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AI Affordance Actualisation: Empirical Evidence from Mobility Ecosystem Organisations

Short Paper

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Abstract

One of the UN Sustainable Development Goals (SDGs) is to transform urban mobility to be more accessible, efficient, safe, and sustainable. Artificial Intelligence (AI) can be applied to address some critical urban mobility issues and facilitate the achievement of SDGs. However, there is a need to understand how mobility ecosystem organisations use AI in alignment with their organisational goals to contribute to SDGs. To address this puzzle, this study draws on the affordance theory and preliminary interviews with ten key informants from mobility organisations in Australia. The preliminary findings show that mobility organisations' exploitation of AI systems and technologies leads to the emergence of decarbonising, optimising, conditioning asset management, and provisioning customer-centric services. To do so, they develop AI literacy, business-IT collaboration, change management, and technology and data foundation. The paper contributes a tentative framework linking AI affordances with mobility-related SDGs, serving as a guide for future research and practice.

Keywords: Artificial intelligence, mobility ecosystem, affordance actualisation, sustainable development goals

Introduction

Despite trends such as working from home, increased use of personal transport modes, and greater awareness and concerns about health, safety, and environmental sustainability (Parliament, 2021), changing mobility habits, especially in cities, is a complex problem. There continues to be significant traffic congestion, inefficiency, accidents, high prices, and pollution challenges (Abduljabbar et al., 2019). Hence, the United Nations (UN) has included the provision of accessible, efficient, safe, and sustainable mobility in the sustainable development goals (SDGs). These include SDG 3.6 on road safety, SDG 9.1 on infrastructure, and SDG 11.2 on offering access to safe, affordable, accessible, and sustainable transport systems for all and expanding public transport (UnitedNations, 2015).

To address some of the critical urban mobility issues and facilitate the achievement of SDGs, transformative digital solutions such as smart mobility, intelligent transport technologies, and Artificial intelligence (AI) can be implemented in mobility operations, products, and services (Kozlov, 2022; Pathik et al., 2022; Rajabi et al., 2023). AI refers to technologies and systems that interpret data, learn from data, and use the learning to perform cognitive functions, and other tasks generally associated with humans (Kaplan & Haenlein, 2019). While AI has been touted as one of the viable solutions to address urban mobility issues simultaneously attaining the mobility transformation goals (Abduljabbar et al., 2019), a fragmented and isolated application of AI has left potential outcomes unexplored. For instance, while automotive manufacturers and technology companies have utilised AI to advance autonomous vehicles, governments and transport infrastructure operators have not adequately updated the transport infrastructure to meet the unique needs of these AI-driven vehicles, which hinders autonomous vehicles from reaching their full potential (Chong et al., 2022). AI research in the realm of mobility explains the potential of AI in facilitating specific tasks such as customisation (Rajabi et al., 2023), route optimisation (Kozlov, 2022), and accident prevention (Pathik et al., 2022). The focus of such research has been more on highlighting the potential of AI by taking a technological lens and less on explaining how the same technology could present different effects in different application contexts by taking an ecosystem and affordance lens (Anderson & Robey, 2017).

The mobility ecosystem is a network of different mobility organisations that offer interconnected sets of mobility products and/or services that fulfill a variety of mobility needs (Kaiser et al., 2019). AI's isolated applications in mobility can hinder optimal outcomes, missing the strategic benefits that arise from a holistic ecosystem view. Especially when considering the nuances and interplay between various mobility players, from automotive manufacturers and transport service providers to technology giants, understanding AI's role from this wider perspective is indispensable. For instance, while an automaker might leverage AI to improve vehicle leasing or selling, a ride-sharing provider could harness it to offer usage-based mobility services. These distinct AI applications for different goals could result in inefficiencies and even conflicts within the broader mobility landscape. Hence, an ecosystem perspective can facilitate a wholistic understanding of how the transformative potential of AI affordances could be actualised.

Affordances are defined as *"the possibility for goal-oriented actions afforded to specific user groups by technical objects"* (Markus & Silver, 2008, p. 622). Thus defined, affordances are not a set of features inherent to the object and independent of the actor. Instead, affordances are the emergent property of an actor-object system. It thus offers a useful theoretical lens for investigating the interrelationship between IS artefacts, ecosystem actors, and goals from a comprehensive sociotechnical view (Volkoff & Strong, 2018). Affordances are possibilities for action, rather than actions per se (Strong et al., 2014). Therefore, goal-oriented mobility ecosystem organisations must create these possibilities in order to transform potential into relevant collective outcomes for the urban mobility ecosystem transformation (Du et al., 2019). Thus, the first question this paper addresses is:

RQ1: What AI affordances emerge through mobility ecosystem organisations' use of AI?

In order to actualise the affordances of AI, organisations, especially pre-digital companies with established business models, processes, organisational structure, and legacy resources need to adjust their digital capabilities (Sebastian et al., 2017). Digital capabilities refer to an organisation's ability to manage digital resources (data, processes, skills, and ICT infrastructure) in pursuit of its organisational goals (Khin & Ho, 2018). Studies on the actualisation of affordances in digital technologies across diverse contexts, such as the business-to-business software solution provider (Liu et al., 2022), the smart parking company (Sun et al., 2022), and the automotive group (Dremel et al., 2020), underscore the imperative of refining organisational digital capabilities to meet the requirements of emergent affordance actualisation. Nevertheless, most organisations in the mobility ecosystem face challenges such as resource reorganisation lags, limited technology abilities, and lack of AI leaderships to renew their digital capabilities (Abduljabbar et al., 2019; Nikitas et al., 2020). Hence, the second research question is:

RQ2: How do mobility ecosystem organisations create and exploit AI affordances?

An ecosystem could not be investigated without regard to the locations in which the ecosystem is based (Anggraeni et al., 2007). Australia is selected to ensure that the mobility ecosystem is anchored within the same socio-political, regulatory, policy, and market environment. The Australian mobility ecosystem encompasses, but not limited to, automotive manufacturers and their accessory suppliers; public and private transport service providers (public transport, ride-sharing, e-scooter, car-sharing, etc.); transport infrastructure operators; regulators; other stakeholders (e.g., car insurance companies, transport consumer advocacy organisations, and energy providers); and technology companies (e.g., Google and Telstra) (Commission, 2018).

The rest of the paper is structured as theoretical framing, research methods, initial findings, preliminary framework, and conclusion, expected research implications, and future research direction.

Theoretical Framing: The Affordances-Actualisation Theory

To understand the role of material features of AI in relation to mobility advances in contributing to mobility-related SDGs, we adopt an affordances theory perspective. The concept of affordances allows a better understanding of how technology affords different ways of actions regarding the context to achieve goals (Volkoff & Strong, 2013). Particularly, the technology affordance refers to *"the possibility for goal-oriented actions afforded to specific user groups by technical objects"* (Markus & Silver, 2008, p. 622). This statement underscores the relational characteristics of affordances. Technology affordances not only focus on technological features but also consider how actors perceive and interact with the technology (Li et al., 2021). Hence, the actor and the object cannot be investigated separately, and an actor is always required as a frame of reference to investigate affordances (Markus & Silver, 2008).

The affordances theory originally focuses on individual actors (Li et al., 2020; Steffen et al., 2019). However, the theory is increasingly applied on an organisational level to examine the role of IS artefacts in their situated organisational context while considering the decisive role of actors, their intentions perceiving the material properties, and features of an IS artefact (Dremel et al., 2020; Du et al., 2019; Keller et al., 2019; Strong et al., 2014). In this study, we follow the affordance-actualisation theory defined as *"the actions taken by actors as they take advantage of one or more affordances through their use of the technology to achieve outcomes in support of organisational goals"* (Du et al., 2019, p. 53).

The affordance-actualisation theory has been used to investigate blockchain in the context of smart parking (Sun et al., 2022), the value realisation of big data analytics in an automotive group (Dremel et al., 2020), and the role of big data for digital transformation in a software service provider (Liu et al., 2022). These studies aim to understand the features of different IS artifacts and their realisation of action possibilities to achieve concrete outcomes. Further, they highlight the importance of differentiating affordance, the potential to achieve a goal, and its actualisation (Volkoff & Strong, 2018) to identify potential actions, goals, actors, and reached consequences (Dremel et al., 2020; Du et al., 2019; Keller et al., 2019).

The affordance-actualisation theory allows conceptualising AI implementations as the actualisation of clusters of AI affordances (Keller et al., 2019). It also allows viewing AI technologies and applications as providing the means to perceive, comprehend, learn based on a vast volume of data, and thus act to the continuously changing environment (Bawack et al., 2019; Rzepka & Berger, 2018). For example, AI enables recognising road conditions, optimising travel route, and customising mobility services (Nikitas et al., 2020). On this technological basis, AI affordances emerge, such as the improvement in decision-making processes, productivity, products, and services (Abduljabbar et al., 2019; Nikitas et al., 2020). The actualisation of AI affordances, in turn, could lead to organisations' actions enabled by AI (Dremel et al., 2020).

Further, the affordance-actualisation theory acknowledges the differentiation between transformation processes and associated outcomes by separating transformation trajectories that emerge during the process of linking use contexts within specific features of technologies (Trocin et al., 2021). Thus it allows exploring affordances and their associated outcomes in the form of the mobility ecosystem transformation enabled from the material properties of AI technology in relation to the socio-technical features of the organisations (Strong et al., 2014). Using this perspective, we conceptualise the mobility ecosystem organisations' effective actualisation of AI affordances as an entanglement of AI technological features (i.e., AI material properties), organisational processes, and goals. The conceptualisation of affordance-actualisation with a focus on organisational digital capability changes required to actualise AI affordances helps answer the question of how mobility ecosystem organisations create and exploit AI potentials.

Research Methods

To address the research questions, preliminary interviews were undertaken online in 2021 and 2022 with ten key informants selected from different types of organisations within the mobility ecosystem in Australia. Purposive sampling was adopted to recruit 10 participants from (a) top executives who are responsible for setting the AI vision, strategic directions and actions in their organisations, and (2) operational staff responsible for AI implementations. The participants were from two public transport providers, a transport infrastructure operator, an automotive company, three government authorities, and three new-age mobility service providers.

The interviews lasted on average above 40 minutes. The interview questions covered about AI technologies and features (Achmat & Brown, 2019; Keller et al., 2019), organisational goals, settings, characteristics, and actions (Strong et al., 2014), and ecosystem environment and the role of AI (Anggraeni et al., 2007; Tan et al., 2020). All interviews were audio/video-recorded and converted to text for analysis.

The first author analysed the interviews with the assistance of NVivo 12. Using open coding, the raw data (interview transcripts) were organised. Through constant comparison within the same and across different transcripts, similar codes were grouped to arrive at concepts addressing the two main research questions. Figure 1 illustrates an example of the data analysis process.

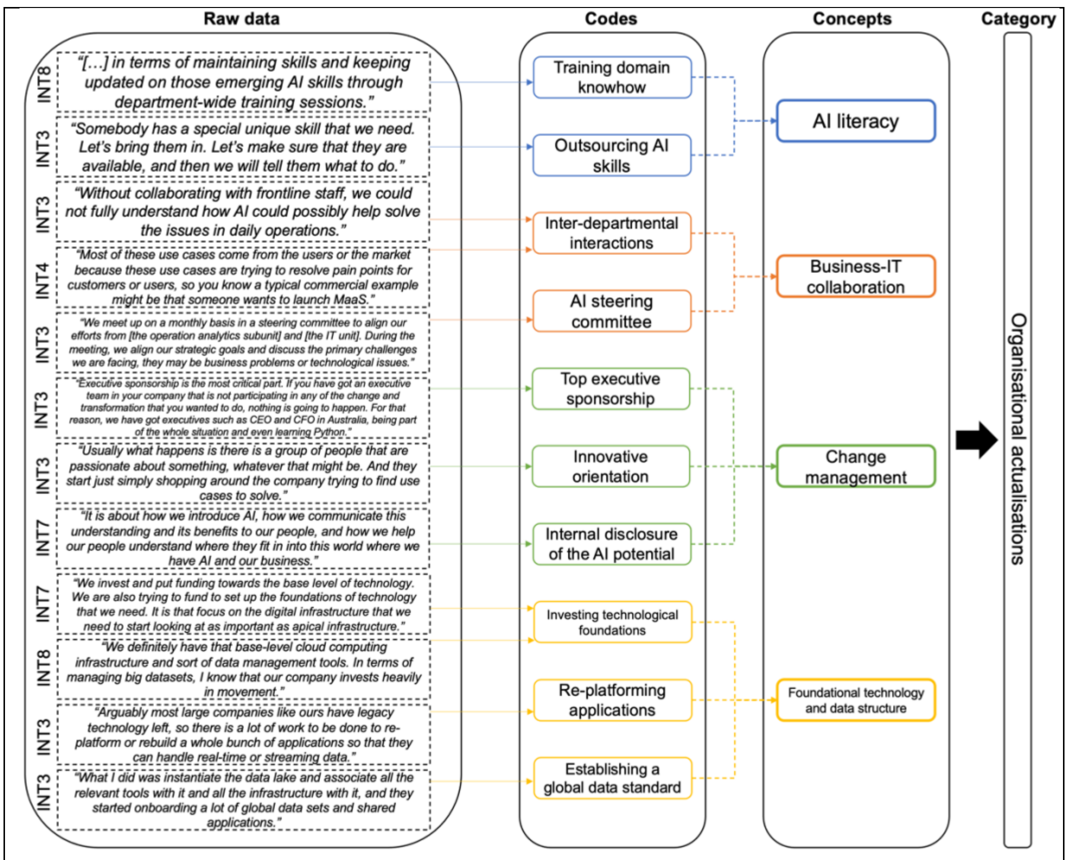

Figure 1. Example of Data Analysis

Initial Findings

Organisational Goals

Affordances are action potentials of goal-oriented actors, we thus identify mobility organisations' goals first before discussing affordances that emerge through the use of AI in achieving their goals. The mobility organisations interviewed share the goal of mitigating environmental impacts of mobility (***sustainability***). However, there are some differences across the ten interviewees. Public transport providers aim to improve the efficiency of their operations, reduce operation costs, enhance customer experience, and improve asset management. These relate to the ***efficiency*** dimension of the SDG goals. The transport infrastructure operator targets improving asset management as well due to its organisational nature, but it also aims to optimise the design of transport infrastructure. This relates to the ***accessibility*** dimension of the SDG goals to make transport infrastructure accessible to everyone. The automotive participant is a dealer and aims to promote marketing and sales through personalised customer interactions. Its goal also relates to improving car safety and functionality. Governments focus on community, such as enhancing road safety, reducing congestion by reducing cars on the road and reducing accidents, which relates to all the dimensions of SDG goals but especially to the ***safety*** dimension to reduce road accidents and associated deaths and losses. New-age mobility service providers aim to offer customer-centric services, i.e., the convenience goal of SDGs.

AI Affordances

To address the first research question, this section unravels four affordances that emerged from mobility organisations' use of AI technologies and systems in achieving their organisational goals. The first affordance is ***decarbonising*** which emerged through mobility ecosystem organisations' application of AI in the pursuit of the sustainability goals. The findings show that public transport providers use deep learning and Power BI to analyse their transport fleets and reduce energy consumption. Transport infrastructure operators and governments employ AI-embedded transport systems to optimise transport flows and decrease carbon emissions resulting from mobility. The new-age mobility service providers apply machine learning to enable on-demand transport services and influence customer mobility behaviour to change toward less carbon footprint choices.

The second affordance is ***optimising*** which reflects the clusters of AI affordances leveraging the knowledge-based, neural networks, and data analytics features of AI. All participants indicated getting AI-enabled insights from transport networks, fleets, infrastructure, and services for improving the efficiency of operations. As mentioned above, public transport providers use AI for efficient management of their fleets, which helps achieve not only the goal of sustainability but also operation optimisation. AI has also been used to enable the optimal design of transport network targets, analyse how transport networks work, and inform decision-marking regarding transport infrastructure construction.

The third affordance that emerged from mobility ecosystem organisations' collective use of AI is ***"conditioning" (condition-based) asset management***. This AI affordance is related to the organisational goal of improving asset management through automatic defect detection and predictive maintenance via computer vision-based systems and deep learning. For instance, a transport infrastructure operator employs computer vision-based software called Asset Vision with vehicle-mounted cameras to help its inspection crew automatically diagnose its asset base like signs and road surfaces. Another example is that a public transport provider uses deep learning to predict maintenance requirements.

The fourth affordance is ***provisioning customer-centric services***. It is characterised by the organisational goal of enhancing customer experience and offerings through efficiency-improved and customised mobility services enabled by AI. Public transport providers use Power BI to understand transport demands and fleet performance. Such understandings support the delivery of reliable, punctual, and efficient public transport services. New-age mobility service providers employ AI to address rule-based decision problems of mobility such as choice of travel modes, routes, and departure time. They introduce new features to proactively suggest itineraries, estimated time of arrival, and rerouting in case of incidents, based on personal condition and travel history, localisation, and real-time traffic data.

AI-Affordances Actualisations

The second research question this paper tackles is how mobility ecosystem organisations create and exploit AI affordances. The AI technologies and systems used by the interviewed mobility organisations consist of Power BI, deep learning, knowledge-based systems, computer vision systems like Asset Vision, adaptive traffic systems, neural networks, and machine learning. The 10 interviewees listed several AI initiatives and use cases. These include predicting transport demands, understanding fleet performance, optimising traffic flows, automatic defect detection, predictive asset maintenance, understanding customer preferences, customising mobility services, recommending routes, etc.

As indicated in figure 1, the data analysis shows four underlying mechanisms used by mobility organisations to advance affordance actualisation. First, the results show that mobility organisations established ***AI literacy*** to actualise AI affordances. This was done in two ways. Four of the organisations upgraded onboard employees' skill sets with AI knowhow and AI use in mobility through a central training program across the organisation. Two adopted an outsourcing strategy and sourced AI skills to third parties.

Second, the actualisation of AI affordances requires the ***collaboration*** of the IT department, which is responsible for exploring and employing the technological potential to address business problems of mobility organisations, and the frontline operation departments, which manages operations and the development of customer services. For example, a public transport provider developed a mutual understanding of what AI could be used across the organisation through inter-departmental interactions. The automotive organisation, recognising the risk of misalignment between the two organisational entities without appropriate governance instruments in place, established a joint steering committee responsible for AI project portfolio management and prioritisation.

Third, the interviewees highlighted that harnessing the affordances of AI requires ***change management***. AI use involves a change of processes and technologies and a shift in mindset and organisational structure to accommodate the changes. Effective change management cultivates much-required confidence towards the transformation. The participants shared that while top executive sponsorship facilitated openness to change; building a corporate culture that enabled and promoted innovations; and internal disclosure of the AI potential in line with organisational goals helped to mitigate employees' change resistance.

Finally, the mobility organisations ***established foundational technology and data structure*** to make AI function. When the mobility organisations' legacy technology and data infrastructure failed to accommodate the big data requirement of AI, they had to invest in revamping their technological foundations to actualise AI affordances. For example, three interviewed organisations established global data standards across the entire organisation to consolidate data from multiple sources and to identify which data can be used for training AI.

A Preliminary Framework of AI Affordances for Transforming Mobility

The above findings offer an initial picture of how AI affordances emerge at an ecosystem level through mobility organisations' use of AI and how actions that change an organization's socio-technical system contribute to actualising such AI affordances. The features of the AI technologies and systems that mobility organisations adopt offer the foundations for affordances. These systems have important consequences to the transformation of the urban mobility ecosystem since they afford action potentials that were historically either impossible, costly, or difficult to achieve. However, AI affordances do not pre-exist in AI itself but emerge through organisations' use of AI technologies and systems in achieving their goals, which is in line with the emergent view of affordances (Markus & Silver, 2008). In addition, the affordances of a technological artifact could change across different contexts even though its materiality does not (Treem & Leonardi, 2013). Taking an ecosystem lens and affordance-actualisation theory allows conceptually generalising from the specific context of individual organisations' exploitation of AI's action potentials to examine the role of AI in mobility ecosystem transformation. This approach is in line with other studies on the actualisation of IS artifacts' affordances (Dremel et al., 2020; Du et al., 2019; Keller et al., 2019; Strong et al., 2014).

Figure 2 shows a tentative framework to depict how AI affordances emerge and are actualised in mobility organisations. The AI's features and organisational goals provide the base for each collective affordance that emerges from AI use by goal-oriented mobility organisations. It reflects that mobility organisations come to AI technologies and systems with organisational goals, and treat AI as affording distinct potential under specific organisational and ecosystem contexts. It also indicates that mobility organisations' goals influence the implementation of AI technologies and systems. To make the potential come true, they undertake specific affordance actualisation mechanisms to change their digital capability accordingly. The AI affordances collectively actualised by diverse mobility ecosystem organisations further contribute to mobility-related SDGs (accessibility, efficiency, safety, and environmental sustainability) at the ecosystem level, in turn, SDGs guide the formation of organisational goals.

The framework depicts the process of affordance emergence to actualisation. For example, large amount of data is streaming through the various dimensions of urban mobility ecosystem, including all transport modes (cars, buses, trams, trains, on-demand services), transport management centres, and pedestrian movement (Docherty et al., 2018). It is less possible for humans to manage such huge data (Davenport & Ronanki, 2018). However, organisations in the mobility ecosystem have to cultivate value from an overwhelming pool of data, and thus to obtain competitive advantages and economic growth and to be at the leading edge of the mobility ecosystem transformation (Fagnant & Kockelman, 2015). In achieving these goals, mobility organisations need to explore an efficient way to manage and utilise the data, while the availability of such big data enables machine to learn and thus makes AI function (Bawack et al., 2019). That is how AI affordances emerge in mobility organisations. It is notable that AI is distinct from conventional IT that enables acquiring and processing data because AI technologies and systems can leverage data to undertake automatic and enhanced self-learning actions and can make decisions on behalf of people and organisations (Faraj et al., 2018). Realising AI's potential to learn from data requires the transformation of firms' technological and social structures (Li et al., 2010). Training and sustaining self-learning algorithms require continuous extraction of large volumes of high-quality data.

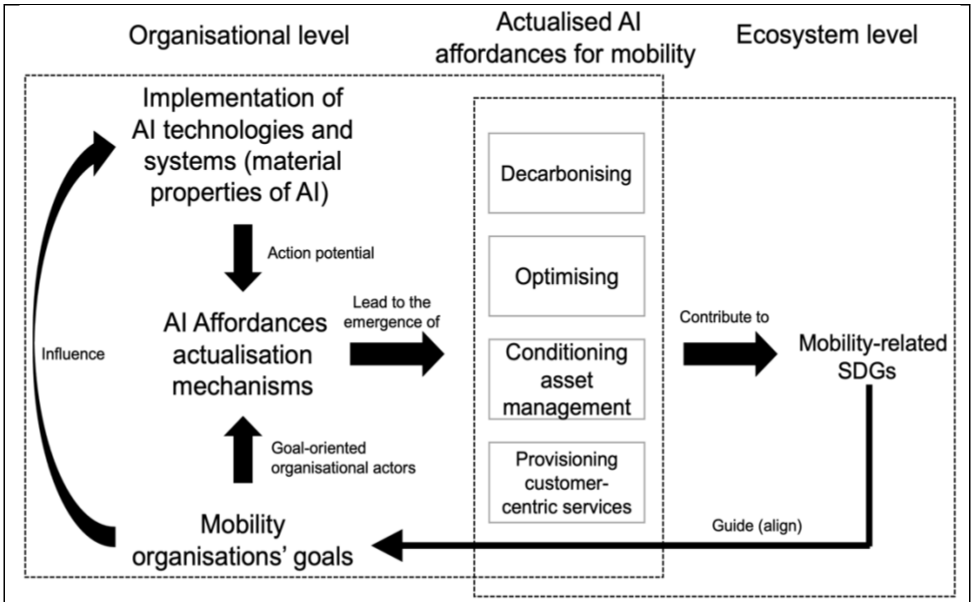

Figure 2. AI Affordances Emergence-Actualisation Model

Conclusion and Future Work

Urban mobility ecosystem needs to be transformed towards providing accessible, efficient, safe, and sustainable mobility whilst meeting consumer expectations of personalised and user-centric mobility services. Although new technologies like AI can facilitate this transformation, technologies alone will not spontaneously resolve the complex problems in urban mobility. This study connects organisational AI use cases with SDGs through an affordance approach to show how AI can contribute towards urban mobility ecosystem transformation. The approach balances the material properties of AI with social goals without privileging one side (Treem & Leonardi, 2013).

The paper has both theoretical and practical implications. From the theoretical perspective, the paper contributes four AI affordances and organisational affordance actualising mechanisms and adds to the literature on the effective applications of AI technologies and systems and associated organisational preconditions to transform the mobility ecosystem. In doing so, the paper offers preliminary insights to Benbya et al. (2020)'s call for the investigation of the exact role of AI in the transformation of business ecosystems. It can facilitate discussion among IS researchers on the role and management of AI in the digital transformation of organisations and the business ecosystem. From the practical perspective, the paper reinforces the value of crafting AI vision and strategic directions to act upon AI's potential in line with organisational and ecosystem goals.

We plan to extend the study to provide holistic explanation and actionable guidelines for mobility organisations to adjust their digital capability to create and actualise AI, to achieve a more accessible, efficient, safe, and sustainable mobility. To do so, further interviews will be conducted to achieve theoretical saturation and strengthen the preliminary framework. These interviews will include technology companies and car/travel insurance providers as well as more participants with diverse roles from the same organisation. The data analysis shall focus on the interaction of affordances and on how the actualisation of one affordance can influence other interrelated affordances leading to a specific ecosystem outcome.

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