

# TAXONOMY FOR REAL-TIME DIGITAL DATA INITIATIVES

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Publié dans Management & Datascience Vol.4 N°1, le 13 janvier 2020

Catégorie : Recherche

DOI : <https://doi.org/10.36863/mds.a.9967>

## RÉSUMÉ

Real-time digital data are becoming important assets in a growing number of organizations. This paper, applying the affordance theory, describes the development of a taxonomy for understanding real-time digital data initiatives. The proposed taxonomy is composed by two categories, the Technology affordance and the Affordance actualization, respectively gathering four and five dimensions. Specifically, the Technology affordances of the real-time digital initiatives are real-time sensing, real-time mass visibility, real-time experimentation and real-time coordination, while the Affordance actualizations are service, efficiency, analytics, aggregation and generation.

| AFFORDANCE ACTUALIZATION | BIG DATA | REAL-TIME DIGITAL DATA | TECHNOLOGY AFFORDANCES

**Citation** : Vitari, C., Raguseo, E., & Pigni, F. (Jan 2020). Taxonomy for real-time digital data initiatives. *Management et Datascience*, 4(1). <https://doi.org/10.36863/mds.a.9967>.

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## TEXTE COMPLET

### Introduction

A Digital Data Stream (DDS) is the continuous real-time digital encoding and transmission of data describing a related class of events (Pigni & Piccoli, 2016 [<https://journals.sagepub.com/doi/abs/10.1525/cmr.2016.58.3.5>]). Examples abound: every day, people generate digital data through tweets, clicks, videos and the plethora of sensors embedded in their devices (Raguseo, Pigni, & Piccoli, 2018 [<https://doi.org/10.4018/JGIM.2018100106>]). Beside humans, instruments and machines such as smart devices, manufacturing sensors, equipment logs, and vehicle tracking systems, automatically and continuously, generate digital data. As firms increasingly rely on data to face market variability, changing in data availability and timing directly affect firms' ability to create value in the form of new products, services, or processes.

These DDSs refer to the Velocity dimension of the 'big data' initiatives. In established companies, DDS and 'big data' initiatives attracted increasing investments for exploring their potential (Chen, Chiang, & Storey, 2012 [<http://aisel.aisnet.org/misq/vol36/iss4/16>]), driving digital business strategy and improving decision making, and successes

were reported across a wide range of industries (Grover, Chiang, Ting-Peng Liang, & Dongsong Zhang, 2018 [<https://doi.org/10.1080/07421222.2018.1451951>]; Wamba et al., 2017 [<https://doi.org/10.1016/j.jbusres.2016.08.009>]).

As with any major disruption, while opportunities for value creation abound, research still need to contribute to our understanding of the phenomenon. In fact, even if emblematic success cases were explored and researched, little attention was devoted to the analysis of the ways through which firms profited from DDS to create value. What did enable these initiatives? Which forms or value propositions did firms configure to create value? To explore these questions, we develop a research framework rooted in the theory of Technology affordances.

Therefore, in our study we identify the emerging DDS affordances and identify the value propositions resulting from their actualization. In this sense, firms' DDS initiatives generate value propositions as outcome of DDS Affordance actualization.

To identify both DDS affordances and DDS actualization outcomes, we employed an inductive multiple case study approach. Our objects of analysis were the DDS initiatives launched by existing organizations and we develop a taxonomy of these DDS initiatives following the methodology advanced by Nickerson et al. (Nickerson, Varshney, & Muntermann, 2013 [<https://doi.org/10.1057/ejis.2012.26>]). At a conceptual level, we identify and classify DDS value creation opportunities as Technology affordances and the outcomes of the actualization actions as value propositions. Empirically, we derive the classification dimensions from the analysis of real cases. Overall, we analyzed 177 initiatives, the majority of which being business solutions marketed by professional vendors.

## Theoretical approach

### Technology affordance

The concept of affordance originated with Gibson (Gibson, 1986 [[https://www.amazon.fr/Ecological-Approach-Visual-Perception-Classic/dp/1848725787/ref=sr\\_1\\_fkmr0\\_1?\\_mk\\_fr\\_FR=ÅMÅŽÕÑ&keywords=The+ecological+approach+to+visual+percpetion%2C+London%2C+LEA&qid=1574498502&sr=8-1-fkmr0](https://www.amazon.fr/Ecological-Approach-Visual-Perception-Classic/dp/1848725787/ref=sr_1_fkmr0_1?_mk_fr_FR=ÅMÅŽÕÑ&keywords=The+ecological+approach+to+visual+percpetion%2C+London%2C+LEA&qid=1574498502&sr=8-1-fkmr0)]) in ecological psychology as the interaction between an actor with the environment, defined as the surroundings of the actor. The conditions that enable the interaction include both the properties of the actor and of the environment (Gibson, 1986 [[https://www.amazon.fr/Ecological-Approach-Visual-Perception-Classic/dp/1848725787/ref=sr\\_1\\_fkmr0\\_1?\\_mk\\_fr\\_FR=ÅMÅŽÕÑ&keywords=The+ecological+approach+to+visual+percpetion%2C+London%2C+LEA&qid=1574498502&sr=8-1-fkmr0](https://www.amazon.fr/Ecological-Approach-Visual-Perception-Classic/dp/1848725787/ref=sr_1_fkmr0_1?_mk_fr_FR=ÅMÅŽÕÑ&keywords=The+ecological+approach+to+visual+percpetion%2C+London%2C+LEA&qid=1574498502&sr=8-1-fkmr0)]).

Recent studies applied the concept of affordance to the IT domain (Dremel, Herterich, Wulf, & Vom Brocke, 2018 [<https://www.alexandria.unisg.ch/255548/1/Dremel%20et%20al.%20-%20Actualizing%20Big%20Data%20Analytcs%20Affordancs%20-%20Pre-Print.pdf>]; Du, Pan, Leidner, & Ying, 2019 [<https://doi.org/10.1016/j.jsis.2018.10.002>]; Tim, Pan, Bahri, & Fauzi, 2018 [[https://www.researchgate.net/profile/Shan\\_L\\_Pan2/publication/314714379\\_Digitally\\_enabled\\_affordances\\_for\\_community-driven\\_environmental\\_movement\\_in\\_rural\\_Malaysia/links/5a99efa045851586a2a9fcc5/Digitally-enabled-affordances-for-community-driven-environmental-movement-in-rural-Malaysia.pdf](https://www.researchgate.net/profile/Shan_L_Pan2/publication/314714379_Digitally_enabled_affordances_for_community-driven_environmental_movement_in_rural_Malaysia/links/5a99efa045851586a2a9fcc5/Digitally-enabled-affordances-for-community-driven-environmental-movement-in-rural-Malaysia.pdf)]). In the IS field, affordances are considered possibilities for goal-oriented action emerging from the relation between an IT and organization systems (Strong et al., 2014 [<http://aisel.aisnet.org/jais/vol15/iss2/2>]). As affordances are just potentials for action, affordances need to be triggered or actualized by a goal-oriented actor to produce an outcome.

In organizations, affordances are the result of the intertwining of the capabilities of IT and the actions performed by organizational systems. Organizational systems can originate, perceive, and enact the affordance with the intention to support organizational goals. In this term, the potential for coordinated action by a group of actors can be thought as an organizational affordance (Strong et al., 2014 [<http://aisel.aisnet.org/jais/vol15/iss2/2>]).

As a consequence, Affordance Theory allows to overcome some of limitations of current management theories that ignore the possibility that humans using technology can enact new practices or outcomes, thus overcome simplistic or deterministic assumptions about the effects of technology on human and organizational outcomes.

### Affordance actualization

Consistently, Affordance Actualization is defined as the action taken by actors to achieve outcomes in support of organizational goals, as they take advantage of one or more affordances through their use of technology (Strong et al., 2014 [<http://aisel.aisnet.org/jais/vol15/iss2/2>]). Actualization is a goal-oriented and iterative process (Leonardi, 2013 [<http://www.jstor.org/stable/43825998>]; Strong et al., 2014 [<http://aisel.aisnet.org/jais/vol15/iss2/2>]).

The concept of actualization at the organizational level was introduced only recently (Strong et al., 2014 [<http://aisel.aisnet.org/jais/vol15/iss2/2>]) and defined as the collective construct emerging from the aggregation of the many actors' actualization processes and outcomes of the individual-level. In other words, actualization as an organizational journey emerged as the collective accomplishment of the many individual actor level journeys. To actuate affordances at an organizational level, Leonardi (Leonardi, 2013 [<http://www.jstor.org/stable/43825998>]) introduced the concept of shared affordance, that is, an affordance shared by all members of a group in which all actors mani-

fest similar use of technology features. In essence, when actors agree on the usage of a similar sequence of technology features, the affordance created by the interaction with a specific technology can be actualized at an organizational level. When an IT affordance is actualized at organizational level, its outcome is an intended IT enabled initiative for realizing organizational goals.

Our challenge is to decline this principle of affordance actualization (Leonardi, 2013 [<http://www.jstor.org/stable/43825998>]) to the DDS and hence to identify the possibilities DDS afforded to organizations and the actualizations resulting in specific value propositions. In other words, we seek to identify the potentials of DDS from the outcomes of the actualization activities.

## Results

Our taxonomy of DDS initiatives is composed by four Technology affordances and five Affordance actualizations.

### Technology Affordances

Real-Time Sensing (RTS) is the Technology affordance gained by detecting in real-time the current state of a single given entity (human, object, event...). Examples are the location of a single airplane, the speed of a car, or the mood of an individual. In one hand, Web 2.0 and social networks created new ways for people to interact in real time. On the other hand, RTS is also emerging from machine-to-machine (M2M) data streams as electronic devices have an unprecedented ability to automatically and continuously sense the environment, and automatically react to the incoming flow of data. Examples are the automatic alerting system at an air traffic control center in case of specific flight path deviation, or the automatic cruise control of the speed of a car.

Real-Time Mass Visibility (RTMV) is the Technology affordance based on identifying the state of multiple entities in real time, altogether, contextualized by their relationships. RTMV is a second-order affordance based on the, hence, first-order RTS Technology affordance. For example, if RTS makes possible to locate a single vehicle, this RTMV second-order Technology affordance makes possible to sense all the cars on a road and new variables, like traffic congestion, could be detected.

Real-Time Coordination (RTC) is the Technology affordance gained by adjusting a behavior based on fast cycle feedback regarding the current state of other entities. RTC is a third-order Technology affordance based on the second-order RTMV Technology Affordance.

Real-Time Experimentation (RTE) is the Technology affordance gained by fast cycling data generation and streaming on the entity with actions on this measured entity or its environment. RTE is another second-order affordance based on the first-order RTS. RTE makes possible to test and have immediate feedback on business decisions, from the change of a webpage layout, such as A/B tests, to more complex information and massive experimentation.

### Affordance Actualizations

Analytics (AN) is the Affordance actualization dimension related to the processing of DDS information to produce analyses or to improve visualizations with the objective of enabling better decision making and producing superior insight or knowledge. This dimension of Affordance actualization focuses on analysis. It merges DDS to create the breadth of information necessary for supporting high-level value creation opportunities and thus reduce innovation risk.

Service (SE) is an Affordance actualization that implies the merging and manipulation of DDS to provide new services or to improve existing ones. For instance, managers of entertainment parks can provide RFID cards to guest enabling them to check entrances to each attraction, and their purchases of food and merchandise during their stay, from simple RFID readings.

Aggregation (AG) is the Affordance actualization that refers to the way firms focus on collecting, and aggregating DDS with the aim to repurpose them and make them available to customers. While some degree of aggregation of data is a prerequisite for all DDS initiatives, the AG Affordance actualization implies that the combination of this collection, aggregation and repurpose of DDS represents the core value proposition for those organizations. Indeed, these organizations create platforms providing access to DDS generated by other companies.

Generation (GE) is an Affordance actualization related to the creation of value in originating the DDS by the organization it-self. This Affordance actualization is developed by organizations that recognize (or stumble upon) events in DDS. These events may have been available in the past, but their value went unrecognized or, more often, their availability has increased recently due to some technology advances. The stream could arise as a by-product of some business operations (e.g., a sale) or as a deliberate action to capture data (e.g., RFID tags in gambling chips to track a player's bets).

Efficiency (EF) is the Affordance actualization that leverages external or internal DDS to optimize an organization's operations. These organizations already recognize the va-

lue that is intrinsic in the streams of events within or outside their boundaries, and develop the initiative with the goal to harvest efficiency gains. Higher performance, lower prices and risks and cost savings are typical examples of how greater organizational efficiency translates into customer value (in the Appendix the synthesis of the taxonomy application to all the DDS initiatives considered in this study and the details of the taxonomy application for 5 randomly selected companies).

## Discussions

The affordance perspective demonstrated its usefulness to the context of big data and DDS and we showed the applicability of the affordance perspective in this new domain for the identification of possibilities of action with these technologies and their actualizations at the organizational level. Indeed, we identified and classified the DDS value creation opportunities in these four distinctive Technology affordances and five different Affordance actualizations.

## Implications to theory

With our work we contribute to the growing literature on DDS and hint toward the existence of idiosyncratic categories of value creation initiatives that may be embodied in novel business models. We then respond to the call to shed light on big data, and DDS specifically, as opportunities for business value delivery (Wamba et al., 2017 [<https://doi.org/10.1016/j.jbusres.2016.08.009>]).

We successfully show that affordance theory provides a solid framework on which base we can ground the study of the complex relationships between IT and organizational systems. While in this paper we focus on the role of DDS in untapping new value potentials, the overall approach can be used to systematize the growing number of cases and studies discussing the challenges and effects of their use.

We deepen the understanding of the actualization process, often neglected in technology affordance studies, and only recently explored. The interesting of our approach lays in the joint identification of both Technology affordances and their actualization, originally building on Volkoff and Strong (Volkoff & Strong, 2013 [<http://www.jstor.org/stable/43826002>]) crucial work. We believe that being capable to extrapolate these conceptual elements from practical examples holds a strong potential for further theorizing as patterns may be observed in how firms actualize Technology affordances. This is an important aspect of all studies based on Technology affordances theoretical underpinning as it enables to account for the variance in the effects of technology on human and organizational outcomes (Majchrzak & Markus, 2012 [<http://papers.ssrn.com/abstract=2192196>]). In this sense, we were unable to discern a pattern or associations among Technology affordances and their actualizations. This result provides further evidence for the appropriateness of an affordance-based theorizing, and the need to overcome deterministic assumptions on IT outcomes in IS studies.

Interestingly, we identified a hierarchical structure among the identified technology, an aspect only hinted in previous IS studies, and postulated when considering affordances as generative mechanism under the critical realist perspective (Volkoff & Strong, 2013 [<http://www.jstor.org/stable/43826002>]). To our knowledge, this is a novel contribution to IS and organizational studies.

## Implication for practice

In terms of implication to practice, the proposed taxonomy could be a useful tool for managers in structuring their evaluation, in the exploratory phases, of the business value of a DDS strategic initiative. The proposed taxonomy is emergent from existing DDS initiatives and could be used to structure the ideation and evaluation of new DDS based initiatives. For example, companies that want to leverage DDS for efficiency purposes should know whether a similar DDS initiative already exists. If a similar DDS initiative exists, the company should understand how to implement and gather value from DDS by looking at successful prior implementations. At the same time, managers may use the proposed technology affordances and actualizations as templates to define further actions. The finite number of categories is suitable for supporting the generation of a combinatory space of value affordance and actualizations to explore. Additionally, value proposition may be generated considering jointly a series of available DDS, the categories of affordance actualization, and a customer for which to generate value. For example, the availability of new real-time data concerning the weather may be examined in the context of the proposed Affordance actualization categories (Service, Efficiency, Analytics, Aggregation, Generation), for the retail customer of a car insurance company. Novel ideas, like the real-time alert in case of hailstorm. While this is just an example, a similar approach may support the design and implementation of DDS initiatives, and guide managers' actions in achieving outcomes according to their organizational goals. At the same time, we alert managers that this study insisted on a wide overview of the DDS initiatives, hence excluding an in-depth look at the internal processes linking a Technology Affordance to its Affordance Actualization, down to the impact on the financial performance or other economic advantages for companies. Hence the effective financial performance of the analyzed DDS initiatives remained unassessed.

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## ANNEXES

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Appendix 1: Methodological Note [<https://management-datascience.org/wp-content/uploads/2020/01/Appendix-1-methodological-note.pdf>]

Appendix 2: Taxonomy application to all the DDS initiatives considered in this study 1 [<https://management-datascience.org/wp-content/uploads/2020/01/Appendix-2-Taxonomy-application-to-all-the-DDS-initiatives-considered-in-this-study-1.pdf>]

Appendix 3: Taxonomy application to 5 randomly selected companies [<https://management-datascience.org/wp-content/uploads/2020/01/Appendix-3-Taxonomy-application-to-5-randomly-selected-companies.pdf>]

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