

ON THE VALUE OF MOBILE BUSINESS INTELLIGENCE: AN AFFORDANCE APPROACH

Research

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Abstract

Mobile BI (m-BI) is an extension of BI delivered on mobile devices such as smartphones and tablets. Even though proponents of m-BI are highlighting its capabilities and outcomes, still its value-generating potential in organizations is surrounded by ambiguity. Given this uncertainty, we use an affordance approach to explore the action possibilities and benefits arising from the interaction of m-BI and users. We conduct a case study in a retail organization where m-BI has been in use for more than four years. Three affordances – cursory scanning, aligning distributed intelligence in real time and real-time performance tracking – are explored in detail based on their constitutive elements, namely, technological capabilities, user intention and key differences with its closest technological rival. Each affordance is further theorized in relation to the decision making process. The affordances primarily support the intelligence and the review phase of decision-making; the design phase is minimally supported, while the choice phase is not supported. Moreover, we note the performative nature of affordances, highlighting the behavioural expectations and practices they produced.

Keywords: mobile business intelligence, affordances, decision-making, benefits

1 Introduction

Business intelligence (BI) systems represent one of the most recent incarnations of decision support systems (DSS) as they analyze vast quantities of data and present this to decision makers in an accessible, visual manner (Watson and Wixom, 2007). In the last few years, BI has been implemented aggressively in many different industries (Arnott and Pervan, 2008), including retail, telecommunication, healthcare, transportation and financial services (Chaudhuri et al., 2011), and it is predicted to continue topping CIOs' agendas for the next few years (Arnott and Pervan, 2014).

With the increasing use of mobile devices, which has contributed largely to the emergence of big data (Mikalef et al., 2017), mobile computing is becoming an important enabler of BI (Arnott and Pervan, 2014) by delivering dashboards with drill-down capabilities especially on smart-phones and tablets. The term mobile BI (or m-BI) was coined in the early 2000's but only became popular after 2010, the year the iPad was released (Tona and Carlsson, 2013). m-BI is defined as "data-driven decision support applications on mobile devices like smartphones and tablet computers" (Power, 2013, p.6). It is particularly relevant in retail, where sales managers, who are frequently on the road, need to keep up with the organization's operational and financial performance in a very dynamic and highly distributed setting (Watson et al., 2013). m-BI is also very useful in healthcare settings, where most employees are on the move rather than tethered to a desk (Brooks et al., 2013). Often, user mobility is pinpointed as a key motivator of m-BI use (Hou and Gao, 2017).

m-BI has attracted both practitioners' and academics' attention in recent years. A recent study by Dresner Advisory Services (2014) shows that the number of respondents that find m-BI to be either a critical or a very important IT initiative increased from 57% in 2013 to 91% in 2014. As a self-service technology, m-BI promises to provide access to organizational information any-time anywhere, to deliver real-time information, and to enhance collaboration and decision-making (Tona and Carlsson, 2013). However, as with every new technology, there is the risk that its capabilities and organizational implications are more a matter of rhetorical hype than reality (Ramiller, 2001). Given the lack of empirical research assessing the many promised benefits of m-BI such as employees' productivity (Watson, 2015), and the uncertainty over how m-BI will generate business value that is distinct from other established technological solutions, has hampered m-BI adoption (O'Donnell et al., 2012, DAS, 2015).

To address questions about a technology's unique capability to deliver business value, an affordance lens can be fruitfully applied (Majchrzak et al., 2013, Volkoff and Strong, 2013). Affordances are the action possibilities that are available to a technology-user system (Zammuto et al., 2007). The affordance construct has garnered considerable interest in IS research in recent years as it recognizes the role of technology's materiality in IT use (Faraj and Azad, 2012, Cousins and Robey, 2015). As such, the affordance lens has become a way of theorizing technology-mediated work sociomaterially (Orlikowski and Scott, 2008), that is, as an entanglement between human and technological actors. Thus heeding the calls for more research that takes the technology's materiality seriously and that explores new technologies such as m-BI in use (Chen et al., 2012, Gao, 2013, Arnott and Pervan, 2014), our study seeks to answer the following research question: *What are the affordances of m-BI?*

The main contribution of this study is to identify the action possibilities that are unique to m-BI. As such, this paper helps to answer questions about how the use of m-BI generates value in ways not available by other technological means. Our findings also provide practitioners with insights into the behavioural expectations and work practices that m-BI use is likely to produce. Furthermore, by applying an affordances lens and taking seriously the entanglement of technology's materiality and target users' goals and intentions (Faraj & Azad 2012), this paper contributes to the sociomaterial theorizing of IT.

The paper is structured as follows. The literatures on affordances and on m-BI are presented. This is followed by a description of our research site and the methods we relied on to gather and analyze the data. We then describe our findings, i.e., the three affordances and their implications for the users' work. We conclude with a discussion of our findings, their implications and their limitations.

2 Literature Review

2.1 Affordances

The concept of affordance has its origin in ecological psychology, where it was defined as the actions that environments (and the objects within them) permit or deny anticipated actors (Gibson, 1979). As action possibilities that material settings and artifacts present to specific actors (e.g., children or able-bodied adults), affordances represent a relational construct, focused on the mutuality and reciprocity of objects and actors in action (Costall, 1995).

In the IS discipline, the concept of affordances is frequently seen as a corrective to the over-socialized, constructionist view of technology (Zammuto et al., 2007). As such, it is used to (re)incorporate the material aspects of a technological artefact into the study of technology-in-use (Faraj and Azad, 2012) without having to consider endless lists of designer-intended affordances that remain latent, unperceived and unused (Markus and Silver, 2008).

The IS discipline has embraced a conceptualization of affordances as being both relational and functional (Hutchby, 2001). Their *relationality* is defined in terms of action possibilities that emerge through the reciprocal and synergistic relationship between a technology's features and a goal-oriented user (Markus and Silver, 2008). Affordances' *functionality* finds expression in affordances belonging to a specific class of technology (e.g., BI) and being located within a specific activity domain (e.g., decision making). Affordances are thus restricted to the potential accomplishment of technology-enabled activities that would have been difficult if not impossible to achieve prior to the technology's implementation (Majchrzak et al., 2013). In other words, IS research defines affordances as action possibilities a technology makes differentially available when compared to its closest competition (Earl and Kimport, 2011).

Combining these definitional elements and borrowing heavily from Majchrzak et al.'s (2013, p.39) definition of affordances, we define affordances as "the mutuality of actor intensions and technology capabilities that provide the potential for a particular action that is distinct when compared to its closest technological rivals." In line with prior IS research (Strong et al., 2014) we equate "technology capabilities" to technological features.

2.2 Mobile BI (m-BI)

BI is "a broad category of applications, technologies and processes for gathering, storing, accessing and analyzing data to help business users make better decisions" (Watson, 2009, p.491). Continuously advancing in response to industry changes (Watson, 2009), BI has adapted to the rapid growth of mobile computing (Hosack et al., 2012, Arnott and Pervan, 2014) by extending BI usage scenarios beyond users' desks and office hours (Tona and Carlsson, 2013). This has led to m-BI as a new sub-category of BI.

Decision making, the process that BI and m-BI is designed to support and improve, is generally conceived of operating in four key phases (Simon, 1977): intelligence, design, choice and review. These phases can be summarized in terms of "...finding occasions for making a decision, finding possible courses of action, choosing among courses of action, and evaluating past choices (Simon, 1976, p.40). The decision making process starts with the intelligence phase in which the environment is examined to identify possible opportunities or problems that require action. Environmental scanning thus is considered a vital process in which organizations obtain information through different data retrieval modes (El Sawy and Pauchant, 1988, Choudhury and Sampler, 1997, Choo, 2001) ranging from general to specific scanning (El Sawy, 1985). While *undirected viewing*, which describes information scanning with no purpose in mind, and *conditioned viewing* where users are exposed to specific type of information but no active search takes place (Aguilar, 1967, Choudhury and Sampler, 1997) are located on the "general" end of the scanning continuum, *searching*, where users actively look for specific information for a particular purpose (Aguilar, 1967) map closely onto the "specific" end of information scanning (El Sawy, 1985, Choudhury and Sampler, 1997).

During the design phase, decision makers develop alternative solutions (Mintzberg et al., 1976, Simon, 1977), which implies developing hypotheses around cause and effect. The conclusion of the intelligence and the design phases is the choice, where a course of action is selected from the available alternatives. While these three phases are the most frequently cited, Simon actually identified a fourth and final phase: the review. The review consists of post-decisional governance activities that compare expected outcomes with actual performance in order to generate insights that inform future decisions (e.g., revised assumptions or hypotheses) and the effectiveness of the decision making process (Silver, 1991).

Inheriting some key mobile technological features, m-BI has the potential to respond to constant organizational needs for efficiency by encouraging users on the road to take actions just in time (Watson, 2015). Furthermore, a recent survey shows that m-BI use improves decision-making, increases job effectiveness and enhances business processes (Peters et al., 2014). We would expect m-BI to speed up the decision making process (Wen et al., 2008) by providing faster access to organizational data unconstrained by organization's temporal and spatial boundaries (Palen, 2002, Yuan et al., 2010). Furthermore, we would expect the process to become more flexible (Sheng et al., 2005) as users would have access to data and insights while they are 'on the move' (Wen et al., 2008, Tona and Carlsson, 2013).

The organizational improvements are accomplished through the enactment or actualization of the affordances that m-BI technology makes available. Since we position m-BI at the intersection of traditional BI (accessed via a desktop or laptop) and mobile technologies, we note that Cousins and Robey (2015) identify five affordances of mobile technologies: (1) mobility: users can choose the place and time when engaging with a mobile technology; (2) connectedness: users can stay connected with others; (3) interoperability: information can be shared among different devices; (4) identifiability: mobile devices uniquely identify users, and (5) personalization: users can customize their mobile devices and apps based on their preferences.

It is important to note that affordances do not only generate action but also reality; in other words, they are performative (Orlikowski, 2007). For example, mobile technologies like m-BI do not only afford mobility and connectedness (Cousins and Robey, 2015), but they also encourage it (Hislop and Axtell, 2007). As the boundaries between work and non-work places erode in the face of mobile technology (Mazmanian et al., 2005), even people with 9-to-5 office jobs are encouraged to engage in such practices as checking their messages continuously and responding to them immediately, even outside of office hours (Orlikowski, 2007). Such examples illustrate the reciprocity of affordances: affordances do not only make the actions of a human-technology system possible, but their actualization creates new organizational practices, intentions and identities. Our research objective is thus to not only identify the affordances of m-BI, but also to pay attention to their performativity.

3 Research Method

In order to answer our research question – what are the affordances of m-BI? – we adopt a single case study research strategy (Eisenhardt, 1989). The case study approach allows us to generate the requisite level of empirical detail to understand how technology is used in practice, which then serves as the basis for deriving the relational entanglement between technology and intentional users. To gain insights into work practices in a situated and detailed manner, an interpretive, qualitative research method was deemed most appropriate (Walsham, 2006). Even though the actualized affordances change based on the context, materiality can set, to a certain degree, some limits on how action-possibilities provided by a certain technology can be interpreted by potential users (Treem and Leonardi, 2012), consequently leading to similarities of typical affordances across organizations.

Our case selection was opportunistic in the sense that a senior executive in EROL (pseudonym), a Scandinavian shoe manufacturer and retailer that had extensive experience in the BI and m-BI use, had close ties to our university, this paving the way for gaining research access. Given that EROL relied on the technology to support their sales managers, who represent the quintessential users of m-BI technology (Tona and Carlsson 2013), we reasoned that the affordance insights we would be able to

gain from their technology use would be not only essential to m-BI but also generalizable. Additionally, EROL's experience with traditional BI provided a useful point of contrast to m-BI, thus allowing us to identify differences between these rival instantiations of this class of technology.

3.1 Research Site

EROL was established in the 1950s, and in 2015, had about 1,400 employees and 300 retail outlets in Scandinavia. EROL designed, produced and sold men's, women's and children's shoes to consumers. To address its historical data integration and information quality issues, EROL implemented BI in 2008. In 2010, after two years of experience with traditional BI, EROL introduced a mobile BI app to its existing BI platform. The primary goal of this mobile extension of BI was to allow the regional sales managers, who were typically responsible for 20 stores and who thus spent at least 80% of their time on the road, to access the BI services at any time and from anywhere. In particular, it was hoped that by giving regional sales managers access to near real-time sales key performance indicators (KPIs), which were refreshed every 30 minutes, they would take more timely action when sales performance was lagging. KPIs included Hit Rate (the percentage of sales per customers visits), Average Receipt Amount (the value of cash per number of cash receipts), Sales per Region/Store, and Average Sales per Customer/Store.

EROL supplied its sales managers with mobile devices such as iPhone 4S, iPhone 5 and iPhone 6 on which the m-BI app was pre-installed. According to the CIO, around 200 smartphone devices were distributed since 2010 in order to facilitate the use m-BI. Yet, the correct number of active m-BI users was unclear because although the organization tracked the BI platform's use it did not distinguish among the devices used to access the data (i.e. desktops/laptops vs. mobile devices). In other words, it did not leverage the identifiability affordance (Cousins and Robey 2015).

In terms of connectivity, using the iPhone to access the BI system, was much simpler and faster than using a laptop because of the m-BI app that was available for the smartphone. This app made the necessary connections to the BI systems, whereas laptop users needed to connect to the BI system through the browser and make the requisite VPN connection manually. Thus, unless users were already using their laptops to interact with the BI platform, they were more likely to use m-BI via their smartphones.

Other than the size and the scaling of the displays, there was no difference between the m-BI and BI applications. The BI server recognized what device was generating the information request and then served the appropriate display. Moreover, the Oracle BI platform supported only descriptive analytics, making available mostly dashboards containing historical information. To generate additional insights from 'what-if' or goal seeking analyses or to develop predictive models, users had to export the BI reporting data to Excel and run these analyses separately when working in a laptop or desktop. Due to screen size, smartphones were generally not well suited to such ad-hoc analytic tasks.

3.2 Data Collection

Data collection in EROL took place between April 2014 and February 2015. Eleven face-to-face interviews were conducted with a total of 12 representatives from three user communities: regional sales managers, business managers and the IT team that supported the BI platform. The interviewees were evenly divided across these groups (see Table 1) and ranged in length from 35 to 75 minutes. All interviews were conducted one-on-one with the first author, with the exception of one interview where two people from IT support asked to be interviewed together.

The interviews followed a semi-structured protocol. Because the core of the affordance definition we adopt in this study consists of actors, technology capabilities and actions, we clustered interview questions into four major areas of interest: (1) questions about the user (e.g., What does a normal workday look like for you?); (2) questions on use scenarios (e.g., What is an example of how you have used m-BI? How did you feel using it?); (3) questions about the technical features of m-BI (e.g., How do you find connectivity in m-BI?); and (4) questions about the effects of m-BI (e.g., How has your job changed as a result of using m-BI?).

In addition to the interviews, we secured some BI system usage log data. These logs chronicle the date and time at which a given user requested a page on the BI platform and the queries to the data warehouse each page request generated. Unfortunately, the logs do not provide information on the device used to access the BI system. Moreover, we were supplied with internal documents that explained the technical features of the m-BI app and the implementation process. Additionally, some of the interviewees demonstrated how they used the m-BI app during their work.

| Data Source | Details |
|--|--|
| 11 Interviews (including 1 group interview) | <ul style="list-style-type: none"> - CIO (1) - Regional Managers (4) - Business area manager (1) - Purchasing manager (1) - Business controllers (2) - IT support team (3) |
| BI Usage logs | For all interviewees BI usage frequency based on: <ul style="list-style-type: none"> - Dashboard page access by day/hour <September 2014> - Aggregated Query count by day/hour <June 2014; September 2014> |
| Documents | <ul style="list-style-type: none"> - Technical features and capabilities of m-BI <7 pages> - Overview of EROL's BI journey <PowerPoint presentation, 34 slides> |
| Product demonstration | <ul style="list-style-type: none"> - BI demonstration <from CIO> - m-BI demonstration <from 5 m-BI users> |

Table 1. Sources of Data

3.3 Data Analysis

All interviews were recorded with the interviewees' knowledge and consent. After transcribing the interviews, they were uploaded into NVivo 11 for content analysis. Given the exploratory nature of this study, the novel domain of m-BI, and the need for further theorization, we followed a grounded, bottom up approach to capture any action-possibilities enacted by m-BI. The first author conducted a first round of coding using descriptive codes (Miles and Huberman, 1994). This entailed clustering interviewees' statements into emic themes while trying to limit the author's theoretically informed interpretation of these statements. The descriptive codes included the role of the user, technical features, use scenarios, usage frequency and user interaction. This initial coding helped the first author gain familiarity with the material in individual interviews, but also the similarities and differences across interviews. Based on the first author's familiarity with affordance theory, the prior research in BI and mobility, as well as a comprehensive understanding of the interview data, interpretive codes were developed (Miles and Huberman, 1994). Examples included curiosity, collective sense making, monitoring, be on the same page, quicker connectivity, quick glance, and updated sales information. The preliminary affordances, pattern codes, followed an iterative descriptive and interpretative coding (Miles and Huberman, 1994). The initial round of data analysis led to the identification of five affordances.

After an in-depth discussion of the data with the co-authors, we collectively determined that some of these affordances were insufficiently unique both respect to other affordances and to m-BI. After pinpointing the overlapping affordances, we worked collaboratively to identify the unique couples of user intentions and technical capabilities. Thus, the affordances' meanings were refined and as a result three affordances were synthesized. Naming the affordances was another repetitive task to be completed during the data analyses since their name needed to capture the inextricably intertwined nature of the human-technological action that is unique to m-BI and the task domain of decision making.

Additionally, the usage logs were analyzed for selected users in order to validate the results of our qualitative data analysis. The 'aggregated query count by day/hour' obtained via an SQL query of the log database was used to get a picture of a given user's sessions. Since the logs contained time stamps, dashboard page opened, path travelled, as well as the number of database queries a given page gener-

ated, we calculated the average duration of a session and average queries per session, and classified these according to when they occurred, i.e., during or outside of official work hours.

4 Findings

In this section for each affordance identified, we will describe the key technological features and user intention that create a given action potential available to the user-technology couple. It should however be noted that we treat the technological features in a somewhat cascading manner (Michael 2000), where basic capabilities – such as connectivity and bookmarking – are considered so foundational to the technology’s functioning, that they will not be considered explicitly in our discussion of the three affordances. Instead, we will highlight only the technological features that are key to each affordance (see Table 2 for summary).

| Key technological Features | User Intention | Unique capability beyond | | |
|--|---|---|---|---|
| | | Phone call | Traditional BI | E-Mail |
| <i>Cursory Scanning</i> | | | | |
| - Device size - Device design - Data visualization | Avoiding surprises by continuously staying apprised of latest organizational developments. | - Asynchronous. - Ability to get information without involvement of others. | - Staying informed any time and anywhere. - Scanning for insights without pressure to act immediately. | - Access to up-to-date information. - Ability to prioritize visuals based on information needs. |
| <i>Aligning Distributed Intelligence in Real Time</i> | | | | |
| - One version of data (Data Warehouse) - Data visualization with drill-down | Achieve shared understanding of information on BI and reconciling it with actual situation with distributed others. | Ability to develop own understanding of situation through direct interaction with data. | Just-in-time involvement in developing shared understanding with distributed others even while decision maker is on the road. | Distributed users have access to the same up-to-date information thus facilitating alignment across perspectives. |
| <i>Real-Time Performance Tracking</i> | | | | |
| - Data visualization with drill-down - Near real-time data | Ongoing, just-in-time monitoring of a decision’s effectiveness to determine need for adjustment. | Ability to track performance visually, especially over time and against goals. | Continuous monitoring outside of office hours. | Increased flexibility to monitor on an ongoing basis despite the users’ changing needs. |

Table 2. Summary of m-BI Affordances

Moreover, we compare action-possibilities afforded by m-BI against its closet rivals, that is, traditional BI and mobile technologies (e.g., phone calls and email), since m-BI lies at the intersection between them. By traditional BI, we mean accessing the platform through relatively stationary devices, i.e., either a laptop or a desktop computer, both of which are likely to be used in a more traditional office setting. By email, we envisage the delivery of periodic (e.g., daily) BI reports, which can be accessed from either mobile or more stationary devices. By phone calls, we envisage that individuals responsible for a decision are alerted via a call to their smartphone to anomalous situations that require their attention, or where decision makers who are on the road, call others with access to the BI system, to gather specific information.

4.1 Cursory Scanning

Cursory scanning is an action possibility of m-BI that enables users to stay informed of the organization’s performance outside of official working hours. Being able to access summary data quickly from

home before the start of the work day or on weekends, meant that users could prepare for their work day:

... every day in the morning when I wake up, I use it. For me it's a response to the last days and yesterday sales. I see that. And it's supportive to start the day with that (Business area manager)

The first thing I do when I open my eyes is [look at m-BI]...I think it's a habit. I mean, when I come to the office I see the figures, but I want to know before. (Purchasing Manager)

One of the motivations underlying the user's intention to 'know' the sales status 'before' they entered the workday or the workweek was to prepare themselves emotionally for the day:

How did the sales go so far on Saturday? Sometimes I go in and check that one so I am updated. When I come to work on Monday there's no surprise. I don't need to take time when I came back on Monday to check the sales. (Regional Manager)

We have information for everything. So I can see all the stores: store 1, store 2, every store [even though] I only have [responsibility for] store 1. So then I can compare, you know, everything. When I am at the store, for example if it's snowing then [I am like] 'oh my god we are not selling anything'. Then the next morning before I go to work... I just look at the Oracle. Everybody is 'oooo' [worried], but [I see that] everyone is the same [in terms of sales]. So I have full control before [I start working]. (Regional manager)

The m-BI app thus gave users a means of predicting what their workday would look like ('no surprises') and feeling like they were able to control a worrisome situation (i.e., below target sales) by using comparative sales data to develop a coherent story that explained the numbers (e.g., snow).

Furthermore, having one's curiosity satisfied by simply being able to look at the colors on the dashboards, which coded above-target performance as green and below-target performance in red, was another motivation underlying the user's intention to stay informed of the organization's performance outside of official work hours:

...in the morning, I am very curious how it went yesterday. I use it to see if there are really nice numbers or red (Regional Manager).

Relying on the interviewees' statements on the amount of time that they used m-BI on weekends and analysing the BI usage logs, we note that BI sessions were not only shorter outside of normal work hours (i.e., on the weekends and on weekdays before 8am and after 5pm), but that they were also limited to viewing the graphs as they appeared on the dashboard and forgoing the possibility of drilling down. This leads us to conclude that cursory scanning entailed a quick look at established dashboards.

The lack of user interaction with the BI data is indicative of the users' intention to not take immediate action. In other words, users just wanted to know what was going on especially with regard to sales, an activity that regularly occurred outside of headquarter's official work hours (i.e., on weekends and after 5pm on weekdays). The following quotes illustrate the absence of action in the users' intentions when they engaged in cursory scanning:

It was in the weekend now, I was very interested how the selling went on Saturday so I log on and watched the selling, I did nothing about it but I got the information (Business controller).

Interviewer: if you see that on Saturday and Sunday something is wrong, can you still call [the store]?

Regional Manager: No, no, absolutely not. We have to wait till Monday.

Even though the cursory scanning affordance was associated with deferred actions, it nevertheless produced an expectation that users be informed about the latest sales performance at all times:

I try to keep it away but I check my email and the sales figures (in m-BI)...everyday, on the weekend as well...[If EROL decided to take away this smartphone] it will be a problem for me, a very big problem. ... Things happen so fast... so if I am not updated every hour I can miss something. It is not enough to work all day and then come home at the computer and see what happened today. No, that does not work. I have to check it all the time. (Regional Manager)

The technological features that appear to be particularly salient in making cursory scanning available include the size and design of smartphones, as well as the data visualizations. Unlike a laptop or desk-

top with their external keyboards and mouse that creates implicit expectations for users to do something with the information they have gleaned – i.e., to take action – the size of smartphones and their reliance on virtual keyboards invites users to just read without an expectation to take action immediately (e.g., write an email to someone). Smartphones and tablets are therefore classified as “lean back” devices that encourage reading¹, while laptops and desktops are “lean forward” devices that encourage writing and action taking. Additionally, the ease and speed of access to m-BI dashboards through the app lowered the cost of looking for sales data simply to satisfy one’s curiosity or one’s desire to avoid (negative) surprises. If this action came at a higher cost, as it did with laptops in EROL, this affordance might be less available. It is in these two ways that cursory scanning is an affordance unique to m-BI, especially when compared to traditional BI.

Cursory scanning is not available in mobile telephony, because phone calls require the presence of at least two people. The coordination costs associated with gathering information in this manner, especially outside of official office hours, would make cursory scanning infeasible, especially when motivated by such personal goals as satisfying the user’s curiosity and helping him/her avoid surprises.

The email technology does not support cursory scanning in that information is sent periodically (e.g., daily), implying that the information presented is not sufficiently current to satisfy a user’s curiosity about the current state of affairs. Sending email updates more frequently would risk information overload as not every user on the distribution list value the information equally. Also, the interactive interface of m-BI allows users to go directly to the information they want to scan rather than page through a linearly arranged email report.

4.2 Aligning Distributed Intelligence in Real Time

Aligning distributed intelligence in real time represents the action possibility most frequently associated with and actualized in m-BI. It entails people, distributed across multiple environments (e.g., store managers in stores, regional managers on the road and controllers at head office), to come to a shared understanding of the data representing a specific empirical situation and the actual situation. In contrast to cursory scanning, this affordance is motivated by an orientation to gain an understanding of a situation immediately. Indeed, a key part of the user’s (i.e., decision maker’s) intent in aligning distributed intelligence in real time is to determine whether an intervention is needed:

I am out in the field and I got a call from the office and they say: ‘We can see that this store has a low turnover or something. Can you check it out?’ Ok. And then I stop the car, and I log in and I check it. Then I call the stores and say ‘I can see here that this turnover is low, do you know why?’ And then... I call the office again to say that I have checked it out. So, that’s when I use [m-BI]. (Regional manager)

We have made a phone call [to the Regional Manager]: ‘look at this.’ And then they are sitting in the car and they watch it and then they say ‘we must do something about it.’ (Business Controller)

These quotes illustrates one of the key characteristics of aligning distributed intelligence in real time: individual users, who are on the road and unaware of a given problem, develop their own, independent understanding of the empirical situation as represented by the BI system after they have been alerted to a troubling situation. Only when members of a distributed work team have formed their own assessments can a sense of collective intelligence be achieved through alignment. Importantly, this alignment also provides the decision maker some insight into the relative feasibility of alternative courses of action he/she may be contemplating.

In the examples illustrated above, it is the business controller who triggers the effort to align the distributed team. Since, the regional managers are responsible for the stores, they are the key decision makers that need to be alerted to a potential problem. Even though the regional manager may be on the road, a series of steps are taken to gather relevant intelligence and decide whether an intervention is necessary. First, the regional manager seeks to develop his/her own understanding by looking up in-

¹<http://www.informationweek.com/mobile/mobile-devices/microsoft-surface-keyboard-is-key/d/d-id/1107317>

formation on the m-BI system. With sufficient insight into the situation to ask the store manager appropriate questions and arrive at an agreed-upon understanding of the data and the actual situation, the regional manager can then get back to the controller to complete the alignment loop. The ability to access the same BI data as the controller and the store manager in a just-in-time manner is key to this intelligence alignment process.

It is also interesting to note, that the regional manager in the quote above, decided to interrupt his activities (e.g., pull his car over) to look at the data and call the store immediately. He seemed to accept that he needed to conform to the immediacy of information access that m-BI afforded by taking instant action (e.g., call the store manager). The following quote further expresses the information access imperative that this affordance produced, and the expectation that different stakeholders' understanding of a situation needed to be aligned before the need for an intervention could be determined:

I can see that if the 'hit rate' in the store is low, then I have to have a meeting with the store manager and the staff, to set goals for improving the 'hit rate' (Regional Manager)

Sometimes I can call the store manager if there is one store that stands out, or if I can see something that my region is not where it should be, I email all of the stores and tell them what I saw. (Regional Manager)

m-BI technology also made collaborative system use possible. For example, regional managers might use their continuous access to the m-BI system to retrieve specific information related to questions that arose during a store visit. The m-BI data immediately informed the situated, collective sense making that the store manager and the regional manager were engaged in as they tried to determine whether there was a problem that needed to be solved:

For example, yesterday I open it to check how many pairs of shoes we have in stock in the store where I was. So, I checked directly on my mobile... We were discussing how the stock situation was, that's why I checked. Then I compared that information with last year, how was that day in comparison with the last year. (Regional Manager)

As this quote highlights, the regional manager explored multiple views of the data, including comparisons of stock levels across time periods. Features such as drill-down that enabled further inquiry of summary data visualizations, made this affordance available from a technical point of view.

Another technological capability key to aligning distributed intelligence in real time was the data warehouse, which ensured that everyone in the intelligence alignment effort was looking at the same data. This meant that little time was wasted reconciling conflicting data; instead, users could focus on coming to a shared understanding of the data's meaning by reconciling stakeholders' disparate interpretation of the empirical situation and its representation in the BI system. With a 30-minute refresh rate, the data available to m-BI users was nearly real-time.

By way of summary, aligning distributed intelligence in real time is only possible in a context in which a decision maker who is on the move, reaches a shared understanding with other relevant stakeholders based on the data made available through m-BI. Mobile telephones would make it difficult for users to gain their own understanding (i.e., un-mediated by others) of the situation and to explore the data in more detail (e.g., visualize trends, drill down). The immediacy with which the intelligence of distributed stakeholders can be accessed such that alignment can be achieved in real time would not be feasible in a BI platform without mobility. Furthermore, periodic BI reports sent via email would not contain sufficiently up-to-date information for a decision maker who is on the move to gain insights that are reliable enough such that he/she is able to form his/her own opinion on a situation.

4.3 Real-Time Performance Tracking

Real-time performance tracking describes the engagement with m-BI to assess on a continuous basis the results of a given decision that has been made. Different use cases illustrated how m-BI users enacted this affordance immediately after a significant intervention had been put into effect e.g. a campaign or changing the display of a store:

...we have new shoes to market so we go and put them in magazines. And it's on Tuesday ... Then [on Tuesdays] I look on the iPhone and see what's happening. Are we having better sales or not? And that's a sign for me to say it works out or not.... And if it doesn't work then what's the problem: is it the weather or was it something wrong with the product we put in the newspaper... We analyze that...(Business Area Manager)

While the real-time tracking affordance allowed decision makers to assess how choices they had made were faring from the moment they were implemented, it also created expectations that all decisions be evaluated immediately. This implied that the assumptions and hypotheses underlying a decision needed to be defined in terms that were measurable in the BI system. Furthermore, there was an expectation that changes would be made as soon as the outcomes were not favourable. Waiting even one day to take corrective action was considered wasteful when poor performance was visible immediately:

I have education in the store [with the staff], we have done everything we can, and every routine is good. And then we are waiting for one shoe sale...one that is not that good. During the day, if I am not there I can follow it [through m-BI]. So I know and I can take action immediately... Then I call them. Or I can talk to others who are in the project: 'we have to do something tomorrow'. We don't have to wait until the day after. So, 'ok how did it go?' So that's the good part. It saves time (Regional Manager).

This performance tracking affordance highlights an orientation towards instant action to remedy disappointing results associated with a given decision. While no action was necessary when KPIs were trending in the right direction or exceeded certain benchmarks, action was imperative at the first sign that the implemented strategy was not working as well as anticipated. The key technology feature that made real-time performance tracking possible was the timeliness of the data that was presented on the BI platform and the users' ability to access this data anytime and anywhere, especially after office hours and on weekends, which tended to be when considerable sales volumes were transacted.

Compared to its closest rivals, the visualization of trends and performance against goals gave m-BI users considerably more diagnostic insight into a decision's current performance than snapshot data that a phone call might provide. The static reports sent via email were neither sufficiently customizable nor timely enough to meet users' changing monitoring needs.

5 Discussion

Motivated by the hype around m-BI and the ambiguity surrounding its value-generating potential in organizations, we identified three affordances that constitute this paper's key contribution: cursory scanning, aligning distributed intelligence in real time and real-time performance tracking. Unlike most prior studies on affordances (a notable exception being Strong et al., 2014), we articulate clearly the three elements that define the action possibilities made available to a technology-user system. These are the technology's features, the user's intentions, and how the affordance made available by a given technology distinguishes itself from the action possibilities of the technology's closest rivals (see Table 2). Furthermore, we consider the performative effects of these affordances, that is, the behavioural expectations, practices and realities they produce (Orlikowski 2008).

Figure 3 provides a graphical summary of the relationship among the three affordances. Two main dimensions are illustrated: the action orientation (y-axis) and the breadth of information considered in the action possibility. The latter is represented by the tapered shape of the inverted triangle. As the arrangement of the three affordances in Figure 3 shows, their respective information breadth narrows and the degree of action orientation increases as one moves through this funnel-shaped arrangement of the m-BI affordances.

With regard to action orientation, we note that a desire to stay informed and avoid surprises, which is enacted in cursory scanning (especially outside office and working hours), connotes a low degree of action orientation. Akin to conditioned viewing (Aguilar, 1967) where information has a broad if not unfocused scope, the cursory scanning affordance represents a general form of scanning limited by users' interest and knowledge.

Reflective of informal search triggered by a stimulus (Aguilar, 1967), aligning distributed intelligence in real time is frequently triggered by an alert that is generated either by the system (e.g., red indicator) or a user (e.g., controller calling the regional manager). A shared understanding on a specific, potentially problematic situation, that is reached among distributed others, is used to determine if any actions are needed. Even though an exploration of the issue might involve additional inquiries through drill-downs, a narrower information breadth is involved when compared to cursory scanning.

The real-time performance tracking limits itself to assessing the effectiveness of a specific decision, intervention or initiative. The action orientation in this affordance is higher than aligning distributed intelligence in real time, because the goal of tracking information that measures the decision's performance in real-time is to take instant and largely pre-meditated action when the outcomes are disappointing. In this case, the breadth of information considered becomes even narrower as only information pertaining to a given decision's effectiveness is deemed relevant.

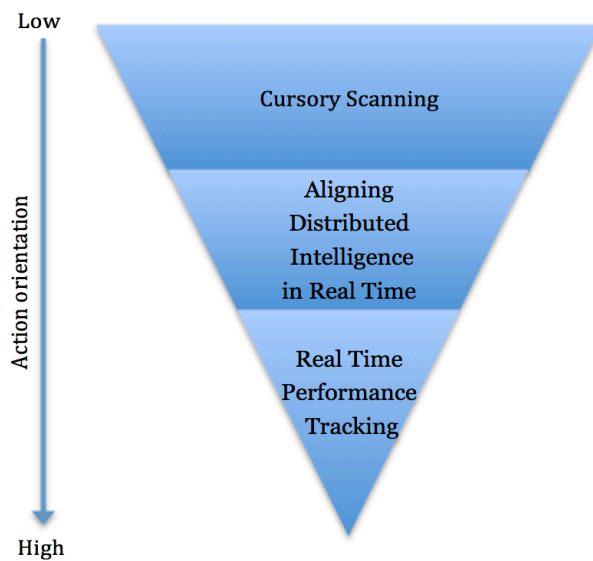


Figure 3. Relationships among m-BI Affordances

In terms of assessing the potential benefits of m-BI, the three affordances align well with Simon's (1977) model of decision making. Cursory scanning falls squarely into the intelligence phase, whereas aligning distributed intelligence in real time seems to address mostly the intelligence phase but also some aspects of design. Even though the primary intention of the aligning distributed intelligence in real time affordance is to achieve a shared understanding of the information in the BI system and reconciling it with actual situation, it is through the engagement with distributed others that the decision maker gains some insight into the feasibility of alternative courses of action. As such, this affordance provides very limited support for the design phase. The real-time performance tracking affordance, in turn, addresses the review phase in Simon's (1977) model. While we note the limited and the lack of support of m-BI respectively for the design and choice phase of the decision-making process, we also recognize that EROL's BI platform did not include predictive analytics and that the small screen size of mobile devices makes complex, ad-hoc data analyses all but infeasible (Tona and Carlsson, 2013).

Based on this alignment between the affordances and the decision making process, we note that decisions making should speed up with m-BI. As the cursory scanning affordance highlights, users were staying informed outside of work hours so that they would not have to spend time gathering data during official work time and that they could prepare themselves cognitively and emotionally for the decisions they would have to make during office hours. Aligning distributed intelligence in real time implied an urgency to develop a shared understanding; sales managers were expected to interrupt what they were doing (e.g., driving) and respond to anomalous situations by aligning with distributed others immediately (e.g., calling the stores). Thus, delays in bringing distributed people together into collective sensemaking were minimized, making it possible to determine a need for action more quickly.

Real-time performance tracking was also infused with a sense of urgency and inevitability: at the first sign of disappointing results, it was expected that a change would be made.

However, the actualization of the affordances also produced sales managers of a certain type, i.e., people who stayed informed even outside of normal work hours. This implies that affordances, when actualized, generate benefits not only through process improvements, but also through changes in user's sense of who they should be. By taking a performative perspective and highlighting that technologies constitute people, just as people constitute technology (Orlikowski and Scott, 2008), our study has gone beyond the typical affordance research. We have done so by showing that user intentions (i.e., human agency) generated three affordances from m-BI's technological capabilities by assigning certain meanings to them (e.g., immediacy, one version of the truth). However, these same technological features (i.e., material agency) produced employees who felt compelled to check sales performance dashboards outside of official work hours, to interrupt other activities in order to attend immediately to missed performance targets, and to take corrective action at the first sign of sub-par results.

The affordances we identified also have implications for the design and architecture of m-BI technologies that organizations should consider when implemented a m-BI solution. In terms of information design, to support cursory scanning m-BI designers should present the information in visualized forms that make it possible to gain key insights at a glance without requiring further drill-downs. However, for real-time performance tracking, a dynamic time dimension should be added, as well as the ability to filter and customize content and to configure personalized alerts. Additionally, m-BI designers should create technological capabilities that support the design and choice phase of the decision making process. While screen sizes are unlikely to become bigger in the mobile space – if anything, they are likely to shrink – sophisticated analytical tools might rely on analytics and artificial intelligence to determine the kind of analytics a user would be likely to need in order to support his/her decision in a given instance. To ensure system responsiveness especially during time-critical performance tracking, special design consideration will need to be given to the system architecture, especially in a resource-constrained technological infrastructure. It might therefore be useful to separate the infrastructure that serves up general-purpose dashboards that satisfy users' sense of curiosity from those that serve performance indicators specific to a given decision.

Our research contributions need to be considered in light of this study's limitations. While the case study approach is appropriate for developing affordances in their social context and EROL represents a typical retailer seeking to leverage m-BI technology today, our data set is somewhat limited. Access to more m-BI users and their usage logs over an extended period of time (especially given retail's seasonality), as well as the ability to ethnographically observe m-BI users, would have boosted the validity of our findings. Nevertheless, the fact that our three affordances, which were developed in an inductive, grounded manner, map onto Simon's (1977) model of decision making well, inspires confidence in the validity of our results. Nevertheless, future research is needed to determine the generalizability of these affordances (e.g. other case studies) and their usefulness in determining how m-BI generates organizational value.

6 Conclusion

The concept of affordance is garnering considerable interest in the field of IS as it provides a conceptual infrastructure for sociomaterial theorizing (Faraj and Azad, 2012). Borrowing heavily from Majchrzak et al. (2013: 39), our definition of affordances reads “the mutuality of actor intensions and technology capabilities that provide the potential for a particular action that is distinct when compared to its closest technological rivals.” Guided by this definition, we identified three affordances in this study: cursory scanning, aligning distributed intelligence in real time and real-time performance tracking. Ranging from a low to a high action orientation degree, the affordances provide primarily support to the intelligence and review phase of the decision-making process. The choice phase has no support, even though the support for the design phase is very limited.

References

- Aguilar, F. J. (1967). *Scanning the business environment*: New York : Macmillan.
- Arnott, D. and G. Pervan (2008). "Eight key issues for the decision support systems discipline". *Decis. Support Syst.* 44(3), 657-672.
- Arnott, D. and G. Pervan (2014). "A critical analysis of decision support systems research revisited: The rise of design science". *Journal of Information Technology* 29(4), 269-293.
- Brooks, D., H. Rupani and M. Padmanaban. (2013). *Optimizing patient flow at Johns Hopkins hospital* [Online]. <http://tdwi.org/Articles/2013/09/09/CASE-STUDY-Optimizing-Patient-Flow-at-Johns-Hopkins-Hospital.aspx?Page=1> [Accessed November 2014].
- Chaudhuri, S., U. Dayal and V. Narasayya (2011). "An overview of business intelligence technology". *Communications of the ACM* 54(8), 88-98.
- Chen, H., R. H. Chiang and V. C. Storey (2012). "Business intelligence and analytics: From big data to big impact". *MIS Quarterly* 36(4), 1165-1188.
- Choo, C. W. (2001). "Environmental scanning as information seeking and organizational learning". *Information Research* 7(1), 7-1.
- Choudhury, V. and J. L. Sampler (1997). "Information specificity and environmental scanning: An economic perspective". *MIS quarterly* 25-53.
- Costall, A. (1995). "Socializing affordances". *Theory & Psychology* 5(4), 467-481.
- Cousins, K. and D. Robey (2015). "Managing work-life boundaries with mobile technologies". *Information Technology & People* 28(1), 34-71.
- Das, D. a. S. (2014). Mobile computing/mobile business intelligence market study. *Wisdom of Crowds Series*.
- Das, D. a. S. (2015). Mobile business intelligence market study. *Wisdom of Crowds Series*.
- Earl, J. and K. Kimport (2011). *Digitally enabled social change: Activism in the internet age*, Cambridge, MA: MIT Press.
- Eisenhardt, K. M. (1989). "Building theories from case study research". *Academy of management review* 14(4), 532-550.
- El Sawy, O. A. (1985). "Personal information systems for strategic scanning in turbulent environments: Can the ceo go on-line?". *MIS Quarterly* 9(1), 53-60.
- El Sawy, O. A. and T. C. Pauchant (1988). "Triggers, templates and twitches in the tracking of emerging strategic issues". *Strategic Management Journal* 9(5), 455-473.
- Faraj, S. and B. Azad (2012). The materiality of technology: An affordance perspective. In: Nardi, L. B. & J., K. (eds.) *Materiality and organizing: Social interaction in a technological world*. NY City: Oxford University Press.
- Gao, S. (2013). "Mobile decision support systems research: A literature analysis". *Journal of Decision Systems* 22(1), 10-27.
- Gibson, J. J. (1979). *The ecological approach to visual perception*, Boston: Houghton Mifflin
- Hislop, D. and C. Axtell (2007). "The neglect of spatial mobility in contemporary studies of work: The case of telework". *New Technology, Work and Employment* 22(1), 34-51.
- Hosack, B., D. Hall, D. Paradice and J. Courtney (2012). "A look toward the future: Decision support systems research is alive and well". *Journal of the Association for Information Systems* 13(5), 315-340.
- Hou, W. and S. Gao. (2017). "Managerial use of mobile business intelligence: An exploratory study". In: *Proceedings of the Pacific Asia Conference on Information Systems*.
- Hutchby, I. (2001). "Technologies, texts and affordances". *Sociology* 35(2), 441-456.
- Majchrzak, A., S. Faraj, J. Kane and B. Azad (2013). "The contradictory influence of social media affordances on online communal knowledge sharing". *Journal of Computer Mediated Communication* 19(1), 38-55.
- Markus, M. L. and M. S. Silver (2008). "A foundation for the study of it effects: A new look at desanctis and poole's concepts of structural features and spirit". *Journal of the AIS* 9(10/11), 609-632.

- Mazmanian, M. A., W. J. Orlikowski and J. Yates (2005). Crackberries: The social implications of ubiquitous wireless e-mail devices. Designing ubiquitous information environments: Socio-technical issues and challenges. Springer.
- Mikalef, P., I. O. Pappas, J. Krogstie and M. Giannakos (2017). "Big data analytics capabilities: A systematic literature review and research agenda". *Information Systems and e-Business Management*.
- Miles, M. B. and A. M. Huberman (1994). *Qualitative data analysis: An expanded sourcebook*, Thousand Oaks, CA: Sage.
- Mintzberg, H., D. Raisinghani and A. Théorêt (1976). "The structure of 'unstructured' decision processes". *Administrative Science Quarterly* 21(2), 246-275.
- O'donnell, P., S. Sipsma and W. Carolyn (2012). The "hot" issues in business intelligence: The view of practitioners. In: Respício, A. & Burstein, F. (eds.) Fusing decision support systems into the fabric of the context. Amsterdam: IOS Press.
- Orlikowski, W. J. (2007). "Sociomaterial practices: Exploring technology at work". *Organization studies* 28(9), 1435-1448.
- Orlikowski, W. J. and S. V. Scott (2008). "10 sociomateriality: Challenging the separation of technology, work and organization". *The academy of management annals* 2(1), 433-474.
- Palen, L. (2002). "Mobile telephony in a connected life". *Communications of the ACM* 45(3), 78-82.
- Peters, T., A. Popovič, O. Isik and H. Weigand (2014). The role of mobile bi capabilities in mobile bi success. *ECIS 2014 Proceedings*. Tel Aviv.
- Power, D. J. (2013). "Mobile decision support and business intelligence: An overview". *Journal of Decision Systems* 22(1), 4-9.
- Ramiller, N. C. (2001). "'Airline magazine syndrome' reading a myth of mismanagement". *Information Technology & People* 14(3), 287-303.
- Sheng, H., F. F.-H. Nah and K. Siau (2005). "Strategic implications of mobile technology: A case study using value-focused thinking". *The Journal of Strategic Information Systems* 14(3), 269-290.
- Silver, M. S. (1991). *Systems that support decision makers: Description and analysis*: John Wiley & Sons, Inc.
- Simon, H. (1976). "Administrative behavior: A study of decision-making processes in administrative organization".
- Simon, H. A. (1977). *The new science of management decision / herbert a. Simon*: Englewood Cliffs, N.J. : Prentice-Hall, cop. 1977
- Rev. ed.
- Strong, D. M., S. A. Johnson, B. Tulu, J. Trudel, O. Volkoff, L. R. Pelletier, I. Bar-On and L. Garber (2014). "A theory of organization-e-hr affordance actualization". *Journal of the Association for Information Systems* 15(2), 53.
- Tona, O. and S. Carlsson. 2013). "The organizing vision of mobile business intelligence". In: *Proceedings of the 21st European Conference on Information Systems*.
- Treem, J. W. and P. M. Leonardi (2012). "Social media use in organizations: Exploring the affordances of visibility, editability, persistence, and association". *Communication yearbook* 36143-189.
- Volkoff, O. and D. M. Strong (2013). "Critical realism and affordances: Theorizing it-associated organizational change processes". *Mis Quarterly* 37(3), 819-834.
- Walsham, G. (2006). "Doing interpretive research". *European journal of information systems* 15(3), 320-330.
- Watson, H., B. Wixom and B. Yen (2013). "Delivering value through mobile bi". *Business Intelligence Journal* 18(1), 4-7.
- Watson, H. J. (2009). "Tutorial: Business intelligence-past, present, and future". *Communications of the Association for Information Systems* 25(1), 39.
- Watson, H. J. (2015). "Tutorial: Mobile bi". *Communications of the Association for Information Systems* 37(1), 29.

- Watson, H. J. and B. H. Wixom (2007). "The current state of business intelligence". *Computer* 40(9), 96-99.
- Wen, W., Y. Chen and H. Pao (2008). "A mobile knowledge management decision support system for automatically conducting an electronic business". *knowledge-based systems* 21(7), 540-550.
- Yuan, Y., N. Archer, C. E. Connelly and W. Zheng (2010). "Identifying the ideal fit between mobile work and mobile work support". *Information and Management* 47(3), 125-137.
- Zammuto, R. F., T. L. Griffith, A. Majchrzak, D. J. Dougherty and S. Faraj (2007). "Information technology and the changing fabric of organization". *Organization Science* 18(5), 749-762.