disclosing private information. Though this principle appears under the core principle of *Human Dignity* above, its emphasis is on harm prevention, not autonomy. This principle has one minor principle:

   a) *Security*: securely protect private and personal information from breaches.

(2) *Safety*: ensure the safety of digital technology and AI for users. This principle involves three minor principles:

   a) *Explicability*: offer clear explanations of underlying mechanisms of digital technology and AI to users. This minor principle supports the safety principle since knowledge and understanding enable users to decide on potential benefits and risks.

   b) *Transparency*: disclose digital technology and AI information, especially training datasets and collecting of users' data. Like *Explicability*, this minor principle supports users' decisions about potential benefits and risks.

   c) *Accountability*: assign responsibilities to different people to be in charge of different procedures and held accountable.

The fourth core principle of *Beneficence* requires an act in the best interests of others. It comprises the following major principles:

(1) *Public Trust*: promote the public's confidence in the safety and security of digital technology and AI. It is presupposed that, if the public trusts the technologies they use, they will have a positive attitude toward them and, therefore, use and benefit from their use. These core principles cover the same set of minor principles as the major principle of *Safety* under the core principle of *Non-maleficence*: *Explicability*, *Transparency*, and *Accountability*.

(2) *Societal and Environmental Well-being*: consider and create a long-term state of healthiness, quality of life, and environmental sustainability. There are two minor principles, that is, *Explicability* and *Transparency*. These principles lead to intelligibility allowing society to subject digital technology and AI to proper use and maintenance. Also, knowledge and understanding can be a basis for further development and innovation.

Principles of management

As indicated above, the analysis showed a group of ethical principles whose role is to serve the implementation of those in the category of general ethical principles. This group was derived from the selected documents and re-organized according to the general ethical principles. The principles of management can serve more than one core principles. In addition, the management principles can serve the major and minor principles under each of the core principles. Since an aim is to present an overall framework, an explanation is omitted of detailed connections between the management principles and the core principles, including the major and minor principles. Explanations of each of the management principles are as follows.

First, the principle of management for Human Dignity includes *Balance of Power* and *Human Oversight.*

i. *Balance of Power*: prevent monopolization of digital technology and AI to maintain a check-and-balance system and negotiation power among government, public, private, and civic sectors. The balance of power protects users from dominance and allows them to make choices and preserve their autonomy.
ii. *Human Oversight*: Allow human access to intervene in digital technology and AI operation procedures to maintain human control and decision-making and prevent total dependence on machines.

Second, the principle of management for Justice involves a *Balance of Power*, which prevents monopolization and allows stakeholders to voice their concerns, needs, and problems. *Participation* allows all stakeholders to make decisions about the use and management of digital technology and AI.

Third, the principle of management for Non-maleficence comprises eight principles as the following.

i. *Privacy and Data Governance*: regulate data collection, sharing, and storage to protect privacy and personal data.
ii. *Scientific Integrity and Information Quality*: research and develop digital technology and AI with scientific rigor and good quality data.
iii. *Risk Assessment and Management*: prevent risks and harms from using digital technology and AI through risk analysis and planning.
iv. *Technical Robustness and Safety*: develop and maintain accurate, reliable, and safety systems to control and monitor the use and operation of technology and AI.
v. *Interagency Coordination*: promote coordination between organizations and parties within the public sector or between the public and private sectors to manage digital technology and AI development and safety.
vi. *Balance of Power*: create and maintain check-and-balance systems to prevent risks and harms.
vii. *Human Oversight*: ensure the human ability to intervene in digital technology and AI operational processes to prevent risks and harms, or rectify mistakes.

viii. *Participation*: encourage all sectors to share their concerns and problems to mutually plan and manage development and use of digital technology and AI to prevent risks and harms.

Finally, the principle of management for Beneficence includes eight principles, as shown in the following lists.

i. *Flexibility*: develop policies and regulations to allow adaptability that facilitates problem-solving, choice, and digital technology and AI development.
ii. *Scientific Integrity and Information Quality*: develop digital technology and AI through scientific honesty and rigor, and good quality data to benefit users and society.
iii. *Risk Assessment and Management*: evaluate and reduce risks to promote the efficiency of technological development.
iv. *Benefits and Costs*: weighing and balancing benefits and costs in choice and development of digital technology and AI.
v. *Interagency Coordination*: promote coordination among different government agencies.
vi. *Balance of Power*: prevent monopolization, which obstructs competition and technological advancement.
vii. *Human Oversight*: allow human intervention in all digital technology and AI operational processes and direct their use toward the most beneficial goals.
viii. *Participation*: All stakeholders can share their concerns, needs, and problems to manage better or develop digital technology and AI.

Based on the above explanation, the ethical framework is shown in Table 1.

Table 1 Ethical framework on digital technology, AI, and health equity

General principles			**Principles for management**
Core principles	**Major principles**	**Minor principles**	
Human Dignity	(1) *Non-humanization* (2) *Privacy* (3) *Autonomy*	a) *Explicability* b) *Transparency*	Principle of management for Human Dignity i. *Balance of Power* ii. *Human Oversight*
Justice	(1) *Solidarity* (2) *Diversity* (3) *Fairness and Non-discrimination* (4) *Accountability*	-	Principle of management for Justice i. *Balance of Power* ii. *Participation*

<table>
<tr><th colspan="3">General principles</th><th rowspan="2">Principles for management</th></tr>
<tr><th>Core principles</th><th>Major principles</th><th>Minor principles</th></tr>
<tr><td rowspan="2">Non-maleficence</td><td>(1) Privacy</td><td>a) Security</td><td rowspan="2">Principle of management for Non-maleficence
i. Privacy and Data Governance
ii. Scientific Integrity and Information Quality
iii. Risk Assessment and Management
iv. Technical Robustness and Safety
v. Interagency Coordination
vi. Balance of Power
vii. Human Oversight
viii. Participation</td></tr>
<tr><td>(2) Safety</td><td>a) Explicability
b) Transparency
c) Accountability</td></tr>
<tr><td rowspan="2">Beneficence</td><td>(1) Public Trust</td><td>a) Explicability
b) Transparency
c) Accountability</td><td rowspan="2">Principle of management for Beneficence
i. Flexibility
ii. Scientific Integrity and Information Quality
iii. Risk Assessment and Management
iv. Benefits and Costs
v. Interagency Coordination
vi. Balance of Power
vii. Human Oversight
viii. Participation</td></tr>
<tr><td>(2) Societal and Environmental Well-being</td><td>a) Explicability
b) Transparency</td></tr>
</table>

Example of applying the ethical framework in digital technology, AI, and health equity

This part presents an example of how to apply the ethical framework (as explained in the previous part) to analyze and categorize issues under fairness and technological

accessibility. The issues were obtained from discussion among participants in the multi-disciplinary workshops. The participants in the multi-disciplinary workshops shared and discussed various details, which required a framework to analyze and categorize into topics and sup-topics that could be further developed into research agendas. Through the ethical framework synthesized in this study, the researchers were able to see that a portion of details could be analyzed and categorized with the principle of *Fairness and Non-discrimination*, the major principle under the core principle of *Justice*; and those of *Privacy and Autonomy*, the major principles under the core principle of *Human Dignity*. The analysis also shows that the management principle of *Balance of Power* is relevant to both of the core principles in this context (please see Table 2.

Table 2: The relevant principles related to the issue under analysis

General Principles			**Principles for management**
Core principles	**Major principles**	**Minor principles**	
Human Dignity	(2) *Privacy* (3) *Autonomy*	-	Principle of management for Human Dignity *i. Balance of Power*
Justice	(3) *Fairness and Non-discrimination*	-	Principle of management for Justice i. *Balance of Power*

That portion of details is as follows. First, because of the widespread use of AI technology, the workshop participants saw the possibility of using collected data to advance a cause of social justice. At the same time, they were aware of the need to request consent and protect privacy. Second, the participants in the workshops discussed problems of digital exclusion and the digital divide. Certain segments of the Thai population, such as the poor and the elderly, cannot access the internet because they lack tools, resources, knowledge, and skills. As a result, they are excluded, especially from the public service and welfare system that requires internet access and digital applications. Third, the participants pointed out the problem of the digital divide in the design and use of AI technology caused when some data sets may be ignored in processes such as machine learning. Problems faced by people with disabilities were also raised. The workshop participants drew attention to a loophole in the effort to promote social justice by offering technological assistance to people with disabilities. When technological choices were being made, a focus tended to be on tools or products while the disabled people's context of life was ignored. Consequently, people with disabilities could not benefit as much as they should from the products used in the actual context. At times, the introduction of new assistive technology accompanied physical discomfort and psychological stress. This led to the conclusion that the availability of physically and psychologically

supportive environments should be considered along with technological choices. Another related issue was that, when the focus of technological choices was on products, a question of the disabled people's capacity to use and access the products was downplayed. Therefore, even though the introduction of these tools was meant to promote their self-dependency, these people with disabilities could not integrate these tools into their usual way of life and became more dependent on others to help them use the tools.

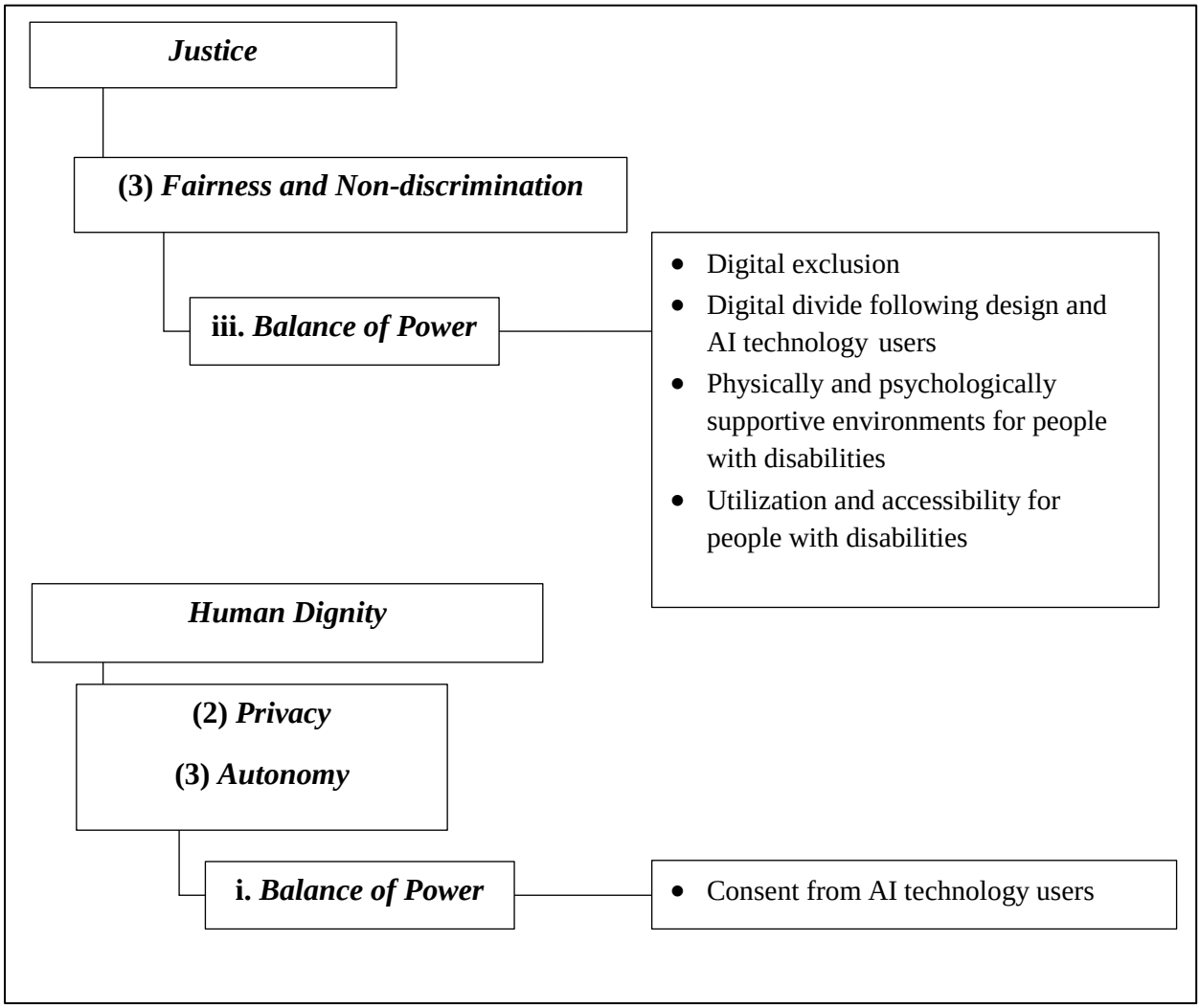

Figure 1 An analysis of fairness and technological accessibility

Based on the ethical framework, the analysis showed that the first point fell under the major principles of *Privacy* and *Autonomy* under the core principle of *Human Dignity*. From the management perspective, it fell under the principle of *Balance of Power*. The principles of *Privacy* and *Autonomy* require that consent be obtained from users of AI technology to protect their privacy and give them control over their personal data. In terms of management, this

allows the users to have some negotiating power over the terms of use. The analysis also showed that the second and third points could be categorized under the principle of *Fairness and Non-discrimination* under the core principle of *Justice*. To serve this principle, the management principle of *Balance of Power* is required to allow affected parties to voice their needs and problems (please see Figure 1. Based on the analysis, these points are not only categorized but also acquire a direction that allows further development into research agendas. For example, not to mention questions about its nature and victims of injustice, the point of avoiding digital exclusion can lead to a research question of how to develop mechanisms to create the balance of power by allowing the excluded population segments to have a say over their needs and problems concerning digital access.

Discussion and suggestion

In Thailand, there is an ethical framework in place. The Office of the National Digital Economy and Society Commission, Ministry of Digital Economy and Society, issued a white paper "Thailand AI Ethics Guideline" for regulators, researchers, designers, developers, service providers, and users to utilize as guidelines to govern AI technology and realize fairness, transparency, ethical principles, and human rights, reliability, safety, and benefits to human beings, society, and environment. The guideline proposes six aspects of the AI ethics principle: (1) competitiveness and sustainability development, (2) laws, ethics, and international standards, (3) transparency and accountability, (4) security and privacy, (5) fairness, and (6) reliability (Office of the National Digital Economy and Society Commission, n.d.). However, this ethical framework is not explicitly designed to analyze digital technology, AI, and health equity issues. In contrast, the framework presented here contains principles to analyze and manage these issues. The core principles of Human Dignity, Justice, Non-maleficence, and Beneficence can provide a lens to identify different aspects of health disparities. At the same time, the major and minor principles enable further analysis of the nature of disparities under each of the core principles. In addition, the principles of management are presented to show what responsible persons or organizations should do to implement the ethical principles.

Nevertheless, since the principles in the ethical framework presented in this study can be related to the Ministry's guidelines, the framework can be seen as an extension of the Ministry's guidelines to respond specifically to health equity issues. For example, the core principle of *Beneficence*, which includes two major principles: *Public Trust* and *Societal and Environmental Well-being*, may strengthen the first principle of the Ministry's guideline, which is "competitiveness and sustainability development." One detail states that "artificial intelligence should be created and used for benefit and well-being of humans, society, economy, and environment in sustainable ways" (Office of the National Digital Economy and Society Commission, n.d.). This principle aims to benefit society in a long-term and sustainable way, which is essential for solving today's world problems. The fifth principle of the Ministry's guideline is "fairness," which says, "the design and development of artificial intelligence should be aware of diversity, avoiding monopoly, and decreasing discrimination and bias. It

will benefit the people, especially vulnerable people, as diverse as it can." Furthermore, it also states that "the decision regarding important research, design, development, services, and uses of artificial intelligence should be able to prove the providing of fairness" (Office of the National Digital Economy and Society Commission, n.d.). These statements are consistent with the principles we proposed in this article, which are (1) the core principle of *Human Dignity* comprising three major principles: *Non-humanization, Privacy, and Autonomy*, and (2) the core principle of *Justice* including four major principles: S*olidarity, Diversity, Fairness and Non-discrimination, and Accountability.* Therefore, it is recommended that further analysis be conducted to ascertain the possibility of this extension.

Lastly, there is a remark that research on AI on a global scale has geographical and contextual restrictions within the U.S.A and Europe. The social impacts of AI are potentially diverse on the geographical and cultural differences. These differences affect people's understanding of ethical concepts and principles (Hagerty & Rubinov, 2019). Since the ethical framework presented in this study resulted from the synthesis of ethical principles proposed in the Western context, research should be conducted to study the understanding of the Western ethical principles in the cultural context of Thailand. The present article is based on the first phase of the research project, which aims to analyze global AI ethical principles applied in those countries with extensive experience in applying and implementing cutting-edge AI technologies. Featuring the multi-disciplinary workshops, its second phase focuses on the perception and application of these global AI ethical principles in the Thai context of medicine and health care to promote health equity. It was found that the ethical framework could assist an ethical analysis and research agenda setting, as shown above.

Acknowledgments

This article is a part of the research "Artificial Intelligence and Health and Social Equity" under the project "Research Program under Inclusive Society Research Excellence Centre (ISREC)," supported by Health Systems Research Institute (HSRI).

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