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Age Matters: How Generational Decision-Making Cohorts Affect Disruptive Technology New Product Development

Yorgos Marinakis, Steven T. Walsh, and Rainer Harms

***Abstract*—The Internet of Things (IoT), a worldwide network of interconnected objects uniquely addressable, based on standard communication protocols, has become a disruptive technology, even for decision-makers who develop products based on them. It was reported in 2015 and 2018 that decision-makers associated with the Fortune 1000 firms stated that they were hesitant to use IoT-based value propositions, primarily due to privacy and security concerns. In this article, we view decision-maker willingness to develop IoT-based products through the lens of the social construction of technology (SCOT) theory. We utilize SCOT-based generational cohorts of firm decision-makers to investigate whether generational cohorts of decision-makers are relevant in a firm's decision to launch an IoT value proposition. We argue that it is pertinent to consider age-based generations as stakeholders for IoT, which currently constitutes a gap in the literature on IoT and SCOT. We employ an exploratory survey analysis that supports the relevance of generational decision-making cohorts. We focus on age to the exclusion of other potential decision-maker cohort possibilities and discuss this as a limitation in our conclusion.**

***Index Terms*—Cyber privacy, cyber risk, cybersecurity, Internet of Things (IoT), new product development, social construction of technology (SCOT), technology entrepreneurship, technology policy.**

I. Introduction

THE Internet of Things (IoT), "a worldwide network of interconnected objects uniquely addressable, based on standard communication protocols" [1, p. 6], has become a disruptive technology for end users, from consumers to industrialists [2, p. 143]. This new technology can induce significant social change [3]. In particular, IoT can stimulate the development of new business models [4], [5], [6], new approaches to logistics [2], Industry 4.0 [7], smart cities [8], [9], and innovation practices [10], [11].

IoT value propositions face tremendous technical hurdles [12]. For example, approximately eight to ten billion sensors are attached to the internet today; some forecast the use of eight to ten trillion sensors in the near future [13]. In 2010, a Hewlett Packard report stated that it would take 1000 of today's internets to create a central nervous system for the Earth [14] to fill the trillion-sensor world requirement. Today, firms and people develop intelligence on edge, swarm intelligence, and local network solutions [15]; these hold promise for resolving some of the associated IoT infrastructure-based technical issues.

However, technological hurdles are only one of the constraints facing disruptive IoT technology-based new product development (NPD). For example, the World Economic Forum Industrial Internet Survey [16] found that the most significant barriers to adopting industrial Internet included the lack of interoperability or standards, security, Return on Investment uncertainty, legacy management, technology immaturity, and—perhaps most importantly—privacy concerns [17]. Moreover, it was reported in 2015 and 2018 that decision-makers from the Fortune 1000 firms stated they were hesitant to use IoT-based value propositions, primarily due to privacy and security (P&S) concerns [18], [19]. Finally, it was reported that successful NPD in other disruptive technology-based product decisions required general stakeholder engagement [20].

Theories on trust [21], the technology acceptance model (TAM) [22], and the social construction of technology (SCOT) [23] provide theoretical backgrounds to address successful disruptive technology-based NPD decision-making processes. We viewed IoT-based NPD through the lens of SCOT to investigate whether the disruptive technology-based NPD process is being affected by differences in opinions between generations of decision-makers. Our aim was to ascertain whether there is a pathway to stabilization or closure, for instance, the pathway to the final design of the artifact or, in this case, the category of emerging technology. SCOT is a theoretical model that explains how technological change at the artifact level (i.e., the NPD decision-making level) emerges from interactions between relevant social groups. We applied SCOT to a category of disruptive technologies as a means of early-stage participatory technology assessment (PTA). PTA is a method of societal engagement in policymaking concerning technology options. Stakeholders, including nonexpert members of the public, are invited by policymakers to apply their values and preferences to candidate deployments of disruptive technology or technology-based products and then to share their opinions about the technology [19], [24].

We argue that it is relevant to consider age-based generational decision-making cohorts as stakeholders for a new IoT-based

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NPD process. This is currently a gap in the IoT literature. First, a large body of literature exists concerning differences in P&S perceptions between generations of internet *users* [25]. This is evidenced in the use of devices connecting to the internet [26], online shopping [27], banking [28], and social media use [29], [30]. However, these all focus on consumers of the technologies rather than on NPD decision-makers.

The growing scope of cyber risk amplifies the impact of this gap. "The associated risks and exposures have progressed from concerns over personal privacy and the confidentiality of corporate assets to threats of widespread organizational interference and operational disruptions, including direct monetary hits involving the illegitimate transfer of funds, and ultimately, to the potential for actual physical harm, injury, or loss" [31]. We focus not on consumer behavior but on generational differences between decision-making cohorts in NPD decision-making.

Closing this gap is essential. Previous studies of generational differences in P&S perceptions focus on the *user* level rather than on the firm NPD *decision-maker* level. To be clear, product technology development decision-makers also socially construct new (in our case, new IoT) value propositions and are, therefore, relevant social groups, according to SCOT theory. This is a novel use of the SCOT construct. More generally, we argue for the consideration of generations as stakeholder groups for SCOT analyses. Our exploratory study shows that impactful differences exist between decision-maker generational cohorts regarding their perceptions of disruptive technologies, analogous to how generational differences exist regarding perceptions of the workplace [32], responsible consumption [33], religion [34], and other subjects.

Closing this gap is relevant from the perspective of research into IoT diffusion. We show that "Baby Boomers" play a disproportionate role in shaping the IoT NPD process in large firms. For example, the average age of all C–suite decision-makers in Fortune 500 and S&P 500 firms is 56 years [35], and of the CEOs is 57 years [35], [36]. We show generational cohort differences in P&S perceptions for IoT and that the baby boomer cohort of NPD decision-makers is more conservative in the IoT-based NPD process.

II. Theoretical Background

There is a plethora of literature on the effects of age (e.g., [37], [38], [39]) and of age cohorts (e.g., [40], [41], [42], [43]) on the consumption of internet-based services and products. Only one article [44] exists in the literature on generational effects on attitudes toward IoT. Moreover, this one article deals only with consumers, not decision-makers. Albert *et al.* [44] formulated hypotheses through analogies with perceptions about the internet and Information Technology (IT); we followed suit.

A. Corporate and Personal Dimensions of P&S Concerns in the Context of IoT

Cybersecurity refers to a computer or computer system's infrastructure's robustness and resilience against unauthorized access from a hacker. This is true for both firm-based and personal computer systems. "Cyber data privacy is a consumer's (either person or corporation) understanding of their rights as to how their …. information is collected, used, stored and shared" [45], [46].

Cyber security concerns are regarding the harm that comes from data loss, data breach, the cost of data recovery, data locality, and the loss of data privacy [47]. Such scenarios are possible if hackers gain control over IoT-based devices, leading to eavesdropping, tampering with applications, unauthorized access, hardware failure, and more [48]. In the *personal end-user* domain, recent security concerns have been household devices, security systems [49], and hacked cars [50], [51]. In addition, the industry has reported several security breaches in the corporate IoT ecosystem, such as tampering with internet-connected security systems, climate control and energy meters, and corporate communications infrastructure across the energy, aerospace, and healthcare sectors [52]. Thus, cybersecurity concerns have both personal and corporate dimensions.

Privacy, in particular, information privacy [53], [54], refers to the "control or restrictions one has over information about oneself" [53, p. 322]. In the personal end-user domain, information privacy concerns often revolve around the right to control the dissemination of one's own words or pictures, demographic information, and sensitive financial information. In addition, privacy impacts technological policy [55], and aging plays a part [56] in the policy process.

While these concerns are already salient on the worldwide web in general, the introduction of IoT leads to additional privacy concerns about identification, tracking, profiling, etc. [57]. Recent examples of privacy breaches include hacked baby surveillance cams [58] and profiling issues with fitness-tracking devices [59]. Examples of corporate IoT privacy concerns include industrial espionage [60], governmental services [61], [62], and the leak of employee and customer information [63]. Thus, cyber privacy concerns also have personal and corporate dimensions.

In the most recent version of the TAM 3, perceived usefulness and perceived ease of use are related to user acceptance of IT technology, and the former is related to, amongst others, external control, anxiety, and output quality [22]. However, this does not address the *decision-makers*' action in an IoT NPD process. Similarly, the degree of technology trust is positively related to technology adoption [21] but has not been applied to *decision-makers*' actions in an IoT NPD process. Moreover, privacy concerns were found to negatively impact the intention to use IoT technology [64], yet these studies, again, do not address *decision-makers*' action in an IoT NPD process. These studies focus on the process of the customer's, not the decision-maker's, acceptance of technology.

The social groups relevant to the NPD process and the diffusion of IoT have not reached an agreement—i.e., stabilization or closure—on IoT due to P&S concerns of at least some social groups. We extended SCOT by applying it more broadly to a category of emerging technologies rather than more narrowly to a particular artifact. Using SCOT at the categorical level is justifiable, as it matches how society responds to emerging technologies. For example, protesters do not protest against genetically modified corn; instead, they protest against genetically modified organisms or the firms that produce and use them.

Similarly, protesters do not protest against fullerenes, micronized zinc oxide, micronized titanium dioxide, or micronized

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quartz silica; instead, they protest against nanotechnology and the firms that produce them. Legislatures do not pass laws regulating the Ti plasmid of the soil bacterium *Agrobacterium tumefaciens* or regulating nano zinc oxide. Instead, they pass laws regulating genetically modified organisms and nanomaterials [65].

B. Generational Technology Product Paradigm Decision-Makers' Cyber P&S Concerns

As stated above, there is only one article [44] on generational effects on IoT perceptions. This article reported a survey on 463 undergraduate business students as consumers, not as decision-makers. The authors found that younger generations were more concerned about IoT security and were more influenced by security in their intentions to purchase IoT devices than older generations. As we discuss below, these results contradict findings and arguments relating to generational differences in attitudes toward IT generally. Nevertheless, the literature suggests that older generations will have heightened P&S concerns regarding IT and IoT.

Our literature review on generational differences in P&S concerns relating to IT provided insight into consumer decisions to embrace digital technologies; however, this literature did not address decision-makers in the NPD process. For example, one author states, "[o]lder adults frequently deploy the concept of distrust when discussing digital technologies," and more specifically, they discuss greater concerns with P&S than younger generations [66]. Additionally, other authors show generational differences in consumer trust, in digital technologies [67], [68] or state that older consumers' understandings of social networks are silly and empty headed [69]. Nonetheless, others focus on how younger consumers of internet banking see it as more secure than other generations [70]. Others explore gender, age, and frequency of internet use as moderators in the adoption of E-government [71], [72] and what it means to "trust" Facebook [73].

However, these researchers focused on consumers of digital technologies, not on technology product paradigm decision-makers. We extended the internet literature on P&S to IoT and used this literature to derive our hypotheses on the relationship between generationally defined decision-making cohorts and the degree of P&S concerns.

We know that many older generations are resistant to the adoption of digital technology, but does the same hold true for older knowledgeable NPD decision-makers? Using the protection motivation theory [74], Jiang *et al.* [25] found generational differences in how much respondents care about online threats and their perceived ability to cope with these threats; however, the authors did not focus on NPD professionals. Older generations had a lower degree of online-threat-coping ability or a lower degree of confidence in their coping abilities [23]. Based on the generational imprinting theory [75], a generation's IT concerns can be related to their adolescent experiences in organizations [76]. Hence, Regan *et al.* [77, p. 89] argued that baby boomers should show a higher level of internet P&S concern, as "that generation grew up during a time of cultural change and questioning of authority." Yet again, these studies focused on consumers rather than NPD professionals. A similar empirical pattern would emerge based on the life stage theory, whereby P&S concerns would be deepest for those in the middle years (Generation X), when "they are most concerned with the stability and integrity of their social and economic lives" (p. 89). We agree with Regan *et al.* [77] that the effects of imprinting, life stage, and the ability to cope are juxtaposed and propose that older generations are more concerned with P&S than younger generations.

C. Generational Cohorts of NPD Decision-Makers

The theory of reasoned action, which was applied to develop the TAM [78], has been used to question self-reported behaviors [79], [80]. Thus, the TAM is a theoretical foundation for our exploratory survey of self-reported action, which we then use in a case study to investigate NPD decision-makers' real actions, which we split into generational cohorts. Further, we utilize the behavioral research theory [81], specifically, its value in leadership decision-making [82], for our SCOT analysis.

Our SCOT exploratory study examines the difference in generational cohorts of NPD process decision-makers through self-reported actions. We further develop these self-reported experimental study results in a case study by examining actual decisions and their outcomes based on generational decision-making cohorts in the IoT NPD processes. We use the same generational cohorts in our case study as we do in our exploratory study. We state that the decision-makers in large firms are the C-Suite professionals [83] and define the entrepreneurial and small-firm decision-makers as the founders [84], [85].

We found that in general, C-Suite professionals (chief financial officers, chief executive officers [CEOs], chief technological officer, and the like) are populated by the baby boomer generational cohort. For example, a study of the top 1000 US firms in 2020 reported that CEOs were on average 59 years of age, and that the average age of all C-Suite executives was approximately 56 years [86]. Further, the recent age trend for C-Suite decision-makers in large firms is on the rise [87].

Entrepreneurial studies on founders' ages tell a different story. Azoulay [88] found the average age of founders in all startups to be 41.8 years. He also found that the average age of high-tech firm founders was 43.2. Finally, he discovered that high-growth entrepreneurial firms' founders averaged 42.8 years in age. This indicates that decision-maker cohorts comprise, on average, generation X and millennials. Therefore, in general, there is a clear decision-maker cohort division between large firms and entrepreneurial enterprises.

D. SCOT Perspective on IoT Diffusion and Its Relation to Generational Cohorts of Decision-Makers

SCOT suggests that technology is socially constructed [89]–[91], [23]. Social construction is essential because "only by exploring and exposing the social roots of technology can we hope to make the technological amenable to democratic interpretation and intervention" [91, p. 92]. Thus, relevant social groups in SCOT have comprised producers, advocates, users, and bystanders [89].

The user group is the advocate for the interests of society. The producer group advocates for the technology in the fullness of its possibilities, such as in the proposed IoT architectures

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for ubiquitous sensing and surveillance [92]. This assignment of agency enables the specification of entirely social theories to the construction of technology, such as generational cohorts of decision-makers. There is also an analogy to this proposed division in the producer—user co-creation of value [93]; however, the co-creation is the SCOT technology itself.

The members of each relevant SCOT social group share meaning about a particular technological artifact. The developmental process comprises the waxing and waning of different artifacts. Eventually, closure is reached when the groups agree on a particular design for the artifact. A seminal example is a bicycle [94], [92]. From 1879 to 1898, the relevant social groups were young men who wanted to demonstrate their virility, young women, older men who wanted transportation, and anti-cyclists. The latter two groups preferred the safety bicycle with solid rubber tires. Younger men preferred big wheelers as they were faster. In 1887, Dunlap made the first useful air tire to decrease vibration. However, the air tire also dramatically increased the speed of the safety bicycle. This unintended consequence was a closure mechanism that stabilized the design in favor of the safety bicycle. The subsequent introduction of the faster recumbent bicycle did not destabilize the design; however, by then, the safety bicycle was a popular means of transportation—and the means for its mass production were already in place—such that race track speed was no longer the deciding factor [94].

We also extended the SCOT by treating generational decision-making cohorts as relevant social groups. In previous SCOT studies, the social group of "users" was sometimes divided into cohorts and sometimes incidentally by age. For example, in past studies, child and teenage mobile media users were divided into three cohorts, comprising teenagers involved (or not) and a convenience sample of pre-adolescents [95]. In the present study, we argue that the generational categorization of relevant social groups should be more systematic than incidental. A generational cohort (in our NPD decision-makers) comprises people born during the same period and living through similar life experiences and significant emotional events during their formative years [96]. The notion of generation is based on the generational cohort theory. This theory was introduced to facilitate the identification and study of alleged mid-term social change [97]. The theory is based on a socialization hypothesis and a scarcity hypothesis [98]. The socialization hypothesis holds that adults' values reflect the socio-economic conditions they experienced in their youth. The scarcity hypothesis holds that generational cohorts put more value in the socio-economic resources that were in short supply during their youth. This theory's specific implication was that these value differences between generational cohorts cause revolutionary social change [99]. Regarding internet technology, a distinction is made between digital immigrants and digital natives [23]. While the former was exposed to the Internet relatively late in life, the digital natives grew up with new technology.

E. Hypothesis Generation

We construct our hypotheses through a novel combination of the cyber-P&S concerns in the context of IoT (see Section II-A) with the generational NPD decision-makers' cyber-P&S concerns (see Section II-B) and further provide the use of a novel relevant social group for SCOT (see Sections II-C and -D). It has been shown that P&S concerns inhibit many Fortune 1000 firms from embracing IoT-based [16] value propositions solutions through their NPD processes, but these authors do not investigate generational decision-maker cohort differences. At the foundation of our hypotheses is that generational cohorts of NPD process decision-makers comprise a relevant social group for the SCOT. Our hypotheses focus on the P&S concerns of these generational decision-making cohorts. We test generational decision-making cohorts in both personal and corporate dimensions. Based on our theoretical considerations as discussed in our literature review and previous empirical findings concerning generational consumer cohorts of digital technology [100], we expect that older generational cohorts of technology product paradigm decision-makers will have stronger personal and corporate cyber P&S concerns [101], [102].

For all hypotheses, we make use of research that points toward generational differences in P&S concerns for digital technologies [43], [57], [66], [68]; our hypotheses provisionally extend these studies to generational decision-making cohorts. Barak [57, p. 121] states that "[r]ecent studies show that there are differences between digital natives and older generations in terms of media use and communication patterns…" Knowles and Hanson [66, p. 19] state that older adults do not comprise a relevant social group, but they form a relevant social group compared to younger adults. Chakraborty *et al.* [68, p. 52] state that "[p]erceived severity and risk are thus more important drivers of online shopping behavior after incidents for the older generations." Zambianchi *et al.* [43, p. 291] state that "[r]egardless of nationality, younger age and higher levels of educational attainment was positively associated with attitudes towards ICTs."

For Hypotheses 1 and 2, we use articles reporting privacy concerns about the current IoT infrastructure [12], [103] and an article that states that the IoT infrastructure is vulnerable to P&S threats [104].

H1: The younger the cohort, the greater the belief that the current IoT infrastructure can be changed to provide better privacy.

H2: The younger the cohort, the greater the belief that the future IoT infrastructure can be changed to provide better privacy.

For Hypotheses 3 and 4, we use one article on the IoT infrastructure [12] and one on consumers' generational concerns regarding P&S risk for digital technologies [104].

H3: The older the cohort, the greater the belief that the IOTs is negatively affecting personal security.

H4: The older the cohort, the greater the belief that the IOTs is negatively affecting corporate security.

For Hypotheses 5 and 6, we use technology readiness levels [12], [103] and the IoT infrastructure literature [104], [105]. Even though managers were well versed in managing risk, they stated that IoT brought new and highly uncertain risk profiles [106]. Further, experts and corporate decision-makers understand that the state of technology readiness can change [107] and that such knowledge may modify decision-making.

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TABLE I
MEAN VALUES OF THE RESPONSES BY GENERATION TO HYPOTHESIS QUESTIONS

	H1**	H2	H3*	H4**	H5**	H6**
Baby Boomers	4.96	Not significant	5.96	5.74	5.14	5.85
Generation X	5.75	Not significant	4.79	5.04	5.95	6.62
Millennials	5.88	Not significant	4.72	4.62	5.94	6.33
Hypotheses Disposition	Accept at the p = 0.05 level	Reject at the p = 0.05 level	Accept at the p = 0.01 level	Accept at the p = 0.05 level	Accept at the p = 0.05 level	Accept at the p = 0.05 level

*indicates significance at p = 0.01 **indicates significance at p = 0.05

H5: The younger the cohort, the greater the belief that the current IoT infrastructure can be changed to provide better security.

H6: The younger the cohort, the greater the belief that the future IoT infrastructure can be designed to provide for better security.

III. METHODS

We tested our hypotheses concerning P&S perceptions between generations of experts and decision-maker cohorts with an exploratory survey, by sampling informed persons (experts) in the industrial, governmental, educational, and not-for-profit sectors. The sampling approach was that of a judgment sample [108]. Judgment sampling was done for two reasons. First, respondents from the general population may not know what IoT is or the effects it has on P&S NPD decision-makers. Second, at an earlier to the mid-level phase of the technology readiness state, where most IoT technologies are [12], [109]–[111], experts rather than the general public shape technological development and societal discourse. To qualify as an expert, one either needed to have at least 10 years' experience working in the technology or technology entrepreneurship sector or have a master's degree in management of technology, technology entrepreneurship, or any technology-related field.

Our fieldwork proceeded along two stages:

First stage: To assess P&S perceptions, we provided short explanations that reflected our understanding of these issues. We also offered concise explanations about IoT.

Second stage: We used a combination of a researcher-administered and self-administered questionnaire. A researcher was always physically present during the survey, which allowed for the respondents to react to the questions and for the researcher to assess whether the respondents were qualified to answer the questions. We refrained from observing the respondents as they answered, in order to mitigate a potential social desirability bias. We used a seven-point Likert scale to assess values on statements such as "The IoT negatively affects personal privacy" (sample item, from strongly disagree to strongly agree). We obtained a sample size of n = 116.

We then proceeded from the fieldwork to the analysis. The analysis also followed a two-stage approach.

First stage: We categorized the respondents into generational cohorts. Though the precise dates are still somewhat in dispute and the generation names vary slightly [112]–[114], dates for generational cohorts include millennials, or those individuals born between 1981 and 2000; generation X, or those individuals born between 1966 and 1980; and baby boomers, or those individuals born 1946 and 1965. The sample comprised 55.2% millennials, 21.6% generation X, and 23.3% baby boomers.

Second stage: We used multivariate analysis of variance to assess significant differences between the generations and between experts' concerns and the concerns they ascribed to their generation.

IV. RESULTS

Our exploratory study addressed whether an NPD decision-maker's IoT P&S concerns were a function of their generational cohort. Table I provides the mean values of the responses by generation to the hypothesis questions (range 1–7).

We found the following:

H1: The millennial cohort was more confident than the generation X cohort, and the generation X cohort was more confident than the baby boomer cohort in the view that the current IoT infrastructure could be changed to provide better privacy.

H2: It was not the case that the younger the cohort, the greater the belief that the future IoT infrastructure could be changed to provide better privacy.

H3: The baby boomer cohort was more confident than the generation X cohort, and the generation X cohort was more confident than the millennial cohort in the view that IoT negatively affects personal security.

H4: The baby boomer cohort was more confident than the generation X cohort, and the generation X cohort was more confident than the millennial cohort in the view that IoT negatively affects corporate security.

H5: The generation X cohort was more confident than the millennial cohort, and the millennial cohort was more confident than the baby boomer cohort in the view that the current IoT infrastructure structure could be changed to provide better security.

H6: The generation X cohort was more confident than the millennial cohort, and the millennial cohort was more confident than the baby boomer cohort in the view that the future IoT infrastructure can be designed to provide for better security.

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V. Discussion

Our research question investigated whether generational differences in the personal and corporate cyber-P&S risk perceptions over IoT technology by firm NPD decision-makers. In particular, we hypothesized that older generations' decision-making cohorts would have a higher level of corporate and personal cyber risk concerns and found support for this set of hypotheses in our exploratory study. In addition, our findings show some differences with the literature on generational effects on P&S concerns regarding IT in general and IoT in particular.

H2 was not significant; for instance, there was a lack of generational effects on perceptions of whether the future IoT could be made to provide greater privacy. The only other article [44] in the literature on generational impact on perceptions of IoT, in contrast, reports that younger generations were more concerned about IoT security and were more influenced by security in their intentions to purchase IoT devices than older generations—perhaps because these younger generations were more familiar with the technology. However, the article [44] was based on a survey of consumers, not of decision-makers. Our result suggests that decision-makers of all ages are similarly skeptical about future IoT infrastructure privacy. We did not test whether this skepticism is due to lack of knowledge or due to familiarity. Further research would be required before a more definitive statement could be made.

We accepted H5 and H6, but the results are more nuanced. Although generation X and millennials were more confident than baby boomers that the current and future IoT infrastructure could be changed to provide better security, the results did not squarely follow age: we found that the generation X cohort was more confident than millennials. These results suggest that baby boomers and millennials are less familiar with IoT than generation X, so they have less confidence in their promise. It is also possible, but less likely due to educational and experiential levels, that millennials are more familiar with IoT than generation X and are more skeptical of its promise. With the result obtained, further study would be necessary before a more definitive statement could be made.

VI. Conclusion

We provide an exploratory study of age-based cohort decision-makers focusing on firm product development processes. As a result, we demonstrated age-based decision-maker bias. At the same time, we understood that our judgment sample of IoT experts has limitations; however, the circle of persons we chose does constitute a highly influential voice at this early moment in IoT technology and market development.

A. Contributions to Theory

We make two primary contributions to theory:

1) Generational cohort decision-makers can be used as relevant social groups for SCOT as applied to P&S concerns about IoT.
2) SCOT can be applied to disruptive technology NPD processes rather than to a single product. SCOT is malleable and useful for technology assessment [22].

One insight from this extension is that it generates new pathways to closure, for example, the path to the final design of the artifact or, in this case, the category of emerging technology. It is possible that the social controversy about IoT, such as the bicycle, will become redefined by the introduction of an unexpected new technology, just as the air tire rendered the big wheeler obsolete. On the other hand, the emergent future use of IoT may become something so different from what is currently envisaged, just as bicycles went from being primarily racing vehicles to mass transportation, that the IoT P&S controversy will dissipate. Now, the COVID-19 pandemic calls for the widespread adoption of IoT to transition into a low-contact economy [115]. Health and safety concerns may become strong enough to overcome P&S problems across generations.

B. Limitations

A higher risk perception needs to be seen in the context of other factors that influence the decisions by NPD decision-makers [116]. For example, other researchers have shown that perceived usefulness was a strong driver to introduce risky technologies because of CEOs' span of control. In addition, CEOs consider the short-term benefits from cost savings and flexibility [80], such as in the wearables market [117], and more standards for IoT infrastructure are being discussed [118]. Further, others suggest intrusion detection systems [119]. We recommend further research into the independent or configuration nature of P&S concerns in the context of other perceived risks and benefits for IoT to better understand the drivers and inhibitors of its viability in a firm NPD process.

Future studies could consider gender or geographic origin [120] or how age cohort decision-makers affect the time to market disruptive technology-based products such as the IoT-based solution [121], [122]. Others might wish to investigate through a survey of Fortune 500 decision-makers and entrepreneurial firm founders versus the chronological age of decision-makers to determine if that would affect a decision-maker's choice in the IoT NPD process. Still others might wish to focus on how a newer set of older entrepreneurs [123] might change the NPD process. Finally, others might want to investigate whether the idea of digital natives being members of IoT-based NPD decision-making is essential to large firms [124]. We also found that we could not make definitive statements about H2, H5, and H6 due to a lack of information regarding respondents' education and experience with IoT.

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