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Systems Engineering

Risks and Side Effects of Digitalization: A Multi-Level Taxonomy of the Adverse Effects of Using Digital Technologies and Media

by

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to be presented at: 27th European Conference on Information Systems (ECIS),
Stockholm, Sweden, June 2019

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WI-939

RISKS AND SIDE EFFECTS OF DIGITALIZATION: A MULTI-LEVEL TAXONOMY OF THE ADVERSE EFFECTS OF USING DIGITAL TECHNOLOGIES AND MEDIA

Research paper

Track "Social and Ethical Implications of ICT Use"

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Abstract

Achieving a bright digital future requires knowing and managing the adverse effects of digitalization. The objective of this paper is to identify, structure, and communicate the most severe adverse risks and side effects of digitalization. To this end, we apply an iterative taxonomy development process informed by academic literature, journalistic articles, and expert interviews. The result is a comprehensive multi-level taxonomy of the adverse effects of IT use. The taxonomy shall serve as platform for further research on identifying and managing the risks and side effects of digitalization. It supports information system scholars in proper net benefit assessments of the effect of increasing use of ever more intelligent, interconnected, and pervasive IT-based systems. Further, it supports the anticipation and management of adverse effects in the design of such systems.

Keywords: IT Use, Dark Side of IT, Affordances, Taxonomy.

1 Introduction

Over the past 70 years, digital technologies and media made our lives easier, safer, healthier, and longer (Tian and Xu, 2015). Our organizations became more productive, and our economies grew (Hitt and Brynjolfsson, 1996; Lee et al., 2018). As a consequence, many information systems scholars focus on the positive effects of digital technologies and media. However, the use of digital technologies and media may also have adverse, unexpected, and unintended effects, especially as IT becomes ever more intelligent, interconnected, and pervasive. The Internet "dramatically transformed the world" (Kim et al., 2011, p. 675). The role of information systems scholars is to research and teach a set of diverse topics associated with IT-based systems and to inform their design and use to achieve a transformation toward the better. Despite a widespread pro-IT bias, this requires a rigorous stocktaking and active management of the risks and side effects associated with the increasing use of IT-based systems. "The recognition that ICT can have both positive and negative effects, both intended and unintended, deepens our field's theorization of ICT" (Majchrzak et al., 2016, p. 273). As information systems scholars, we should ensure that the many positive aspects of digitalization outweigh the related risks and side effects to provide net benefits. To support this, our aim is to provide a multi-level taxonomy that can contribute to a net benefit assessment of the effects of digitalization on individuals, organizations, and societies.

Studying the "dark side of IT" is not new; the term refers to a "collection of 'negative' phenomena that are associated with the use of IT, and that have the potential to infringe the well-being of individuals, organisations and societies" (Tarafdar et al., 2015, p. 61). Pirkkalainen and Salo (2016) review two decades of dark side research in the AIS Senior Scholars' Basket of Journals. They identify 37 articles and detect four types of dark side phenomena: technostress, information overload, IT addiction, and IT anxiety. This is a good starting point. However, considering only: individual-level effects; non-malicious IT use; and effects reported in top information systems journals narrows the scope of the study. Effects on an organizational or a societal level were neglected. Kim et al. (2011) present a taxonomy of the dark side of the Internet (as subset of digital technology and media). They identify technology-centric dark side effects like spam, malware, hacking, and violation of digital property rights. Further, they identify non-technology-centric dark side effects like online theft, cyberbullying, and aiding crime. All their effects base on malicious use of the Internet, that is, on digital technologies and media supporting delinquents.

Two exemplary topics show that the dark side of digitalization is broader and goes beyond the scope of even the two taxonomies of Kim et al. (2011) and Pirkkalainen and Salo (2016) combined: First, digitalization can enable complex and networked (machine learning) algorithms that are beyond proper human understanding and control. These might become discriminating leading to unjust or prejudicial treatment of different categories of people. A specific example is Google's image recognition software wrongly categorizing black people as "gorillas" (USA TODAY, 2015). Further examples are provided in the discussion. Second, digitalization contributed to the emergence of superpowerful corporations, that is, extremely influential national and supra-national institutions that might suppress competition, innovation, and regulation. A specific example is the public debate around Facebook's relation to U.S. political events, privacy problems, and conflict between the firm's social mission and profit growth (TIME, 2018, Vol. 191, Issue 15). These are only two exemplary topics to demonstrate that the dark side of digitalization is broader than prior taxonomies – further topics and examples become evident below.

The "Bright ICT" initiative by the AIS takes a positive stance on shaping the future and simultaneously acknowledges the existence of negative aspects. The initiative's first core research topic—the "Bright Internet"—aims at reducing cybercrime (Lee 2015). Here, too, one sees a yet narrow focus. The aim of this paper is to complement these approaches and move the discourse to the next level. Given the present disenchantment with Silicon Valley high tech and media companies and the perception that digital technologies and media contribute to the destruction of democratic processes—to cite just two examples—we believe the time is right for the creation of a "holistic map" of the adverse effects of digitalization; this would mobilize scholars to participate in illuminating the dark side of IT.

The objective of this paper is to identify, structure, and communicate the most severe *risks and side effects of digitalization* (RSED hereafter). Development, production, use, and disposal of *digital technologies and media* (DTM hereafter) may have consequences beyond the immediate aim. Identifying and assessing these consequences is difficult because of their ambivalence, complexity, and novelty, besides the biases of observers. To overcome these challenges, we apply a taxonomy development methodology and triangulate the RSED by: reviewing extant knowledge encapsulated in academic writing; reviewing journalistic reflections on digitalization; and conducting workshops and interviews with scholars from various disciplines.

The taxonomy contributed by the paper shall serve as platform for further theoretical and empirical research on identifying and managing RSED. According to Gregor (2006), the taxonomy is a "theory for analyzing", that is the most basic type of theory that describes and classifies by summarizing the commonalities found in discrete observations. According to Majchrzak et al. (2016), the taxonomy is a "theory of the problem" that aims to elucidate a specific challenge. Majchrzak et al. (2016) assert that researchers often have a pro-IT bias and subconsciously avoid acknowledging IT-related harms. They call for researchers to explicitly consider the unintended consequences of IT artefacts and IT use. Our taxonomy provides a structure to respond to this call in a systematic way and overcome some subconscious biases.

From an ethical standpoint, the rapid evolution of digitalization creates normative uncertainty that calls for a reflection on the ethical aspects of DTM's role in various social contexts. Our paper and future work building on it shall enrich the societal dialogue on whether to accept RSED and how to manage them, given the substantial (net) benefits of digitalization.

2 Methodology

We follow the iterative taxonomy development procedure suggested by Nickerson et al. (2013) to identify, structure, and communicate the most severe RSED. The taxonomy's intended users are information systems scholars. The meta-characteristic is the types of risks and side effects associated with the actualization of affordances of DTM. The ending conditions are the ones suggested by Nickerson et al. (2013, Tables 2 and 3).

So far, we have completed five cycles of the iterative taxonomy development process (Nickerson et al. 2013). Each cycle followed an empirical-to-conceptual approach of identifying (new) RSED and their common characteristics, as well as grouping and structuring RSED. Each cycle builds on the previous one so that the taxonomy matures over time. The implementation of the cycles partly overlapped in time. Cycle 1 identified RSED from the academic literature. Specifically, we searched in the AIS eLibrary for the keywords "dark side" and "bright side" as well as the keywords arising from a full text search for "dark side". Here and in the following cycles focusing on literature search, identified papers were analyzed by the research team in order to identify RSED, subtypes of RSED, manifestations of RSED and to infer the conceptualization of RSED and their adversity. Cycle 2 centers around two workshops with scholars from the disciplines of ethics and law, as cycle 1 suggested that these disciplines' perspectives could be especially relevant for understanding the conceptualization of RSED and to understand conventional (ethical and legal) categorizations of effects and attribution of responsibility and accountability. Cycle 3 reviewed journalistic reflections on digitalization in leading print media. Specifically, we reviewed all editions of the weekly magazines TIME and DER SPIEGEL from June 2017 until July 2018. Both cover relevant topics globally. Whereas TIME focuses more on the US, the world's largest economy, Der Spiegel focuses on Germany—the largest economy in Europe. While reviewing additional newspapers or magazines could in principle provide additional insights, we restricted the search to one lead magazine per country in the assumption that highly relevant topics should be covered by these magazines. In terms of country focus, China might appear as a natural additional country to look for lead media. However, limits to free speech in China impede this. Journalistic articles are a useful supplement to scientific contributions as they have a shorter lead time in picking up news than academic outlets and are not bound by the scope of individual disciplines or communities. In addition, they shape

public perception, attitudes and norms towards DTM and RSED. Cycle 4 returns to academic publications for a systematic review of all volumes of MIS Quarterly and the Journal of the AIS (search for »"dark side" OR downside OR risk OR adverse OR negative OR "side effect"« in title or abstract without any time restriction; the 156 results obtained processed manually). Cycle 5 focuses on expert interviews from other disciplines to broaden our focus and to put findings from the previous cycles in perspectives from other disciplines. Specifically, we searched for scholars in ethics, criminology, sociology, psychology, and economic and social history as the prior cycles suggested that these disciplines relate to the RSED. In each of these disciplines we looked for a scholar with more than 10 years of research experience, a strong publication record in his field of expertise. To gain a fresh perspective, we specifically did not look for scholars highly involved in digitalization research; however, we searched for experts who have some weak ties to studying digitalization to assure a minimum amount of reflection of the digitalization already before the interview. Given these search criteria, we identified five experts (one from each of the aforementioned disciplines), all of whom agreed to take part in an individual semi-structured, one-hour interview. All interviews were recorded. Recordings and field notes were subsequently analyzed using open substantive coding. Coding constantly stipulated conceptual ideas that were constantly compared against the emerging taxonomy of RSED. Beyond identifying new RSED and their subtypes, the interviews proved useful in conceptualizing RSED and especially the adversity of RSED.

As suggested by Nickerson et al. (2013), along these cycles, we identify examples and characteristics of RSED to develop a structured presentation that is concise, robust, comprehensive, extendible, and explanatory. Conceptual-to-empirical iterations might be a fruitful addition to the taxonomy development process. One might argue that digitalization enhances the non-digital effects. Hence, one might use a list of all adverse effects in the world and consider whether digitalization contributes to them. Second, because each affordance of DTM may lead to RSED, one might use a list of all affordances of DTM and identify potential RSED. Unfortunately, neither of these lists exists. Hence, we focus on empirical-to-conceptual iterations.

The methodology adopted has two key limitations: First, “theories of the problem […] make explicit value judgments that the situation is problematic from the perspective of certain stakeholders” (Majchrzak et al., 2016, p. 271). From our (i.e., the authors’) socialization and the media reviewed, we have a culturally-biased Western perspective despite knowing that assessment of the valence of an effect depends on culture and DTM exert “a nonuniform effect on societal transformations that varies with the stage of economic development“ (Lee et al. 2018, p. 234). Second, we only integrate RSED that are found in print or mentioned by the experts in interviews or workshops. This leads to a bias (but not an exclusive restriction) toward: rather short-term effects already observable at the current stage of digitalization and vague perceptions of potential risks emerging in the future. Thus, the specific RSED, their subtypes and manifestations and the underlying affordances of DTM will likely evolve over time.

3 Conceptualization

The following are the definitions of the primary constructs that are relevant for our research. **Digitalization** refers to the sociotechnical phenomena and processes of adopting and using digital technologies and media in individual, organizational, and societal contexts (Legner et al., 2017). **Digital technologies and media (DTM)** comprise all the electronic devices (hardware) and applications (software) that use information in the form of numerical codes (usually binary codes), as well as all the media (i.e., means and channels of general communication in society) that are coded in formats that can be processed by these devices and applications.

3.1 Risk and Side Effects of Digitalization (RSED)

Risk and side effects of digitalization (RSED) are secondary adverse effects (side effects) or the possibility of such effects (risks) because of digitalization. These are not effects of DTM themselves; they

are the consequences of attitudes, decisions, and behavior related to DTM (Decker 2013). According to common categorizations of technological consequences (Decker 2013), RSED are (possible) secondary effects that are unwanted and unintended, but not the main ones. They may be certain or uncertain, expected or unexpected, and result from individual actions or emerge from the dynamics of collective actions. They may be direct effects or mediated ones; further, they may moderate other effects outside the domain of digitalization. Although, side effects may describe positive and negative effects, the term is commonly used to describe adverse effects (e.g., in pharmacy and medicine). Within this paper, we focus on the negative connotation of side effects.

3.2 Adverse Effects

RSED are adverse effects that cause harm. There is no objective criterion of adversity or harm shared across individuals, cultures, and ages. Judging adversity is not a matter of consensus or majority voting. Thus, we adopt the perspective of an impartial spectator assessing whether an effect is sufficiently adverse, sufficiently common, or likely to qualify as RSED. The concept of an impartial spectator was first mentioned by Adam Smith in 1759 (Raphael 2007). A perfectly impartial and well-informed spectator is an imaginary person that guides our decisions by virtually judging our actions according to common moral principles. To support our judgement about what the impartial spectator considers as adverse, we turn to the philosophy of law: an effect is adverse if it negatively affects recognized interests in a sufficient manner. These interests might be legal interests of natural persons (e.g., integrity of life, health, and freedom of action); legal interests of legal persons (e.g., physical or intellectual property); or collective legal interests (e.g., payment of taxes). This does not imply that RSED are illegal. They have the same effect as socially harmful behavior but may also include, for example, self-harm and incidental harm. For example, social-media whitewashing and excessive exposure to images of presumably perfect bodies may lead to body image insecurity, eating disorders, and suicidal behavior, especially for (female) adolescents. Although there is nothing illegal in this, the individual legal rights of bodily integrity and right to health are curtailed, and we posit that an impartial spectator would consider this specific side effect of digital social media use as adverse.

3.3 Affordances

The theory of **affordances** stems from the ecological psychology and shed light on how animals perceive their environment (Gibson, 1979; Giermindl et al., 2017). Accordingly, affordances arise from the relationship between an artefact and a goal-oriented actor or actors. Each DTM artefact has latent affordances that are action possibilities for at least one goal-oriented actor with the relevant action capabilities (Thapa and Sein, 2018). Affordances are potentialities; to have influence, they need to be actualized. How they are perceived and actualized is contextually influenced by cultural, social, and technical factors (Thapa and Sein, 2018). When an affordance is actualized, it might have the desired main effect and it might have risks and side effects for the very actor actualizing the affordance (self-referring) or others (externality). See Figure 1 for a stylized model. Focusing on affordances of DTM, rather than the technologies and media themselves, pinpoints that RSED are not a technological issue and are not determined by DTM. Rather, RSED depend on how: (i) we humans design, build, and use DTM and (ii) digitalization affects our attitudes, norms, and behavior. Affordances exist at multiple layers. At a low technical level, DTM allow the digitization of analog signals, persistently store digital data, and so on. Building on this, at a higher yet technical level, DTM afford encryption, big data handling, and so on. At a higher sociotechnical level, they afford low transaction costs, automated decisions and actions, rapid innovation and diffusion, and so on. In our study, this sociotechnical level is the main focus because it is more directly related to the RSED than the technical affordances and outlasts individual DTM.

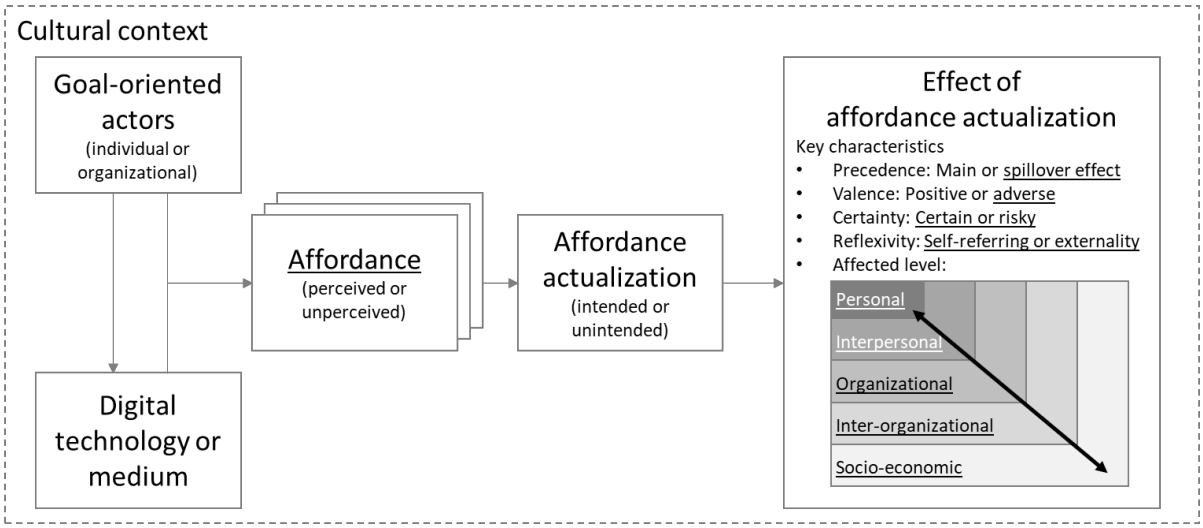

Figure 1. Stylized model of the emergence and types of effects of affordance actualization (Underlining indicates focus of the present paper).

3.4 Affected Level

The actualization of affordances can affect multiple levels, ranging from an individual person to society at large. Specifically, we consider five levels (see Table 1) that are similar to those in Costello et al. (2013) and based on Bronfenbrenner's ecological systems theory. Effects can propagate from one level to the other. An example are effects like technostress from IT unreliability (personal level), which might reduce individuals' socializing (interpersonal level) and work performance (organizational level).

Level	Description	Example of specific risks and side effects
Individual / personal	Adverse intrapersonal effects (behavioral, cognitive, bio-medical, etc.)	Negative psychological effects, such as IT anxiety or technostress
Microsystem / interpersonal	Adverse effects on the interaction and relationships in small groups including the family, work group, and friendship networks	Personal attacks, such as cyberbullying or digital sex crimes
Mesosystem / organizational	Adverse effects on individual social institutions with organizational characteristics with formal (and informal) rules and regulations for operation	IT operational risks, such as system malfunction
Exosystem / inter-organizational	Adverse effects on the interactions and relationships among organizations	Market power of quasi-monopolies hindering competitors and suppressing other companies
Macrosystem / societal	Adverse effects on society and economy at large as well as on nation states and supranational relations	Unscrupulous public discourse, such as hate speech in social media or an "artificial intelligence singularity"

Table 1. Overview on level affected by risks and side effects of digitalization.

4 Taxonomy of Risks and Side Effects of Digitalization

RSED and their subtypes are the core of the taxonomy. They are defined in Table 2. In the following, RSED are printed in bold font, their subtypes in bold and italic font. To illustrate the rather abstract RSED and subtypes, the subsequent text provides manifestations of the subtypes and even more specific

individual examples. Further, the subtypes of the RSED are related to affordances of DTM and the level they affect. Framing the RSED always includes the word "can" to highlight the potentiality rather than determinism of its occurrence. The descriptions of the subtypes put the adverse effects in the foreground in definitive terms. This does not imply that they are universally true today or in the future. They might only apply under specific circumstances or might be risks perceived from today's point of view.

For clarity of the presentation, RSED (level 1, highest level of abstraction) are written in ***italic bold font***; subtypes of the RSED (level 2) in **plain bold font**; manifestations of the subtypes (level 3) *italic font*; and specific examples of the manifestations (level 4, lowest level of abstraction) in plain font.

Table 2 defines all 11 RSED and 35 subtypes. For space restrictions, the subsequent discussion of manifestations and examples is limited to 2 of the 11 RSED. The mapping of the 35 subtypes to affordances and affected levels is fully displayed in Figure 2.

Risk or side effect (RSED)	Subtypes of the RSED
***Adverse exchange**:* Digitalization can facilitate the exchange of information or goods that may be desired by the transaction partners but whose effect is socially undesirable.	**Unscrupulous public discourse:** Objectionable public exchange of information and socially harmful forms of public discourse via DTM.
	Socially undesired transactions: DTM-enabled conclusion of economic transactions that are socially undesirable.
Supporting delinquents: Digitalization can make it easier for malefactors to do harmful deeds and thereby promotes the occurrence of harmful deeds.	**Personal attacks:** Non-criminal attacks among individuals via DTM.
	Cybercrime: Criminal activities carried out in part or fully via DTM.
	Aggravation of prosecution: Criminal prosecution by investigating authorities becoming more difficult due to DTM.
	Cyberterrorism: The politically motivated use of DTM to cause severe disruption or widespread fear in society.
	Cyberwarfare: Use of DTM to disrupt the activities of a state or organization, especially the deliberate attacking of DTM for strategic or military purposes.
Adverse economic shifts: Digitalization can shift economic equilibria and thus may place some parties in a worse position than they would be without digitalization.	**Displacement of traditional structures:** Supplanting traditional economic structures due to DTM harms beneficiaries of the traditional structures.
	Superpowerful corporations: Extremely influential national and supranational institutions and/or quasi-monopolies due to DTM create dependencies and suppress competition, innovation, and regulation.
	Loss of international competitiveness: Nation states and regions loose competitiveness as economic location in global competition due to innovation in DTM along with regional agglomeration and network effects.
Shifting political control: Digitalization can shift political powers and dynamics and may facilitate political changes that are undesirable for a substantive majority of people.	**Trend towards extremism:** Extreme measures or views gain political influence due to DTM.
	Political regimes strengthening control: Autocrat regimes using DTM to strengthen and lengthen their political control.
	Lack of policy making: Retarded enactment and revision of laws and policies regarding DTM-related progress creates an insufficient regulation.
Vulnerable IT operations: Digitalization can worsen or stop organizational operations, as critical DTM assets may not be available or working as expected.	**IT operational risks:** The risks of DTM-related losses resulting from inadequate or failed DTM-based systems or processes.
	Failure propagation: Failures propagate among DTM-based interconnected systems within organizations or across value networks.

Impairment of health: Digitalization can adversely affect individuals' health.	**Reduction of psychological health:** DTM-related infliction of mental disease, illness, or malfunction.
	Addiction and follow-up problems: Persistent, compulsive, and excessive use of DTM at an intensity that leads to individually harmful cognitive or behavioral adaptation. Note: Addiction to DTM is a special form of reduction of psychological health. Its relevance and specificity justify identifying it as a separate subtype.
	Reduction of physical health: DTM-related infliction of bodily disease, illness, or malfunction.
Environmental deterioration: Resource requirements originating from digitalization can change environmental sustainability to the worse.	**Climate impact of energy demand:** Negative climate change triggered by energy demand along the lifecycle of digital technologies.
	Consumption of material resources: Unsustainable level of use of material resources to manufacture digital technologies without proper recycling or reuse.
Ethical challenges: Digitalization can lead to new ethical dilemmas or change how ethical dilemmas are resolved.	**Dissolution of privacy:** DTM-related actual or perceived loss of freedom from unauthorized intrusion by other people or organizations.
	Dehumanization of work: DTM-triggered worsening of work conditions that deprives work of positive humane qualities.
	Loss of autonomy to act: Reduced individual freedom from external control or influence resulting from DTM use.
	Erosion of solidarity: DTM-triggered reduction of social and economic support commonly based on a sense of togetherness and advocacy for one another.
	Ethical programming: Designing, coding, and/or training DTM in a way that their causal agency is non-reductionist and in line with underlying human moral agency.
	Diffusion of responsibility: Lack of accountability for actions and their consequences in DTM-based actor networks.
Ambivalent decision environment: Digitalization can put decision-makers in undesired situations of untrustworthy or contradictory information on facts and agency.	**Uninformative information:** Assumed information becoming uninformative in DTM-based environments characterized by information overload, filtering, and questionable trustworthiness.
	Uncertain agency: Lack of transparency of the nature and agency of technical or social actors in DTM-based systems.
Undesirable behavioral adaptation: Digitalization can lead to a change of traditional competencies and behaviors in a socially undesirable manner.	**Technology-reliance along with increasing incompetence:** Increasing reliance of DTM leading to loss of socially or individually desirable human competencies.
	Data fixation: Reduction of the perception of the world to what is recorded and communicated in digital technologies and media in the form of data.
	Resistance to change and uncertainty: Opposition to change as a reaction to the uncertainty and partial perceived, dreaded, detrimental effects of change.
	Distraction from a principal activity: Harmful loss of focus on a principal activity due to the simultaneous use of DTM.
Losing control over algorithms: Digitalization can enable com-	**Lack of auditability:** Algorithms encoded in DTM not being available for methodical examination and review.

plex and networked algorithms that are beyond proper human understanding and control.	**Discriminating algorithms:** Use of algorithms encoded in DTM leading to unjust or prejudicial treatment of different categories of people.
	Technological singularity: An artificial superintelligence as a specific digital technology abruptly triggering runaway technological growth, resulting in detrimental effects for humanity.

Table 2. Overview of RSED and related subtypes.

As first example, we consider the RSED ***supporting delinquents***: **Personal attacks** as subtype of this RSED manifests in *violent cyber-attacks* like cyberbullying (Lee, 2015), cybermobbing, cyberstalking. Such violent crime in the cyberspace is fostered by DTM allowing for low-cost anonymity or unverified pseudonyms in online media and simplified broadcasting via bulk e-mails or in social media. A more specific related manifestation are *digital sex-attacks* like revenge porn, cyber-grooming, sexting (TIME, 2017, Vol. 190, Issue 2/3; DER SPIEGEL, 7/2018). The third key manifestation of **personal attacks** are *physical violence caused by symbolic display of physical violence in computer games*. All these effects occur on an inter-personal level, as they involve the personal relationship between at least one attacker and at least one victim.

Cybercrime is a further subtype of ***supporting delinquents***. Cybercriminal activities comprise *cyber-enabled crime* (i.e., traditional crimes, such as fraud or theft that are facilitated by DTM), *cyber-dependent crime* (i.e., crimes that evolved after the emergence of specific DTM), and *platform crime* (i.e., crimes that are even more technology-focused and use for example the characteristics of botnets) (Schirrmacher et al., 2018). The manifold examples of **cybercrime** include (identity) theft (Kim et al., 2011; DER SPIEGEL, 41/2017), ransomware, fake shops, computer fraud, chargeback fraud (Guo et al., 2018), concealment of data, and unauthorized sharing of digital content (Beekhuyzen et al., 2015). Cybercriminal activities are facilitated by DTM as they enable criminals to act anonymously, provide a tremendously high interconnectedness, and an ever-increasing amount of innovations and new possibilities (Lee, 2015; Schirrmacher et al., 2018). Cybercriminal activities may harm individuals, organizations or societies at large as proven by the WannaCry attack in 2017 (Schirrmacher et al., 2018)

Another subtype of ***supporting delinquents*** is the **aggravation of prosecution** that comprise inter alia the *technological and organizational backwardness of law enforcement authorities* that prevents for example the identification of anonymous perpetrators (TIME, 2017, Vol. 190, Issue 2/3). This effect is fostered by the rapid innovation and diffusion of new DTM. Another manifestation is the *predictability of police actions* that are planned by using algorithms (cf. predictive policing and predictive tax assessment) (Ashby and Thompson, 2017). A third manifestation is the *difficulty of prosecution beyond national borders* that is required due to the supranationalism of DTM such as the World Wide Web, which is emblematic for the high interconnectedness of DTM (TIME, 2017, Vol. 190, Issue 2/3). As societies at large aim at prosecuting perpetrators, the **aggravation of prosecution** is an effect that impairs on a societal level.

Cyberwarfare as a further subtype of ***supporting delinquents*** occurs on a supranational level and comprise manifestations such as *espionage*, *sabotage*, *propaganda*, or *economic disruption* (Hay and LaFountain, 2017; Kim et al., 2011; DER SPIEGEL, 2/2018). In many countries, there are national programs to establish and strengthen cyberwarfare capabilities (Kim et al.; 2011). The **cyberwarfare** is enabled by the low-cost ubiquity of DTM and the rapid innovation and diffusion of new technologies that may lead to a strategic advantage towards competitors and enemies. Warlike actions that are enabled by DTM affect the societal level.

Finally, the RSED ***supporting delinquents*** comprises **cyberterrorism** as fifth subtype. The threat of **cyberterrorism** is enlarged by the fact that (critical) infrastructures, such as transportation, energy or telecommunication have become vulnerable due to a high level of interconnectedness (Lee, 2015). As **cyberterrorism** affects (critical) infrastructures, this subtype occurs on a societal level.

As a second example, we consider the RSED ***impairment of health***: The **reduction of psychological health** as a subtype of ***impairment of health*** comprises the manifestation *reduced mental health from*

excessive use of DTM. Related effects that may occur are for example sleep disorder (TIME, 2017, Vol. 190, Issue 19; DER SPIEGEL, 41/2018) or burnout (Pirkkalainen and Salo, 2016). Further the **reduction of psychological health** manifests in *technostress* (*digital stress)*, i.e., stress that results directly from the use of DTM (Tams et al., 2018; Pirkkalainen and Salo, 2016; Galluch et al., 2015; Maier et al., 2015), *IT anxiety* (Thatcher and Perrewé, 2002), and *body image insecurity* (e.g., social media images from super thin models may lead to insecurity and eating disorders) (TIME, 2017, Vol. 190, Issue 19). The manifold manifestations of the **reduction of psychological health** are fostered primarily by the high social interconnectedness and the ubiquity of DTM. As any health impairment the effects harm on an individual level. The **reduction of psychological health** is already strongly covered in extant information systems research like, for example, reviewed by Pirkkalainen and Salo (2016).

Another more specific subtype of ***impairment of health*** is **addiction and follow-up problems**. An addiction to DTM may result in serious mental or physical complaints, such as depressions or overweight (DER SPIEGEL, 46/2017). An *excessive smartphone or internet usage* is fostered by persuasive technologies based on business models that focus on eyeball time, that is, the time a visitor spends on a specific app or website (TIME, 2018, Vol. 191, Issue 15). Smartphone addiction is caused by a lack of self-regulation (Soror et al., 2015). The *excessive usage of computer games* allows users to escape from problems in other domains by experiencing power, achieving an instant gratification, and being part of a community of gamers (Ledder, 2013; DER SPIEGEL, 1/2018). Such addictions may lead to a *worsening of human cognition* (e.g., less deep thinking, less nuanced ideas, worse memory), a *reduction of emotional intelligence* (e.g., empathy) (TIME, 2017, Vol. 190, Issue 27/28), a neglect of responsibilities (e.g., at school, at work), a *deterioration of adolescents' mood* (e.g., loneliness, envy, suicidal thoughts) (Pirkkalainen and Salo, 2016), and an impaired development of the self-image due to reduced intense, personal contact. Furthermore, frequent users of DTM may develop a *fear of missing out* (Ledder, 2013). Additionally, there is some research that link *changes to children's brains* to media multitasking (TIME, 2018, Vol. 191, Issue 15; TIME, 2017, Vol. 190, Issue 19). The subtype **addiction and follow-up problems** may be traced back to the low-cost ubiquity of DTM and affects primarily on an individual level.

Additionally, the RSED ***impairment of health*** manifests in the **reduction of physical health**. There may be a **reduction of physical health** that results *directly from excessive use of DTM*, such as shortsightedness, lack of activity, and obesity (DER SPIEGEL, 41/2018). Further, the use of DTM may indirectly cause a reduction of physical health, e.g. the *spread of infectious diseases*. For example, the introduction of Craigslist in the USA led to an increased ratio of HIV infections due to the possibility of arranging physical meetings between people who have not met before (Chan and Ghose, 2014). Other indirect effects are for example *injuries caused by distraction* (e.g., car accidents that result from the use of smartphones while driving). The **reduction of physical health** is primarily fostered by the high social interconnectedness and the low-cost ubiquity of DTM. As any health-related issues, the **reduction of physical health** affects on an individual level.

There are cross-relations between the different subtypes of ***impairment of health:*** Addiction is a special form of psychological illness; psychological and physical illness may be mutually dependent. Three of the four dark side phenomena identified in the extensive literature review by Pirkkalainen and Salo (2016) belong to the RSED impairment of health, namely technostress, IT addiction, and IT anxiety. Their fourth dark side phenomenon – information overload – belongs to the RSED ambivalent decision environment.

These two examples – the RSED supporting delinquents and impairment of health – illustrate the manifestations and examples underlying the RSED and their subtypes as well as the reasoning on the affordances of DTM and the affected level. Figure 2 lists all 35 subtypes, relates them to the respective affordances and levels affected and (by color coding) to the 11 RSED. The different sizes and overlays of boxes have only graphical reasons and do not indicate similarity or importance.

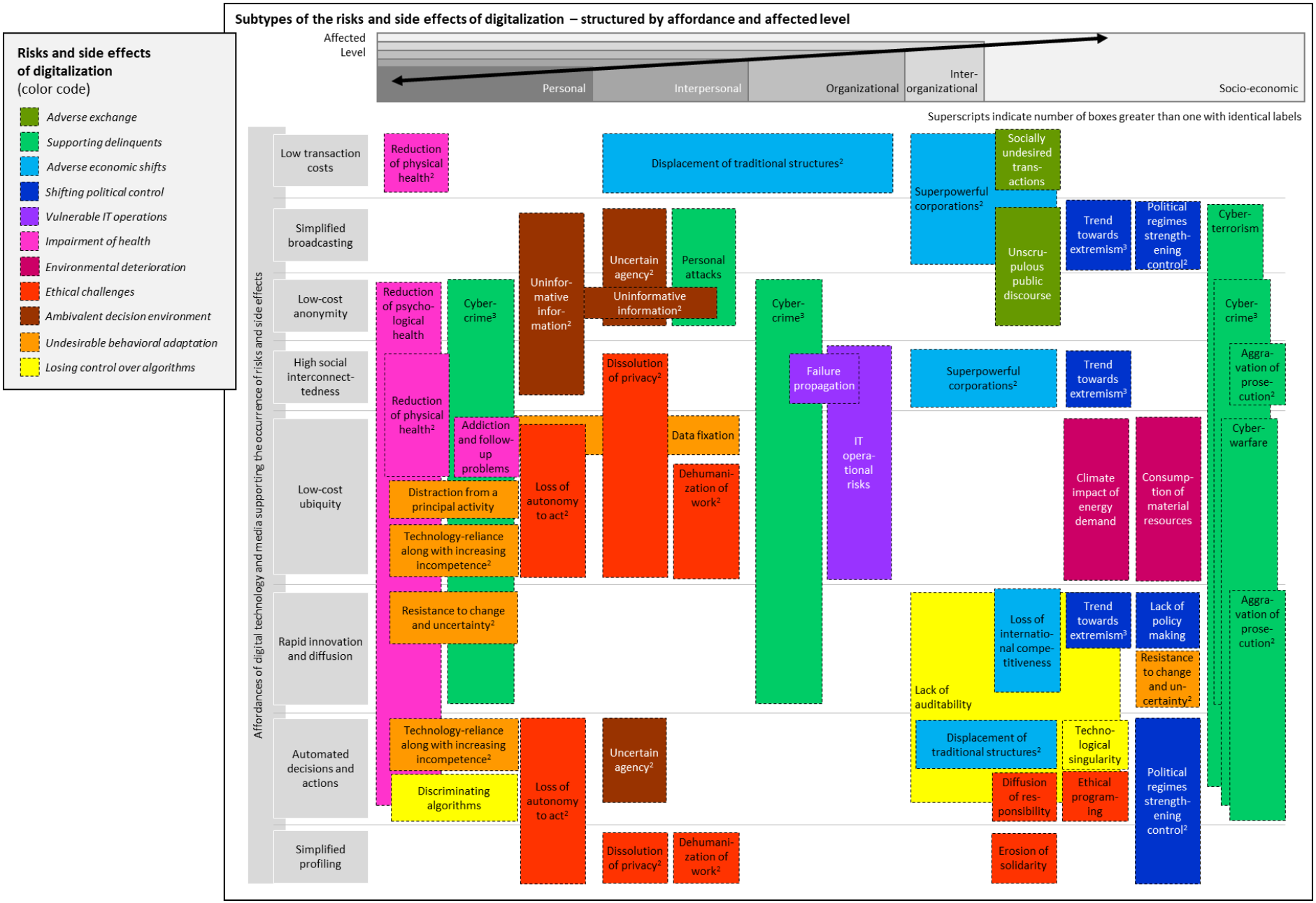

Figure 2. Map of risks and side effects of digitalization and their subtypes by affordances and levels affected

5 Discussion and Conclusion

The contribution of this paper is a taxonomy of the risks and side effects of digitalization (RSED). Our taxonomy provides a holistic map of RSED at different levels ranging from the individual to society at large. Specifically, the taxonomy comprises 11 RSED, and their 35 subtypes.

This holistic perspective broadens the conceptualization of the dark side of IT use. It includes phenomena previously studied under the label "dark side of IT" as, for example, discussed by Tarafdar et al. (2015) and Pirkkalainen and Salo (2016). These prior dark side phenomena are primarily included in the RSED ***impairment of health***, ***ambivalent decision environment***, and ***vulnerable IT operations***. Phenomena included in the taxonomy of the dark side of the Internet presented by Kim et al. (2011) belong to the RSED ***supporting delinquents***. Our taxonomy further comprises additional phenomena studied in information systems but not under the label 'dark side'. Examples include echo chambers and filter bubbles (included in the RSED ***ambivalent decision environment***) and privacy (included in the RSED ***ethical challenges***). Beyond that, the taxonomy covers perceptions of current negative effects and potential future risks that are hardly yet addressed in information systems research like technology-reliance along with increasing human incompetence (included in 'undesirable behavioral adaptations'), discriminating algorithms (included in 'losing control over algorithms'), and cyberterrorism (included in 'supporting delinquents').

The intended users of our taxonomy of RSED are primarily information systems scholars. Due to the broad character of our taxonomy, we see various fields of application in information systems research. However, the taxonomy may be adopted in other disciplines, such as criminology, psychology, and political science that also study digitalization from their disciplinary perspectives.

For scholars, the taxonomy provides a terminology of RSED that may be observed in business and everyday life, but – to some extent – have not yet been discussed in scientific literature. The terminology of RSED may be adopted in future research projects considering the effects of digitalization. Further, it may help to identify focus areas of previous research and gaps to focus on in the future.

In development of new DTM-based systems, design science researchers may consider the affordances and can use the taxonomy for a first identification of potential RSED. Additionally, researchers may take a complementary perspective by systematically considering all levels affected starting with the one (s)he wishes to improve but also considering potential externalities at other levels. At each level, the researcher should evaluate whether the related RSED may occur when using the new IT-based system.

In behavioral science, researchers may use our taxonomy as a basis for manifold research questions. For instance, empirical research should evaluate the importance of the single RSED for the different levels affected in order to enable a prioritization for the development of appropriate countermeasures. Furthermore, the taxonomy may be helpful to examine the perception of digitalization within groups of different cultures, ages, or professions.

Further, practitioners working on the analysis and design of DTM-based systems can use our taxonomy in order to identify potential RSED related to the use of specific IT-based systems. With that knowledge, practitioners may choose DTM-based systems that minimize the effects of RSED, develop appropriate countermeasures, or at least inform about the potential RSED. An example: A developer working on an artificial-intelligence-enabled assistance system (Mädche et al., forthcoming) might identify the affordances of the system including automated decisions on behalf of its user. The developer might then use the map of RSED presented in this paper and identify "discriminating algorithms" as an RSED subtype that might originate from this affordance. Investigating the issue deeper, the developer who was previously unaware of the issue might search the news for examples. For instance, in 2015, a programmer revealed that Google's image recognition software categorized black people as "gorillas" (USA TODAY, 2015). Further, in 2016, Microsoft launched a Twitter account for Tay, a self-learning chatbot. Twitter users were engaged to communicate with Tay. As Tay rapidly adopted insulting and racist comments from other users, the chatbot was shut down on the same day (The Guardian, 2016). To dig deeper, the developer might turn to academic literature and find a discussion that being non-discriminatory is

an important moral principle but biased training data might lead algorithms to become discriminatory (Mädche et al., forthcoming). There, the developer will find further examples, specifically Amazon's presumably sexist recruitment support system (no longer operational) and Northpointe's presumably racist recidivism scores used in the US criminal justice system (currently operational). Looking further at the map of RSED, the developer will see many other RSED subtypes related to the affordance of automated decisions. Considering the description of these affordances, the developer might start considering how to ensure *ethics-by-design* for her or his system.

Policy experts can use the taxonomy of RSED to evaluate whether present legislation is sufficient to cover the effects of innovative DTM. For instance, our taxonomy shed light on the negative effects of DTM on individuals who need to be protected by legislation in a particular way. By an earlier identification of (potential) RSED, the taxonomy may help to reduce the retarded enactment and revision of laws that are affected by the socio-technical progress.

As any research, our taxonomy of RSED comes along with limitations. As digitalization is enabled by a multitude of innovative DTM that evolve continuously, also the RSED will change over time. Potentially, some of the RSED will disappear, others will change, and additional RSED will appear. Hence, our taxonomy should be seen as a snapshot of recent RSED. Having multiple layers of abstraction and focusing on affordances rather than individual technologies, we expect the top-level RSED to remain up-to-date for five or ten years. However, at latest beyond that, they need periodic review and refinement.

As we exclusively considered current RSED, future research may give an outlook on potential RSED related to emerging DTM. By focusing on weekly magazines, interview partners, and workshop participants from Germany and the USA, we took a primarily Western perspective. In addition, the taxonomy of RSED may be biased by the authors' Western moral principles. Hence, further research may shed light on different perceptions of RSED between various cultural areas.

Although, we tried to broaden our view by identifying relevant RSED by studying the weekly magazines TIME and DER SPIEGEL and by conducting expert interviews with researchers from various disciplines (e.g., ethics, criminology, sociology), we then focused on academic literature from IS discipline to verify and illustrate the RSED. Hence, the integration of academic articles from other disciplines may be an appropriate extension to our work.

Furthermore, upcoming research should examine the impact of the identified RSED and develop appropriate countermeasures for individuals, organizations and societies at large. Depending on the respective RSED, this research question should be examined in joint research projects with scientists from appropriate disciplines (e.g., criminology, psychology, political science). By evaluating whether users of DTM are aware of the related RSED, researchers should identify potential information gaps (within certain groups) that may be addressed by future educational campaigns.

Senior IS scholars "have called for adopting a "positive lense" in IS research" (Agogo and Hess, 2017, p. 1). Yet, we believe that our discipline benefits from a detailed and comprehensive theoretical perspective on the dark side of IT use and digitalization. This is especially true as information systems scholars tend to have a pro-IT bias and need support in overcoming this bias (Majchrzak et al., 2016). Adverse effects of the increasing use of digital technologies and media are a reality and they are increasingly present in the perception of many and in mass media. We as information systems scholars need a sound understanding of these effects in order to support the public debate and to mitigate the risks and side effects to digitalization with the overall aim to contribute to the net benefits of digitalization. Metaphorically speaking one could say that you have to know the corners and angles of the dark side if you want to provide light. Our taxonomy maps the dark side of digitalization. As theory of the problem and theory for analysis, it provides a basis for illuminating the dark side.

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