Transformative Outcomes of Consumer Well-Being in the Era of IR 4.0: Opportunities and Threats of Physical, Biological and Digital Technologies Across Sectors

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Objective: Background and Purpose of the Study

This article focuses on the rise of the machines and the 4th Industrial Revolution (henceforth IR 4.0) with a focus on the transformational aspects it may have on consumer, societal, and environmental well-being. With the advent of the IR 4.0, we see the rise of several phenomena such as artificial intelligence (AI), machine learning (ML), intelligent agents, Internet of Things (IoT) (Lee and Lee 2015), blockchain (Tapscott and Tapscott 2016), 3D printing, and robotics, amongst others. According to experts, innovations and technologies continue to change our world (Stearns 2018). Cyber-physical systems, autonomous vehicles, genetic engineering are just a few examples. Research on these topics continues to be of interest in the field of marketing. For example, the potential of social robots in service encounters is investigated (see Mende et al. (2019); van Doorn et al. (2017) as examples).

The overarching goal of the article is to address how the IR 4.0 technologies influence macro-consumer behavior, specifically identifying relevant public policy considerations, and ethics to ensure consumer well-being. It is important to identify how IR 4.0 technologies enable consumer well-being because new technologies are profoundly transforming key sectors in society, such as, community, financial, health, educational, environment, and safety. We explore how such dramatic changes are going to change several facets of our lives. Specifically, we begin by exploring the blurring boundaries of the physical, biological, and digital domains in the 4th Industrial Revolution by examining the intersectional ties of newer technologies across the three domains of IR 4.0. We then examine how these technologies are likely to operate within the context of some major sectors of society, namely, education, finance, health, manufacturing and retail; and to influence the three critical dimensions of well-being, namely consumer, social, and environmental. We also discuss transformative outcome potentials for well-being in the context of the three domains of IR 4.0. In the end, we conclude by providing implications for public policymakers and directions for future research.

Significance: the gap in the literature/need for the study

There are two main literatures that we are contributing to. First, is literature on IR 4.0 as well as diverse technology-specific literature that investigates sub-fields – AI, ML, robots, etc. Second is the Transformative Consumer Research literature that focuses well-being. While there is an established understanding of well-being, the literature is lacking focus on technology-enabled changes that can be associated with well-being. At the same time, parallel literature on IR 4.0 does not show connection to well-being. Our work is an attempt to integrate understanding of emerging technologies and their impact

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on various levels of well-being. We contribute to TCR and IR 4.0 literatures by presenting a conceptual framework that describes key principles of IR 4.0 Technologies, its transformational impact on key sectors as well as technology-enabled view towards well-being on consumer, societal, and environmental levels. First, we detail key elements of IR 4.0, we chart and describe it as an entity. We are mapping out IR 4.0 Technologies as well as key principles relevant to well-being. We discuss the intersectionality between various domains of IR 4.0 as well as positive/negative aspects of technologies in relevance to well-being.

Method:

The Blurring Boundaries of Physical, Biological, and Digital Domains in IR 4.0

The phenomenon of the 4th Industrial Revolution sees both human and new technologies as becoming increasingly intertwined. Consumers are increasingly interacting with various forms of new technologies across various platforms in their day-to-day activities. The time that the decision-making process was following a linear, top-down approach is over. The 4th revolution has opened an era of breakthroughs that is not in sync with the slow pace of implementing laws and regulations (Xu, David and Kim 2018). As the physical, biological, and digital domains continue to converge, these new technologies will increasingly enable consumers to collaborate closely with governments to voice their opinion to implement new public policy.

We consider three global domains to which new technologies can be assigned: physical, biological, and digital spheres. However, the boundaries between these domains are blurring, and new technologies can no longer be easily assigned to only one domain. (Huang and Rust 2018; Schwab 2017). We begin by describing the three major clusters, and then detail their interrelatedness in influencing major sectors of society (e.g., education, finance, health, manufacturing, retail, etc.) and the potential impacts that these technologies can have on both consumers' lives as well as society and the natural environment. The overarching framework is depicted in Figure 1.

Insert Figure 1 about here

The physical domain involves manifestations of material objects such as autonomous cars, advanced robotics, wearables, and three-dimensional (3D) printing (Xu, David and Kim 2018). The biological domain involves innovations in the realm of biological or living organisms and includes advancements in genetics, neuroscience, synthetic food production and implantable technology (Schwab 2017). Major digital advancements in IR 4.0 include Internet of Things (IoT), blockchain technologies, machine learning, and the sharing economy. As the physical, biological, and digital domains continue to converge, many advancements are anchored in the digital domain, which bridges either or both physical and biological domains. Thus, we start with the predominant digital technologies, as these are the vehicles for many cross-domain applications. In the following sections, we further explicate the interactions amongst these domains.

Results:

The interactions between the three domains (physical, biological, and digital) are illustrated in Table 1.

Insert Table 1 about here

Based on our research, we also investigate how the intersections in the three domains of IR 4.0 influence some of the major industries. We also discuss the opportunities and threats that these interactions offer in each industry. The list of industries is not exhaustive - the most important ones likely to be impacted by IR 4.0 are discussed in a tabular form below.

Opportunities and Threats on the Influence of the Intersections in the Domain of IR 4.0 on Major Sectors

	Examples of the Influence of the Intersections in the Domains of IR 4.0 on some Sectors of the Economy	
	Opportunities	**Threats**
Education	➢ On-demand online courses adapting to the user needs and convenience: opportunity to decide the time and location for studying. ➢ Lower costs & higher interactions between faculty and students.	➢ Readiness in responding to IR 4.0, and universities capability of managing the convergence, fluidity, power shifts, contingency, and ethical issues. ➢ Revenue management issues and resource reallocation because of the digitization of campuses.
Finance	➢ Digital payment systems and platforms via mobile payments result in decentralization of insurance and financial institutions databases ➢ Lower cost by eliminating intermediaries' bankers and agents.	➢ High privacy issue & security breach. Discrimination against a part of the population if personal data are not concealed. ➢ Financial institutions may take advantage of personal data by offering a lower price to premium consumers.
Healthcare	➢ Tools to diagnose diseases that doctors sometimes miss. ➢ Supplements the care provided by medical staff, especially with patients suffering from dementia.	➢ Technology developed by private and profit-driven companies raises security issues. ➢ Companies could collect sensitive data that could be used against individuals.
Manufacturing	➢ Self-driving cars could reduce traffic accidents and fatalities reducing healthcare costs. ➢ A smart home can manage the optimal temperature and lighting reducing environmental footprint.	➢ Self-driving cars lead to legal and ethical issues. Policies need to consider who is to hold accountable in case of an accident. ➢ Severe job losses in the transportation industry because of autonomous vehicles.
Retail	➢ Blockchain increases transparency in product production and tracking. ➢ Consumers can instantly and directly pay the artist with digital currency after signing smart contracts with music and entertainment content providers	➢ Voice assistants are susceptible to get hacked, causing security risks. ➢ Hacked commands inaudible for the human ear can be directly embedded into music or spoken text to manipulate the system into carrying out criminal or mischievous acts without the user consent.

Conclusions/Relevance:

The key objective of this study is to better understand the impact of IR 4.0 technologies on consumer well-being across major sectors of society. It is already widely acknowledged among scholars that IR 4.0 is now at a stage where it matters to society in general and people's lives in particular. In this article the major interrelated drivers of IR 4.0 have been identified, each of which is underrepresented in the macro consumer literature: artificial intelligence (AI), machine learning (ML), intelligent agents, Internet of Things (IoT), blockchain, and robotics. Furthermore, those drivers have been grouped into three domains of IR 4.0 are discussed in terms of benefits and implications for the domains of well-being identified by an earlier study. Figure 1 shows how the domains operate as a kind of layered-nexus, implying an interrelationship that makes each in itself insufficient for understanding the wider transformative outcome of IR 4.0. Arguably, only by looking at how the domains of IR 4.0 align with the domains of well-being is it possible to develop strategies for consumer adoption.

Consequently, drawing on the interrelations of the two domains of IR 4.0 and wellbeing, a conceptual framework is developed to explain possible opportunities and threats in major sectors of the economy. Consequently, the results of this study may help policymakers and planners become knowledgeable of IR 4.0 and its transformative outcome potentials of well-being. As consumers look for help and support in these technologies, policymakers and planners need to be particularly aware of possible negative implications and thus continuously questioning IR 4.0 technologies consumer's adoption to ensure broad and fair access to IR 4.0 throughout society. Arguably, policymakers need to monitor, evaluate, promote and provide infrastructure to harvest the benefits of IR 4.0 and to help enable the continuous diffusion in all aspects of societal life. This paper has taken a major step in outlining the most important areas, but more work needs to be done, to help policymakers and others make informed choices about future investments IR 4.0. Consequently, and since IR 4.0 technologies are interrelated, future research should explore their boundaries in a macro consumer context.

The consumer under IR 4.0 will be more engaged, and the marketing processes have to be dramatically transformed in responding to the transformed consumer. The intersection of the three major domains of IR 4.0, i.e., physical, biological, and digital domains will continue to spur innovations that impact consumer behavior and disrupt marketplaces. Some of these technologies like smartphones, streaming videos, and social media are already a major fabric of consumers' lives. Marketing in a digital world will consist of more than simply harnessing digital channels. It will involve harnessing automation to make marketing more productive and agile, mining new sources of data to create more personalized and targeted communications, leveraging artificial intelligence to optimize the use of consumer insights, but most importantly to enhance the consumer well-being.

Figure 1 - IR 4.0 Framework for Technology-enabled Well-being

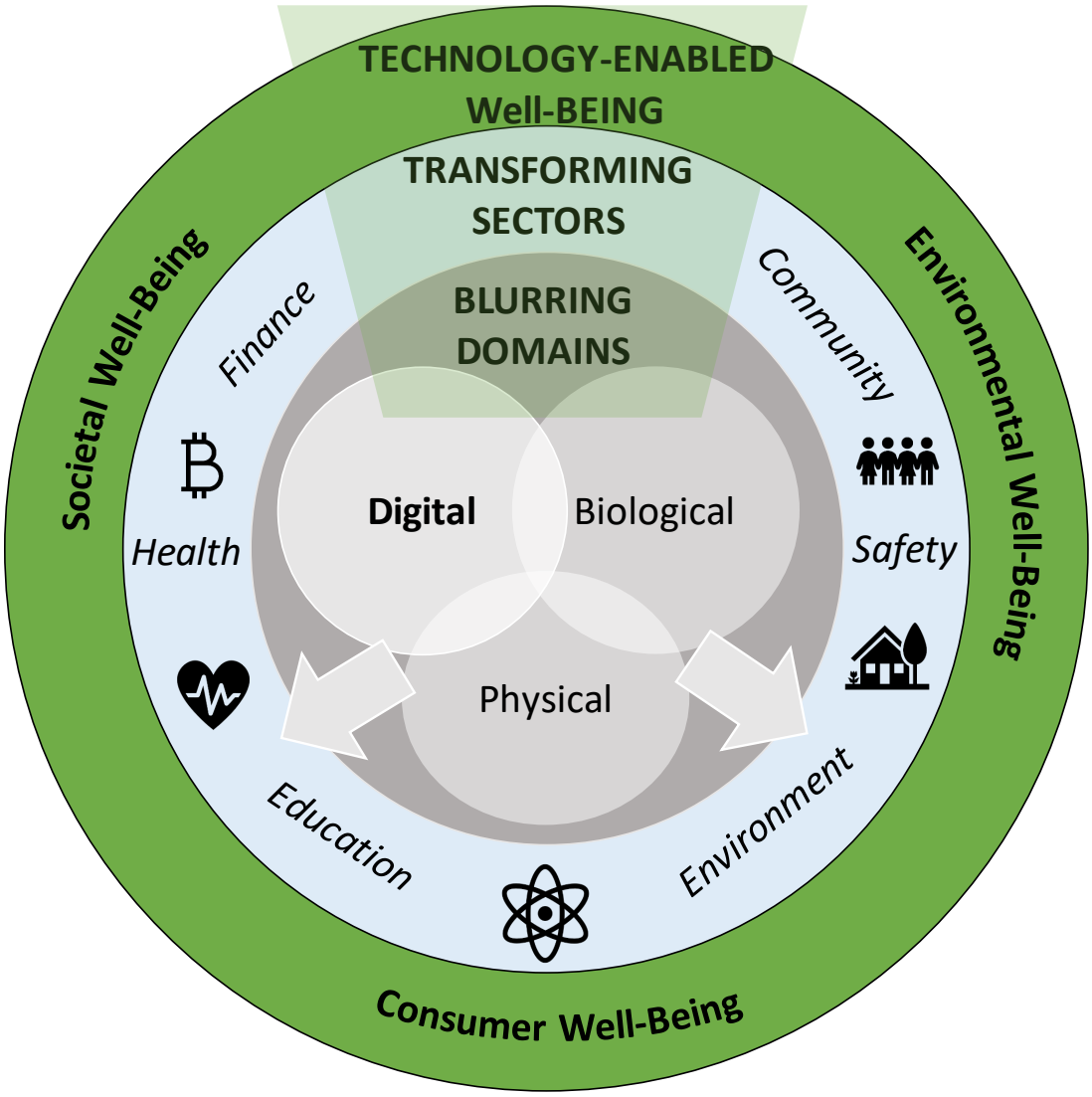

Table 1: Intersectional Ties of Newer Technologies Across the 3 Domains of IR 4.0

IR 4.0 Technologies		DOMAINS OF IR 4.0		
		DIGITAL	PHYSICAL	BIOLOGICAL
Predominant Digital	Internet of Things (IoT)	●	◑	○
	Machine Learning	●	○	◑
	Blockchain Technology	●	◑	○
	The Sharing Economy	●	◑	○
Predominant Physical	Autonomous Vehicles	◑	●	○
	Robotics	◑	●	○
	Wearables	◑	●	◑
	3D Printing	◑	●	◑
Predominant Biological	Genetic Engineering	◑	◑	●
	Synthetic Food	◑	◑	●
	Neurotechnology	◑	◑	●
	Implantable Technology	◑	◑	●

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