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## Socio-Technical Design of Algorithms: Fairness, Accountability, and Transparency

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Socio-Technical Design of Algorithms: Fairness, Accountability, and Transparency

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## SOCIOTECHNICAL ALGORITHM

### Abstract

Algorithms play increasingly critical roles these days. With the conceptualization of algorithms as a socio-technical system, this study investigates the algorithm initiatives in Korea in terms of opportunities, risks, and challenges embedded in their development. It analyzes the algorithm development and trends from a critical socio-technical lens: social, technological, cultural, and industrial phenomena that represent the strategic interaction among people, technology, and society, eliciting sensitive issues of legal, cultural, and ethical rhetoric. Despite rosy predictions and proactive drives, new risks such as privacy, transparency, and fairness emerge as critical concerns of the social ramifications of algorithms and their impact on the new information milieu. With these rising issues, the questions are raised as to how to govern algorithms and how to respond to the possible outcomes that such a policy choice may have on society and industry. The socio-political implications of algorithms are discussed using Korean cases of algorithm initiatives to identify key features as the country progresses toward an algorithm-based and AI-driven society.

*Keywords:* Algorithms; algorithm-based society; algorithm policy; socio-technical perspective; socio-technical algorithms

### Socio-Technical Design of Algorithms: Fairness, Accountability, and Transparency

#### **1. Introduction**

The use of algorithms and analytics in society is drastically increasing (OECD, 2017). Nowadays, artificial intelligence (AI) increasingly arbitrates decisions in our lives through a wide variety of implementations such as online machine learning recommender systems, tailored news aggregation services, credit scoring methods, and location-based services. Advancements in algorithms provide unprecedented venues for breakthrough in important decision-making fields such as content curation, recruiting, health and safety, security, crisis management, and public management (Mackenzie & Vurdubakis, 2011). Driven by very large amounts of big data that have become available, algorithms have emerged as the new power agents in society (Diakopoulos, 2016). Algorithm technology is drastically revolutionizing industry and society, and is becoming an integral part of everyday life.

The great potential of an algorithm-driven economy is broadly acknowledged, and there is mounting enthusiasm and pressure to achieve the vision of an algorithm-based society (Beer, 2017). The rapid adoption of algorithm technologies has the potential to greatly improve user experiences and human life, but it also poses a number of problems and questions that need to be addressed when such a system is more widely diffused in societies (Kitchin, 2017). Although algorithms have the potential to offer increasingly sophisticated products and services, governments and firms have encountered problems in establishing justifiable governance and management in regard to algorithm initiatives (Ziewitz, 2016). In Korea, for example, while the benefits of algorithm technologies are observable, the realization is slow and complicated, primarily owing to emerging concerns and issues. Recent discussions concerning algorithms have been technology-driven and industry-oriented, leaning toward functional efficiency at the

## SOCIOTECHNICAL ALGORITHM

cost of user privacy and data security (Mittelstadt et al., 2016). Thus far, most algorithm development efforts have predominantly been based on the supply side, or on the technical development of predictive analytics and commercializing automated processes (Ziewitz, 2016). Little attention has given to the complex ramifications of the social, organizational, cultural, and political dynamics integral to algorithm development and implementation (Diakopoulos, 2016). Particularly, prevailing issues surrounding algorithms, such as privacy invasion, abuses, fairness, and data governance are rarely addressed in light of the intense technology development (Doneda & Almeida, 2016). Against this backdrop, the European Union (EU) introduced the General Data Protection Regulation (GDPR) to address data privacy laws in the EU to protect and ensure people's data privacy and to shape the way that organizations approach data privacy (OECD, 2017). GDPR privacy monitoring will be enhanced under the revised ePrivacy Regulation in 2018. The regulation will further control the inputs to algorithms and the use of outputs (European Commission, 2017), augmenting the general law proposed in the GDPR with rather more specific rules for communications regarding personal data. These issues, including user privacy, data policy, and ethical considerations of how we develop and oversee the evolution of the use of algorithms, will be important to its sustainability and long-term success, both in Korea and worldwide.

This study views an algorithm as a socio-technical system and contextualizes its critical discourse. Algorithm technologies are a part of broader social realities, wider programs of socio-technical change, and thus, their design and development should be grounded on user interests and rights within a social, political, and cultural environment. This point is consistent with the socio-technical perspective that the development and implementation of technologies should be based on contextual knowledge, that is, a context-sensitive design and assessment that defines

## SOCIOTECHNICAL ALGORITHM

the suitability of a technology within a particular setting (Shin & Choi, 2014). Contextual issues regarding algorithms, such as fairness, accountability, and transparency have surfaced, representing potential concerns regarding the processes of algorithm development (Sloan & Warner, 2017). Such issues are contextual in the sense that they are not readily resolved with technical solutions, as the issues are heavily rooted in local features of different societies and existing socio-technical regimes. In such issues, involving much of machine learning, there are no clear solutions, and issues may be further complicated by relationships with various components in socio-technical algorithm systems. High complexity and social ramifications imply the concept of an algorithm ecosystem, in which an algorithm represents an interrelated, multifaceted ecosystem of networks, protocols, applications, services, practices, and users.

This study conducts socio-technical evaluations on the design, development, prospects, and limitations concerning algorithm development in the Korean context. By recognizing challenges and opportunities, it identifies a socio-technical solution for algorithms by seeking suitable social norms, governance, market and industry dynamics, and user acceptance. A socio-technical perspective integrates the social, political, and technological understanding of algorithms and suggests an interface ecology for their interactions, where the interface is a zone between people, activities, codes, components, and systems (Avgerou, Ciborra, & Land, 2004). The relationship between algorithms and their contextual discourse offers heuristic insight into the planning, strategy, and development of an algorithm-based society.

The Korean case offers normative examples of technology development, where the government has been proactively implementing policies and making significant investments over several years, promoting algorithmic initiatives that offer critical cases with respect to infrastructure development, regulatory systems, industry mobilization, and organizational

## SOCIOTECHNICAL ALGORITHM

configurations conducive to policy execution. Korea's strong development of algorithms has generated further *a priori* matters concerning conceptualizing and the planning of algorithms as a socio-technical ensemble. The insights from *a priori* questions can suggest an *a posteriori* justification for algorithm implementation. It is societally relevant and technologically meaningful to evaluate the Korean initiatives to algorithms and the momentums that affect the country's algorithm initiatives. Discussion of algorithms through socio-technical ensemble has yielded the following inquires:

Research Question 1: What challenges and issues have been faced with national initiatives to forge a nation-wide algorithm-based society?

Research Question 2: To what extent has society adapted to the development of algorithms? What are the social and contextual issues emerging from the proliferation of algorithm-based systems?

Research Question 3: How have these dynamics influenced people, industry, and society?

The socio-technical analyses in this study review the effects of algorithms on the representation epistemologically, realization ontologically, and governing politics economically. This multilayered examination leads to conceptual frames of each level: individual epistemological reflection, organizational developmental guidelines, and societal regulatory framework. The frame gives a sustainable paradigm and an ecology model for algorithm practices and development. Korea's strategy reflects an "Artificial Intelligence Information Society," a future envisioned by the risks and challenges brought about by the proliferation of automated machines and computers at all levels of the economy. An important task is to understand how to catalyze and support the process of transitioning towards algorithmic innovations rather than technical development. This study concludes that algorithms should be

## SOCIOTECHNICAL ALGORITHM

designed and developed in a human-centered and socially accountable manner to contribute to more transparent and fairer development to produce significant positive impact with clear accountability.

This conclusion is related to the key contribution of this study. The results of this study contribute to the insights and practical knowledge on the interactions between society and algorithms. The algorithm society is increasingly featured with an ecosystem of complex, socio-technical applications. This study contributes to the understanding of how to see algorithms within a social context, how to design algorithm systems that are human-centered and socially-accountable, and how to govern algorithm systems effectively and legitimately.

### **2. Literature Review**

#### *2.1: Theory of socio-technical systems: Algorithm ecosystem*

Algorithm systems are socio-technical systems that handle human interaction with technological systems (Kitchin, 2017; Shin, 2014). Algorithm systems are composed of one or more technological algorithms, and at the same time, the algorithm reflects user knowledge and social experience, and ultimately user acceptance. What establishes an algorithm system as a socio-technical system is that it is generated by or related to a system that is adopted and used by social users in societies. Thus, socio-technical approaches to algorithm evaluation focus on the relationship between technology and its social environment. A socio-technical lens helps us to view algorithms not only as technological artifacts, but also as sensitizing devices that can help us to rethink entrenched premises regarding fairness, transparency, and accountability (Ziewitz, 2016).

With a socio-technical frame in place, this study complements the notion of ecology. Given the social ramifications of AI, it is important to be aware of the entanglement of



## SOCIOTECHNICAL ALGORITHM

algorithms with their ecology — the technological and human environment within which a particular set of instructions is interpreted and put to work. It emphasizes an algorithm's relational properties — how it interacts with technologies and human collectives. In exploring their ecology, we can elucidate key questions on fairness, transparency, accountability, and trust.

Although it is obvious that the vast competitive benefits afforded by algorithms, specifically efficiency through impressive automation and sophisticated filtering, questions remain over the extent to which human decision-making will be processed by computers (Diakopoulos & Koliska, 2016). The prevalent practice and over-reliance on algorithms has also triggered issues of potential anti-competitive behaviors, as they can easily facilitate companies to attain and enhance collusion without any appropriate process or agreement (OECD, 2017). Among others, there is an inherent problem with algorithms, which begins at the most basic level: human bias that is embedded in these algorithm-based decision-making systems (Pariser, 2011).

Related to this point, there is a rising concern over the accountability of algorithm services (Diakopoulos, 2016), that is, a question of who is accountable for the results of firms' programmed algorithms (Fink, 2018). This concern goes hand in hand with algorithmic transparency, which requires firms be forthcoming regarding the goals, structure, and underlying procedures of the algorithms used to search for, process, and deliver information (Diakopoulos & Koliska, 2016). The issues of accountability and transparency can significantly undermine an algorithm-based society by creating a series of undesired and even hazardous problems in AI systems if not addressed properly (Burrell, 2016).

From a socio-technical system view, algorithms represent normative principles and heuristic guidelines that can be used to offer user benefits and improve society. A socio-technical

## SOCIOTECHNICAL ALGORITHM

analysis does not consider algorithms as ideal accomplishments or hypothetical abstracts, but instead unravels the human and social choices that lie behind these technical artifacts (Shin & Choi, 2014). Understanding algorithms as a socio-technical ensemble facilitates the smooth transfer to human-centered and sustainable algorithm use within human society (MacKenzie, 2014).

### *2.2 Algorithm policy around the world*

The European Union is the most progressive law-making organization with regard to algorithm policy. With GDPR coming into effect in May 2018, the EU has established itself as a role model of algorithm policy in the world. The basic premise of GDPR is that users must give their consent before a company such as Facebook can start to collect personal data. GDPR enshrines data privacy as a fundamental human right, and has become a model for other countries. For example, calls for America to follow the EU's GDPR in the US have become increasingly vocal. However, the US is preparing to formulate a better way to balance the industry's interests of technological innovation with privacy concerns. US federal regulators are considering data policy in the age of big data, and for the US, this task will be challenging because global companies based in the US, especially those using cloud-based marketing and ad technology that tracks European users' browsing habits, face significant regulatory exposure. The US Public Policy Council released their "Statement on Algorithmic Transparency and Accountability," including seven principles that organizations should follow to address potentially harmful biases stemming from using algorithms. The seven principles include users of analytic systems maintaining awareness of biases arising within their design, institutions maintaining accountability for the decisions they make based on their algorithms, and ensuring all decisions are recorded in case an audit is conducted in the event that harm is suspected. While

## SOCIOTECHNICAL ALGORITHM

these principles cannot guarantee transparent and fair algorithms, this effort has been given in the US.

While the Western hemisphere has prepared GDPR well, Asian countries in general are still struggling coming up with appropriate policies. More than half of businesses in Japan, Singapore, and Korea are among the least prepared for the upcoming data privacy laws. Some 50 percent of Singapore-based firms had expressed concerns that they would have difficulties with GDPR. Further, 60 percent of businesses in Japan as well as South Korea expressed similar concerns, placing them last globally in GDPR readiness (OECD, 2017). About 21 percent in Korea as well as Japan were concerned that non-compliance could result in loss of customers due to negative media and social coverage, while this figure stood at 20 percent in Singapore.

Amongst such worries, Japan recently issued an extensive amendment to the 2003 Act on the Protection of Personal Information. The Act was designed to protect the rights and interests of individuals while ensuring due consideration for the use of personal information by basic principles for the proper handling of personal information. The amendment was a reflection of the global trend of increased data privacy regulation, specifically the EU's GDPR. The Japanese government and European Commission reached a joint agreement that they would work side by side to provide their citizens with a higher level of data privacy. In late 2017, the two also agreed that they would work to whitelist each other by early 2018, spotlighting the growing role of data privacy in international business relations.

### **3. Methodology**

The data analyzed in this study were collected from a variety of venues and diverse methods. Algorithm systems are complex and heterogeneous, and the process of understanding the phenomena should be varied and multi-faceted. Multiple triangulation methods were used to

## SOCIOTECHNICAL ALGORITHM

validate data through cross verification from two or more sources. By combining multiple observers, concepts, methods, and empirical materials, this study overcomes limitations, intrinsic biases, and problems of single method, single-observer, and single-theory studies.

Primary data were collected through interview methods; however, secondary data were used as a main source, that is, archival materials were used such as government white papers, industry reports, public documents, technical reports concerning design, planning, and implementation of algorithms, machine learning, and AI. Content analysis was used to analyze the secondary data obtained from the literature. The content analysis provides explicit knowledge that is appropriate for this study because the institutional factors of algorithm society may not be directly observable or verifiable. In addition, a content analysis is context sensitive, thereby enabling this study to process the symbolic forms of an intelligence society. The documents used in the content analysis were collected from journals, newspapers, government and industry reports, public documents, and databases.

Interviews were performed with people from the public sector (government officials), industry (practitioners), universities (professors), and government-run research institutes (researchers/advocates). A total of 33 people were interviewed by phone, email, or online conferences. Respondents chose interview methods depending on their preferences and availability. Telephone interviews lasted from 20 to 60 minutes and were recorded on audio tape.

The analysis was refined after data collection by a focus on the socio-technical factors in AI project development, the demand and supply roles in the ecology model, the roles of governments and industry, and player involvement in AI development. Collected data are used for triangulated findings. Whereas different data from the various methods contributed to various aspects of algorithms, certain methods were operated for specific aspects of AI. Specifically,

## SOCIOTECHNICAL ALGORITHM

content analysis of secondary sources was mainly used for the description of infrastructure, software and technology, service and applications, social and cultural issues, and usage.

Interview data were used for the description of government/governance and the social aspects of algorithms.

Table 1. Data collection

Sectors	Methods		Respondents
Public sector (Government)	Face-to-face	3	9
	Phone	3	
	Email/online	3	
Industry (Practitioners)	Face-to-face	4	11
	Phone	3	
	Email/online	4	
Research community (Academia)	Face-to-face	5	13
	Phone	4	
	Email/online	5	
Total			33

### 4. Korea's AI initiative: Concerns over FAT

Since 2016, the Korean government has strongly supported AI development. Se-dol Lee, one of the world's top Go players, had a historical match with Google's Alpha Go AI in Seoul. This event shocked Korea, as most Koreans were confident that Lee would win. Following this match, the Korean government has believed that AI will be one of the major industries to lead global markets, and has begun to invest in AI more strategically and efficiently (Kim, 2017).

AI has been selected by the government as a core field for the nation to focus during the coming decades (MSIP, 2016). The government began to strengthen the AI industry and market, with plans for completion by 2025, by improving the development of relevant technologies and augmenting the infrastructure and number of cognate services (Zhang, 2016). The Ministry of Science, ICT, and Future Planning (MSIP) began to provide support through the foundation of

## SOCIOTECHNICAL ALGORITHM

over 20 major algorithm firms and the development of up to 6,000 professionals in order to be Korea's position as a cutting-edge leader in algorithm technologies (Lee, 2016). The ministry also plans to invest 465 million USD in the emerging market until 2020. The government's plan to loosen regulations relating to online payment and transactions to strengthen its economic initiative will also develop public services by connecting massive data from the public and private sectors. To advance Korea's competitiveness in the AI sector, the ministry, in cooperation with the Electronic Telecom Research Institute has been developing AI service architectures that integrate private and public and data with plausible ideas (Zhang, 2016). The joint project is expected to introduce a smart intelligent service model, where public and private data converge and integrate. A total of 2 million USD (with each project ultimately receiving 22 to 41 million USD) has been assigned to the project, and additional capitals have been allocated after the selection of several consortiums (Kim, 2017). The ministry, through this project, will develop usable services for people and produce a series of collaborative projects by promoting sharing of data and active disclosure between the private and public sectors (Zhang, 2016). Against the progressive technical development of algorithms, there are emerging issues — matters that are socially, politically, and economically critical, and culturally sensitive subjects.

First, while algorithms produce many convenience and benefits, an algorithm-based system can create biased and manipulated results. A majority of Koreans read the news through portals on their smartphones or computers. They click on the stories that interest them among the ones offered by the portal on its main page. Once done with a story, they check the comments posted by readers. It gives Koreans a sense of how each issue is being received by the general public. This provides an important context to a recent online comment-rigging scandal involving a power blogger and former members of the ruling Democratic Party. They are suspected of

## SOCIOTECHNICAL ALGORITHM

rigging support for online criticism of the Moon Jae-in administration. What the members of the party and the power blogger, “Druking,” have done is highly manipulative, but going further than simply writing comments, they deliberately made people believe that certain comments were the most popular opinions. The blogger and ex-members of the ruling party, all currently in custody, allegedly used a computer program that artificially ramps up the number of clicks on “agree” — the equivalent of Facebook’s “like” — for comments on news stories on the Korean portal Naver. The portal automatically places the comments that receive the most “agree” responses at the top of the comment section, thereby giving them the most exposure to online viewers. This is not the first time that the country has been swept up by an opinion rigging scandal. In 2013, prosecutors concluded that agents from the National Intelligence Service, Korea’s spy agency, posted some 1.3 million online messages in 2012 to rig public opinion in favor of former president Park Geunhye (Lee, 2017).

Second, the issue of fairness emerges with the proliferation of machine learning algorithms in Korea. Machine learning algorithms are widely adopted and pervasively used now in everyday lives. They have recently begun replacing human decision makers in domains such as the criminal justice system and the field of medical testing, but the algorithms in such domains do not always behave fairly and equitably. Training machine learning algorithms with the objectives of maximizing prediction accuracy on the training data have often resulted in algorithms that behaved in a manner in which a human observer would deem unfair, often especially toward a certain group. For example, Naver, Korea’s most popular Internet search engine, has used search algorithms that take into account the users’ search patterns and provide more tailored and conclusive search results. Using Naver Contextual Knowledge Plus technology and Localized-Temporal Personalization System technology, the Naver search engine is able to

## SOCIOTECHNICAL ALGORITHM

predict and provide accurate search results. Yet, questions of whether Naver abides by users' rights when collecting user data and whether the search results are fair remain unclear. Despite advanced machine learning, algorithmic fairness has not been clearly defined, nor has there been any attempt to settle or stabilize the issue.

Third, the growing use of algorithmic systems in news production, from algorithmic recommendation to fact-checking and automated articles, problematizes the normative turn toward transparency as an important ethical code of journalism practice (Diakopoulos, 2016; Diakopoulos & Koliska, 2016). In Korea, a question of whether or not algorithms should be made transparent remains controversial. There is a common misconception among Koreans that algorithms automatically produce impartial decisions. In reality, inscrutable algorithms can also unfairly limit opportunities, restrict services, and even improperly reduce freedom. All information must be explained in context. Korean lawmakers have called for more transparency from online platforms (Naver & Daum) to open or at least share their internal algorithms to ensure a certain level of transparency. Civil and advocate groups call for transparent information algorithms that are accessible, verifiable, and understandable (Kim, 2017). As complex political and social issues emerge and develop, citizens should demand that all of the information related to algorithms be explained in context (Goodman & Flaxman, 2016).

Fourth, as algorithms and machine learning are increasingly being used to make decisions in Korea, how should firms go about making their automated decisions accountable?

Algorithmic accountability is the responsibility of algorithm developers to offer rationales regarding possible or actual harm (Diakopoulos, 2016). Naver recommendations are based on AI and algorithms; Daum ranks news articles based on its code; and Kakao Story's News Feed is being controlled by machine learning. While these services may greatly improve efficiency of



## SOCIOTECHNICAL ALGORITHM

user services, the algorithms employed can also amplify structural inequity, generate critical errors that deny services to people, or even seduce an electorate into a forged sense of security. Indeed, there are growing concerns in Korea that the public should be wary of the risks posed by over-reliance on these systems and should hold them responsible and eventually accountable for their systems. Altogether, fairness, accountability, and transparency (FAT) pose significant inhibitors to the development of AI and algorithms in Korea. In fact, if handled properly, Korea can turn these issues into opportunities for an AI-based society. Korea must keep the FAT framework in mind when developing technological solutions with AI and algorithms.

### **5. The Algorithm as an Ecological Ecosystem**

Algorithms are a part of everyday human life. From a social-technical lens, algorithm phenomena can be dissected into constituents of the ecological ecosystem respectively, that is, data infrastructure, governance, industry, practice, people, and society. The frame reviews the reciprocal co-evolving interactions within the broader ecology of societies, communities, markets, institutions, and the usage and production of services (Carayon et al., 2015; Shin & Choi, 2014). The conceptualization of the algorithm as an organic ecosystem is useful, and it is critical to address all facets that comprise a socio-technical system.

#### *5.1. Infrastructure*

Algorithms provide low cost and automatized solutions. An algorithm requires certain optimized system and network infrastructures to be able to process a large amount of data, provide calculations, and provide reasonable automated processes. The algorithm infrastructure enables valuable decisions to be made without any human intervention by supporting the data lifecycle and improving the capacity of data collection and analysis, accretion, and generation

## SOCIOTECHNICAL ALGORITHM

over a long and extended period of time. Korea's approach to algorithms have, thus far, remained at the tactical level of technical implementation (Lee, 2016).

The government plans to invest \$840 million by 2022 to boost the AI industry (Zhang, 2016), and has supported the foundation of a state-of-the-art research center that would serve as a hub for the country's R&D in the AI fields. Samsung, SKT, KT, Hyundai, Naver, and Daum have joined the initiative. Each firm dedicates to invest approximately \$30 million. "Once the private companies set up the research institute, the government will provide financial support for core R&D projects," the ministry said.

### *5.2. Software and technologies*

The Korean government has been promoting the development of software and technologies related AI. Thus far, most attempts have geared toward the growth of algorithmic codes, data aggregation and integration, meta-heuristic algorithms, natural language processing, machine learning, simulation mechanism, programming, and data structures. Additional technologies involving algorithms include traffic prediction, route planning, data-mining grids, cloud-based file systems, and the Internet of Things.

There are numerous applications and services using AI in Korea. Among the application and services of AI, Korea's plan to develop autonomous weapons using AI triggered significant criticism. Korea planned to develop autonomous weapons (reported as "killer robots" by news outlets) in cooperation with

Korea Institute of Science and Technology/Korea Advanced Institute of Science and Technology and its industrial partner, defense firm Hanwha. This plan sparked serious opposition domestically and internationally. Artificial intelligence experts from nearly 32 nations are boycotting the plan expressing concerns that a new lab in partnership with a major defense

## SOCIOTECHNICAL ALGORITHM

company could lead to unethical killing machines. More than 60 renowned academics signed a letter calling for cancelling the plan. They resist working with the university or Korea arguing that it can aggravate the arms race to develop autonomous killing machines. Korea's open declaration of developing autonomous weapons sparked serious concerns.

### *5.3. Service and applications*

Services and applications are the heart of the AI systems. In Korea, algorithms have been widely used in search engines, online shopping sites, and public online services. Among others, algorithms have been heavily used for recommendations by search engines, automated recommender systems, suggested terms, and auto completion functions. Naver, Korea's largest online platform provider, handling over 75% of all web searches in Korea, is providing search engine services using algorithms. Naver's power lies in amassing relevant information for popular topics, often generated by the users themselves, and presenting such information in a user-friendly fashion. Naver uses different algorithms in each segment of Naver search (e.g., News search, Blog and Cafes search, and Knowledge search). Naver's search algorithm is built around the Korean language, which enables Naver to provide more personalized results than Yahoo or Google.

Despite such popularity and convenience, Naver has been heavily criticized for controlling and manipulating search results (Lee, 2017). Most of the search results users see on Naver are paid inclusions, and the prices for content inclusion and ads appearing on Naver can be fairly expensive. Content producers should be able to feed their content into Naver for free or for a reasonable fee. The manner in which Naver's search engine discovers and arranges information to users has less to do with users' queries than with Naver's financial interests. In 2015, the Naver search engine revamped its search algorithm and interface to allow it to interact

## SOCIOTECHNICAL ALGORITHM

with its users, going beyond merely providing information based on search keywords. By incorporating search algorithms that take into account the users' search patterns, Naver hopes to provide more tailored and conclusive search results.

By doing this, however, Naver violates user privacy and data policy. Fortunately for Naver, most people do not seem to care about their individual data invasion or data privacy. The society overall tolerates such privacy disclosures in favor of industry competitiveness or service convenience. In October 2017, Naver admitted that they intentionally manipulated news rankings. Naver admitted to rearranging the news list at the request of an official from the football division K League who wanted negative news regarding the association to be less conspicuous on the portal. The incident was the first confirmation that Naver intentionally tinkered with its news editing. Naver's rival, Daum has also admitted to similar accusations. There were suspicions in 2015 that the Samsung Group pulled strings to erase negative news related to it on the Daum portal. There is reasonable concern that if some news has been edited this easily, then there is no telling what other news may have been manipulated by interested parties who are even more powerful and influential. Across all portal providers, there have been rising accusations that they manipulated news headlines and the editing process to influence the presidential campaign in 2017. The incidents regarding the portals in Korea imply that algorithms reflect the intent of the people who create them. News consumers or users usually do not know the operational rules of algorithms run by portals, so the process lacks transparency. Such issues — the manipulation of the news being displayed, the manipulation of top search words in real-time, and the social irresponsibility of portals — will continue to recur, and such incidences will increase as Korea progresses toward a hyper-connected algorithm society.

### *5.4. Market*

## SOCIOTECHNICAL ALGORITHM

As far as AI development, not much research has been performed in Korea, despite its high reputation as an IT powerhouse. Korea's market size in 2013 was approximately 2.5 billion USD and is expected to grow to 4.5 billion USD by 2020 (Lee, 2016). Some of the large IT companies are investing in AI, but this is still limited to some of the internet portal or game related companies. For example, NC Soft (a Korean game company) and Naver have been researching and developing AI for several years. In 2015, Samsung Electronics acquired an AI startup called Vicarious and invested in an AI robot startup called Jibo. This indicates that Samsung is also planning to do business in the AI industry. In addition, Samsung has collaborated with Wolfram Alpha to provide the S Voice service for English speaking countries. On the other hand, MSIP has been investing in Exobrain software development since 2013. This software provides knowledge reinforcement learning services by accumulating and self-learning big data information. The government plans to sponsor a knowledge contest with a human competing against a robot. This investment will amount to 83 million USD over the next ten years (Zhang, 2016).

### *5.5. Social and cultural aspects*

While Korea is a democratic country per se, the country has experienced countless cases of opinion manipulations and comment fabrications in online venues. The past few years have seen growing recognition that algorithms raise unusual challenges for ensuring non-discrimination, due process, and understandability in online communities. A series of incidents that recently occurred in a web portal revealed the current status of online democracy in Korea, which is under threat. Online portals have become sources of manipulation and distortion, riddled with slander and profanity. In January 2018, President Moon's supporters and his opponents engaged in a "battle of the real-time search word." The president's supporters

## SOCIOTECHNICAL ALGORITHM

decided to have "Peace Olympics" top the real-time search word chart on major web portals to celebrate the birthday of President Moon, but his opponents decided to block this. "Peace Olympics" is a term that reflects the direction of the Moon government, which seeks to establish peace on the Korean Peninsula through inter-Korean dialogue. The opposition argued that "The government is turning the PyeongChang Olympics into the Pyongyang Olympics" and worked to have "Pyongyang Olympics" appear at the top of the real-time search word chart. The opponents fought to earn the top place in the real-time search word standings. On January 18, a person posted a petition on the Cheong Wa Dae website asking the government to investigate the online comments on the article titled "North and South Korea to Enter Together Behind the Korean Peninsula Flag." The person claimed that the number of recommendations on a malicious comment instantly soared to the top, leading to suspicions of manipulation.

On the Internet, the list of popular real-time search words and online comments work as a window providing glimpses into other people's views and public opinion. People can also personally post comments or sympathize with others as they read comments posted by other people. The problem is that in this process, the opinion of a few people can be distorted into what appears to be the prevailing public opinion of the masses. The recent incident mentioned above confirms this. The fact that "Peace Olympics" and "Pyongyang Olympics" went back and forth, dominating the chart, proves that anyone can top the list if they are determined to do so. Furthermore, as a result of this battle to manipulate public opinion, the online comments on news articles were plastered with slander and profanity. The Internet as a forum for public debate and as a channel of public communication has long been challenged. Democracy is threatened if people do not recognize, in civilized fashion, the opinions of their opponents and instead simply voice slanderous opinions on different views. The larger problem is that contents unilaterally

## SOCIOTECHNICAL ALGORITHM

distorted by Naver can be distributed to all citizens. The diversity of available news is choking. At present, the alternative that politicians have presented to clean the web portals is to have people use their real names when posting online comments, but the court has judged this to be unconstitutional. Monopolistic web portals are simply denying that they are media organizations, which allows them to spread false information and undermine democracy in Korea. The real-time search word chart tempts people to manipulate public opinion. Overall, Korean society and culture in general is not ready and not mature enough to accept an algorithm society in a full-fledged manner. For now, it appears that public literacy involving the media and technology is much needed along with technological progress in algorithm development.

### *5.6. Government and governance*

The Korean government has taken highly aggressive steps and has assumed a key role in AI promotion and market growth (Lee, 2016). An interview with a government official revealed that they plan to have Korea catch up with global AI development. The government respondent said, “Korea is considered an underdog in AI development.” “We have come under public criticism as the country lags behind other nations in preparing for the 4th Industrial Revolution.” The official even presented specific numbers saying that the “global artificial intelligence market was estimated at \$127 billion last year, but it could reach as much as \$165 billion this year. Korea accounted for 3.2% of the world’s AI market and will be increasing more and more in near futures.”

In February 2017, MSIP released a plan to prepare Korea for advancements in AI-enabled technologies. The plan identifies policy goals relating to workforce preparedness, education, and social welfare as well as a number of targeted measures to manage the development of AI in Korea. These reforms include an overhaul of the country’s *Framework Act*

## SOCIOTECHNICAL ALGORITHM

on *National Informatization* and the establishment of a *Charter of Ethics for AI* and protocols to guide developers and users.

The government has produced the roadmap for a technological approach to thoroughly manage AI networks and systems (Figure 1). In addition, numerous companies have developed ambitious strategies for AI development. This vision focuses more on improving the algorithmic performance capacity by implementing enhanced data server technologies, and less on the applications and social services on top of infrastructure (Shin & Choi, 2014). The government has been expected to take proactive roles in promoting local manufacturers to set algorithm standards.

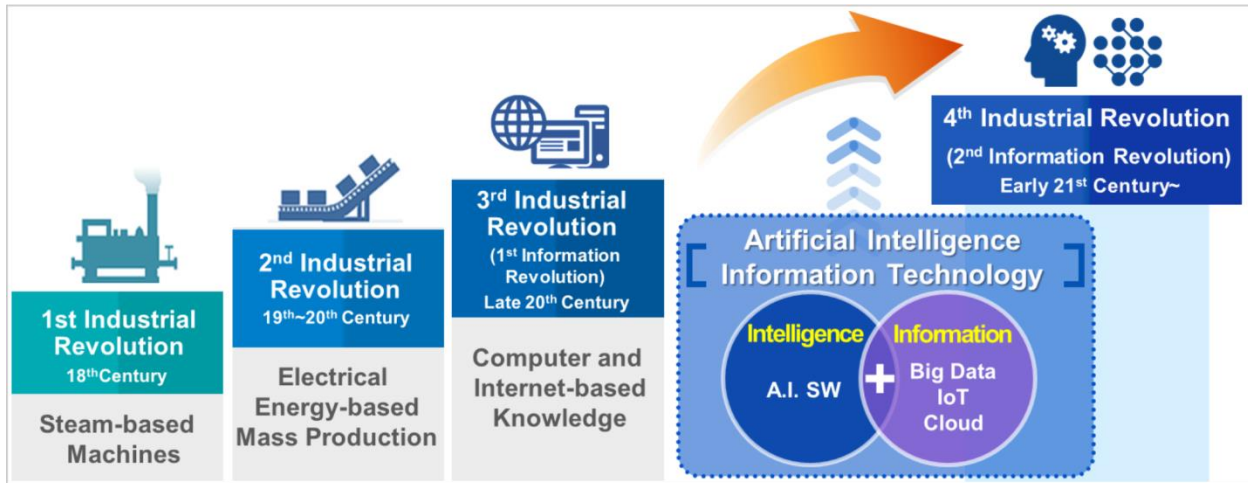
The government shows a clear desire to catch up to advanced countries like the US and other Western countries, and has started a set of technological initiatives for AI. The Korean government published the “Artificial Intelligence Industry Development Strategy” in November 2017, and began supporting the use of AI intensely. The government released this strategy to promote the use and development of AI with each focusing on different aspects of AI policy: scientific research, talent development, skills and education, public and private sector adoption, ethics and inclusion, standards and regulations, and data and digital infrastructure.

The strategy is divided into three parts. First, to secure AI talent, the government will establish six graduate schools in AI by 2023 with the goal of training 6,000 AI specialists (1,500 AI researchers and 3,700 data management specialists). The government also announced an initiative to train 700 people in AI to address the immediate short term need for AI talent. The second area of focus is development of AI technology. The government will fund large scale projects in national defense, medicine, and public safety, and will start an AI R&D challenge similar to DARPA. Finally, the government will invest in infrastructure to support the



## SOCIOTECHNICAL ALGORITHM

development of AI start-ups and SMEs. This includes funding for the creation of an AI semiconductor by 2029 and an AI- oriented start-up incubator to support emerging AI businesses.



*Figure 1.* Artificial Intelligence Information Society (Source: MSIP, 2017)

Unlike the well-prepared government's plan, the governance of algorithms and AI in general has not been addressed at all. For example, there is no overarching legal framework such as the GDPR. Regulation on data protection and privacy for Koreans will surely be critical. As in the case of GDPR, Korea needs to give control back to users and citizens over their personal data and to streamline the regulatory environment for international business by combining the regulations within the country. Korea's 1995 Data Protection Regulation legacy framework needs to be updated to cope with the changing environment. Korea is not currently prepared to meet regulations such as the GDPR. The majority of Korean-based companies expressed concerns that they would not be able to meet the compliance date. Their failure to ensure GDPR compliance could have a serious negative impact on their business, as it could cause almost 30% of companies concerned to shutter their businesses in Europe. A similar prediction applies in Korea, where almost 35% of non-compliant companies could be put out of business if a plan

## SOCIOTECHNICAL ALGORITHM

similar to the GDPR is followed. The GDPR's key component, the "Right to be Forgotten", will cause Korean portals to face fines and perhaps even shut down. Further, the GDPR's Right to Explanation would require Korean portals to reveal how certain algorithmic models arrive at a particular decision. The two rights combined (along with other rights such as right to be informed, right to data portability, and right to access) may seriously jeopardize Korean portals' routine but illegal practices.

### *5.7. Industry*

Korea's establishment of its impressive IT and dynamic IT industry has led to a standing as an IT powerhouse in the global area of IT (Shin, 2014). This trend has continued in the development of AI and algorithms. Leading companies are apparently increasing investments in their AI technologies and commercialized products as they seek potential market breakthroughs. Samsung, LG, and SKT have established AI teams, and online portal sites have adopted AI systems. Naver and KakaoTalk have AI-based news provider services (Park, 2017). Naver continues to expand its deep learning technology, and leads the artificial intelligence market. Naver will build a deep learning data center that integrates sources, learning algorithms, usage methods, and application results for deep learning in various forms of media such as video and images. The company aims to improve its artificial intelligence service research and development. Naver's competitor, Daum, also has expanded research into various deep learning AI services such as autonomous driving, search base shopping, and object recognition, to speed up market adoption. External exchanges for market growth and technological improvement are also expected. Despite the active development by industry, the general mistake such companies make is to push algorithm technologies based on top-down decisions, which can be difficult to adopt by users who are not ready or who have not been considered in these decisions.

## SOCIOTECHNICAL ALGORITHM

Korean journalism and media sectors have been increasingly relying on algorithms. The decreasing number of readers, audience and viewers; collapse of the advertising-based business model; downsizing of news workers; publishing more stories with less reporters in less time; lower quality of journalistic products; and fall of trust in news media, were the characters of the vicious cycle in Korean media sector. Thus, there was an imperative need to use algorithms, as algorithm decisions affected the way in which people see reality and form opinions through filtering, making priorities and association. “News diversity is affected by algorithmic diversity: we need an algorithm method which is an alternative to the one based on the ‘give what they want’ logic,” one respondent said.

### **6. Discussion: Socio-technical Approach to Algorithms**

“Algorithm” is currently a popular buzzword in Korea as the AI society initiatives progress toward full maturity (Lee, 2016; Kim, 2017). Korea has one of the most favorable conditions for algorithms to thrive due to robust broadband infrastructures and the vast amounts of data generated, collected, and analyzed simultaneously (Shin, 2014). Korea hopes to continue broadband momentum to algorithm development with an expectation that the establishment of an AI-based society that can bring social benefits and new industrial markets. Such potential, however, will not be easily realized without deliberate and thoughtful socio-technical preparation and structure. The resolution of the government to construct state-of-the-art AI infrastructures and the country’s robust IT markets reveal strong signs that Korea will keep the algorithm momentum high. This relation represents a unique one between business and government. The government has controlled and intervened in the market in numerous strategic ways and has done so in a controlled and pre-determined manner (Shin, 2014). The government’s actions are critical in triggering and amplifying private sector mobilization and linking it with the nation’s goals.

## SOCIOTECHNICAL ALGORITHM

Industry-favored IT promotional governances have helped advance infrastructure and improve data structure while the sectors have developed applications ranging from commerce to social software that have promoted the relevance and demand for such services. The hyper-connected network infrastructure has greatly supported to the generation of algorithms, and the overall data ecology has led to an era where algorithms are used in numerous ways and areas of everyday life.

Among data-driven development, a compelling question regarding the interface ecology is how to align the concept of the algorithm to ongoing technology projects along with social progress. This issue is essentially concerned with socio-technical and ecological matters.

Algorithms as a means of social progress are arguably the common good that government and industry pursue. With this common goal, the developmental approach has encountered significant challenges to its continued development. The question remains as to how to continue the momentum for sustainability and the future trajectory of algorithms over the long term. With similar projects' continued failures, how can algorithm development be justified? Can algorithm projects grow, particularly in light of civic criticisms regarding privacy, fairness, transparency, and accountability? These doubts come along with a prevailing tendency in Korea to approach algorithm development through the assumption that technologies can be best built strictly from a top-down plan in a very premeditated, strategically organized, and fully directed fashion.

The development of AI may incorporate a socio-technical perspective within which an algorithm is evaluated as its social and cultural functions rather than its economic value, and it should be accessible to the societies it is supposed to benefit. Against this argument, the questions being raised involving algorithms in Korea are not about algorithms per se, but about the way society is structured with regard to algorithm use and diffusion. It also involves how

## SOCIOTECHNICAL ALGORITHM

models and analytics are being used to predict the future. There is currently an awkward partnership between data and algorithms in Korea. From a socio-technical perspective, there are numerous issues and obstacles for Korea to develop a workable AI-based society.

First, the main issue is to act on the protection of personal information. Korean firms are prohibited to use personal information of customers without their permission. Large conglomerates are lobbying to ease the regulations, as they claim that this law hinders the development of AI and IT industry overall. The MSIP and other ministries are susceptible to these companies and have attempted to, or have changed regulations according to companies' will. Other than the regulation issues, companies claim that they do not have sufficient big data which could be utilized for the development of AI; their companies are not large enough to analyze the big data, and there is no work that needs AI solutions. High level executives are, in general, ignorant of the effective investment of AI and big data, there is distrust in the effectiveness of introducing big data technology in the company, and there are no or few specialists who understand big data and AI.

Second, there should be an overarching governing framework to ensure FAT requirements are met. In the AI era, systems involving users and technologies are being developed in diverse societal milieu. Data analytics have been widely used as subcomponents for explanatory, prescriptive, and predictive works, often trained using deep learning algorithm. But when analytics components are placed in large-scale socio-technical systems, it is often problematic to predict how well the systems will work and operate, as assessed by criteria relevant to reality (Sloan & Warner, 2017).

Third, algorithms present both opportunities and challenges to policy makers. Algorithm technology affords an enormous chance for policymaking, and the establishing of more user-

## SOCIOTECHNICAL ALGORITHM

based systems that prioritize the preferences, requirements, traits, and experiences of users with respect to public services. People generate useful data that firms might exploit for other heuristic uses. Policy makers also have access to substantial data on public behavior patterns that are analyzed real-time whenever users interact with government administrations or undertake acts of civic engagement such as signing a petition. As for challenges, algorithm systems produce technological obstacles for governments as well as new ethical and moral quandaries for policy makers. Large-scale IT developments are particularly difficult and complex. Algorithm use poses basic but essential questions such as how governments should conduct surveys or draw profound results. Governments must respond responsibly to any repercussions. They should address concerns and social issues, which include lack of structure, scale and heterogeneity, privacy, governance, suitability, attribution, and analytics at all phases of the analysis pipeline from data collection to analytics. These challenges will inherently involve transformative practices or paradigm change, which are not resolved easily or autonomously by the technical progress of artifacts.

Based on the present study, practical suggestions can be made to the government for future algorithm initiatives. First, algorithm use in Korea sheds light on another significant obstacle, the social practice of usage and adoption. The use of algorithms matters, rather than the development of automation for algorithm systems. Pushing algorithm technologies based on top-down decisions is the general mistake. Thus far, algorithm usage applies mainly to specific services (e.g., recommender systems, news feed recommendations) or particular business models (e.g., search engines) rather than to deployment for a series of societal benefits and public services. The information and communications technology (ICT) design process should constructively include users, social issues, cultural factors as well as legal, political, economic

## SOCIOTECHNICAL ALGORITHM

aspects of ICT. While algorithm technologies may be valuable for development initiatives, they also inherently carry crucial threats that are often underestimated (Anderson, 2012). In the course of seeking the potential social benefits of algorithms, it is vital that basic user rights and human values are not taken lightly nor underplayed. What matters in Korea is the proper use, rather than simply the development and automation, of algorithm systems. Although automation, prediction, accessibility, and connectivity are basic components in an algorithm-based society, algorithm usability is more significant since it cultivates the ICT ecosystem eventually. The success of integrating society into the algorithm ecology depends on the motivations and attitudes of the public toward the use of algorithms. While the government fosters algorithm development and use, individuals must willingly adopt algorithms and information knowledge as part of society. People must willingly allow the infusion of such ideologies into the center of their individual domains, and the inclusion of IT ideology within their everyday lives, which will affect models of cognition and behaviors. The use of algorithms is essentially involved with ethical values. The starting point of algorithm policy is the outlining of guidelines on data protection and privacy for all individuals, just like the EU's GDPR.

Second, algorithm development should be performed on a continuous timeline instead of one-off event or single project. Over the history of Korean technology development, the top-down, government intervention model continues to dominate and take its toll on people's public interest. There has been a cost for such a top-down build-and-fix mechanism (Shin & Choi, 2014), and algorithm development is no exception to this mechanism. Building infrastructure and forming an ecology takes a long time. An algorithm is not technical code; rather it is a process to develop a well-defined set of actions that produce certain results in a specified order. Thus,

## SOCIOTECHNICAL ALGORITHM

Korea needs to shake off technological obsessions and focus on the societal and cultural effects of algorithms.

Third, as a specific socio-technical evaluation method, Korea can practice the Social Construction of Algorithms. The idea is derived from the Social Construction of Technology that human action shapes technology rather than technology determines human action. With the idea of the Social Construction of Algorithms, various methods can be derived. For example, constructive algorithm assessment can be used as a tool to design algorithms that can broaden the design of new algorithms through feedback of assessment activities into the actual construction of algorithms. It has three analytical processes: socio-technical mapping, which combines the stakeholder analysis of traditional assessment with the systematic plotting of recent technical dynamics; early controlled testing, through which unexpected impacts can be identified; and discussion between firms and the public, to articulate the demand side of algorithm development.

Lastly, the answers for the research questions can be outlined in Table 2.

Table 2. Research questions and answers

Research Questions	Findings
What challenges and issues have been faced with national initiatives to forge a nation-wide algorithm-based society?	The issues of fairness, accountability, and transparency have been problematic at micro, mezzo, and macro level.
To what extent has society adapted to the development of algorithms? What are the social and contextual issues emerging from the proliferation of algorithm-based systems?	The “use” of algorithms matters, rather than the “development” of automation of algorithm systems. Pushing algorithm technologies based on top-down decisions creates a series of problems as shown the Druking opinion rig case.
How have these dynamics influenced people, industry, and society?	Despite active development and proactive drives, new risks such as privacy, transparency, and fairness emerge as critical concerns of the social ramifications of algorithms and their impact on the new information milieu.

### **7. Implications: Fairness, Accountability, and Transparency**



## SOCIOTECHNICAL ALGORITHM

Algorithms are now so widespread in Korea, and so subtle, that they function as a form of social control. Enormous investment in algorithms and AI have been made to realize technological innovation, but most important social issues seem to be sidelined, such as the realization of true socio-technical ensemble of users, technology, law, and society. The socio-technical analyses reveal a series of issues to be resolved before algorithms are fully integrated into Korean society. The analyses raise complex social and ethical dilemmas: How can we best use AI to benefit people and offer enhanced human rights, while avoiding exposing them to various types of inequity and bias in society? How can we balance the need for exploration and efficiency with fairness and accountability to users? As we move toward relying on smart agents in our everyday lives, how do we ensure that people can trust AI robots? These questions correspond to FAT principles. Recent incidents of algorithm abuse such as the Druking case and Naver's recommended news manipulation have only further spotlighted the urgency of addressing the FAT issues. These issues will be recurring and will become even more complicated as FAT is extended to other issues, such as interpretability, reliability, and ethical concerns (Figure 2). In all, social responsibility should be the governance principle applied to designing algorithms and managing how they are used. Social responsibility can be algorithmic accountability, how it is used, and how responsibility for the results of algorithms is enforced. As algorithmic systems are vulnerable to making mistakes or leading to undesired consequences, efforts should be given to hold them accountable and transparent (Ananny & Crawford, 2018). Korea needs predictive systems that are transparent for consumers such that they able to readily ascertain the risks and benefits associated with the algorithm systems to which they are subjected.

## SOCIOTECHNICAL ALGORITHM

Recently in Korea, there are also active debate on countermeasures of algorithms such as standardizing the algorithmic accountability or algorithm transparency to cope with the technical or social side effects or adverse effects of AI. The starting point of such discussion is the understanding that the AI algorithm is neither fair nor neutral since the selection of the specific algorithms or algorithm-based decision-making causes discriminating and exclusive consequences.

Korea needs to experience such a reality-check regarding algorithms. Based on the realization of such consequences and limitations of algorithms, Korea can build realistic plans for algorithm-based society. For example, the country can start with accountability and transparency. With a clearly defined, accountable mechanism and transparent processes, this would result in accurate search results and thus improve accuracy and fairness eventually. While the three factors are equally important, accountability can be an underlying antecedent factor of transparency and fairness. Within the socio-technical algorithm, accountability should be considered a key requisite for achieving transparency and fairness (Figure 2). In terms of the FAT model, the following implications can be drawn for the Korean algorithm case.

First, while technologically progressive, the Korean public should demand, and Korean firms should make efforts for creating algorithmic accountability in their services. They can create a level of automated transparency that will allow users, the online community, or public officials to understand “what is going on.” Industry should not rely on the government to play this role. Government-led regulations might be sought given the context of the Korean industrial structure based on the Chaebols and the consequent political and economic power balance. Yet, too much government-driven approach would burden firms and slow innovation. Thus, a combination of government-led and industry-driven approaches would be effective. For example,

## SOCIOTECHNICAL ALGORITHM

government may establish overarching governing frameworks while firms practice their own corporate guidelines. The government may provide firms with an extension of corporation regulations, like the European model of GDPR. In this case, however, such a GDPR-based approach should be tailored and contextualized in order to reflect unique aspects of the Korean case. For example, right to explanation (Goodman & Flaxman, 2016) may be flexibly adopted as the right would trigger serious repercussions in terms of legal, social, and industrial dimensions as in the case of Naver's right to explanation recently. In general, owing to technology outpacing regulatory processes, lack of government capacity, and political turmoil, there is a need for more voluntary self-governance by private firms. The FAT governance model (Figure 2) is largely based on self-regulatory functions given the ongoing situations in Korea.

Second, regarding accountability, the issue of transparency has to be critically addressed and considered. The rise of data mining and predictive analytics makes the problem of algorithmic transparency a more pressing one. Korea needs to address the criteria of transparency and the specific methods to meet those criteria. Algorithmic modeling may be prejudiced or skewed, and the uses of algorithms are still obscure in many critical sectors in Korea. Firms like Naver, Daum, KT, SKT, and Kakao should proactively embed algorithmic responsibility into their systems to faithfully and transparently act as their own watchdogs or risk eventual burdensome regulation. Concern over black box algorithms that govern human lives has been emerging recently. Scholars and stakeholders have widely questioned the adequacy of existing mechanisms governing algorithmic decision-making and are grappling with new challenges presented by the growing algorithmic power in terms of fairness, transparency, and equality (Sloan & Warner, 2017).

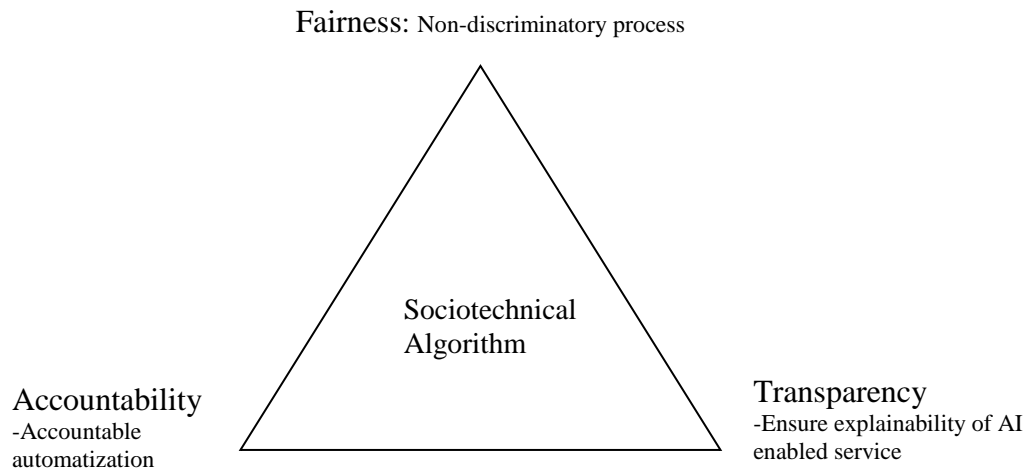
## SOCIOTECHNICAL ALGORITHM

Third, fairness has been an elusive issue in traditional media, but it becomes an even more difficult one in algorithm development. Korean users heavily rely on search engines in their news consumption, shopping, political participation, and social activities (Lee, 2016). The search results are ranked in descending order based on some measure of the relative quality of items. The results of these algorithms potentially have an impact on the entities that are ranked, and contribute to shaping the experience of everybody online and offline. Thus, it is a matter of societal and ethical significance to examine whether these algorithms eventually produce results that demote, marginalize, or exclude social groups or specific parties. These algorithms may have discriminatory effects, even without discriminatory intention, imposing less favorable care to disadvantaged groups or communities. These problems are exacerbated if details about the algorithms used for ranking are unknown. In addition to providing key benefits to society and individuals, improving algorithmic fairness can enhance user trust. One way to improve user trust is to allow the right to explanation. It has been taken for granted by Korean users to not know details about an algorithm. The users should be given an explanation for the output of the algorithm. Given the complex nature of the IT ecology in Korea, the right to explanation should be interpreted flexibly, functionally, and should, at a minimum, enable users to exert their rights. Of course, the EU's GDPR exact version cannot be directly applied to Korea due to different social, political, and economic milieu, but Korea should find an optimal point to balance data privacy and industry practice.

In terms of regulation, the findings shed light on a series of legislative transformations that should be made to conceptualize and prepare for future AI services more clearly to effectively include algorithms in that infrastructure (Figure 2). Legislative transformations should be careful, deliberate, conscious, and developed with due attention to FAT principles.

## SOCIOTECHNICAL ALGORITHM

Korea needs to ensure that regulations provide valuable tools for realizing a legitimate policy objective, and that they are procedurally non-discriminate, transparent, and impartial. For industry, this study provides a new design principle for algorithm development. The recent advances in algorithm technologies enable establishing socio-technical systems which closely interweave users and their social structures with technologies. With the emerging importance of the algorithm, the question is how to make human-centered algorithms. Industries such as online platforms may gain stronger user trust in the AI ecosystem through enhanced FAT provisions.



*Figure 2.* FAT model of socio-technical systems

## SOCIOTECHNICAL ALGORITHM

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