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Conceptualising the Internet of Behaviours (IoB): A Multi-Level Perspective and Research Agenda

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Full research paper

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Abstract

The Internet of Behaviours (IoB) is an emerging phenomenon with significant business and societal impacts. This paper argues that Information Systems (IS) researchers, with their tradition of engaging with behavioural issues can play leading roles in shaping the IoB body of knowledge. Yet, there is a lag in IS research on the IoB. To address this, the paper presents an exploratory content analysis of literature and webliography. This identifies several mutually complementary notions of IoB as a protocol, technology, data, system, and behaviour as well as IoB use cases and concerns. Then drawing from the Multi-Level Perspective (MLP), the paper provides an IoB conceptualisation framework and research direction. The framework makes the first attempt to offer IS researchers with conceptual facilities to explore and explain IoB, its application areas at different levels, and the tensions and struggles in IoB transitions.

Keywords Internet of Behaviours, IoB, multi-level perspective, socio-technical systems, behaviour science, research direction

1 Introduction

Contemporary society faces formidable environmental, social, and economic challenges. Addressing these challenges requires deep socio-technical transformations at individual, organisational, societal, and eco-system levels. Digitisation of manual and analogue activities; the digitalisation of socio-technical systems and processes (Legner et al. 2017) and the digital transformation of structures, networks, culture, products, and behaviours (Vial 2019) hold significant promises for the transitions. Success requires effective exploitation of existing and emerging technologies (Vial 2019). These technologies and their applications differ from their precursor due to the possibility to deeply learn from the massive amount of data they generate, and autonomously act based on the insight gained from the learning. In addition, the 2010s has witnessed significant shifts in sharing economy, datafication and the demand for more personalised products and services. It has also led not only to massive connectivity among and between things, individuals, value systems, and digital platforms, but also increased collaboration and orchestration of the human activities associated with them (Stary 2020). This is leading to a growing interest in the "Internet of Behaviours/Behaviors (IoB)".

Individuals have been generating behavioural data that can be used to understand and attribute actions. For example, speed cameras that capture driving behaviour are used to attribute demerit points. Entertainment services suggest movies for individuals by keeping track of viewing behaviours. Despite such practices, the origin of the IoB, as a concept, dates to Nyman (2012). Nyman's original idea of the IoB (which he refers as IB) is a protocol (equivalent to internet's IP address) that can uniquely identify "selected and meaningful behaviors patterns" of individuals. He opines that IB address assignments can be undertaken either by individuals, external agencies, or intelligent systems. This, he argues, opens opportunities not only for IB system developers but also for commercial and non-commercial entities to influence behaviour based on increased awareness of people's activities.

Since 2012, Nyman refined the IoB idea as a systematic way to teach AI systems good behaviour manners (Nyman 2018) and a coordinated and standardised system of coding behaviours and making those codes available for a wide variety of uses (Nyman 2020). Although Nyman continued to advocate the concept of IoB, the concept, with a rare exception (Celaschi 2017), didn't get much traction until Gartner lists the IoB in its Top Strategic Technology Trends for 2021 in late 2020. Gartner refers to the IoB as the "the collection and use of [behavioural] data to change behaviors" (Panetta 2020). This promoted Nyman (2021) to differentiate "General IoB" with an open approach to privacy from "Private IoB", a concept that promotes the separation of behavioural from identity data to preserve privacy.

Studying about the behaviour of information systems (Orlikowski and Iacono 2001); information systems users (Halilovic and Cicic 2013; Ranganathan et al. 2006) and behaviours influenced by information systems (Wang et al. 2020) has always been a core pursuit of the information systems (IS) scholarship. IS research can therefore make significant contributions to advancing IoB knowledge. Yet, there is a lag in conceptual, theoretical, and empirical research on IoB. Conceptualisation of a phenomenon is an important first step to help shape the IoB research and advance knowledge (Shapira 2011). Indeed, when a research domain or phenomenon is at an early stage of inquiry, a conceptualisation framework provides clarity and common language to explain the phenomenon, craft research questions, and define methods to advance the theoretical and empirical foundations of the research (Shapira 2011). It can also help to establish the empirical facts, constructs, appropriate theorising, and the development of research design that enable scientific inquiry to proceed. Thus, and in view of the relative newness of the IoB, this paper addresses the question of how to conceptualise IoB?

The aim of the paper is to propose an IoB conceptualisation framework based on the concepts and ideas of the multi-level perspective (MLP) that has been applied in explaining socio-technical transitions (Geels 2011). Following a brief discussion of research approach, the paper presents an analysis of the IoB conceptions, use cases and goals which is followed by the multi-level conceptualisation and research direction.

2 Research Approach

Given the IoB is emerging research, we follow an exploratory approach to understand how the current literature (both academic, and grey) defines, describes, and discusses IoB. The protocol is like a systematic literature review protocol. It involves (a) defining search term(s) and delimiters (b) searching for relevant materials (c) screening and selecting materials for quality and relevance (d) analysis, synthesis, and discussion. Table 1 summarises the protocol. Because the study is exploratory and most of the identified materials are from webliography, the quality of publications exclusion criteria expected in systematic literature reviews is not applicable in the context of this study.

Phase	Description	Result
Defining search protocol	The search terms cover both US and Australian spelling conventions for "behavior/ behaviour". Since Nyman (2012) is considered as the originator of IoB, the search period was delimited to 2012-2021.	Four search terms defined as:"internet of behavior, behaviors, behaviour and behaviours".
Searching	The search terms are searched on July 9, 2021, on Scopus (within the title, abstract and keywords); Google Scholar (within the document); Google Advanced Search (delimited to English and search terms in title of article).	**317 articles identified.** Three from Scopus; 19 from Google Scholar and 293 from Google.
Screening and selecting	The results are screened for quality and relevancy: **Scopus:** Review all three papers and exclude articles that have only a single appearance of the search term (1). **Google Scholar:** Exclude duplicates from Scopus (1); non-English references (5); duplicate hits (2); false hits, i.e., articles that do not have IoB (4); search terms appear once in the entire document (5). **Google:** Two researchers inspect the 293 results and exclude duplicates (9), false hits (18) and single and passing reference to IoB in the entire document (199). Identify additional academic articles through a process of backward and forward reference search.	**73 articles selected.** From Scopus 2 (Stary 2020, 2021); from Google Scholar 2 (Javaid et al. 2021 and Masip-Bruin et al. 2021) and from Google 67 Webliography selected. Two additional academic articles (Basu 2021; Celaschi 2017) identified.
Analysis	The analysis process (particularly the Webliography) followed the guidelines proposed by Braun and Clarke (2006) and reflected the exploratory orientation of the study. This process involved coding and themes identification using Nvivo (Appendix 1). The coding relied on a consensual approach between two researchers analysing for tentative, descriptive concepts that were derived inductively. These are then linked to themes.	Three broad themes identified as (a) Descriptions, (b) Application areas and Goals and (c) Issues and Concerns of IoB.

Table 1 – Literature and webliography collection and analysis protocol

3 Results

The results indicate that three broad theme that include the description, goals and application areas as well as concerns of IoB. Each of these themes are discussed accordingly.

3.1 Descriptions of IoB in Academic and Grey Literature

Academic research on IoB has yet to emerge. As indicated in Table 1, as of July 2021, a Scopus and Google Scholar search show only four academically published and relevant papers. The analysis of academic (Javaid et al. 2021; Masip-Bruin et al. 2021; Stary 2020, 2021) and grey (including Nyman's blogs) literature show diverse, but not necessarily mutually exclusive, focus on the descriptions and meanings of the IoB. These can be summarised as a protocol for identifying behaviours uniquely (Nyman 2012, 2018, 2020, 2021); an extension of the IoT affordances (Masip-Bruin et al. 2021); the application of data to change behaviours (Javaid et al. 2021); a system to digitally track people and their eligibility for service (Stary 2020); an emergent property from the orchestrated use of IoT, AI and Big Data and a digital behavioural science innovation (Vector-ICT 2021).

Since 2012, Nyman has been promoting the IoB concept mainly as a protocol for systematically and uniquely identifying and coding human behaviours. In his 2021 clarification of the IoB, he envisions the IoB as a privacy preserving global platform for identifying behavioural intentions, wishes and actions and making that behavioural data available for commercial applications (Nyman 2021). Nyman opines that IoB address assignments can be undertaken either by individuals, external agencies, or intelligent systems. The importance of assigning Internet address for behavioural patterns is also shared by others (Stary 2020). Assigning behavioural identifiers would certainly require other prerequisite procedures such as collecting or monitoring patterns or actions of users. Nyman (2012, 2018, 2020, 2021) argues

that his idea opens opportunities not only for IoB system developers but also for commercial and non-commercial entities to offer influences based on increased awareness of people's activities and states.

IoB Lens	Sample definitions (reference)	References
IoB as a protocol	"My core idea behind The Internet of Behaviors (IB) is to offer individuals and/or communities a new means to indicate selected and meaningful behavior patterns, as many as they like, by assigning a **specific IB address** to each behavior. (Nyman 2012)	(Nyman 2018, 2020, 2021); (Stary 2020)
IoB as a system	"I**oB as a system** that "delivers operations, automation, and total user experiences anywhere" (Stary 2021)	(Stary 2020)
IoB as an extension of IoT	"The I**oB is an extension of IoT** where the data collected from IoT devices are crunched to extract valuable insights into users' behaviours, interests, and preferences." (Raibagi 2021)	(Masip-Bruin et al. 2021)
IoB as use of data to change behaviours	"As demonstrated by the COVID-19 protocol monitoring example, **the IoB is about using data to change behaviors**. With an increase in technologies that gather the "digital dust" of daily life — data that spans the digital and physical worlds — from a variety of sources and that information can be used by public or private entities to influence behaviors through feedback loops." (Panetta 2020)	(Javaid et al. 2021)
IoB as an emergent system property	IoB is "**the set of all the enabling technologies used simultaneously generates this effect**: user behaviour is monitored and designed as it continuously evolves, and the producer does not abandon the product at the time of purchase but through it enters the individual user's life (home, car) or collective life (smart city), massively influencing the individual at all times" (Celaschi 2017, p. 101)	(Stary 2020)
IoB as digital innovation	"The Internet of behavior (IoB) is a **digital innovation** that combines the three fields: the Internet of Things (IoT), data analytics, and behavioral science. […] IoB consists of multiple approaches to capture, analyze, understand, to monetize users." (Glovory-Tech 2020)	(Vector-ICT 2021)

Table 2 – IoB description lenses and examples

Although Nyman continued to promote the idea of IoB as a new system of coding behavioural data, subsequent descriptions of IoB take an application lens with emphasis on enabling technologies, data and behavioural science (Celaschi 2017; Javaid et al. 2021; Masip-Bruin et al. 2021; Stary 2020, 2021). Generally, IoT, data analytics algorithms and AI are recognised as **enabling technologies** of the IoB (Celaschi 2017; Javaid et al. 2021; Stary 2020). IoT is a network of interconnected physical objects for detecting activities and relationships among Internet-connected devices (Guo et al. 2013). The role of IoT in understanding human behaviour is not new (Guo et al. 2013; Kim et al. 2019). However, IoB is different from IoT as it is a network of people behaviours and their interactions with cyber-physical systems through the combined application of IoT, data analytics algorithms and AI. Data analytic algorithms not only track or monitor individual activities on the digital space, but also, through the applications of AI tools such as machine and deep learning, link it to other activities to provide understanding of their behavioural patterns (Stary 2020). Through the application of AI, the design of IoB systems is not limited to enabling technologies that can monitor behavioural patterns but need to consider the continuous changing behaviour of users and business requirements (Stary 2020).

The second emphasis of IoB descriptions is **data, its type, and applications** (Panetta 2020). The emphasis on data shows that in addition to IoT generated data, IoB relies on other forms of data. These include individual discourses on social media, consumers data from commercial services, citizens data from smart cities and government applications, and sharing economy data from software, mobility, music, entertainment, etc digital platforms. Collecting and combining data from these different sources and using them to influence behaviour through data feedback loop is a pursuit of IoB (Bose, 2021). For example, behaviour-based insurance premiums rely on driving behaviour data such as sudden braking, rapid acceleration, sharp turns, and speeding that are collected either through an app or telematics systems to decide on discounts a user receives at renewal.

The third element of the IoB is the application of **behavioural science** (Javaid et al. 2021; Nyman 2012)**.** The emphasis is on applying behavioural science approaches such as emotions, decision, augmentations, and companionship to influence actions, both digitally and physically to understand or

influence behaviour. For example, web user profiling applies judgements to behavioural actions of users. Intentions, preferences, and likes can be deduced from data (Nyman 2012), when pre-existing knowledge forms the basis for generating or predicting behavioural patterns (Javaid et al. 2021).

3.2 Goals and Application areas of IoB

Another theme identified is the general goals of IoB as well as specific areas of applications. The general goal of IoB involves monitoring, understanding, and influencing behaviours to achieve desired commercial such as improved customer services, personalisation of products and services and eventually revenue and societal goals (Javaid et al. 2021; Stary 2020). The specific applications are associated with use cases of IoB (Nyman (2012). This include public applications of IoB for ensuring safety (e.g., the Chinese government social credit system) and health (compliance amidst the COVID-19 pandemic) (Willemsen 2021). Others include personal health, sales and marketing, mobility and insurance applications(Panetta 2019; Stary 2020; Javaid et al. 2021) (Table 3).

Application Area	Goals	Sample Sources
Digital Marketing and Research	Understanding customer behaviour for targeted advertising and product recommendations.	(Javaid et al. 2021; Nyman 2012)
Mobility	Tracking driver behaviour to deter bad and reward good driving behaviour	(Panetta 2019)
Public Health	Monitor and enforce public health protocols, such as hand washing or wearing mask during COVID 19	(Javaid et al. 2021; Stary 2021;)
Government	Offer social credit by tracking loyalty to regime, monitoring the public security	(Willemsen 2021)
Personal Healthcare	Monitor health status and notify users necessary information such as schedules, status or need for medical intervention	(Javaid et al. 2021; Stary 2020)
Cyber security	Detect suspicious activities through risk engines to identify threats.	(Ganguli 2021)
Workplace relations	Identify and monitor employees to deter counterproductive and encourage positive behaviour.	(Javaid et al. 2021)

Table 3 - Examples of Application Areas of IoB and their Institutional Goals

3.3 Issues and concerns of IoB

Despite the potential benefits reflected in Table 3, there is apprehension about IoB. The most prominent ones are complexity, security, and socio-ethical concerns (Masip-Bruin et al. 2021; Willemsen 2021). *There are significant* computational and technical complexities *for* identifying and coding behaviours and applying AI algorithms and data analytics with behavioural science to deliver meaning and context about individual behaviour (Nyman 2021). Moreover, humans have complex and variable behaviour which are not easy to code into systems that can produce reliable results (Stary 2020; Willemsen 2021).

Increased vulnerabilities of users from IoB applications to cybercriminals is a*nother* major concern (Basu 2021). Cybercriminals can steal not only scattered bits of sensitive medical records or banking details, but also deep behavioural patterns identified from a combination of cyber-physical systems and use that for fraud, espionage, or blackmail (Basu 2021; Nyman 2012). There are also social concerns associated with ethical use of data, invasion of privacy, unwanted influence, or censorship (Basu 2021; Javaid et al. 2021). The collection and combination of behavioural data from personal wearable, mobile or home devices and social media dusts without users consent and their application to influence user behaviour poses a major ethical and moral challenge (Basu 2021).

The exploratory content analysis clearly shows that IoB is an emerging phenomenon. Given the state of IoB research and the purpose of this research, which is to aid in IoB conceptualisation and research direction, it was appropriate to look outside the IoB and IoT literature for conceptualisation. In this paper, we argue that there could be equivalence between the introduction of IoB and the idea of socio-technical transitions (Geels 2011). In particular, we saw the utility of the Multi-Level Perspective (MLP) conceptualisation of technology, not limited to narrow artefacts, but as a system of innovation and a product of socio-economic institutions that shapes and is shaped by institutions and human and social relations (Geels 2011; Rip and Kemp 1998). The concepts of niches, socio-technical regimes, landscape and transitions (Geels 2011) are relevant in developing a comprehensive conceptualisation of IoB. In the

ensuing sections we first introduce the MLP and the concepts that we appropriated before presenting our conceptualisation framework and the research issues and questions derived from it.

4 The MLP Theoretical Lens

The MLP is "a middle-range theory that conceptualises overall dynamic patterns in socio-technical transitions." (Geels 2011, p. 26). It utilises a set of concepts from social construction of technology, institutional theory, and structuration theory such as innovations niches, technological trajectories, regimes, landscape, structures, and agency (Geels 2020). These concepts are useful for understanding socio-technical systems changes and transitions (Geels 2020). Socio-technical systems represent linkages between "technology, policy, markets, consumer practices, infrastructure, cultural meaning and scientific knowledge" (Geels 2011, p. 24). They encompass production, diffusion and use of technology (e.g., IT artefacts). The MLP offers three analytical levels:

Socio-technical regimes refer to "deep-structure that accounts for stability of an existing socio-technical system" (Geels 2011, p. 27) or a network of systems and its inter-coordination elements. The socio-technical regime also represents sub-regimes of policy, technology, market, and users. It is the locus of established rules which is important as transitions imply shifts from one regime to another. The regime rules demonstrate duality as they shape and in turn are shaped by actions. Thus "innovation occurs incrementally with small adjustments accumulating into stable trajectories" (Geels 2011, p. 27)..

Niches "are protected spaces such as R&D laboratories, subsidised demonstration projects, or small market niches where users have special demands and are willing to support emerging innovation" (Geels 2011, p. 27). Niches represent the locus for radical innovations where entrepreneurs and actors peruse radical innovations. Generally, as innovations are introduced into existing regimes, some fail because of misfit with existing regimes (such as regulations or market readiness) while others succeed and, in the process, reconfigure the regime and transition it from one socio-technical system to another.

Socio-technical landscape refers to "the wider context which influences niche and regime dynamics" (Geels 2011, p. 28). It represents relatively durable trends and structures (macro-economics, deep cultural patterns, macro-political developments)" that are beyond the direct influence of niche and regime actors in the short term (Geels 2011, p. 29).

Although the MLP levels are described as a heterogenous socio-technical configurations, they form a nested hierarchical interrelationship such that "regimes are embedded within landscape and niches within regimes" (Geels and Schot 2010, p. 18). As a processual framework, the MLP suggests that the necessary conditions for socio-technical transitions would be the alignments of trajectories and ongoing processes within and between these three analytical levels. It rejects simple "causality in transitions" (Geels 2011, p. 29) and recognises that transition at each level of configuration can take either a substitution or transformation or reconfiguration or de-alignment and re-alignment pathway (Geels 2011). The pathway depends on the level of development of niches, the extent of changes at the landscape level and the push pressures on and internal dynamics of regimes.

5 A Multi-level perspective framework for IoB

This section presents the IoB conceptualisation framework drawing both from the results of the exploratory literature and webliography analysis in section 3 and the concepts of the MLP in section 4. The framework is theoretically grounded on MLP. The purpose of the framework is to guide future research by offering conceptual facilities and vocabularies to investigate IoB instead of testable propositions (Shapira 2011). The exploratory content analysis shows IoB has been discussed through the lenses of protocol, technology, data, system, and behaviour. To encapsulate these lenses, and consistent with the broader understanding of technology, which is different from the artefact view, in the MLP literature (Geels 2011; Rip and Kemp 1998), we define IoB as follows:

IoB is a socio-technical system of innovation involving a network of public and private organisations that develop niche privacy-preserving platform(s) to generate, diffuse and utilise systematic protocol(s) that represent and code behavioural patterns from a wide variety of data sources which can then be identified, mined, and utilised to ethically influence behaviour for advancing commercial and societal goals.

This conception of IoB has similar ideas to Nyman's (2012, 2021) "specific architectures and platform solutions" to code behaviours separately from identity. It is based on the paradigm of supporting a behaviour protocol, akin the IP protocol, to a wide variety of behaviours. In that sense, it differs from narrow forms of IoB applications as indicated in the previous section. The system of innovation can start with coding common behaviours and extend to those at edges. Given that many devices are yet to be

connected to the internet through the IoT (Guo et al. 2013), not all behaviours could be connected to the internet at the same time through the IoB.

The conception also recognises Nyman's notion of the difference between General IoB, "an open approach… [for monitoring] any behaviors … with suitable tracking and pattern recognition technologies and individuals can be approached based on that information" from Private IoB "a permission contracting" system of innovation. It separates the IoB from narrow (such as advertisement) behavioural data mining applications. More importantly, it introduces privacy preserving architecture, and ethics as core considerations of the IoB innovation. The protocol/ framework relies on existing as well as emerging technological niches for monitoring, identifying, mining and applying behavioural data. Currently these niches are IoT systems, data mining algorithms and AI but they also can include other emerging technologies. This implies a transition from narrow forms of IoB to transformational IoB which require reconfiguration and transformation of existing socio-technical regimes related to technology, ethics, privacy, market and regulation and users.

As a socio-technical system of innovation, and using the conceptual tools of the MLP, the IoB can be analysed at the niche and socio-technical regimes levels within the landscape of digitisation, digitalisation and datafication. It can also be analysed in terms of how niche IoB start-ups and commercial and social goal seekers' application is shaped by existing socio-technical regimes and how its diffusion transition those socio-technical regimes to new ones. Figure 1 depicts our conceptualisation.

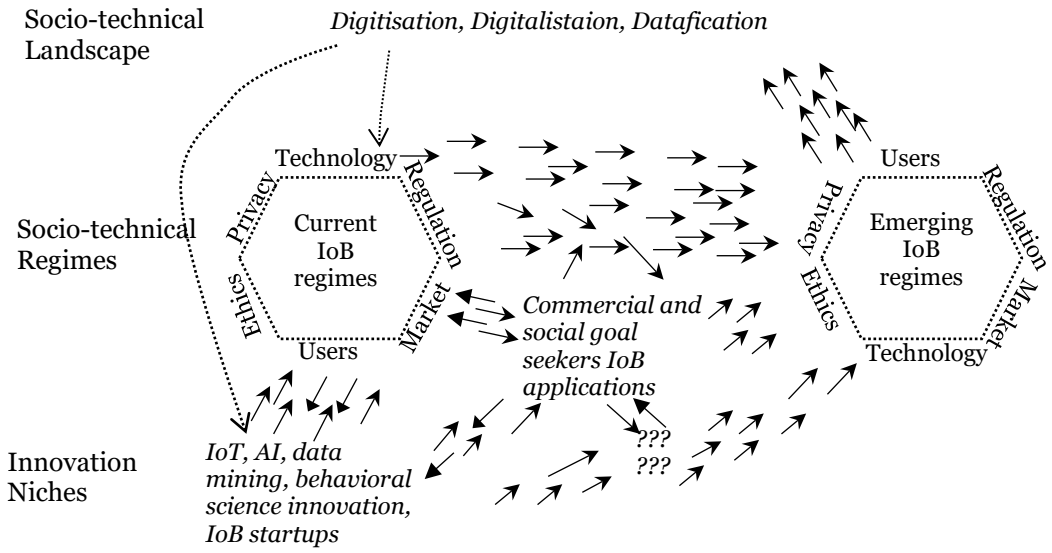

Figure 1 - A Multilevel IoB Conceptualisation Framework

5.1 Discussion and Research Direction

Although IoT research has a relatively long tradition with several contributions, despite popular interest in IoB, academic research has yet to properly investigate the IoB phenomenon. This presents several issues for researchers. Table 1 summarises some of these key research issues from the MLP perspective and our recommendations for addressing them followed by selective (due to conference page limits) discussion of how these issues lead to worthwhile research questions for IS researchers.

Research Issues	Description	Recommendation
IoB concept(s)	The conceptual ambiguity and framing of IoB risks building a cumulative body of IoB knowledge	Adopt/adapt the conceptualisation provided in this paper by defining clear bounders and whether the perspective on IoB is a technical artefact or socio-technical system of innovation.
IoB level of analysis	Differing units and levels of analysis	Use the MLP IoB conceptualisation framework to clearly define the level and units of analysis in IoB studies.
Socio-technical regimes	IoB is emerging within an existing system of privacy, ethics, regulation, technology, market, and user	Analyse the tensions, struggles and resistance of existing IoB regimes and their impact on

	preferences which is hardly understood.	niche IoB innovations and the trajectories IoB innovations take.
Socio-technical Landscape	Lack of clarity what constitutes the socio-technical landscape for IoB and how it affects the IoB	Develop a contextualised understanding within which IoB regimes and niches are emerging using longitudinal research designs.
Niche	Lack of prescriptive guidelines how IoB applications should be designed	Develop design knowledge on how IoB applications should be designed by adopting design science research.
IoB application	Lag in conceptual, theoretical, and empirical research on the IoB applications	Investigate how commercial and social goal seekers perceive and realise IoB affordances, and the adoption, and value of IoB.
Socio-technical transitions	Unclear pathways and conditions for socio-technical transitions of IoB regimes and niches	Study Adopt complex systems theory to unravel the nested hierarchical interrelationships
MLP Interrelatio nships	How rules, socio-technical systems, and agency shape and are shaped by the IoB trajectory	Conduct a structurational and holistic analysis on multilevel dynamics of IoB.

Table 4 – A Multilevel Perspective of IoB Research Directions

How to conceptualise IoB?

The concept of mining behavioural data for potential business applications started with Nayman in 2012. The collection and analysis of internet data have been associated with some well-known practices such as Business Intelligence (BI), Big Data or Cisco Discovery Protocol (CDP). Earlier literature that examines the application of data has also described that data analytics can facilitate a better understanding of user behavioural patterns (Shim et al. 2002). Nevertheless, the IoB emphasises the interaction between people and their actions at scale. Through an exploratory content analysis, this paper shows the different, but not necessarily mutually exclusive, lenses through which the notion of IoB is discussed. This includes technology, system, data, innovation, and behavioural lenses. From a technical perspective IoB can be seen as an extension of IoT. However, such understanding is limited in scope as it doesn't include "digital dusts" generated in different platforms. This paper offers the first attempt towards a comprehensive conceptualisation of IoB. However, we do not claim to settle the conceptual ambiguity surrounding IoB. To advance IoB body of knowledge, IS researchers could adopt/adapt/extend challenge the conceptualisation provided in this paper**.**

How to understand the effect of landscape on IoB regimes and niches?

Digitisation and digitalisation of social and economic activities are accelerating at a rapid scale generating massive data (Legner et al. 2017; Vial 2019). Datafication is converting aspects of life that has hardly been conceived as informational into data format is taking place at scale. Examples includes Facebook and Twitter that "datafy" relationships and stray thoughts, smart city applications that "datafy" citizens movements; Airbnb and Uber that "datafy" sharing of accommodation and mobility and other education, and health providers that "datafy" learning and healthcare. Society is increasingly becoming reliant on datafication. IoB involves cyber-physical data capturing and analysis that can provide an understanding of user behavioural patterns at scale. Therefore, how digitisation and datafication affect existing regimes of ethics, privacy, technology, markets, and users' preferences for IoB applications and niche technology innovations is another direction for IoB researchers.

How do regimes influence niche ***IoB*** innovations?

IoB are introduced in existing technology, user, regulation, privacy, and ethical regimes. The technology regime and their institutions have several components that interact with each other and with other sub-regimes. These include facial recognitions such as those used in Social Credit systems of China, AI assistants in Siri, Cortana, Alexa, or Google Home, and search engine optimisations. There are also classes of wearable devices and smart city and home technologies, social media platforms, and the streaming services and service providers of YouTube, Weibo, Amazon, and Netflix. Researchers can investigate how technologies, and applications, and the institutions that generate, mine and apply behavioural data impact and are impacted by existing privacy, ethics, regulation regimes and how they play an essential role in creating, nurturing, and fostering the development of niche IoB innovations.

In several Asian, South American and African countries, rules are not well developed, and people care less about their privacy and personal data. In contrast, North America and Europe take this issue

seriously. Given publicised privacy scandals (Patterson 2020), investigating the role of trust on IoB applications is an important research direction. In addition, the role of other market and institutional players that seek to monitor and influence or even manipulate human behaviour patterns in shaping commercial and government applications of IoB is another avenue for research.

The influence of existing global, regional, and local regulations such as the Australian Privacy Act, the European Union's General Data Protection Regulation (GDPR) that are designed to foster transparency and accountability and that prescribe compulsory data protection impact assessments, security measures, recording and reporting on IoB niche innovations will yield interesting insights. GDPR offers several rights that business organisations must notice such as right of access to personal data, right to rectification, right to erasure (be forgotten) under certain conditions, right to transfer data to other business. Whether regulators use the sandbox instrument to foster IoB innovations in the context of strict GDPR regime is an area worth exploring. The positive and adverse impact of national/local cybersecurity strategies on the on the development of IoB is another area of enquiry.

How should IoB applications be designed?

Understanding the design practices of IoB designers, how existing regimes inform their choices and practices (Stary 2020) and how they challenge those same regimes to instigate either incremental or disruptive shifts are yet to be addressed. Insight from the digital platform literature can also be brought to explore the trade-off that IoB designers make, i.e., to what extent are trade-offs like evolvability and sustainability informing IoB design practices? How and when to tackle platform issues, and how design choices early in a design cycle impact the IoB evolution in the long run require design knowledge.

Which pathways lead to successful IoB regime transitions?

Socio-technical transitions are contested, and conflictual processes. Thus, apart from the framing struggles, there are other struggles in the interactions between niche IoB innovations and existing regimes. Research can explore the effectiveness of the different IoB regime transition pathways. The MLP recommends four pathways. Substitution pathways start with either radical or incremental innovations that disrupt existing technologies which can lead to either limited or strong institutional changes in the socio-technical regimes (Geels 2020; Geels and Schot 2010). Transformation pathways consists of a technical breakthrough by new entrants and incumbents and the changes in rules and institutions (Geels 2020). Reconfiguration pathway starts with new alliances between incumbents and new entrants, from initial add-on innovations to 'innovation cascades' to solve unintended problems, then to knock-on effects that reconfigure system structure which results in limited to substantial institutional changes. De-alignment and re-alignment start with the collapse of incumbents under landscape pressure as the failure of existing technologies (Geels 2020). This creates opportunities for new entrants with the emergence of radical niche-innovations that competing together. These concepts offer researchers facilities to investigate the question of successful IoB regime transitions.

6 Conclusion

This paper, by appropriating concepts from the MLP, proposes a conceptualisation framework to facilitate future IoB research. As indicated by Shapira (2011), unlike theories or models, conceptual frameworks do not necessarily offer testable predictions. Instead, their main purpose is to offer a common vocabulary that help "help … make sense of the field and understand its boundaries, major findings, and challenges" (Shapira 2011, p. 1314). The framework adopts the definition of IoB as a technology that is shaped by existing socio-technical regimes related to technological advances, consumer preferences, data protection policies, ethics, and morality and that shapes the transition of these regimes into new ones under the pressure of social trends and entrepreneurial actions that combine behavioural science with advanced data analytics and AI algorithms. The framework also helps to highlight the contested and conflictual processes as well as the tensions and struggles in the interactions between niche-IoB innovations and existing regimes.

In summary, it is possible to differentiate between at least two forms of IoB: narrow IoB and transformational IoB. Narrow IoB relies on existing technologies to collect and track data from IoT systems and devices and other digital platforms (such as social media, streaming, e-commerce, shared economy), move it to a new level by applying AI powered behaviour mining and modelling systems, identify patterns and use that to influence behaviour in narrow and singular areas of applications. The application domains include (but not limited to) buying and selling, product development, health, and driving. On the other hand, transformational IoB requires new technologies that must be architected to preserve privacy, systematically code behavioural patterns, and uniquely identify those patterns in broad areas of applications. While narrow IoB is already here, and there are many instances of them in advertising and marketing, transformational IoB is a little too far from reality.

If Gartner's prediction of what it means to be human is changing due to the application of existing and emerging technologies and through the processes of digitisation, digitalisation and digital transformation, it is likely that deep socio-technical transitions are taking place exposing society to one or the other form of IoB applications. Our analysis of academic and grey literature use cases shows that as much as there are great values associated with the potential applications of IoB, there are equally significant grey areas and concerns related to data, cybercrime, ethics, privacy, and morality, especially if IoB systems are becoming the rite of passage to access citizen and commercial services.

IS researchers, with their tradition of engaging with behavioural issues, and foundations in systems, institutional, socio-technical and socio-material theories, can play leading roles in shaping the IoB body of knowledge. The conceptualisation framework in this paper makes the first attempt to offer IS researchers with theoretical facilities to explore and explain IoB, its application areas at different levels, tensions and struggles in IoB transitions and concerns and impacts.

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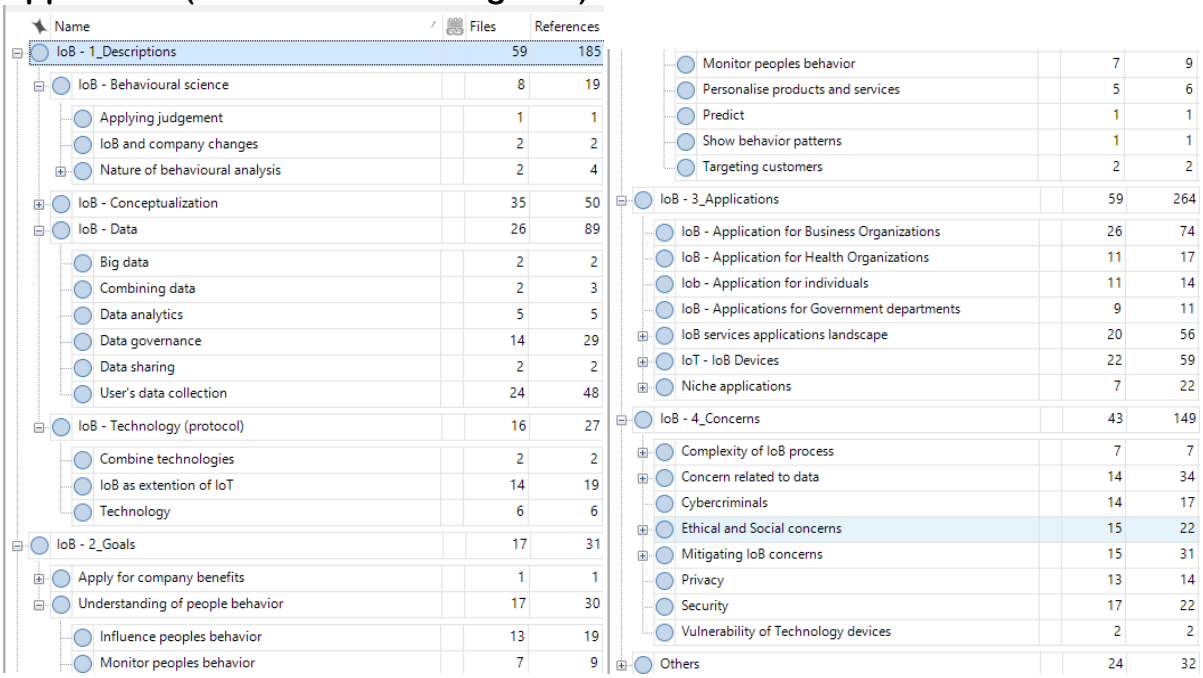
Appendix 1 (Partial Nvivo coding tree)



Name	Files	References
IoB - 1_Descriptions	59	185
IoB - Behavioural science	8	19
Applying judgement	1	1
IoB and company changes	2	2
Nature of behavioural analysis	2	4
IoB - Conceptualization	35	50
IoB - Data	26	89
Big data	2	2
Combining data	2	3
Data analytics	5	5
Data governance	14	29
Data sharing	2	2
User's data collection	24	48
IoB - Technology (protocol)	16	27
Combine technologies	2	2
IoB as extention of IoT	14	19
Technology	6	6
IoB - 2_Goals	17	31
Apply for company benefits	1	1
Understanding of people behavior	17	30
Influence peoples behavior	13	19
Monitor peoples behavior	7	9
Monitor peoples behavior	7	9
Personalise products and services	5	6
Predict	1	1
Show behavior patterns	1	1
Targeting customers	2	2
IoB - 3_Applications	59	264
IoB - Application for Business Organizations	26	74
IoB - Application for Health Organizations	11	17
Iob - Application for individuals	11	14
IoB - Applications for Government departments	9	11
IoB services applications landscape	20	56
IoT - IoB Devices	22	59
Niche applications	7	22
IoB - 4_Concerns	43	149
Complexity of IoB process	7	7
Concern related to data	14	34
Cybercriminals	14	17
Ethical and Social concerns	15	22
Mitigating IoB concerns	15	31
Privacy	13	14
Security	17	22
Vulnerability of Technology devices	2	2
Others	24	32

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