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Taxonomy for real-time digital data initiatives

Taxonomie des initiatives sur les données digitales

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Abstract

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.

Résumé

Les données digitales en temps réel deviennent des atouts importants dans un nombre croissant d'organisations. Cet étude applique la théorie des affordances dans l'élaboration d'une taxonomie permettant de comprendre les initiatives en données digitales en temps réel. La taxonomie proposée est composée de deux catégories, les affordances technologiques et l'actualisation des affordances, regroupant respectivement quatre et cinq dimensions. Plus précisément, les affordances technologiques sont la détection en temps réel, la visibilité de masses en temps réel, les expérimentations en temps réel et la coordination en temps réel, tandis que les actualisations d'affordances concernent le service, l'efficacité, l'analyse, l'agrégation et la génération.

Keywords: Big Data; real-time digital data; Technology affordances; Affordance actualization.

Mots-clés: Données Massives; Données digitales en temps réel; Affordances technologiques; Actualisation des affordances.

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](#)). 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](#)). 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](#)), 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](#); [Wamba et al., 2017](#)).

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](#)). 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](#)) 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](#)).

Recent studies applied the concept of affordance to the IT domain ([Dremel, Herterich, Wulf, & Vom Brocke, 2018](#); [Du, Pan, Leidner, & Ying, 2019](#); [Tim, Pan, Bahri, & Fauzi, 2018](#)). 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](#)). 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](#)).

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](#)). Actualization is a goal-oriented and iterative process ([Leonardi, 2013](#); [Strong et al., 2014](#)).

The concept of actualization at the organizational level was introduced only recently ([Strong et al., 2014](#)) 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](#)) introduced the concept of shared affordance, that is, an affordance shared by all members of a group in which all actors manifest 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 actuated 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](#)) 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 value 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](#)).

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](#)) 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](#)). 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](#)). 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 actuations 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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Appendix - methodological note

To identify the potentials of DDS from the outcomes of the actualization activities, we employed an inductive multiple case study approach. This research approach is suitable for examining a contemporary phenomenon in its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. The multiple cases are synthesised in a taxonomy. Taxonomies are systems of groupings that are derived conceptually or empirically and they serve to understand and structure the knowledge ([Nickerson, Varshney, & Muntermann, 2013](#)). Taxonomies are particularly important when the domains are complex and difficult to analyse, as they offer the possibility to bring concepts, relationships among concepts and order, in general out of the intricacies of the contemporary phenomena, especially true for the big data phenomenon. Our objects of analysis were the DDS initiatives and we looked at the Technology affordances and the Affordance actualizations. Then we classified the Technology affordances and the Affordance actualizations in the taxonomy, following the methodology advanced by Nickerson et al. ([Nickerson, Varshney, & Muntermann, 2013](#)).

The adopted taxonomy building methodology is iterative and requires to define the objective and subjective ending conditions of each iteration. Our objective ending condition demands that: “All objects have been examined”, while our subjective ending condition requires that our taxonomy is concise, robust, comprehensive, extendible, and explanatory ([Nickerson, Varshney, & Muntermann, 2013](#)). We performed three iterations before meeting the defined ending conditions.

The first iteration took place in 2012, when we formally launched this study. For this first iteration we analysed the 12 DDS initiatives we were already aware of. The second iteration took place between 2012 and 2014. We gathered data about all the DDS initiatives from multiple publicly available sources: prospectuses, annual reports, academic and professional articles, company web sites, press releases, initiative descriptions, white papers, web search engines. We analyse a total of 58 new DDS initiatives. We analysed both start-ups as well as established large corporations, spanning several countries. The third iteration took place at the end of the 2014. We downloaded all the articles available on the news aggregator Factiva1 starting from the first of January 2011 to the end of November 2014, containing as keyword “real-time data.” Overall, we downloaded and read 1,839 articles and among these articles, we identified 101 DDS initiatives. We used the term “real-time data” instead of “digital data stream” to extent the search to all communications eventually referring to uses and exploitation of real-time data, thus configuring DDS initiatives.

Every iteration was characterized by three steps. In the first step, we identified the initiatives to consider for defining the new dimensions to include in the taxonomy. In the second step, we defined the dimensions to add in the taxonomy. In the third step, we verified whether our ending conditions were achieved.

Besides the results of the taxonomy development process, and with illustrative purpose, we further detail the application of the taxonomy to five distinct DDS initiatives.

Overall, we analyzed 177 initiatives, the majority of which being business solutions marketed by professional vendors. In terms of industry, Information Technology is the sector that includes the highest percentage of DDS initiatives of the total sample. The second most representative sector is transportation, followed by healthcare, while the less representative sectors are the aerospace, agriculture, construction and gaming.

Industrial Sector	Vendor	Number	Percentage	Total in the sample	Percentage
Information Technology	Yes	75	42.37%	80	45.20%
	No	5	2.82%		
Transportation	Yes	13	7.34%	26	14.69%
	No	13	7.34%		
Healthcare	Yes	14	7.91%	15	8.47%
	No	1	0.56%		
Manufacturing	Yes	11	6.21%	14	7.91%
	No	3	1.69%		
Energy	Yes	9	5.08%	10	5.65%
	No	1	0.56%		
Commerce	Yes	1	0.56%	4	2.26%
	No	3	1.69%		
Finance	Yes	4	2.26%	9	5.08%
	No	5	2.82%		
Tourism	Yes	0	0.00%	7	3.95%
	No	7	3.95%		
Other*	Yes	7	3.95%	12	6.78%
	No	5	2.82%		
Vendor all sample					
Yes				134	75.71%
No				43	24.29%
Total				177	100.00%

*Aerospace, agriculture, construction, gaming.
Sample composition

I32	Smart metering	Iren	x									x
I33	Taxy call	MyTaxy.net	x				x					
I34	MobiHealth Mobile	MobyHealth	x									x
I35	OneBusAway	MTA Bus Time	x									x
I36	MBTA real-time Website	Massachusetts Bay Transit Authority	x				x					
I36	MBTA real-time API	Massachusetts Bay Transit Authority	x									x
I37	Service-oriented Data-Driven Organisation With Big Data	<u>InterContinental Hotel Group</u>	x							x		
I38	Revenue Management	Marriott	x		x					x		
I39	Big Data To Deliver Excellent Customer Service	Southwest Airlines	x							x		
I40	Know Me program	British Airways	x							x		
I41	Airport Collaborative Decision Making	Heathrow Airport Holdings	x	x				x				
I42	Big Data Analysis With HP Vertica	BlaBlacar	x							x		
I43	Uber	Uber	x	x			x					
I44	Tripadvisor	Tripadvisor	x	x			x					
I45	Hipmunk Flight Ranking	Hipmunk	x	x			x					
I46a	Kayak A/B Testing	<u>Kayak</u>	x		x			x				
I46b	Kayak Price Forecast	<u>Kayak</u>	x	x			x					
I47	Reputation Manager	Reputation Manager	x	x			x					
I48	TrustYou	TrustYou	x	x							x	
I49a	Optimizely Testing	Optimizely	x		x					x		
I49b	Optimizely Personalization	Optimizely	x	x			x					
I50	Datameer	Datameer	x							x		
I51	Amadeus	Amadeus	x								x	
I52	Facebook	Facebook	x	x			x					
I53	Digital cow	J.R. Simplot company	x	x						x		
I54	Nike+ shoes	Nike	x				x					
I55	Zynga	Zynga	x	x			x					
I56	People You May Know	LinkedIn	x		x		x					
I57	High-performance-analytics	Macy's	x							x		
I58	Natural language processing solution	United Healthcare	x							x		
I59	Big Data at Bank of America	Bank of America	x							x		
I60	Data as a service solution	Sears Holdings	x							x		
I61	ORION	UPS	x	x				x				
I62	Total Rewards loyalty program, web click-streams, and real-time play in slot machines	Caesar	x		x					x		

I63	Tesla logs	Tesla Motors	x	x							x
I64	Anvita Insight analysis	<u>Anvita health</u>	x						x		
I65	Talend Real-Time Big Data Platform	Talend	x						x		
I66	ParStream's Analytics Platform	ParStream	x						x		
I67	RMG's Visual Supply Chain solutions	RMG Networks	x	x					x		
I68	BigMemoryMAX	Software AG	x						x		
I69	Druid	Metamarkets	x					x			
I70	Real Time Data	London Stock Exchange	x					x			
I71	Digital Suites for Oil and Gas	Honeywell Process Solutions	x						x		
I72	Salesforce Lighting Connect	Salesforce.com	x	x							x
I73	Aisys CS2 anaesthesia platform	GE Healthcare	x					x			
I74	the ParStream Analytics Platform	ParStream	x							x	
I75	PubMatic Analytics	PubMatic	x							x	
I76	ANPM product	Optus	x					x			
I77	MOM application	GMT	x	x					x		
I78	NOVOsphere	NOVOTM	x						x		
I79	Predictive Analytics Solution	AudaExplore	x	x					x		
I80	TIBCO Engage	TIBCO Software Inc	x			x				x	
I81	Biometric-based time and attendance system	UGO Foods	x						x		
I82	GE Monitor Asset Tracking	GE Capital Fleet Services	x	x					x		
I83	iCommand	Overwatch Intelligence Solutions	x	x						x	
I84	Drive Safe Systems	Con-way Freight	x						x		
I85	Patient Classification Clinical Information Interface software solution	API Healthcare	x						x		
I86	Sensorium software	2BM	x						x		
I87	AdMall PRO's Digital Audit	AdMall Pro	x								x
I88	ExASolution	ExASOL AG	x							x	
I89	Preclarus	Pharmaceutical Product Development	x	x						x	
I90	AQUARIUS Forecast	Aquatic Informatics Inc	x						x		
I91	SolarSNAP	Shoals Technologies Group and Synapse Wireless	x						x		
I92	Brand LIVE Pulse	NetBase	x	x						x	
I93	Bloe washroom service and Tork EasyCube	Svenska Cellulosa	x						x		

I94	StoryTeller Inrix Traffic App	AccuWeather	x	x			x			
I95	Hyundai Dealer Portal	Dealertrack Canada	x	x			x			
I96	Plexus	PROFILE Software	x	x				x		
I97	Shiraz	W&H Systems Inc	x					x		
I98	RFRTDTemp2000A	MadgeTech Inc	x	x						x
I99	AquaView	Select Energy Services	x					x		
I100	NC-1 non-contact in-line system	Konica Minolta Sensing Americas Inc	x					x		
I101	NASDAQ Last Sale	SINA Corporation	x							x
I102	Simplify Commerce	SumAll	x						x	
I103	Metronome device	MetroMile	x					x		
I104	VeriWise	Asset Intelligence	x					x		
I105	OmniWell	Weatherford International Ltd	x	x					x	
I106	Orion	United Parcel Service Inc	x	x				x		
I107	INRIX real-time traffic information	INRIX	x	x				x		
I108	Graco InSite	Graco Inc	x	x						x
I109	Jibe Recruiting Analytics	Jibe Inc	x	x					x	
I110	TDSR	Talksum Inc	x	x						x
I111	First Derivatives	NYSE	x	x				x		
I112	Elektron Real-time	Thomson Reuters	x	x						x
I113	DEC	Thismoment	x	x					x	
I114	Product Link	Caterpillar	x	x				x		
I115	RTSM	Perceptive Informatics	x	x					x	
I116	Faronics LabPro	Faronics	x	x				x		
I117	TASS	Verint(R) Systems Inc	x	x					x	
I118	FleetLocate	<u>Spireon, Inc.,</u>	x	x				x		
I119	Parker	Bellis	x	x				x		
I120	Customer Conversation Hub	Message Systems	x	x				x		
I121	DMFusion 2.0	Luxoft	x						x	
I122	ProFicient 5	InfinityQS International Inc	x						x	
I123	ION Mustering	Apprion	x	x					x	
I124	TrackWise Analytics	Sparta Systems Inc	x						x	
I125	WebTrak	Finavia	x	x						x
I126	PPD InVision	Pharmaceutical Product Development, LLC (PPD)	x	x					x	
I127	ParkSight Portal	Streetline Inc	x	x					x	
I128	Publishflow	Sargas Capital	x	x						x
I129	ProRAE Guardian System	RAE Systems	x						x	
I130	Intel AIM Suite	Broadcast Internatio-	x	x						x

		nal (BCST.OB)									
I131	SCADA Application Software	Chemtrols Industries Ltd	x	x						x	
I132	Aegis Pi	Aegis	x	x						x	
I133	Imagine	Ingenious Med	x	x						x	
I134	HPM solution	Cognizant	x	x						x	
I135	Bi3 SaaS applications	Bi3 Solutions Inc	x	x						x	
I136	Acscis ProducTrak	Acscis	x	x					x		
I137	ProRAE Guardian Cloud-Server	RAE Systems Inc	x					x			
I138	SYNC Destinations	Ford Motor	x					x			
I139	WV511	Open Roads Consulting	x	x				x			
I140	AutoVault	Talyst	x	x					x		
I141	LP Marketer	LivePerson, Inc.	x							x	
I142	OneViewPOV	Verizon Wireless and Pedigree Technologies	x						x		
I143	DataSift platform	DataSift	x	x							x
I144	Timecard GPS	Econz	x	x				x			
I145	REFLExx	Digitexx Data Systems Inc	x	x						x	
I146	Trimble(R) RTx technology	Trimble	x					x			
I147	SiRFstarV	Cambridge Silicon Radio	x					x			
I148	InCrowd platform	InCrowd	x	x				x			
I149	SonicWALL Global Management System (GMS) 7.0	SonicWALL Inc	x	x						x	
I150	Oracle Health Sciences Pharmacovigilance Operational Analytics	Oracle	x	x						x	
I151	Google Analytics Real-Time	Google	x							x	
I152	BioClinica Express EDC	BioClinica Inc	x						x		
I153a	Blackbay's enterprise mobility solution	DPD Ireland	x	x				x			
I153b	Blackbay's customer feedback	DPD Ireland	x								x
I154	BMW Routes Portal	BMW ConnectedDrive	x	x			x	x			
I155	MEDHOST HD	MEDHOST	x						x		
I156	SD Card Real-Time Data Logging Instruments	General Tools & Instruments	x					x			
I157	ODBC	Attunity Ltd	x								x
I158	WaferSense	CyberOptics Semiconductor	x						x		
I159	Fleet Director 8.2	Teletrac	x	x						x	
I160	Trac Tag	Libramation	x						x		
I161	EffiMax 3000 Boiler Effi-	Forbes Marshall	x						x		

	ciency Monitoring Packages											
I162	LiveInsights	InsightExpress	x						x			
I163	4SIGHT solution	4SIGHT	x	x				x				
I164	FireScope Analytics	FireScope Inc	x						x			
I165	GRRM platform	MConcierge Systems Inc	x				x					
I166	PI for StreamInsight	OSIsoft, LLC	x						x			
I167	GreenGlobe Data Visualizer	NEC Corporation	x								x	
I168	Web-based Check-Net data management platform	Checkpoint Systems	x					x				
I169	Excalibur-Litho	Magma Design Automation Inc	x						x			
I170	Engagement A/B Reporting	FetchBack Inc	x		x				x			
I171	GO 2505 M LIVE	TomTom	x	x				x				

Taxonomy application to all DDS initiatives

Appendix - Taxonomy application to 5 randomly selected companies

In this section, we illustrate the whole taxonomy on a set of five companies, randomly selected from our original sample.

Scada Application Software of Chemtrols Industries Ltd company

Chemtrols Industries Ltd is a manufacturing company of industrial equipment and offers a Supervisory Control and Data Acquisition (SCADA) software application. This kind of applications refers to the combination of telemetry and data acquisition. The company packages its SCADA software application in their CT Meerkat product. The CT Meerkat is a software application for real-time monitoring and control of a whole set of different, and eventually interconnected, equipment parts. The company targets, with its CT Meerkat product, station and substation automation. CT Meerkat affords real-time sensing thorough a terminal unit that collects data from the field. It affords also mass visibility since a master station collects and displays the data in real-time, using various colors and animations, via a communication system from remote terminal units. CT Meerkat provides additional tools to efficiently monitor, safely operate, accurately analyze data and maintain the system, by leveraging on the analytics affordance actualization.

Affordance	Taxonomy dimension	Scada Application Software by Chemtrols Industries Ltd
Technology affordance	Real-time sensing	A terminal unit collects data from the field.
	Real-time mass visibility	Master station collects the data in real-time via a communication system from remote terminal units.
	Real-time experimentation	None
	Real-time coordination	None
Affordance actualization	Service	None
	Efficiency	None
	Analytics	CT Meerkat accurately analyzes real-time data.
	Aggregation	None
	Generation	None

Taxonomy application to the Scada Application Software initiative of Chemtrols Industries Ltd

Acsis ProducTrak of Acsis company

Acsis is a supply chain operator and sells Acsis ProducTrak. It is a software suite for data collection and task management that adds functionality to major ERP systems, including SAP and Oracle. Acsis ProducTrak brings real-time connectivity to the different passage points in the supply chain, from incoming materials, through manufacturing, warehousing and distribution. Acsis ProducTrak provides the infrastructure to manage data collection points (e.g., label scanners, PLCs, label printers, and a host of other real-time devices) and deliver the data to the supply chain actors on the shop floor to operate effectively and efficiently. At the same time the Acsis ProducTrak aggregates the data for the management and reports the eventual inaccuracies in the supply chain process. This consistent, granular data is the key to providing a true picture of product movement throughout the extended supply network, offering real-time sensing and real-time mass visibility.

Affordance	Taxonomy dimension	Acsis ProducTrak of Acsis
Technology affordance	Real-time sensing	Acsis ProducTrak brings real-time access to the movements of each product in the supply chain
	Real-time mass visibility	Acsis ProducTrak brings real-time accessibility to the points in the supply chain and the movements of all the products.
	Real-time experimentation	None
	Real-time coordination	None
Affordance actualization	Service	None
	Efficiency	With Acsis ProducTrak, the enterprise gets the real-time data it needs for effective management achieving efficiency goals.
	Analytics	None
	Aggregation	None
	Generation	None

Taxonomy application to the Acsis ProducTrak of Acsis

DataSift platform of DataSift company

DataSift is a data management company and offers a platform for real-time social media data-filtering and aggregation. The DataSift platform sorts user conversations from sources like Twitter, making real-time sensing. The same platform is able to gather hundreds of millions of social media posts per day to find granular and relevant insight, giving real-time mass visibility. The platform is able to filter social media data for such as demographic information, online influence, sentiment, location, gender, or language. Through this solution, organizations can access to real-time data published on social media that could be impactful to their business for brand monitoring and other applications. Organizations allow to easily and quickly detect and respond to major trending events, social behaviors, customer preferences, and ultimately, avert any impending crises.

Affordance	Taxonomy dimension	DatSift platform of DataSift
Technology affordance	Real-time sensing	The DataSift platform collects and filters data from each social media user.
	Real-time mass visibility	The DataSift platform gathers data from many social media users, altogether.
	Real-time experimentation	None
	Real-time coordination	None
Affordance actualization	Service	None
	Efficiency	None
	Analytics	None
	Aggregation	The DataSift platform aggregates data from social media users, filters them, and describes trends about what is happening on the social media.
	Generation	None

Taxonomy application to the DatSift platform of DataSift

BMW Routes Portal of BMW ConnectedDrive company

BMW, is an automotive company, and the BMW ConnectedDrive offers an intelligent network between the driver, the vehicle and the surrounding environment, at large. Its features allow the delivery of comfort, Infotainment, and safety services, while on the road. The BMW Assist of the BMW Routes Portal is an interesting example of available service within ConnectedDrive. Customers of BMW Assist have access to the latest traffic reports with any Internet-enabled device and assist drivers in planning travel routes and avoiding congested areas or unfavourable conditions in advance. The BMW ConnectedDrive tracks the movement of mobile communication devices, taxis and fleet vehicles having navigation systems that communicate

with central dispatchers, making real-time sensing. The BMW ConnectedDrive understands the speed and position of the vehicles and obtains an overview of the current traffic situation, making possible real-time mass visibility. Finally, it feedback the drivers about traffic conditions to put in place real-time coordination.

Affordance	Taxonomy dimension	BMW Routes Portal of BMW ConnectedDrive
Technology affordance	Real-time sensing	The ConnectedDrive is able to understand the position of the vehicle.
	Real-time mass visibility	The ConnectedDrive creates a precise overview of the current traffic situation.
	Real-time experimentation	None
	Real-time coordination	The ConnectedDrive enables the coordination among the car drivers.
Affordance actualization	Service	BMW offers new services to drivers like the route planning services, by sending alerts to the driver to suggest an earlier departure time in case of traffic.
	Efficiency	None
	Analytics	None
	Aggregation	None
	Generation	None

Taxonomy application to the BMW Routes Portal of BMW ConnectedDrive

Engagement A/B Reporting of FetchBack Inc. company

FetchBack Inc. is an online advertising company and it proposes Engagement A/B Reporting as a tool that describes the behavior of customers while browsing web sites, making real-time sensing . In addition, the Engagement A/B Reporting, allows beta tests showing how consumers perceived the website, advertisements and retargeting campaigns, obtaining real-time experimentation. The Engagement A/B Reporting tool is part of FetchBack’s analytics platform, FIDO, which displays real-time analytics of a client’s retargeting campaign and gives evidences of the factors that can significantly influence online consumer behavior.

Affordance	Taxonomy dimension	Engagement A/B Reporting of FetchBack Inc.
Technology affordance	Real-time sensing	The Engagement A/B Reporting collects data on the online consumer behaviours.
	Real-time mass visibility	None
	Real-time experimentation	Engagement A/B Reporting allows for experiments during retargeting campaigns.
	Real-time coordination	None
Affordance actualization	Service	None
	Efficiency	None
	Analytics	FetchBack’s proposes the analytics platform, FIDO, which displays real-time analytics for the client’s retargeting campaign.
	Aggregation	None
	Generation	None

Taxonomy application to the Engagement A/B Reporting of FetchBack Inc.