"Use" as a Conscious Thought: Towards a Theory of "Use" in Autonomous Things

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Abstract

The way users perceive and use information systems artefacts has been mainly studied from the notion of behavioral beliefs, deliberate cognitive efforts, and physical actions performed by human actors to produce certain outcomes. The next generation of information systems, however, can sense, respond, and adapt to environments without necessitating similar cognitive efforts, physical contact, or explicit instructions to operate. Therefore, by leveraging theories of consciousness and technology use, this research aims to advance an alternative understanding of the "use" associated with the next generation of IS artefacts that do not require deliberate cognitive efforts, physical manipulation, or explicit instructions to yield outcomes. The theory and proposed model were refined and validated through the burst detection technique, IS expert involvement (n=10), a pilot study (n=130), and end-user surveys (n= 119). Structural equating modelling techniques were employed to test the theory. We show that unlike the manually operated IS artefacts, the "use" of a fully autonomous artefact is a *conscious thought* rather than a *physical activity* of operating a system to produce certain outcomes. We argue that, unlike the traditional notions of use associated with manually operated technologies, *conscious use* is not characterized solely by behavioral beliefs stemming from logical and reflective cognitive and physical efforts (e.g., effort expectancy). We propose the notion of conscious use within the context of fully autonomous entities and empirically validate its measure. Additionally, we offer recommendations for future research directions in this area. The conceptualization of this new theory for fully autonomous IS artefacts adds significant academic value to the literature given the convergence of AI-based machine learning systems and cognitive computing systems.

Keywords: autonomous things, conscious use, conscious thoughts, scale development.

1 Introduction

The way end users perceive and use information systems has been mainly studied on the premise of deliberate cognitive efforts (i.e., learning to use the system), active (Thatcher et al., 2018), and physical use[1] behaviour (e.g., clicking, scrolling, pressing, or tapping) by human actors operating manual technologies (Adams et al., 1992; Delone & McLean, 2003) to produce certain outcomes, for instance, sending an email. (Benbasat & Zmud, 2003). The current notions of *information systems (IS) use* (Sun & Teng, 2012) are characterized by behavioral beliefs such as, perceived self-efficacy and perceived effort expectancy (Venkatesh et al., 2003), deliberate cognitive and somatic labours i.e., physically operating the system (Schuetz &

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[1] In this research, any type of IS use that involve logical and deliberate cognitive efforts and bodily actions (such as clicks, taps, scrolling, and waving) is considered as physical or active use.

Venkatesh, 2020) to carry out tasks and activities for which the system is designed to support (Adams et al., 1992; Delone & McLean, 2003; Marangunić & Granić, 2015; Seddon, 1997; Venkatesh et al., 2003).

The next generation of technologies, however, does not involve any reflective *cognitive efforts*, *physical actions*, and *instructions* to operate since they are self-governing (Inagaki & Sheridan, 2019; Jayaraman et al., 2019), context-aware, adaptive, and interactive (Schuetz & Venkatesh, 2020) sensing, reasoning, and responding to their environments through embodied actions (Hoffman, 2012; You & Robert, 2018). Therefore, the question arises: *when there are no logical and deliberate cognitive and physical efforts involved, how would a user then perceive and use an IS artefact?* Owing to these developments, the IS researchers have questioned the core assumptions of theorizing the use of IS artefact s (Lee et al., 2015) on the premise of cognitive and physical processes calling for novel theoretical underpinning to deal with the "*entire domain of research questions that cannot yet be answered with our existing theories*" (Schuetz & Venkatesh, 2020, p. 461).

It is profoundly evident that the earlier *use* theories were developed for a different genre of end-users faced with manually operated technologies (Benbasat and Zmud, 2003; Rivard, 2014). Hence, it is vital and timely to depart from the current practice of theorizing the use associated with self-governing things on the premise of existing theories (e.g., see Zeitzew, 2007) and advocate for a novel theoretical underpinning (Rivard, 2014; Schuetz &Venkatesh, 2020). Aside from the theoretical value for academics, developing theories and constructs for the emerging technologies will have greater practical benefits for the businesses that are keen to understand their customer needs and demands (Davis, 1989).

Consequently, this research aims to advance an alternate understanding of the "use" associated with the next generation of IS artefacts that do not require any deliberate cognitive efforts, physical (or digital) use, and instructions to produce outcomes. We draw on literature spanning from technology adoption (Davis, 1989) to the theories of consciousness (Baars, 1988; Rosenthal, 1996) and combine it with experts and end-users surveys to propose the notion of *Conscious Use* in autonomous things. We put forward that

- **Conscious Use**—*is a conscious thought directed towards an autonomous artefact when it is carrying out tasks and activities for which it is designed*.

We argue that unlike the manually operated IS artefacts (Lee et al., 2015), the "use" of a fully autonomous artefact is a *conscious thought* rather than a *physical activity* of operating a system to produce certain outcomes. Simply put, when a fully autonomous IS artefact does not require any deliberate cognitive efforts (e.g., learning to operate the system), physical actions (pushing a button or clicking on a screen), and instruction to operate, its "use" becomes a conscious thought directed towards a fully autonomous IS artefact while it is carrying out the tasks and activities for which the system is designed to support it. For example, the kind of conscious thoughts a user will experience when they are relaxing on a comfy sofa, while their attention is directed towards an autonomous vacuum cleaner anticipating their needs through sensory information and situational awareness without requiring any deliberate mental efforts (e.g., learning to operate the system), physical use (e.g., pushing or clicking), and instructions (from the user). Similarly, the kind of conscious throughs a user may experience when sitting in a fully autonomous vehicle where the 'user' is not driving or directing the machines i.e. there is no cognitive effort involved for operating the vehicle (Endsley, 2017; Dikmen & Burns, 2016).

Our argument is that in these types of situations the experiences, thoughts, efforts and behavior of users significantly differ as compared to circumstances where users are fully involved with the machines (Norman et al., 2003; De Melo et al., 2019). Unlike the traditional notions of *use* associated with manually operated technologies (Adams et al., 1992; Delone & McLean, 2003; Marangunić & Granić, 2015; Seddon, 1997; Venkatesh et al., 2003), *conscious use* is not characterized by active use behaviour (Thatcher et al., 2018) and by the behavioral beliefs that stem from logical and reflective cognitive and physical efforts (e.g., perceived self-efficacy and effort expectancy). One implication that can be drawn here is that autonomous technologies will need to be designed to function reliably and smoothly (without human intervention); otherwise, they may trigger an undesirable state of consciousness or dissatisfying thoughts leading to anger, anxiety, and so forth.

Further validating and extending the proposed notion will profoundly increase our understanding of the way people accept or reject autonomous things that do not require any deliberate cognitive efforts, physical contact, and instructions to operate. This research opens up several avenues for future research on a variety of fronts to further expand our understanding of the nature of use in autonomous things (see Table 3). The rest of the article is as follows. Next, we briefly discuss a theoretical background and draw conceptual boundaries around our theorization by constructing and elaborating a continuum developed through extensive literature reviews. This is followed by discussing the theories that we leveraged to develop the conscious use construct for autonomous things. We conclude with a discussion summarizing the contribution of the study and the future research avenues available to extend this research.

2 Theoretical Background

A significant amount of research has been dedicated to theorizing and examining the way individuals (Venkatesh et al., 2003), groups (Brown et al., 2010), and organizations (Wang & Butler, 2006; Del Aguila-Obra & Padilla-Meléndez, 2006) perceive and use certain technologies and IS (Agarwal & Karahanna, 2000). IS theories provide conceptual frameworks for understanding and explaining the complex relationships between people, technology, and organizations in the context of information systems (Henningsson & Kettinger, 2016; Wu et al., 2022).

Information systems theories developed for technologies at a certain time period may not suit the evolving and dynamic technological industries often disrupted by novel digital technologies (Vial, 2019). For example, the Technology Acceptance Model or TAM (Chuttur, 2009), which posits that perceived usefulness and perceived ease of use are the two primary factors that determine an individual's intention to use a new technology, is oversimplifying the complex social and organizational dynamics that influence technology adoption and use (Ajibade, 2019; Malatji et al., 2020).

2.1 Information Systems and Evolving Technological Dynamics

Over the years, several IS theories have emerged, each with its own set of assumptions, concepts, and principles. Although several IS theories are available (f.ex. see Levy & Ellis, 2006 for a list of IS theories), predominantly the technology adoption model advanced by (Davis, 1989) and later extended, shaped, and reshaped by several researchers (Adams et al., 1992; Delone & McLean, 2003; Marangunić & Granić, 2015; Seddon, 1997; Venkatesh et al., 2003) has profoundly expanded our understanding of the way people accept or reject certain technologies and systems. A vast majority of hypotheses that deal with information systems and technology perceptions, attitudes, behaviors, and intentions (Lee et al., 2003; Taylor & Todd, 1995; Venkatesh et al., 2003), values, satisfaction, and system characteristics, success, and failure (Delone & McLean, 2003; Wixom & Todd, 2005) leads to *use* (see Figure 1).

Some investigations even go beyond the use and look into IS post-use behaviour and consequences (Wang & Butler, 2006; Ahuja & Thatcher, 2005; Jasperson et al., 2005). IS use has also been extensively investigated in a variety of levels, such as individual and group levels, and contexts, such as business context, domestic context, education context, healthcare, military, and cultural contexts (Im et al., 2011), to name a few (Figure 1). IS use has been conceptualised in mainstream research domains including IS success, IS acceptance, IS implementation, and IS for decision-making and formally defined by Burton-Jones and Straub (2006) as "an individual user's employment of one or more features of a system to perform a task" (p. 6). This definition implies that IS use is a complex *cognitive and physical activity* involving a user, the system itself, and a task that needs to be completed over time (Burton-Jones & Straub, 2006).

The existing notion of IS *physical use* (Schomaker et al. 1995; Sun & Teng, 2012) can be conceptualized as an activity of expanding logical and deliberate *cognitive efforts* (e.g., needed to learn and use the system) and *physical actions* (e.g., clicks and scroll) carried by human actors through a graphical user interface (such as displays) to produce the desired outcomes such as, sending a message or ordering a product online (Figure 1). In this sense, the existing notions of IS use rest on several assumptions (Schuetz & Venkatesh, 2020) and postulate the "use" as a *physical activity* associated with an IS artefact on the premise of deliberate *cognitive efforts* e.g., learning to operate the system (Agarwal & Karahanna, 2000) and *physical actions* (of clicking, scrolling, pressing, or tapping) performed by human actors (Adams et al., 1992; Delone & McLean, 2003) to produce certain outcomes (Benbasat & Zmud, 2003).

In such systems, "humans define the input" (Schuetz & Venkatesh, 2020, p. 645) and physically (or digitally) *uses* the artefact to "carry out tasks and activities on the job for which the information system is designed to support" (Sun & Teng, 2012, p. 1565). These notions of technology use are primarily rooted in the theory of reasoned action developed by Ajzen and Fishbein (1980), which suggests that "external variables influence beliefs about the outcomes associated with performing a behaviour, which in turn shape attitudes toward performing a behaviour. Attitude, in turn, influences intention to perform the behaviour and, ultimately, influences the behaviour itself." (Wixom & Todd, 2005, p. 86).

In the technology adoption model context, this implies that the use of technology is influenced by users' beliefs (e.g., perceived ease of use, self-efficacy, and effort expectancy), which impact attitudes toward using the technology, and which in turn shape behaviours (and intentions) to use technology. By suggesting a radically different concept "conscious use" in autonomous entities and verifying it through empirical methodologies, we are confident that this study not only offers a substantial addition to the prevailing IS research landscape but also pioneers a pathway that emphasizes the urgency and importance of acquiring deeper insights. This forward-thinking approach is crucial, especially as we anticipate the evolving needs and challenges of the upcoming generation of autonomous systems (Schuetz & Venkatesh, 2020).

For instance, when surrounded by fully autonomous artefacts, users' conscious thoughts regarding an autonomous technology (not the physical use) will determine users' satisfaction/dissatisfaction, purchase decisions, adoption/rejection, and so forth. This is because traditionally, "use" encompassed tangible interactions between users and systems. Yet, with the rise of highly autonomous technologies, interaction doesn't necessarily imply tangible, hands-on engagements. According to Wang and Benbasat (2017), interactions in the autonomous landscape can often be more observational than participatory, encompassing activities like monitoring, overseeing, or even just recognizing system functionalities. Such passive engagements, contrary to being insignificant, profoundly shape user perceptions and trust.

Supporting this idea of the evolving nature of information systems, Riek (2017) suggests that technological interactions, especially with systems possessing a high degree of autonomy, are becoming deeply cognitive. Users might not continuously provide explicit commands to such systems. However, they're constantly processing information, making judgments, and framing perceptions based on the autonomous actions of the system. This dimension of cognitive interaction is central to understanding conscious use in the realm of autonomous IS. While tangible interactions might be sparse, cognitive processing and acknowledgment denote a form of "use" that is intrinsic to our current technological landscape.

Transitioning to outcomes, autonomous systems have redefined this dynamic. Traditional outcomes, such as user satisfaction, often grounded in direct user-system interactions (De Guinea & Markus, 2009), now undergo transformation. In autonomous systems, outcomes are perceptual. For example, trust in an autonomous system might hinge more on its perceived reliability, predictability, and transparency rather than interface design or traditional usability metrics (Desai et al., 2017). Gerlach and Kuo (1991) emphasize the repercussions of users' conscious perceptions of such systems. Trust, satisfaction, and even intent to use the system in the future can hinge on the users' consciousness. The understanding, acknowledgment, and consequent mental processing of the system's actions underpin user responses and are pivotal in predicting user behavior.

Autonomous IS mandates a new lens of understanding "use." As systems operate with diminished direct human oversight, our engagement with them is characterized by acknowledgment, observation, and cognitive processing rather than hands-on interaction. Conscious use, with its focus on this evolved form of engagement, offers a fresh, relevant framework, and integral discussion avenue for the ongoing discourse in today's evolving digital landscapes. Among the core constructs that explain users' accepting or rejecting technology is the "perceived ease of use" which is defined as the "degree to which a person believes that using a particular system would be free of efforts." (Davis, 1989, p. 320). Moreover, if users perceive technology as "easy to use" and "useful" then they are more likely to physically "use" it (Adams et al., 1992).

In addition to ease of use and usefulness, other behavioural beliefs and attitudes such as self-efficacy and effort expectancy are important predictors of technology usage behaviours (Agarwal et al., 2000; Adams et al., 1992; Delone & McLean, 2003; Marangunić & Granić, 2015; Seddon 1997; Venkatesh, 2000). Self-efficacy is the "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3). And effort expectancy is the amount of ease associated with using a system (Venkatesh et al., 2003).

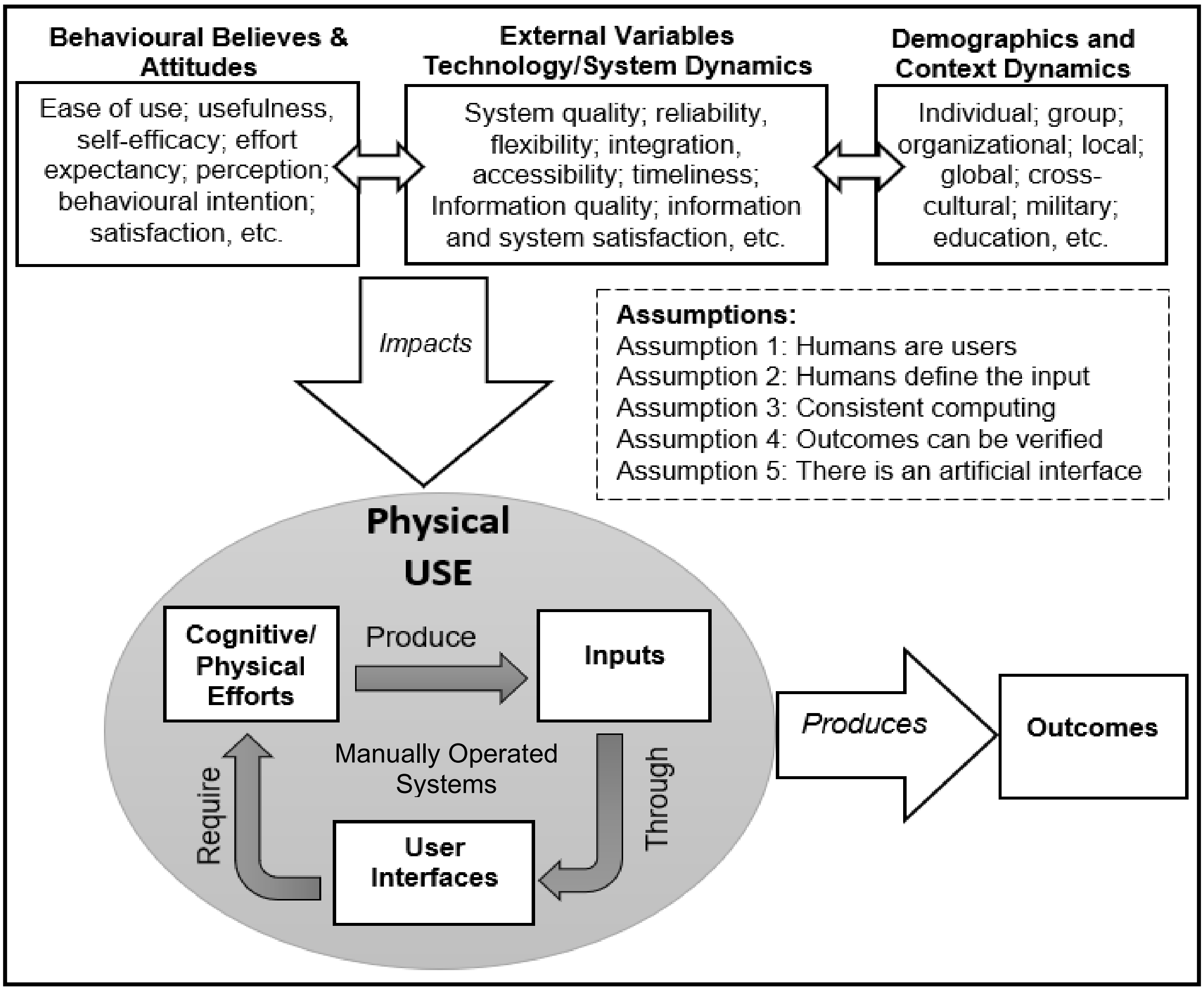

Figure 1. The Existing Notions of Information Systems/Technology Use

Owing to these assumptions, the *use* of an IS artefact has been theorized as "intentional and deliberate" (Schuetz & Venkatesh, 2020) dealing with the users' behavioural beliefs and attitudes toward an IS artefact that requires deliberate physical and cognitive efforts (Agarwal & Karahanna, 2000) and active use behaviour (Thatcher et al., 2018). While this theorization is flawless, it runs into infinite regress when dealing with autonomous things that do not require any logical and reflective cognitive efforts, physical use, and instruction to operate (Schuetz & Venkatesh, 2020). The way end-users interact with IS artefacts (Lee et al., 2015) has come a long way from the humble beginnings of interacting with punch cards to keyboards and mice, touch screens, and now to interactions with autonomous things not requiring any inputs (Ernst 2020; Musk, 2019; Ronkainen et al., 2007; Sen et al., 2015).

2.2 Human-Robot Interaction (HRI) and Conscious use

Integrating insights from the human-robot interaction (HRI), an interdisciplinary domain that examines the dynamics, mechanisms, and outcomes of the interactions between humans and robots, this paper sheds light on how users perceive, understand, and navigate their relationship with autonomous robotic systems. As technological advancements continue, the relationship between humans and robots has evolved, and so has the need for a deeper understanding of this bond. Traditionally, HRI was rooted in usability, aiming to ensure that robots were tools that could be efficiently and effectively operated by human users (Goodrich & Schultz, 2007).

Over time, however, as robots became more autonomous and integrated into daily life, HRI research began to address a broader range of topics, including trust, emotion, cognition, and long-term interaction. The way users perceive robots plays a vital role in interaction dynamics. Desai et al. (2017) explored how perceived robot autonomy affects user interactions, concluding that mismatches between perceived and actual autonomy can impact task performance. These findings reinforce the need for a "conscious use" perspective, emphasizing the role of cognition and perception in HRI.

Recent literature underscores that robots, particularly those with social functions, invoke a plethora of emotions in humans (Broadbent, 2017). Not merely tools, these robots often transform into entities sharing emotional bonds with their users. For instance, Nomura et al. (2008) in their extensive review identified that the design, aesthetics, and responsiveness of a robot play pivotal roles in determining human emotions towards them. This emotion-centric dimension of HRI aligns seamlessly with broader debates about the anthropomorphism of autonomous IS artefacts. Dautenhahn (2007) was among the pioneers who highlighted the significance of the social and emotional dimensions of HRI.

Traditionally, industrial robots were isolated from human workers mainly due to safety concerns. Co-bots, or collaborative robots, represent a pivotal shift in the industrial landscape, particularly within the Human-Robot Interaction (HRI) sector. These robots are designed to work alongside humans, enhancing productivity and safety while fostering a symbiotic relationship between man and machine. This paradigm shift is reshaping traditional manufacturing processes by augmenting human capabilities with robotic precision and efficiency (Arents et al., 2021; Zacharaki et al., 2020). Current research in this domain delves into optimizing human-robot collaboration, ensuring safety, and understanding the psychological implications of shared human-robot workspaces. Robots and autonomous IS, especially those designed for social interactions, are no longer mere tools; they are entities with which users form emotional bonds. This perspective aligns with our "conscious use" paradigm, suggesting that interaction with robots, especially autonomous ones, is not merely a function of physical operation but also involves cognitive and emotional processes.

The core tenet of conscious use is rooted in the conscious recognition and acknowledgment of an autonomous system's operations. As specified in recent literature, the relationship users forge with autonomous systems is a blend of cognitive processing and subtle forms of engagement (Wang & Benbasat, 2017; Riek, 2017). Consequently, a new genre of IS research is emerging that questions the existing notions of theorizing users' beliefs and interactions with autonomous systems on the premise of *physical use* (Demetis & Lee, 2018). Schuetz and Venkatesh (2020) argue that human-like artificially intelligent systems break down the prevalent unilateral notions of "user-artefact interaction" where a human is assumed as a deliberate user of the system.

The role of the human as active users is also challenged by Demetis and Lee (2018) by advancing the notion of "role-reversal" between humans and technology where humans are considered as artefacts shaped and used by technology and not the other way around. Hence, we believe the *use* associated with the next generation of technologies is not characterized by behavioural beliefs and attitudes (e.g., system self-efficacy and effort expectancy) associated with manually operated technologies and propose an alternative notion of "use" in the context of autonomous things, discussed next.

3 Conceptual Boundaries

To draw conceptual boundaries around our theorization, a continuum was developed based on the key aspects of autonomous technologies discussed in the literature above as well as burst detection technique that was employed to investigate the emerging research themes (see Appendix A). Table 1 explains these aspects. The "use" related assumptions listed in Table 1 are derived based on theoretical reasoning provided in the subsequent sections and the conceptualization provided by Schuetz and Venkatesh (2020). One of the core facets that distinguish the next generations of technologies from conventional technologies is the state of its autonomy (Ernst, 2020). The concept of autonomy (which is distinct from automation) has been studied by human-robot interaction researchers, behavioralists, and scientists in various fields for decades (Vagia et al., 2016). The term "autonomy" refers to a system's ability to make its own decisions regarding its activities while executing various tasks without the involvement of an external system or operator (Albus & Antsaklis, 1998).

From the perspective of human-machine interaction and cooperation, the amount of autonomy of the system/technology can be expressed by various levels of automation (Inagaki & Sheridan, 2019). Each of these levels specifies a different degree to which a task is automated. The automation theorists normally characterize the automation levels in terms of the human-computer interaction required to complete a task or achieve a goal. In this sense, autonomy has several levels from being completely autonomous, and partially autonomous, to non-autonomous things (Inagaki & Sheridan, 2019). Following the autonomy standards reported in the literature (Endsley, 1999; Inagaki & Sheridan, 2019) and by considering the key attributes of the autonomous IS artefact proposed by Schuetz and Venkatesh (2020) and the way autonomous technologies work (Hoffman, 2012), we created a generic taxonomy of the autonomous things as shown in the continuum (see Figure 2).

For this research, we define an *autonomous information systems artefact* (denoted as: AIA) as any physical (or digital) IS artefact that can work independently without any human intervention (e.g., self-driving cars, drones, virtual agents, and robots) thus requiring no interaction from the end user to complete a task or achieve a goal. We consider AIA as an IS artefact because it is essentially formed when cutting-edge technology (technology artefact) interacts with the sensory information it processes (information artefact), and the social context in which it operates e.g., social artefact (Lee et al. 2015). AIA takes in sensory data, interprets the information, adapts, and responds to users' needs accordingly (Hoffman, 2012). The main differentiator among the levels of autonomy, in our approach, is the need for deliberate *cognitive efforts*, *physical contact,* and *instructions* to operate an autonomous IS artefact.

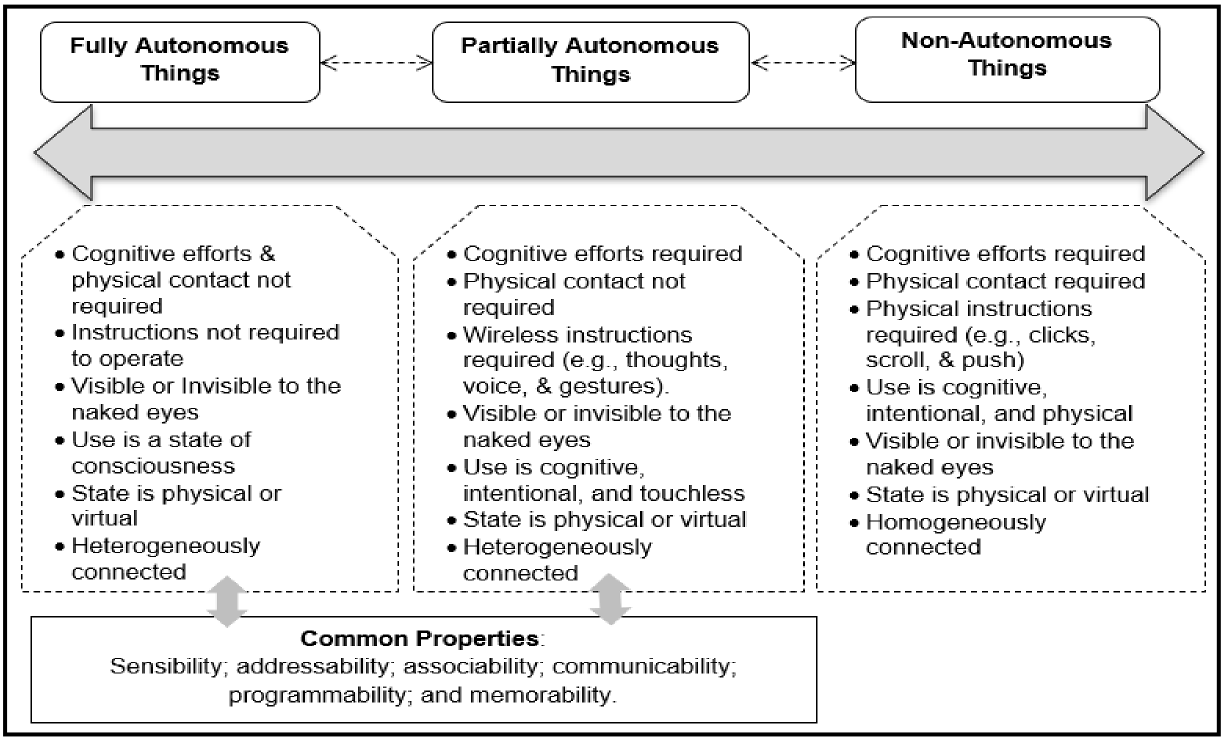

Figure 2. Autonomous Things Continuum

At the one end of the continuum (see Figure 2) are fully autonomous IS artefacts that do not require any cognitive efforts, physical contact, and instructions to function; whereas, at the other end are the 'manual technologies' that always require cognitive effort, physical contact, and instructions and physical use. It is noted that the continuum itself does not capture all possible types of systems having a more blended set of interactions, for simplicity sake we capture and explain the three distinct types.

3.1 Fully Autonomous IS Artefact (FAISA)

FAISA is any (physical or digital) IS artefact that does not require deliberate *cognitive efforts*, *physical contact*, and *instructions* to produce outcomes in all situations permanently. Although most autonomous artefacts are designed for humans to engage in verbal and physical human-machine interaction and cooperation at various levels of automation (Vagia et al., 2016). For example, even with a fully autonomous robot-human interaction may be required to complete a task or when enabling the robot's fully autonomous capability. However, for the theory construction purposes in this research, we restrict our conceptualisation to a FAISA that does not require any deliberate *cognitive efforts*, *physical contact*, and *instructions* to produce outcomes in all situations permanently.

Leveraging sensory data, such an IS artefact is constantly sensing, responding, and adapting to users' needs without requiring human intervention (Hoffman, 2012). The FAISA is autonomous, context ware (Irene & Susan, 2017), adaptive, interactive, and stateful (Schuetz & Venkatesh, 2020). With major advancements in the fields of engineering, robotics, and artificial intelligence, coupled with improved computational power and network availability, autonomous things are now becoming ubiquitous across many industries. Examples of FAISA include autonomous vehicles (Bimbraw, 2015; Jayaraman et al., 2019) and autonomous robots (Kwak et al., 2017; Pellenz et al., 2009), autonomous virtual agents (Kramer et al., 2014; Wang et al., 2018), smart mirrors (Hossain et al., 2007), to name a few. Furthermore, a FAISA can either be visible to naked eyes, invisible (blended in the background or implanted in the body), digital (such as a software product) or physical (such as a vacuum cleaner).

In addition to being virtually experienced (e.g., virtual reality games); ubiquitous or everywhere (Borriello, 2000); and heterogeneous networked (i.e., linked to other connected things) (Atzori et al., 2010), the autonomous technologies have some additional properties that set it apart from the conventional technologies (Ng & Wakenshaw, 2016). These properties include *sensibility*: it can sense and respond to stimuli hence making it context-aware; *addressability*: it can be identified and located in real-time; *associability*: it can be associated (and coordinated) with other objects to enable inferences about future states and conditions; *communicability*: it can send and receive digital messages; *programmability*: it can receive new sets of instructions and to modify its behaviors according; and *memorability*: it can store information and historical logs of its state and user interactions (Ng & Wakenshaw, 2016).

3.2 Partially Autonomous IS Artefact (PAISA)

PAISA is any (physical or digital) IS artefact that does not require physical contact but needs reflective cerebral efforts and instructions to produce outcomes in all situations permanently. The instructions needed can be cognitive, gestural, or speech-based wirelessly communicated through a variety of mechanisms. In this scenario, physical contact (e.g., push or click) is not required but the system still needs cognitive efforts (e.g., learning to operate the system) and instructions to operate. Examples of PAISA include voice-commanded systems (e.g., Siri and Alexa) (Sen et al., 2015); systems that are controlled with thoughts (e.g., Elon Musk's Neuralink) (Musk, 2019), and gestures-enabled systems (e.g., SelfieType, a gesture-based virtual keyword developed by Samsung).

3.3 Non-Autonomous IS Artefact (NAISA)

NAISA is any (physical or digital) IS artefact that requires deliberate cognitive efforts, physical contact, and instructions to produce outcomes in all situations permanently. The instructions are provided in the form of physical actions performed by the users (e.g., clicking on a screen). Most conventional technologies come under this category (e.g., a smartphone, personal computers, email agents, word-processing, and so forth). These technologies may have a certain level of automation and context awareness but based on our criteria of requiring deliberate cognitive efforts, physical contact, and instructions to operate, they are classified as non-autonomous from the users' perspective. Use in NAISA is the domain of existing technology perception and use theories. And although the use of PAISA is contactless, it still requires cognitive efforts to operate, hence the existing theories can be adapted to explore it. In this study, we only focus on the use of FAISA discussed next.

Facets	**Full Autonomy**	**Partially Autonomy**	**No Autonomy**	**Description**
Cognitive Efforts	Cognitive efforts are not required.	Cognitive efforts are required.	Cognitive efforts are required.	Full autonomous IS artefact s sense, respond, and adapt to user needs not requiring deliberate cognitive efforts (e.g., learning to use the system) and physical use (e.g., clicking); however, thoughtful cognitive efforts are needed to operate partial and non-autonomous IS artefacts.
Physical Contact	Physical contact is not needed.	Physical contact is not needed.	Physical contact is needed.	Physical contact is not required to operate fully and partially autonomous IS artefact, but it is a core element of the non-autonomous things.
Instructions	Instructions to operate are not needed.	The instructions to operate are cognitive, vocal, or gestural.	The instructions are physical or deliberate.	While a fully autonomous IS artefact works without any instructions, partially autonomous operates on the principle of wireless instructions (in form of thoughts, voice, & gestures); whereas the non-autonomous artefact s need physical instructions to operate (e.g., clicks, scroll, & push).
Use	The use is a conscious thought.	The use is cognitive, vocal, or gestural but contactless.	The use is deliberate, cognitive, and physical activity.	Given that a fully autonomous artefact does not require reflective cognitive efforts, physical contact, or instruction to operate, its use becomes a state of consciousness rather than a cognitive and physical activity (i.e., pushing a button or clicking on a screen); whereas the use of a partially autonomous thing is a physical cognitive, vocal, or gestural not requiring physical intervention. However, the non-autonomous things require physical (active) use in the form of clicks, scroll, & push.
Visibility	Visible or invisible to the naked eye.	Visible or invisible to the naked eye.	Visible or invisible to the naked eye.	Visibility is a non-differentiator but if combined with autonomy it becomes a key aspect of the fully autonomous artefact.
State	The state is either physical or digital	The state is either physical or digital	The state is either physical or digital	All these IS artefact s can be either physical (atoms) or digital (bits) in nature.

Connectivity	Hetero-geneously connected.	Heterogeneously connected.	Homo-geneously connected.	The fully (and partially) autonomous things connect heterogeneously to dissimilar things (e.g., the connection among the home appliance aka IoT); whereas the non-autonomous things are homogeneously connected to similar technologies (e.g., a smart-to-smart phone and personal-to-personal computer connections).

Table 1. Key Characteristics of the Next Generation of Things

3.4 "USE" in Fully Autonomous Artefacts

As alluded to earlier, the use of a manually operated IS artefact is driven either by deliberate physical and cognitive efforts (Schuetz & Venkatesh, 2020; Thatcher et al., 2018) or automatic behaviour resulting from past usage not requiring conscious processes (Jasperson et al., 2005; Kim et al., 2005). Deliberate or *active use* of a system is rational behaviours driven by logical and reflective mental processes and somatic actions (Jasperson et al., 2005); whereas, automatic use, although still associated with manually operated technologies, occurs unconsciously largely due to habitual or repetitive use of a system (Kim et al., 2005). Mindfulness or being "aware of, and open to, value-added use of the system" (Thatcher et al., 2018, p. 837) also plays a crucial role in operating IS artefact s that require physical use and cognitive efforts (Table 2).

Whereas, a typical FAISA sense, respond, and adapt to user needs not requiring deliberate (1) *cognitive efforts*, (2) *physical contact,* and (3) *instructions* from human actors to produce outcomes (Hoffman, 2012) not characterized by physical actions and deliberate cognitive efforts (Schuetz & Venkatesh, 2020; Thatcher et al., 2018) or automatic use associated with manually operated technologies (Jasperson et al. 2005; Kim et al., 2005).

Construct	**Definition**	**Use Context and Key Attributes**	**Examples**
Conscious Use	Use is a conscious thought directed towards an autonomous artefact when the artefact is carrying out tasks and activities for which it is designed.	Context: autonomous IS artefact. Key attributes: is not characterised by deliberate cognitive efforts and physical actions from the users.	This study
IS use	Use is a human-driven activity of expanding cognitive efforts and physical actions to produce the desired outcomes through a system.	Context: manually operated IS artefact. Key attributes: is characterised by logical, reflective, and deliberate cognitive efforts and physical actions required from users.	(Burton-Jones and Straub, 2006; Adams et al., 1992; Venkatesh et al., 2003; Sun and Teng, 2012).
Automatic Use	Unconscious use of a system driven by habitual or repetitive physical use of a system.	Context: manually operated IS artefact. Key attributes: is characterised by habitual logical, reflective, and deliberate cognitive efforts and physical actions required from users.	(Kim et al., 2005; Limayem et al., 2007).

Low-Intention Interaction	A type of human-computer interaction that occurs when a user's action intended for one purpose is interpreted to achieve a variety of other purposes.	Context: manually operated IS artefact. Key attributes: is characterised by logical, reflective, and deliberate cognitive efforts and physical actions required from users.	(Dix, 2017).
Awareness	The state of an observer "consciously seeing" a stimulus in a given situation	Context: Not specifically related to IS artefact.	(Henley, 1984)
Situational Awareness	The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future	Context: Not specifically related to IS artefact. Key attributes: characterized by stimuli, comprehension of the environment and, propagation of events	(Endsley, 1995)
Context Awareness	An umbrella term used to describe the technologies that consider the context to characterize the situation of users.	Context: autonomous and manually operated IS artefact. Key attributes: requires context and situational awareness from the technology in use.	(Dey, 2001)
Mindfulness	Being in a state of paying attention in a particular way that is on purpose, in the present moment, and non-judgmentally	Context: Not specifically related to IS artefact.	(Kabat-Zinn, 1994)
IT Mindfulness	A mindset driven by an individual's awareness of the context, and openness to, value-adding applications of IT.	Context: manually operated IS artefact. Key attributes: requires context and situational awareness from the users.	(Thatcher et al., 2018)
IT Habit	The automatic physical use of a system due to past learning.	Context: manually operated IS artefact. Key attributes: requires previous IT use experience from the users.	(Limayem et al., 2007)
Consciousness	A state of being aware of an external object or something within oneself.	Context: not specifically related to IS artefact.	(Baars, 1998; Rosenthal, 1996)
Flow	A mental state experienced when someone is completely immersed in activities and a corresponding shift in one's perception of time, people, distractions, and even basic bodily needs.	Context: not specifically related to IS artefact.	(Mihaly, 1990)

Table 2. Conscious use vs. other forms of IS use

More importantly, the user consciously perceives an autonomous IS artefact in service anticipating their needs through sensory information and situational awareness without requiring any deliberate cognitive efforts, physical or visual use, and instructions (Figure 3). Such a use can be characterized as "low attention" and/or "low intension" automatic use not requiring thoughtful human inputs (Dix, 2017). For example, the light in a room may switch off as the occupant goes into a sleep state. Context-awareness plays a crucial role in characterizing the situation of users as it takes into account all information relevant to the interaction between a user and an application, including the user and applications themselves. Unlike the traditional IS systems where user inputs are interpreted only in terms of the state of the system, context-aware systems looked to the environment or context (Dey, 2001).

Furthermore, even if the autonomous system is operating smoothly, the user is generally aware of the system and will expect the tasks (automatically performed by the system) that are entirely below the user's awareness (Dix, 2017). Thus, the use associated with a FAISA becomes a subject of human consciousness rather than a matter of deliberate physical/ cognitive efforts and active use associated with operating manual technologies/systems (Schuetz & Venkatesh, 2020; Thatcher et al., 2018). Therefore, contrary to the current practice of theorizing the use associated with FAISA on the premise of existing theories (Hewitt et al., 2019; Zeitzew, 2007), we advocate for leveraging the theories on human consciousness (Baars, 1988).

Human consciousness has been a complex and puzzling construct of physiological sciences for centuries (Baars, 1988). More recently, significant interdisciplinary research has been dedicated to understanding consciousness—both biologically and psychologically—in cognitive science, involving fields such as psychology, linguistics, anthropology, and neuroscience, to name a few. The theory of consciousness explains consciousness as a state of being aware of an external object or something within oneself (Baars, 1988; Rosenthal, 1996) and the Oxford Living Dictionary defines consciousness as "the state of being aware of and responsive to one's surroundings." A more recent theory (Marchetti, 2018, p. 435) suggests that "consciousness is a special way of processing information" due to three vital cognitive procedures namely, the self, attention, and working memory.

The concept of self, primarily mediated by the central and peripheral nervous systems in humans, plays a pivotal role in individuals' ability to perceive and navigate their bodies, their environment, and their interactions within the world. Attention facilitates the selection of pertinent variations in the state of the self that hold significance within a given context. Subsequently, working memory is indispensable for assembling the chosen specific pieces of information identified through attention (Marchetti, 2018). This unique way of processing information produces (rather transmitting) individualized information meaningful for the person who consciously experiences it, and it has "that" meaning only for the person experiencing it, not for other people (Marchetti, 2018).

In the context of autonomous things, for example, users know what it means for them to experience an autonomous IS artefact, but onlookers cannot directly know what it means for the users to experience the IS artefact (and vice versa). In other words, experiencing a FAISA is a very individualist state of consciousness producing meaningful information about the FAISA not accessible to others. This individualist conscious state of mind allows users to process information based on their desires while consciously being aware of a FAISA at their disposal. The users consciously anticipate a FAISA sensing, responding, and adapting to their needs through sensory information and situational awareness without requiring any mental efforts, instructions, and physical contact.

Furthermore, our consciousness informs us in real-time about the impact an external object (in this case a FAISA) will have on us, where the object is relative to us now, and whether we can cope with it (Marchetti, 2018). In this sense, the use of a FAISA is the subject of human *conscious thoughts*. Thoughts refer "to mental states that can be the output (and input) of thinking processes" (Vosgerau & Synofzik, 2010) (p. 206) having two types: unconscious and conscious thoughts. Conscious thoughts are defined as the "object-relevant or task-relevant cognitive or affective thought processes that occur while the object or task is the focus of one's conscious attention;" whereas, unconscious thought refers to "object-relevant or task-relevant cognitive or affective thought processes that occur while conscious attention is directed elsewhere" (Dijksterhuis & Nordgren 2006, p. 96). Furthermore, "attention" is the core differentiator between the unconscious and conscious thought i.e., conscious thought is "thought with attention" and unconscious thought is "thought without attention" (Dijksterhuis & Nordgren, 2006).

In addition, Kahneman (2012) suggests that the human brain operates in two modes of thinking: system 1 and system 2. System 1 is characterised by effortless and automatic thinking; whereas system 2 deals with deliberate, effortful, and rational thinking. Unlike system 2 where task effects arise from deliberate thoughts and effortful comparisons among options, system 1 operates with comparatively 'passive' way of thinking directed at certain tasks. It is argued that choice effects are the results of intuitive processing and require little deliberation in the context of system 1 (Dhar & Gorlin, 2013). Therefore, based on how human brain functions automatic and conscious use is the result of system 1 related choice effects whereas, habitual, and compulsive patterns of use arise from system 2. Considering the above discussion, we propose the notion of conscious use (CU), which is *"a conscious thought directed towards an autonomous artefact when it is carrying out tasks and activities for which it is designed"* (see Figure 3).

We theorize the "use" associated with an autonomous artefact as a *conscious thought* rather than a physical (or somatic) activity. Unlike the "use" associated with the manually operated technologies that require deliberate cerebral efforts, instructions, and physical actions (such as pushing a button or clicking on a screen), a typical fully autonomous artefact sense, respond and adapt to user's needs without requiring any deliberate cognitive efforts and physical (or somatic) activity from the users. For example, the sort of conscious thoughts a user will experience when their attention is directed towards an autonomous artefact (e.g., an autonomous vacuum cleaner) anticipating her needs through sensory information and situational awareness without requiring any deliberate cognitive efforts (e.g., learning to operate the system), physical use (e.g., pushing or clicking), and instructions (from the user).

Theoretically, one can argue that any conscious thoughts the user has when a fully autonomous artefact is carrying out tasks and activities would qualify as conscious use? For example, when a user is happy watching a football match while their robot vacuum cleaner was operating autonomously? However, we argue that conscious use captures conscious thought *when attention is directed* towards an autonomous artefact. In the other words, the mind is connected to the fully autonomous artefact. Furthermore, based on the definition, any conscious thoughts the user happens to have when attention is directed towards a fully autonomous will also qualify as conscious use including performance monitor, anger, anxiety, enjoyment, so forth. In this research, we are only measuring the conscious thoughts when attention is directed towards a typical fully autonomous artefact that senses, respond, and adapt to the user's needs as explained in our instrument development section.

Notably, conscious use may appear to share some conceptual underpinnings with the notion of automatic use. Precisely, they both capture the use of a system that is not driven by deliberate mental efforts. Automatic use, however, is post-use behaviour resulting from repetitive physical and active use of a manually operated technology (Jasperson et al., 2005; Kim et al., 2005); whereas, conscious use is a state of a user's consciousness (a conscious thought) directed towards a fully autonomous IS artefact sensing, responding, and adapting to the tasks and activities for which the artefact is designed to support.

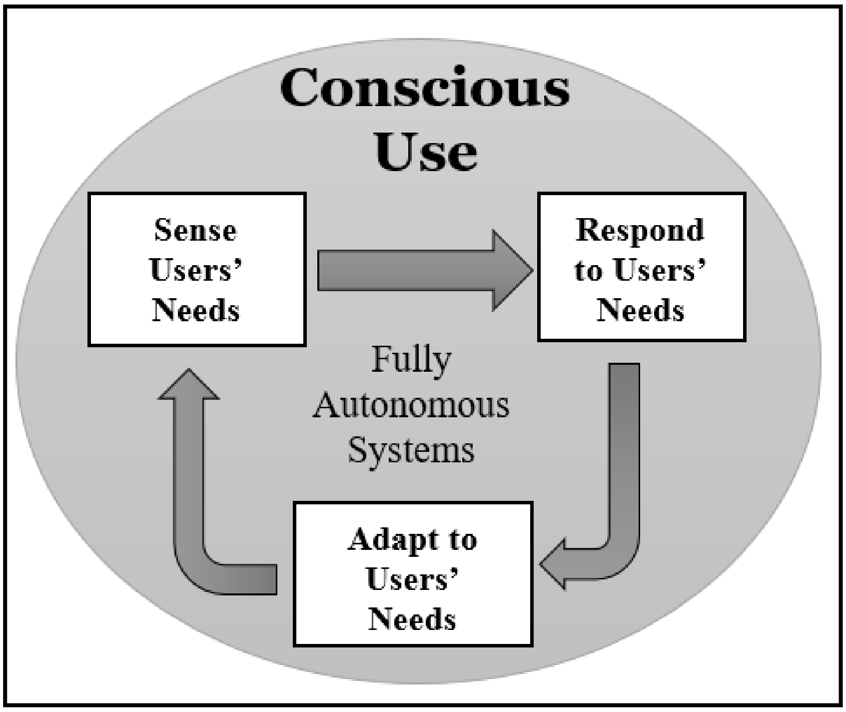

Figure 3. Proposed Conceptual Model

Similarly, other conceptualizations of "state of mind" exist in literature in diverse settings. For example, "flow" is a mental state experienced when someone is completely immersed in an activity such that "nothing else seems to matter" (Mihaly, 1990, p. 4). In essence, "flow" conceptualizes the state of concentration that people experience when they are deeply involved in a physical (or cognitive activity) and what makes the experience they are having satisfying. Mihaly (1990) argues that the activity people experience becomes genuinely satisfying when the state of concentration is deeply focused to the point of complete immersion in a task. Leveraging the flow notion some authors have attempted to better understand human-technology interactions (Trevino & Webster, 1992) and technology usage (Agarwal & Karahanna, 2000).

Although "flow" and "conscious use" both focus on the state of a user's mind, they are opposite concepts. Conscious use attempts to conceptualize conscious thoughts of a user when a fully autonomous artefact is carrying out certain tasks and activities not requiring any involvement from the users. For example, the state of mind a user will be in when they are observing an autonomous vacuum cleaner buzzing around doing its job. In other words, as alluded to earlier, conscious use is attempting to capture a user's conscious thoughts directed towards an autonomous artefact anticipating their needs through sensory information and situational awareness without requiring any deliberate involvement (cognitive or physical) from the users. Table 2 offers a comparison of conscious use with other forms of IS use.

4 Methodology

4.1 Instrument Development

Given that no instrument exists to measure user's conscious thought *when attention is directed* towards an autonomous artefact, we create such an instrument. To validate the psychometric properties of the proposed "Conscious Use" construct and the subconstructs, we followed the structured approach commonly used to develop scales (Davis, 1989; Hinkin, 1995; Noar, 2003). The process of scale development started with (1) conceptualization of the theoretical construct, which was followed by (2) generating potential items for each construct considering the definitional properties of the construct and the issues reported in the literature, and finally (3) the scale was refinement and validated through IS expert involvement, end-user surveys, and robust statistical analysis.

The practice of selecting potential items of a scale from the onset ensures content (Davis, 1989; Nunnally, 1978) and face validity (Broder et al. 2007) of a scale. We also followed the suggestions by Noar (2003) and did our best to produce scale items that were (a) clear and concourse dealing with one issue per item; we avoided (b) jargon and dated phrases and (c) confusing sentences, words, and double negatives; we added (d) both positively and negatively worded statements and (e) were mindful of gender and culturally sensitive; (f) kept the statement short, and finally (g) we made an effort to cover most of the issues suggested by the theories and the literature. The basis for the construct conceptualization was the nature of a typical autonomous artefact and based on guidelines from the literature (Jarvis et al., 2003; Petter et al., 2007), we conceptualize conscious use as a multidimensional formative construct consisting of 3 formative and 1 reflective sub-constructs."

4.2 Items Generation and Construct Conceptualization

Drawing upon the literature and discussions above (Wisdom et al., 2014), we developed the subconstructs for conscious use based on the definitional properties of the construct and by taking into consideration the nature of a typical autonomous technology (Hoffman, 2012; Schuetz & Venkatesh, 2020). By considering the crucial attributes of autonomous systems such as timeliness, reliability, flexibility, and accuracy (Delone & McLean, 2003; Seddon, 1997), a list of 16 items for conscious use (4 for each sub-constructs) was developed. Experts in the IS field were consulted in advance regarding the list of subconstructs. Furthermore, we included the satisfaction construct (Delone & McLean, 2003) in our survey for nomological validity. The context of the instrument development was a fully autonomous robot currently employed in an international supermarket chain (name of the robot, its location, and brand identity is withheld at the request of the company).

Leveraging embodied cognition principle (Wilson, 2002), a fully autonomous robot roams in the supermarket isles *sensing* (through sensory inputs such as videos and images) hazards (such as fallen objects), *responds* to the hazards by alerting the staff, and adapts to the environment by avoiding obstacles. Using sensory inputs and situational awareness, the fully autonomous robot senses users' needs and actions *"based on repetitive past events"* and model the *"resulting anticipatory expectation as [a] modal perceptual simulation"* (Hoffman, 2012, p. 764). This context was chosen because the fully autonomous robot, as an archetypal autonomous technology, perfectly fits the theoretical construct. At the time of the survey, the employees (the survey respondents) were fully mindful of the fully autonomous robot operating in the supermarket and knowing that it is fully autonomous not requiring deliberate cognitive efforts, physical contact, and instructions (from the employees) to sense hazards, respond to the hazards, and adapt to the environment.

Based on the criteria from (Jarvis et al., 2003) criteria and guidelines from (Petter et al., 2007), we conceptualize conscious use as a multidimensional formative construct consisting of 3 formative and 1 reflective sub-constructs (Figure 4).

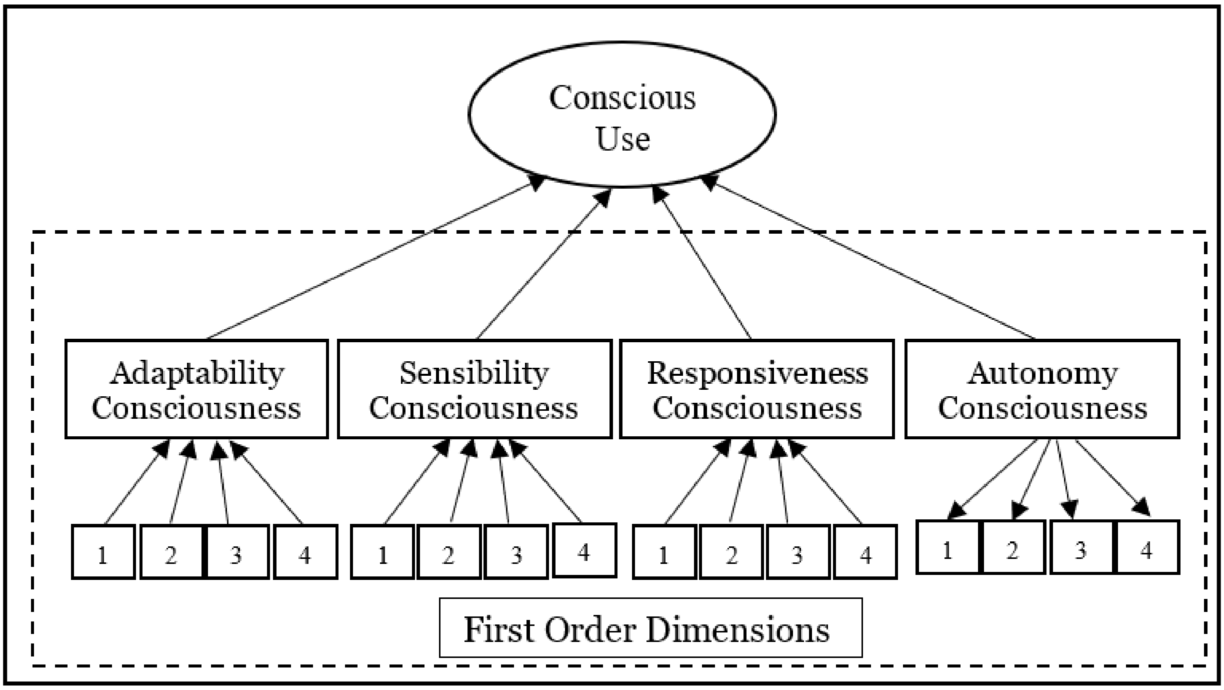

Figure 4. Conceptualization of Conscious Use

Autonomy Consciousness (ACO)—this reflective sub-construct accounts for a user's overall state of mind (or awareness) regarding a fully autonomous artefact at their service.

Sensibility Consciousness (SC)—this formative sub-construct measures a user's conscious thoughts when a fully autonomous artefact is sensing the tasks and activities for which the system is designed to support it.

Responsiveness Consciousness (RC)—this formative sub-construct measures a user's conscious thoughts when a fully autonomous artefact is responding to the tasks and activities for which the system is designed to support it.

Adaptability Consciousness (AC)—this formative sub-construct measures a user's conscious thoughts when a fully autonomous artefact is adapting to the tasks and activities for which the system is designed to support it.

4.3 Face and Content Validity

To confirm the face and content validity of the proposed scale (Bohrnstedt 1970; Broder et al. 2007), the theoretical constructs alongside the proposed items were reviewed by 10 senior IS academics who had knowledge of survey design and autonomous technologies. Feedback from these academics was used to identify the items that were confusing, redundant, or concepts that were overlooked, and to exclude the unwanted item from the scale. while several minor adjustments were made to the wording of items, some examples of the major changes are reported here. For instance, experts reported that items for conscious use sub-constructs were very broad not matching the construct's definition. Hence, the original phrasing of the conscious use sub-constructs "[name of the robot] senses my needs…" were replaced with "[name of the robot] senses hazards…" to capture the actual user needs (of detecting hazards) that the autonomous IS artefact is addressing. Similarly, the item "[name of the robot] is at my service" belonging to conscious use was replaced with "I know [name of the robot] is present" and one new item "I understand [name of the robot] is around" was added to conscious use. Similarly, one new item "[name of robot] senses new conditions" was added to SC, RC, AC sub-constructs. These changes led to leaving conscious use with 4 items and SC, RC, and AC with 5 items each.

Following that, a sample of 130 business professionals enrolled in executive programs at a large public institution in New Zealand were given the revised scale. Overall, 60 completed the survey, resulting in a 46% response rate (see Appendix B for sample demographics). Before filling out the online survey, the respondents were asked to observe the working mechanism of autonomous IS artefact by watching a purpose-made video. The video portrays the artefact roaming in the supermarket isles sensing hazards (such as spills and fallen objects), responding to the hazards by alerting the staff and adapting to the environment by avoiding obstacles. In each section of the survey, the definition of the constructs was first presented, followed by measurement items corresponding to the construct.

4.4 Survey Data Collection

In the next stage, the participants were asked to "*rank the degree to which each item matches the variable's definition*" (content validity) (Davis 1989, p. 324) on a 5-point Likert scale setup through the Qualtrics surveying tool. The participants ranked the items and provided written comments about the clarity and appropriateness of the wording of the items and suggested new items if any (face validity) (Broder et al. 2007).

Demographic	**Category**	**Count**	**%**
Age Group	20 and below	17	14.3
	21-30 years	63	53.4
	31-40 years	29	24.4
	41 years and above	10	8.4
Tenure	Less than 1 year	35	29.4
	Between 1 to 2 years	29	24.4
	Between 2 to 3 years	24	20.2
	Greater than 3 years	31	26.1
Exposure to Autonomous IS artefact	Less than 1 year	92	77.3
	1 to 2 years	23	19.3
	2 to 3 years	4	3.4
Gender	Male	53	44.5
	Female	66	55.5
Education	High School Degree	24	20.2
	Associate Degree	15	12.6
	Bachelor Degree	48	44.3
	Master Degree	16	13.4
	Other	16	13.4

Table 3. Sample characteristics (n = 119)

Some minor adjustments were made to the wordings of the items resulting in a further refined survey instrument having 22 items representing the constructs identified in Table B2 (in Appendix B), as well as a series of demographic questions (Table B1 in Appendix B). The study participant were employees of an international supermarket chain [location and brand name withheld] who have employed autonomous IS artefact (*fully autonomous robot)* used in the pilot study.

At the time of the survey, the employees were fully conscious of the artefact operating in the supermarket understanding that it does not require deliberate cognitive efforts, physical contact, and instructions (from the employees) to sense and respond to hazards and adapt to the environment. With the help of the store manager, an online version of the survey was sent to all the employees working in the supermarket chain. All surveys were confidential and did not require the collection of personal information that could uniquely identify any participant. 5 Likert-type scale to measure their responses, with 1 representing strongly disagree and 5 strongly agree. Overall, 119 useable surveys were returned. The demographic profile of the sample is shown in Table 3.

5 Results

The calculations were done through SmartPLS (Ringle et al., 2015) using a partial least squares (PLS) structural equation modelling technique which is less demanding on sample size especially when dealing with several items needed for less developed theories (Hair et al., 2019). PLS-SEM is particularly suited for predicting and developing new theories (Hair et al., 2011; Hair et al., 2019). PLS also offers the flexibility of modelling construct to be either reflective or formative constructs. PLS analysis was performed in two steps (1) the reliability and validity statistics were reported both for the formative and reflective constructs; and then (2) assessment of the structural model was carried out.

5.1 Reliability and Validity of Formative Constructs

To demonstrate reliability and validity of formative constructs, indicator outer weights, the significance of weights, and multicollinearity of indicators statistics were calculated (Becker et al. 2012; Hair et al., 2019) using the repeated indicator approach and the inner factor weighting scheme employing PLS-SEM algorithm; which is the recommended method for testing reflective-formative models (Becker et al., 2012). For bootstrapping the subsamples were set to 5000. The results are shown in Table 4. The outer weights for four items AC1, RC1, RC3, and SC2 were not significant, hence these items were eliminated from the scale. The high levels of multicollinearity in formative constructs is one of the fundamental concerns with their validity (Hair et al., 2019; Petter et al., 2007).

	Original Sample	**Sample Mean**	**T-Values**	**P-Values**	**VIF**
SC1 -> Sensibility Consciousness	0.27	0.25	2.28	0.01	2.0
SC3 -> Sensibility Consciousness	0.36	0.34	3.54	0.00	1.8
SC4 -> Sensibility Consciousness	0.30	0.30	2.17	0.02	2.1
SC5 -> Sensibility Consciousness	0.29	0.31	2.56	0.01	1.8
RC2 -> Responsiveness Consciousness	0.34	0.33	3.00	0.00	1.5
RC4 -> Responsiveness Consciousness	0.29	0.29	2.31	0.01	2.0
RC5 -> Responsiveness Consciousness	0.53	0.53	4.91	0.00	2.2
AC2 -> Adaptability Consciousness	0.18	0.18	1.89	0.03	1.8
AC3 -> Adaptability Consciousness	0.31	0.31	2.19	0.01	2.7
AC4 -> Adaptability Consciousness	0.34	0.34	2.92	0.00	2.2
AC5 -> Adaptability Consciousness	0.33	0.33	2.49	0.01	2.6

Table 4. Formative Constructs Outer Weights and VIF

To show that our first-order constructs are not highly redundant in forming second-order CU, we performed a variance inflation factor (VIF) test. The VIF values for the three sub-constructs were all less than 3.0, which is the cut-off point (Hair et al., 2019). Our formative construct model of CU is highly supported by these low multicollinearity data. The final survey instrument is shown in Table 5.

Constructs	**Mean**	**ST-DV**	**Loading/ Outer Weights**
Autonomy Consciousness (reflective)			
ACO1: I am mindful of__	4.4	0.6	0.81
ACO2: I am aware of __	4.5	0.6	0.82
ACO3: I know __ is present.	4.5	0.6	0.76
ACO4: I understand __ is around.	4.6	0.6	0.81
Sensibility Consciousness (formative)			
SC1: __ senses hazards correctly.	4.1	0.9	0.27
SC3: __ reliably senses hazards.	4.0	0.8	0.36
SC4: __ flexibly senses hazards.	3.7	0.8	0.30
SC5: __ senses new conditions.	4.0	1.0	0.29
Responsiveness Consciousness (formative)			
RC2: __ responds to hazards in a timely fashion.	4.2	0.8	0.34
RC4: __ flexibly responds to hazards.	3.8	0.8	0.29
RC5: __ responds to new conditions.	4.0	0.8	0.53
Adaptability Consciousness (formative)			
AC2: __ adapts to hazards in a timely fashion.	4.1	0.8	0.18
AC3: __ reliably adjusts to hazards.	4.1	0.8	0.31
AC4: __ flexibly adapts to hazards.	3.9	0.8	0.34
AC5: __ adapts to new conditions.	4.0	0.9	0.33
Satisfaction (reflective)			
SAT1: All things considered, I am very satisfied with __	4.2	0.8	0.92
SAT2: Overall, my experience with __is very satisfying.	4.2	0.7	0.90
SAT3: Overall, I am satisfied with __	4.3	0.8	0.91

Table 5. Final Instrument and Measurement Properties

5.2 Reliability and Validity of Reflective Constructs

The discriminant and convergent validity of the two reflective constructs (i.e., Autonomy Consciousness and Satisfaction) was carried out through the PLS-SEM algorithm. As seen in Table 6, all Cronbach's alpha values exceed Nunnally (1970)'s recommended cut-off of 0.7. Furthermore, good internal consistency is demonstrated by the composite reliability values range from 0.88 to 0.93p which are above the endorsed value of 0.80 (Nunnally & Bernstein, 1994). Furthermore, factor loadings of the measurement items on their respective construct, ranging from .70 to .86, are larger than the cut-off value of 0.70 (Fornell & Larcker, 1981) supporting the convergent validity of each measured item on the corresponding latent construct. Besides, each item loads on its latent construct at the significance level of 0.05. The low Heterotrait-Monotrait Ratio of correlations (Henseler et al., 2015) and the cross-loadings support the discriminant validity of the constructs.

	Autonomy Consciousness	**Satisfaction**
Cronbach's Alpha	0.81	0.89
Composite Reliability	0.88	0.93
AVE	0.64	0.86
Heterotrait-Monotrait Ratio	0.46	0.22
ACO1	0.81	0.13
ACO2	0.82	0.20
ACO3	0.76	0.10
ACO4	0.81	0.17
SAT1	0.12	0.92
SAT2	0.19	0.90
SAT3	0.21	0.91

Table 6. Reliability, Loadings, and Cross-loadings for Reflective Constructs

5.3 Test of Structural Model

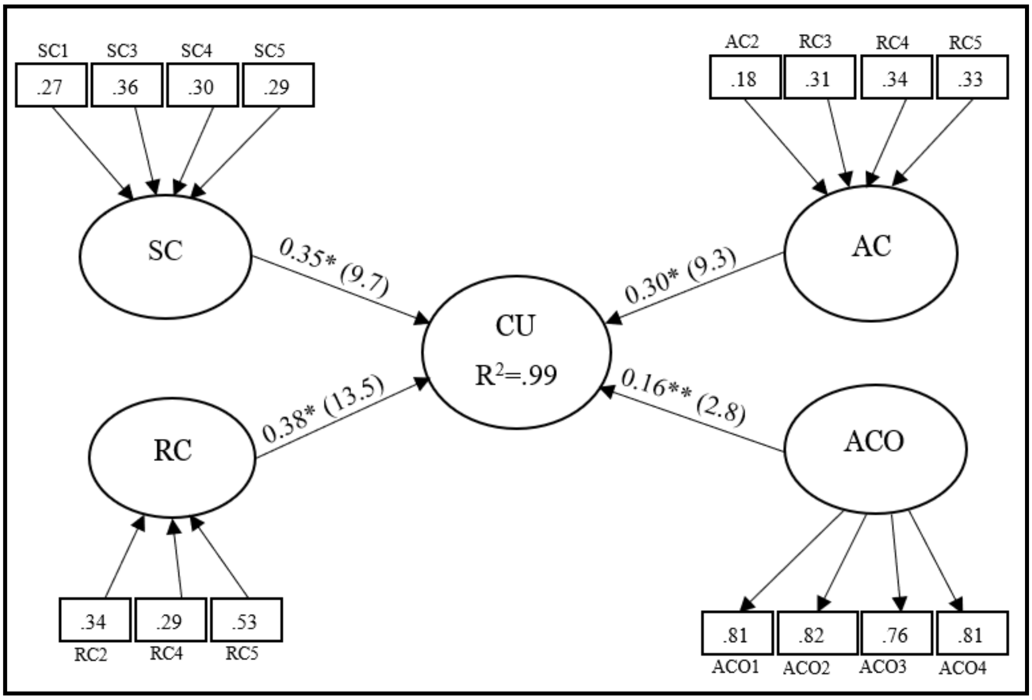

Figure 5. Impact of Sub-constructs on Conscious Use (CU). $*p < 0.000$, $**p < 0.005$

The test of the structural model includes estimates of the path coefficients and the R^2 values. The results (Figure 5) from PLS indicate that all four first-order conscious use constructs (SC, RC, AC, and ACO) have significant paths (SC, $b = .35$, $p < 0.00$; RC, b =. 36, $p < 0.00$; AC, $b = .33$, $p < 0.00$, and ACO, $b = .15$, $p < 0.005$) onto overall conscious use ($R^2 = .99$); indicating that these three formative sub-constructs have a significant in forming the overall conscious use construct. This result supports our conceptualization of conscious use as a formative construct. Figure 6 displays the results of predictive validity of the conscious use construct with SAT as the dependent variable. As shown in Figure 6, CU had a significant impact on SAT ($b = .70$; $p < .000$) with an R^2 of 50%; indicating that the conscious use also has sound predictive validity.

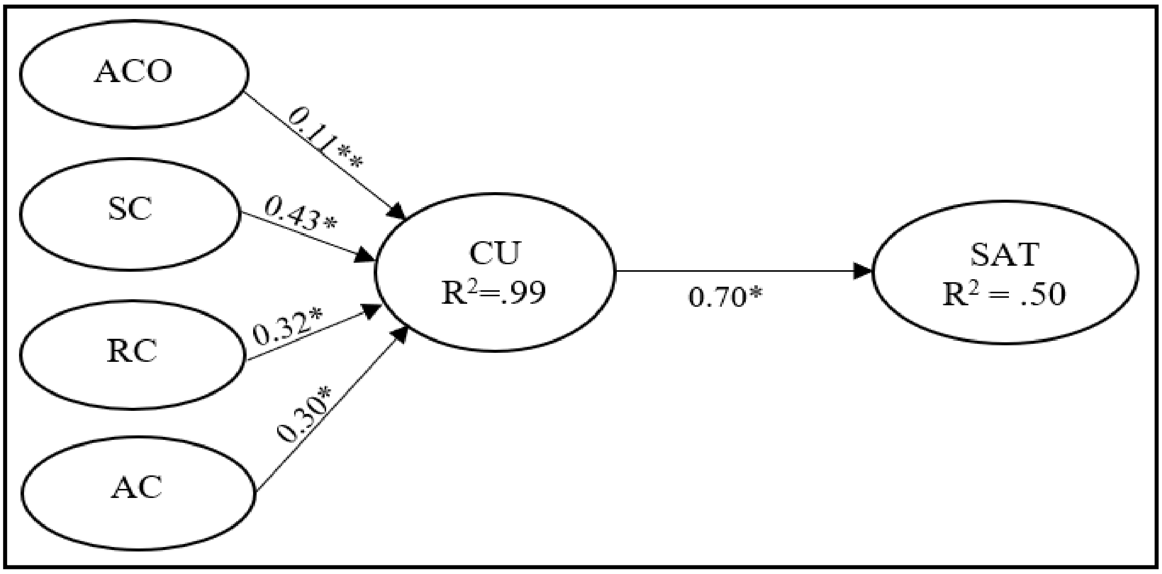

*Figure 6. Predictive Validity of Overall CU on SAT. *p < 0.000, **p < 0.01*

Finally, a set of variables, including age, gender, exposure (number of years since the robot is known to the respondents), tenure (the respondent's spent years with the current organization), and education were included as control variables in the PLS models (Figure 7). None of the control variables were found to be significant. The *t*-test results for the gender difference show that the relationship is not significantly different due to gender (b = .10; *t* = .98).

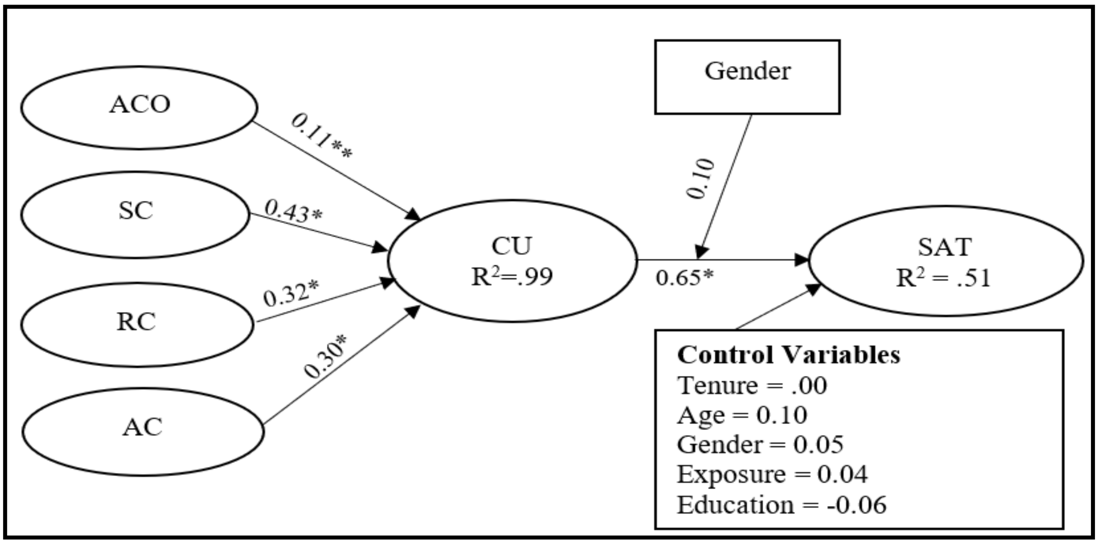

Figure 7. Predictive Validity of *CU on the SAT with Control Variables. *p < 0.000, **p < 0.001*

6 Discussion

In this research, we advanced an alternative understanding of *use* in autonomous things and proposed a novel construct: *conscious use*. We argue that unlike the manually operated IS artefacts, the "use" of a fully autonomous artefact is the domain of *conscious thoughts* rather than a deliberate cognitive and physical activity. This understanding is advanced based on theories of consciousness (Baars 1988; Rosenthal, 1996) combined with the way a typical fully autonomous artefact s function i.e., by anticipating user's needs through sensory information and situational awareness without requiring any instructions and physical contact (Hoffman, 2012; Schuetz and Venkatesh, 2020). The traditional notions of technology adoption conceptualize "use" as physical activity (i.e., learning and physically operating a vacuum cleaner) (Adams et al., 1992; Delone and McLean, 2003; Marangunić and Granić, 2015; Seddon, 1997; Venkatesh et al., 2003); whereas, we advanced the notion of "use" as a *conscious thought* (a state of consciousness).

We showed that conscious thoughts related to a FAISA lead to satisfaction; however, unlike physical use, thoughts have no limits. Any conscious thoughts the user happens to have when attention is directed towards a fully autonomous artefact will qualify as conscious use including happy thoughts, anger, anxiety, enjoyment, so forth. Hence, it is crucial to understand users' conscious thoughts regarding an autonomous technology (not the physical use) as it may determine users' satisfaction/ dissatisfaction, purchase decisions, adoption/ rejection, so forth. Although, the link between conscious thoughts and emotions need to be tested in future research, the implication here is that fully autonomous technologies will need to be designed to function reliably and smoothly (without human intervention) otherwise it may trigger an undesirable state of consciousness or dissatisfying thoughts leading to anger, anxiety, etc.

Further validating and extending the proposed notion will profoundly increase our understanding of the role of conscious thoughts in accepting or rejecting autonomous things that do not require any cognitive efforts, physical contact, and instructions to operate. Unlike the traditional notions of use, the *use* of FAISA does not require thoughtful mental efforts, physical contact/actions, and instruction to produce outcomes, hence it is not characterized by the behavioural beliefs (e.g., perceived self-efficacy and effort expectancy) that stems from cognitive and physical efforts required to operate a manual IS artefact. A question arises, how would then the existing nature of casualties among core IS variables come into play when faced with IS artefacts that do not require any cognitive efforts, instructions, and physical use? More research is needed to investigate the nature of causal linkage among conscious use and the well-established IS behavioural beliefs (such as perceived ease of use and perceived self-efficacy) and attitudes (e.g., intentions to use) (Adams et al., 1992). Such investigations will reveal meaningful insights and generate implications both for academics and practitioners alike. Furthermore, it is well established that our consciousness plays a greater role in having perceptions and feelings (Marchetti, 2018), how would then the conscious experiences arising from using a FAISA lead to the forming beliefs and perceptions related to the artefact?

6.1 Nature of Use

Looking at the continuum (see Figure 2), several plausible scenarios may arise in addition to the ones portrayed in this article. For instance, autonomous things come in a variety of forms, shapes, and states: they can either be visible to naked eyes (such as autonomous robots), invisible (e.g., blended in the background or implanted in the body), digital (such as software products), or physical (such as a vacuum cleaner), wearable, or ridable (such as autonomous cars or drones). Furthermore, a FAISA may exhibit state transition property switching from a fully autonomous state to a partial or non-autonomous state. For example, a self-driving vehicle can transit from a fully autonomous state to a manually controlled state when the need arises (Politis et al., 2018).

A variety of strategies and design elements are suggested to facilitate this transition including rich displays (Eriksson et al., 2017) and dialogue interaction system (Politis et al., 2018).

However, in this research, we are only focused on FAISA that does not require reflective cognitive efforts and physical use/contact and instructions to produce outcomes in all situations permanently. Future research (see Figure 8) should look into autonomous IS artefact s that fit into more than one scenario on the continuum (such as voice-enabled autonomous IS artefact or autonomous artefact requiring cognitive and physical efforts). And how would the nature of conscious use change (vary) in the transitional stages of FAISA i.e., when it is switching from a fully autonomous state to a partial or non-autonomous state?

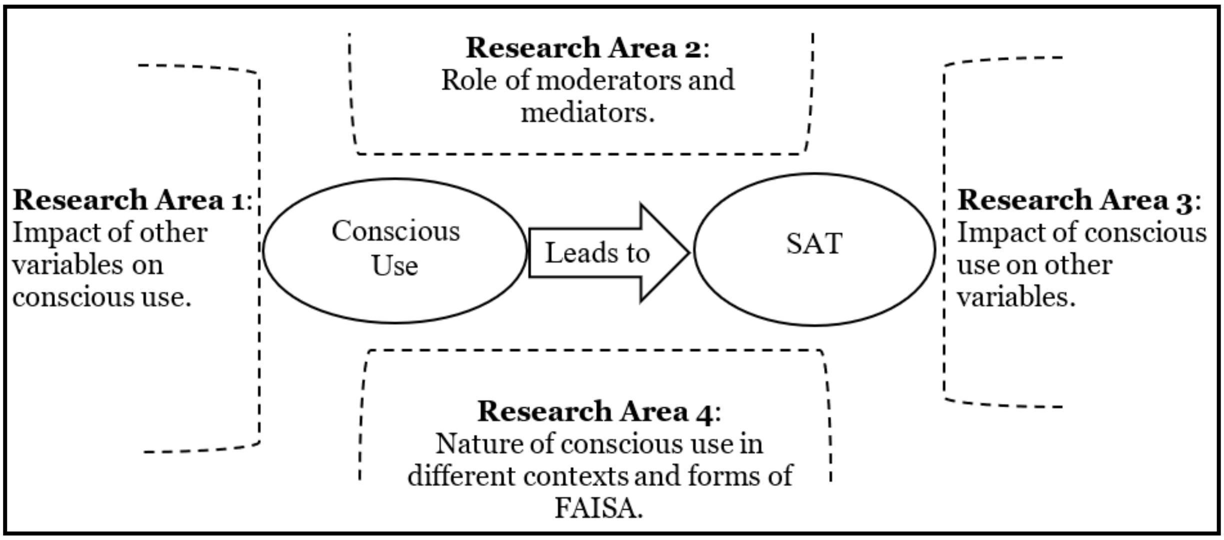

Figure 8.Conceptualization of Future Research Directions

6.2 Use in Different Contexts and Levels

Information systems use has been extensively investigated in a variety of levels, such as individuals and group level, and contexts, including business context, domestic, education, healthcare, military, and cultural contexts, to name a few. Likewise, the context in which FAISA is consciously used is of paramount importance. Autonomous technologies are slowly becoming available due to the rapid developments and use of facial recognition, big data, automation, and artificial intelligence revolutionizing the retail industry with innovative products and services (such as unmanned shops, drones, and virtual agents). Hence, more research is needed to shed light on the use of FAISA in different contexts (such as home vs., business context) and levels (such as individual vs., group settings) to document fluctuates and the manifestation of conscious use in these contexts.

Furthermore, similar to habitual (Jasperson et al., 2005; Kim et al., 2005), low attention/intension use (Dix, 2017), and system 1 thinking (Kahneman, 2012), being conscious of a fully functional FAISA doesn't constitute too much mental effort for users, which may naturally lead to cognitive ease. Cognitive ease is the mental state in which "things are going well—no threats, no major news, no need to redirect attention or mobilize effort" (Kahneman 2012, p. 61). Users experience cognitive ease when there is less information processing strain on the brain and things are generally going well. Conversely, users experience cognitive strain when processing too much information and solving complex tasks such as operating a manual technology artefact (Moody, 2004).

Focus	**Background**	**Potential Research Questions**
Impact and association of core IS variables with conscious use.	The use (and no use) of IS artefact is influenced by behavioural beliefs and attitudes (e.g., self-efficacy, effort expectancy, ease of use and usefulness, and intentions), system characteristics, and personality traits (Delone & McLean, 2003; Lee et al., 2003; Taylor and Todd, 1995; Venkatesh et al., 2003). Given that no cognitive efforts and physical use are involved in FAISA, investigating the relations among conscious use and other IS variables will reveal meaningful insights and generate implications. Any conscious thoughts the user happens to have when attention is directed towards a fully autonomous will qualify as conscious use (including happy thoughts, anger, anxiety, enjoyment, so forth) making conscious use a challenging and dynamic construct to measure. \	Q1. How would the existing notions of casualties among IS variables (e.g., self-efficacy, effort expectancy, ease of use, usefulness, and intentions) come into play in the context of the autonomous IS artefact s that do not require any logical and deliberate cognitive efforts and physical actions? Q2. How would the conscious experiences and thoughts arising from using a FAISA lead to the forming beliefs and perceptions related to the artefact? Q3. In what ways do different conscious thoughts ((such as happy thoughts, anger, anxiety, enjoyment, so forth) related to FAISA impact users' satisfaction?
Nature of use in different forms of FAISA.	FAISA comes in a variety of forms, shapes, and states (Figure 2). It can either be visible to naked eyes, invisible (blended in the background or implanted in the body), digital (such as a software product), physical (such as a vacuum cleaner), wearable, or ridable. FAISA may exhibit state transition property switching from a fully autonomous state to a partial or non-autonomous state (Politis et al., 2018).	Q4. What is the nature of conscious use in different forms of FAISA such as digital vs., physical and invisible vs., invisible FAISA? Do such scenarios render the need to measure the use of an invisible FAISA absolute? Q5. Is a digital FAISA (such as a software product) consciously perceived and used differently when compared to a physical FAISA (such as a vacuum cleaner)? Q6. How would the nature of conscious use change (vary) in the transitional stages of FAISA i.e., when it is switching from a fully autonomous state to a partial or non-autonomous state?
Use of FAISA in different contexts and levels.	Information systems use has been extensively investigated in a variety of levels, such as individuals and group level, and contexts, such as business context, domestic context, education context, healthcare, military, and cultural contexts, to name a few. The role of technologies in bridging the digital divide is apparent (Andrade and Doolin, 2016). FAISA is not characterized by behavioural beliefs that stem from cognitive and physical use, it could potentially break down the barriers of the digital skills divide (i.e., the lack of skills needed to operate the technology) particularly among the less privileged groups and indigenous communities.	Q7. Given that use in FAISA is an individualistic conscious thought, how does this notion of use change in group settings (e.g., when FAISA is used collaboratively rather than individually)? Q8. How is the nature of conscious thoughts manifested in different contexts in which FAISA is used such as business vs., domestic context? Q9. In what ways the notion of conscious use can be best leveraged to break down the barriers of the digital skills divide particularly among the less privileged groups and indigenous communities?

Focus	**Background**	**Potential Research Questions**
Nature of use in partial autonomous things.	As alluded to earlier, PAISA does not need physical use (e.g., push or click) but requires cognitive, vocal, and gestural instructions wirelessly communicated through a variety of mechanisms (e.g., see (Ernst, 2020; Musk, 2019; Sen et al., 2015). Examples of PAISA include voice commanded systems (e.g., Siri and Alexa) (Sen et al., 2015); systems that are controlled with thoughts (e.g., Elon Musk's Neuralink) (Musk, 2019), and gestures enabled systems (e.g., SelfieType, a gesture-based digital keyword developed by Samsung).	Q10. How would the existing notions of casualties among IS variables come into play in the context of the autonomous IS artefact s that are used through cognition, voice, and gestures? Q11. What is the nature of ease of use, usefulness, and use in the partially autonomous artefact s that do not need physical use (e.g., push or click) but require cognitive, vocal, and gestural instructions wirelessly communicated?

Table 6. Future Research Directions relating to Use of Autonomous Things

Following this logic, it can be argued that when users are consciously using a FAISA that does not require logical and reflective cognitive efforts, physical contact, and instructions they may experience cognitive ease due to the less information processing strain on their brain. Hence, future research investigate the impact of *conscious use* on *cognitive ease*—which we define as is an individualist state of mental ease experienced when a fully autonomous artefact is carrying out tasks and activities for which the system is designed to support.

In addition, it is well established that when people are in a state of cognitive ease they are generally happy and comfortable whereas when people feel strained, they are more likely to be suspicious, feel uncomfortable, and less creative (Kahneman, 2012). As posited earlier, the autonomous nature of FAISA reduces information processing strain on the brain leading to potential cognitive ease, which could further impact users' modes, feelings, and creativity. It has also been established that people are more inclined to interact with new technology if they believe the interaction will require little cognitive work (Adams et al., 1992). Future research is needed to further understand this association and investigate in what ways and how FAISA impacts users' feelings, modes, and creativity.

Furthermore, previous research suggests that people may feel uneasy in the presence of sophisticated technology, and it causes intense anxiety among onlookers (Jayaraman et al., 2019; Stein et al., 2019). This aversion to advance technologies can naturally arise from "sociocultural constructions and biological adaptations for threat avoidance" (MacDorman & Entezari 2015, p. 141). For example, Złotowski et al. (2017) reported that people perceive autonomous machines as a threat not only to lose human identity/ distinctiveness (identity threats) but also as a threat to material resources, safety, and physical wellbeing (i.e., realistic threat). Similarly, using a virtual reality agent, Stein et al. (2019) proposed a model of autonomous technology threat and showed that proximal threat (concerns about human uniqueness) and distal threat (perceived situational control in interactions with autonomous technology) plays a crucial role in technology aversion and "reduced" technology acceptance.

Employing a modified technology adoption model in the context of the autonomous vehicle, Hewitt et al. (2019), among other things, reported that users are eager to use fully autonomous cars, however, their lack of trust and anxiety associated with it negatively impacted intention to use the self-driving cars. On the other hand, studies suggest that the users particularly appreciate the time savings that come with FAISA. Zeitzew (2007) investigated the use of autonomous utility mowers and suggest that users appreciated the straightness of the mowing stripes and time savings which could potentially be invested in other activities (such as leisure time). Hence, conscious use may lead to the *autonomous technology acceptance paradox*—that autonomous IS artefact s may both increase and diminish technology acceptance and/or cognitive ease particularly when users are faced with sophisticated autonomous machines. Such contradiction has been previously reporting in the context of conventional technologies (i.e., mobile email devices) when users juggle between personal interest and professional commitment (Mazmanian et al. 2013). This warrants testing the notions of conscious use and cognitive ease in other studies when investigating issues related to technology fear, aversions, trust, and privacy.

Furthermore, the role of technologies in bridging the digital divide has been widely studied (Andrade & Doolin, 2016). The nature of FAISA and the notion of conscious use has the potential to reshape the digital divide literature. When a technology is not characterized by behavioural beliefs that stem from cognitive and physical efforts (e.g., perceived self-efficacy and effort expectancy), it could potentially break down the barriers of the digital skills divide (need to operate the technology) particularly among less privileged groups and indigenous communities. Like the traditional technologies (Andrade & Doolin, 2016), future research is needed to investigate how autonomous technologies and the notion of conscious use can be best leveraged to close the technology skills gap and uplift less privileged groups and indigenous communities across the globe.

6.3 Nature of Use in Partial Autonomous Things

The availability of partially autonomous things controlled with voice (such as Apple's Siri, Amazon's Alexa, Google's Assistance, Microsoft's Cortana, and Samsung's S Voice) has become a common household item offering users hands and eyes-free interaction with systems while eliminating the need for keyboards. Similarly, cognition or thought-based technologies (such as "AlterEgo" designed by a researcher at the Massachusetts Institute of Technology) decode thoughts and wirelessly transmit them to another device (such as a computer) to perform certain tasks (e.g., typing a message without a keyboard with thoughts only) (Boucha et al., 2017). Gesture-enabled products are also available in the market, such as the gesture sensing stunt car that is controlled with gestures transmitted through a wearable strap wrapped around the palm. Research suggests that one of the greatest challenges facing gesture-enabled technologies is not technological but it is related to acceptance of gestural inputs (Ronkainen et al., 2007).

There are a variety of issues that must be considered when theorizing and testing partially autonomous technology-related theories and constructs. However, reliable measures did not exist to understand the use associated with this new genre of IS artefacts. Future research should propose and validate a novel construct and its measures for partially autonomous IS artefact s that do not require contact but need instructions in the form of speech (such as Alexa), thoughts, and gestures. For example, what is the nature of ease of use, usefulness, and use in the partially autonomous artefact s that do not need physical use (e.g., push or click) but requires cognitive, vocal, and gestural instructions wirelessly communicated? Partially autonomous things can be wearables (i.e., worn on the body) and capable of collecting, analysing, and transmitting data related to the user's vital signs (e.g., pulse, temperature) and activities (e.g., steps, sleep, physical exercise) (Mettler & Wulf 2019). What is the nature of use and ease of use in wearable technologies and how does user interaction with wearables enable behavioural and cognitive outcomes?

6.4 Contributions to Theory and Practice

We believe this research made an important contribution by further advancing the emerging IS strain of research that questions the core assumptions of theorizing the use of IS artefact s on the premise of physical use (Demetis & Lee, 2018; Rivard, 2014; Schuetz & Venkatesh, 2020). The proposed theorization and construct are in agreement with the emerging viewpoints that argue for novel theories for the next generation of things (Schuetz & Venkatesh, 2020, p. 461) as the existing theories were developed for a different genre of end-users technologies (Benbasat & Zmud, 2003; Rivard, 2014). In line with the IS custom of advancing new understanding for the emerging technologies (Davis, 1989), we believe that the constructs proposed in this research will have greater theoretical value for academics and practical benefits for the businesses who are keen to understand end-user perceptions and use related to autonomous things.

The paper also developed a continuum of autonomy of IS artefact s. Given the constellations of numerous emerging technology artefact s equipped with new features and abilities, the taxonomy of autonomous technologies developed in this study can potentially make a significant contribution to IS research and practice. This research opens up several avenues for future research on a variety of fronts to further expand our understanding of the nature of use in autonomous things (see Figure 8 and Table 6).

In terms of practical implications, this paper highlights several points that relate to the prospective use of autonomous things in organizations. First of all, the efficiency of organizational processes and value creation mechanisms are considered important aspects that conscious use can potentially have an impact on. Given the speed of digital transformation of organizational processes (Feroz et al., 2023), autonomous IS is set to become integral to modern organizational landscapes, revolutionizing the way tasks are performed, decisions are made, and data is managed paving way for heightened operational efficiency that not only enhances productivity but also allows for resource optimization (Davenport, 2019). In this regard, this paper introduces a human-centric conscious-driven dimension to the deployment of autonomous systems, influencing how individuals interact with and perceive these technologies.

By acknowledging the role of conscious use, organizations can better tailor autonomous systems to complement human decision-making, thereby maximizing operational benefits. conscious use, in this context, emphasizes the need for users to be consciously aware of how they engage with autonomous things, ensuring that the convergence of human-IS interaction lead to alignment with organizational goals and values (Smith et al., 2020). In organizational behavior context, the successful implementation of autonomous things is closely tied to user acceptance and positive experiences (Venkatesh et al., 2021). Conscious use can contribute to user satisfaction by aligning system functionalities with user expectations through minimal interaction with the autonomous IS. Understanding the practical implications of autonomous things is crucial for organizations seeking to leverage these technologies effectively. The paper introduces the concept of conscious use, a human-centric dimension to the deployment of autonomous systems, that can influence how individuals interact with and perceive these technologies. Organizations can utilize the influence of conscious use on the user experience to enhance overall system acceptance and foster a positive attitude toward autonomous technologies.

6.5 Limitations

Finally, the research has several limitations that need to be addressed. Firstly, the proposed notion of conscious use assumes that fully autonomous technologies do not require deliberate cognitive efforts and active use behaviour. However, most autonomous artefact s are designed for humans to engage in verbal and physical human-machine interaction and cooperation at various levels of automation (Vagia et al., 2016). For example, even with a fully autonomous vehicle, the passengers might have to verbally engage with the vehicle when it comes to providing a destination, preferred route, or when enabling the vehicle's fully autonomous capability in the first place.

However, the construct and conceptualisation proposed in this study are only relevant when users are faced with an IS artefact that is operating in a *fully autonomous mode* not requiring deliberate cognitive efforts, physical contact, and instructions to produce outcomes in all situations *permanently*. In such cases, the use of a fully autonomous artefact becomes a conscious thought directed towards the technology rather than a deliberate physical activity. Hence, future research is needed to propose and validate a novel construct and its measures for autonomous IS artefact s that require human-machine interaction and cooperation at various levels of automation across a continuum of fully autonomous state to a partial or non-autonomous state.

Secondly, although we examine using a typical autonomous technology that senses, responds, and adapts to the environment, further research is necessary to evaluate the utility of our measure in more complex autonomous technology contexts. For example, we only looked into use associated with a FAISA assuming that the users are aware of its presence and attention is directed towards it. However, there may arise scenarios when a user is not conscious or aware of a FAISA that is anticipating their needs (such as chatbots, recommender systems, or products embedded in the environment) (Dix, 2017; Schuetz & Venkatesh, 2020). Future research is needed to understand the nature of conscious use in different forms of FAISA such as digital vs., physical and invisible vs., invisible FAISA. And how such scenarios may render the need to measure "use" and of an invisible FAISA absolute.

As discussed earlier, any conscious thoughts the user happens to have when attention is directed towards a fully autonomous will also qualify as conscious use including anger, anxiety, enjoyment, so forth. Future research needs to investigate the variety of conscious thoughts that may arise in different situations such as when a FAISA is not performing its job smoothly. Furthermore, the proposed theorization does not consider the initial setup requirements and unboxing experience related to autonomous things, as one expert commented during the pilot study: "*I think it's important to think about not just the actual application of products, but also consider the initial setup and unboxing experiences of the product. The Echo dot for example requires users to download an app to register the product as well as add devices to their Alexa Cloud services. This is not always easy to do interface and requires some hands-on with hardware*."

Future research is needed to consider issues relating to initial setup requirements and unboxing experience when investigating autonomous things. Similarly, the small sample size and cross-sectional nature of the study may limit its generalizability. And finally, a better approach to clearly demonstrating that the proposed notion of use is separate and distinct from other previous types of use is to measure it alongside existing use measures and present the empirical analysis. However, this was not done in this research. Future research should retest the proposed measures alongside the existing use measures.

7 Conclusion

Leveraging the theories of consciousness, we proposed conscious use as a novel construct for use in autonomous things and empirically validated its measures and predictive validity. We showed that when an IS artefact does not require deliberate cognitive efforts, physical contact, and instruction (to produce outcomes), its "use" essentially becomes a conscious thought rather than deliberate cognitive efforts or physical activity (i.e., pushing a button or clicking on a screen). The autonomous capabilities of next generation artefact s will have an impact on the way humans interact with and manage "consciously aware" computers. Departure from deliberate cognitive behaviour to conscious thoughts when interacting with the intelligent machines creates new horizons in terms of human-machine interface which will ultimately lead to the transformation of industries, societies, and organizations. More research is needed to expand the findings of this study in a variety of different settings provided in Table 6. Extending the findings of this study will make a crucial theoretical and practical contribution to IS research.

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APPENDIX A

1. Burst Detection

In this study, we employed Kleinberg's burst detection algorithm (Kleinberg, 2003) implemented in the Sci2 tool (Sci2Team 2009) to identify the emerging trends in the autonomous things research domain. The burst detection technique is a reliable way to identify emerging trends in any research domain by analyzing large corpora of text (Kleinberg, 2003). Researchers from a variety of domains including the information systems domain (Khan & Trier, 2019) have successfully employed this technique to identify emerging trends in their respective research domains. Before applying the burst detection techniques, the data were lowercased, tokenized, and a common set of stop words were removed from it.

2. Data

The data for burst detection were obtained from the Web of Science (WoS) database. Previous research has shown that the keywords and titles of the articles are the best places to identify the emerging trends in a domain (Leydesdorff, 2006). Hence, we entered a research query into the WoS search engine to find the publications (from 2000 to early 2020) with the following topics in the keywords, title, and abstract of the articles.

Searched for topic: *("autonomous things" OR "autonomous systems" OR "autonomous products" OR "autonomous artefact " OR "autonomous robots" OR "autonomous machines" OR "self-governing things" OR "self-governing systems" OR "self-governing artefacts" OR "self-governing product" OR "self-governing robots" OR "self-governing machines" Timespan*: 2000-2020. Indexes: Social Sciences Citation Index (SSCI).

The search retrieved 252 articles that had appeared in 156 journals. Furthermore, a vast majority of articles (70%) were published since 2011 and the largest number of publications (n=20) appeared in Adaptive Behavior Journal. This was followed by 9 (3.6%) articles in Ethics and Information Technology, 8 (3.2%) in Ergonomics and Human Factors each. None has appeared in the top IS journals, which is consistent with the conclusion reached by (Schuetz & Venkatesh, 2020), 6 (2.4%) in Bulletin of the Atomic Scientists, and 5 (2%) in Cognitive Systems Research.

3. Results

Table A and B shows the bursting topics included in the titles of the articles and the keywords supplied by authors with their weight, length, start year, and end year. In the case when there is no end date noted, the terms are considered to still be active. The burst words with the start year indicate that the word started appearing in that year and the end year indicates the year that the word last appeared. The burst words without an end year are for those intervals which extend to the most recent publications, suggesting terms that are in the middle of a large weight burst at present (Kleinberg 2003). The length represents the period of the burst word measured in the number of years.

Currently, the most significant fading research trends represented in the field of self-governing things from a title perspective (Table A) include neural (2001-2008), improve (2015-2011), control (2001-2007), determin (2010-2015), individu (2004-2009), and spatial (2008-2012). And the themes that are still active include embed (2016-present), ethic (2018-present), mental (2017-present), machin (2018-present), autom (2018-present), and accept (2018-present). These highlight potential areas of research that are very much the focus of contemporary. On the other hand, the author-supplied keyword analysis (Table B) also shows which areas of research are not active as they once were; these include the likes of dynam (2002–2015), function (2002–2012), activ (2000–2010), and mobil (2000-2009). Furthermore, the research topics that are still actively pursued are team (2017-present), analysi (2018-present), driverless (2018-present), car (2018-present) and driver (2019-present), so forth. This shows that most of the research on self-governing things seems to be focused on driverless cars and the issue associated with them. The appearance and disappearance of words also indicate that the research area and priorities are changing over the years.

Word	Weight	Length	Start	End	Word	Weight	Length	Start	End
neural	1.45	8	2001	2008	network	1.62	3	2000	2002
improv	1.46	7	2005	2011	AI	0.87	2	2016	2017
situat	1.10	7	2004	2010	convers	0.78	2	2009	2010
control	1.87	7	2001	2007	embodi	1.19	2	2012	2013
determin	1.16	6	2010	2015	humanoid	1.12	2	2013	2014
individu	0.82	6	2004	2009	design	1.44	2	2019	
spatial	0.95	5	2008	2012	user	1.24	2	2019	
embed	1.11	5	2016		intellig	1.27	2	2017	2018
unman	0.90	5	2010	2014	trust	1.30	2	2019	
play	0.90	5	2010	2014	drive	1.53	2	2019	
mental	1.06	4	2017		human	4.00	2	2019	
ethic	1.84	3	2018		context	0.93	2	2019	
machin	2.47	3	2018		experi	0.81	2	2019	
autom	2.28	3	2018		interact	1.08	2	2019	
voic	0.82	3	2007	2009	interfac	1.82	2	2019	
speech	1.53	3	2009	2011	adapt	1.13	2	2001	2002
develop	0.98	3	2012	2014	robot	0.97	2	2001	2002
context	0.80	3	2010	2012	dialogu	1.79	2	2010	2011
intellig	1.62	3	2001	2003	interfac	0.84	2	2010	2011
smart	1.60	3	2016	2018	cognit	1.14	1	2018	2018
accept	0.91	3	2018		decis	0.95	1	2012	2012

global	0.91	3	2018		autonom	1.04	1	2003	2003
defin	0.91	3	2018		learn	1.23	1	2001	2001

Table A. Top Bursting & Disappearing Stem Words in Titles of the Articles

Word	Weight	Length	Start	End	Word	Weight	Length	Start	End
dynam	2.57	13	2002	2014	agent	2.41	3	2011	2013
function	1.85	11	2002	2012	driverless	1.56	3	2018	
activ	1.74	11	2000	2010	theori	1.78	3	2011	2013
mobil	2.03	10	2000	2009	netswork	1.55	3	2000	2002
eye	1.55	9	2005	2013	car	2.99	3	2018	
visual	1.83	7	2010	2016	moral	1.69	2	2015	2016
evolutionari	1.74	7	2002	2008	driver	1.64	2	2019	
emerg	1.96	7	2008	2014	respons	2.16	2	2014	2015
imit	1.7	5	2004	2008	attent	1.62	2	2009	2010
unman	1.56	5	2010	2014	engin	1.89	2	2017	2018
organ	1.8	5	2004	2008	vehicl	2.2	2	2019	
afford	1.57	5	2007	2011	intellig	1.74	2	2000	2001
self	1.62	5	2004	2008	robot	1.94	2	2006	2007
behavior	1.83	4	2008	2011	drive	1.76	2	2019	
learn	2.06	4	2005	2008	social	1.65	2	2003	2004
team	1.74	4	2017		agent	1.85	2	2000	2001
technolog	1.96	4	2014	2017	machin	2.43	1	2018	2018
process	1.95	4	2012	2015	emot	1.58	1	2016	2016
model	2.1	4	2008	2011	institut	1.81	1	2017	2017
spatial	1.95	4	2012	2015	fethic	1.56	1	2018	2018
cognit	1.71	4	2010	2013	autonom	2.18	1	2008	2008
languag	1.65	4	2002	2005	biolog	1.99	1	2008	2008
analysi	2.11	3	2018		human	1.52	1	2016	2016

Table B. Top Busting & Disappearing Topics in the Author-Supplied Keywords

APPENDIX B

Demographic	Category	Count	%
Age Group	below 30	15	25
	30-39 years	22	36
	40-49 years	14	23
	50 and over	9	15
Work Experience	1-5 years	11	18
	5-10 years	15	25
	10-15 years	9	15
	15-20 years	11	18
	20-25 years	5	8
	More than 25 years	9	15
Education	Bachelor's degree	25	42
	Master's degree	24	40
	Professional degree	4	7
	Some college credit	3	5
	Trade/technical/vocational	4	7
Gender	Male	32	53
	Female	28	47
Industry	Information Technology	12	20
	Sales & Marketing	9	15
	Education	7	12
	Tourism Hospitality	6	10

Demographic	Category	Count	%
	Banking & Finance	5	8
	Health	4	7
	Others	12	20
	Not working	5	8

Table B1. Pilot Study Sample Characteristics (n = 60)

Constructs	Mean	ST-DV	Skewness
Autonomy Consciousness			
ACO1: I am mindful of __.	3.7	0.9	-1.3
ACO2: I am aware of __	3.9	0.9	-1.3
ACO3: I know __ is present.	3.9	0.9	-1.3
ACO4: I understand __ is around.	3.9	0.9	-1.4
Sensibility Consciousness			
SC1: __ senses hazards correctly.	4.2	1.0	-1.4
SC2: __ senses hazards in a timely fashion.	4.1	0.9	-1.0
SC3: __ reliably senses hazards.	4.2	0.9	-1.2
SC4: __ flexibly senses hazards.	3.8	1.0	-0.8
SC5: __ senses new conditions.	4.1	0.9	-1.4
Responsiveness Consciousness			
RC1: __ responds to hazards correctly.	3.7	1.0	-1.1
RC2: __ responds to hazards in a timely fashion.	3.7	0.9	-0.8
RC2: __ reliably responds to hazards.	3.9	0.8	-0.9
RC3: __ flexibly responds to hazards.	3.7	0.9	-0.7
RC4: __ responds to new conditions.	3.8	0.9	-1.0
Adaptability Consciousness			
AC1: __ adjusts to hazards correctly.	4.1	1.0	-1.2
AC2: __ adapts to hazards in a timely fashion.	4.1	0.9	-0.7
AC3: __ reliably adjusts to hazards.	4.0	1.0	-0.7
AC4: __ flexibly adapts to hazards.	4.0	0.9	-0.6
AC5: __ adapts to new conditions.	4.1	1.0	-0.8
Satisfaction			
SAT1: All things considered, I am very satisfied with __	4.1	0.7	-0.4
SAT2: Overall, my experience with __is very satisfying.	4.1	0.9	-0.5
SAT3: Overall, I am satisfied with __	4.1	0.8	-0.6

Table B2. Pilot study survey items ranking results

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