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## THE AFFORDANCE-ACTUALIZATION PROCESS IN A PREDICTIVE POLICING CONTEXT: INSIGHTS FROM THE FRENCH MILITARY POLICE

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# THE AFFORDANCE-ACTUALIZATION PROCESS IN A PREDICTIVE POLICING CONTEXT: INSIGHTS FROM THE FRENCH MILITARY POLICE<sup>1</sup>

*Research paper*

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## Abstract

*Drawing on the Affordance-Actualization Theory (AAT), our article addresses the following research question: how do the affordances of a predictive analytics are actualized? We aim at providing a conceptual framework of the affordance-actualization process which works to advance our understanding of the way actors and a predictive system interact to actualize affordances. We employed an exploratory multisite case study focusing on a predictive policing system recently implemented in French military police – Gendarmerie. Based on the qualitative content analysis of datasets gathered over an 18-month, we show that the actualization process of affordance rests on different patterns of uses developed by police officers in interaction with associated outcomes. We further highlight how these patterns-of-uses-outcomes interactions result in non, partial or full actualization of perceived affordances.*

*Keywords: Affordance, Actualization, Patterns of uses, Predictive Analytics, Predictive Policing.*

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## 1 Introduction

Recent technological developments have given rise to predictive analytics. Based on artificial intelligence and learning algorithms, predictive analytics generate hidden trends and patterns from big data or large datasets to make predictions about future events and/or behaviours (Shmueli & Koppius, 2011; Delen & Zolbanin, 2018; Lehrer et al., 2018). They provide organizations with dynamic predictions, in order to guide their future actions and push them to become more responsive (Grover et al., 2018).

As noticed by Shmueli and Koppius (2011), there is a “near-absence of predictive analytics in mainstream empirical IS research” (p. 554). This lack of concern from MIS literature is surprising given the transformative effects of predictive analytics on work and organizing (Orlikowski & Scott, 2016; Schildt, 2017). Predictive analytics challenge existing “frameworks that ontologically separate between people and things [and ...] blur the line between user and technology, human and technological agency” (Faraj et al., 2018, p. 68). Our article offers insights on predictive analytics by questioning how actors actualize their perceived affordances to achieve their professional goals.

A promising way to analyse this affordance-actualization process is provided by Strong and her co-authors in 2014. They investigate the iterative process of “affordances as potentials for action and actualization as actions taken by individuals to realize those potentials” (p. 54). Strong et al. (2014) develop the affordance-actualization theory (AAT). The AAT investigates the temporal construction and evolution of affordance-actualization over time (Mallampalli et al., 2018) by studying the respective roles of technology, actors and work practices in organizational context.

Notwithstanding its significance, IS-affordances-actualization research, included that of Strong et al. (2014), does not sufficiently distinguish affordance and the actualization of affordance (Du et al., 2019). Moreover, the literature on affordance has been so far “inconsistent in carefully distinguishing the outcome of affordance actualization from the affordance itself” (Leidner et al., 2018, p. 119). Such confusions complicate the comprehension of the affordance-actualization interactions. Especially, it is difficult to understand how affordances are actualized, and what actors concretely do with the technology to achieve their goals. With a few exceptions, notably in a recent study by Du et al. (2019), prior literature has not considered this gap and the black box of the affordance-actualization process remains to be opened.

In line with this purpose, our article aims at providing a conceptual framework of the affordance-actualization process which works to advance our understanding of the way actors and predictive analytics interact to actualize affordances. This prompts the following research question: how do the affordances of a predictive analytics are actualized?

Our article develops a qualitative research on the in-depth study of a single case which focuses on a predictive policing system recently implemented in eleven territorial department units of the French military police – Gendarmerie. This system provides police forces with crime mapping data about futures crimes. Our sample consists of 14 individual semi-structured interviews with predictive policing system users, on-site direct observations of the system interface, requests and uses as well as archival records from professional and press articles. We gathered these multifaceted datasets over an 18-month field investigation.

Our results drive to suggest a conceptual framework which shows that the actualization process of affordance rests on different patterns of uses developed by police officers in interaction with associated outcomes. We further highlight how these patterns-of-uses-outcomes interactions result in non, partial or full actualization of the perceived affordances.

In what follows, the article presents the theoretical underpinnings of this work based on the concepts of affordance, actualization and the AAT (Strong et al., 2014). It then details the empirical context of this research, the French Gendarmerie predictive policing system named PAVED, and the methods carried out, an exploratory multisite case study. The findings elaborate upon two different perceived

affordances, distinctive patterns of uses and feedbacks to explain the actualization process. The article finally discusses the meaning of these contrasting findings.

## 2 Literature review

According to seminal research in ecological psychology (Gibson, 1979, 1986), the concept of affordance specifies the range of possible activities available in the environment to an actor. Affordances are relational for Gibson, reflecting a potential action linked to actor-environment relationships. Affordances are preconditions for action, but do not “imply that the activity will occur, although it contributes to the possibility of that activity” (Greeno, 1994, p. 340).

The Gibson view of affordance is labelled “real affordance” by Norman (1999), which distinguishes it from what he calls “perceived affordance”. Real affordance needs to be perceived to become a possible action. As a cognitive engineering scholar, Norman deeply roots his comprehension of perceived affordance in a design approach: “the-affordance-is-in the-object” (Faraj & Azad, 2012, p. 247). In that sense, perceived affordance of a designed object is viewed as suggestion(s) of how to interact with it in a certain way (Volkoff & Strong, 2013). An actor engaged with a specific object perceives and interprets its potential from his/her own previous experience and know-how (Norman, 1988, p. 219). The perceived affordance is thus dependant of the actor knowledge and skills.

In IS studies, the last few years have witnessed a growing prevalence of the affordance lens, especially to investigate the transformative effects of digital and emerging technologies on work and organizing. For example, Vaast et al. (2017) embrace the affordance perspective to examine how social media use affords new forms of collective engagement during organizational crisis. More recently, Krancher et al. (2018) employ the concept of affordance to explain how the use of platform-as-a-service (PaaS) changes technology-mediated collective learning activities. Finally, Lehrer et al. (2018) demonstrate how big data analytics afford human-material customer-sensitive service practices. Despite the richness of such research, the concept of affordance is described in manifold ways (Leidner et al., 2018), and it is not always easy to understand whether authors adopt the Gibson view of real affordance or rely rather on the concept of perceived affordance (Faraj & Azad, 2012).

This article embraces the Norman comprehension of affordance, recognizing that “the materiality of an object favours, shapes, or invites, and at the same time constrains, a set of specific uses” (Zammuto et al., 2007, p. 752). Perceived affordances are tie to constraints, which limit potential usages to those intended. Affordance and constraints let actors use knowledge in the world rather than knowledge in the head (memory from experience) (Norman 1988, chapter 3). In that way, technology affordance refers to perceptions of a range of opportunities about how material properties and functionalities of a technology could be possibly used in a given context (Leonardi, 2011, 2013; Mettler et al., 2017). Technology affordance gives equal play to the material and the social (Leonardi, 2011, 2013; Vaast et al., 2017), relying on the symbiotic relationship between the materiality of technology and the potential actions individuals could perceive and take. As Cabitza and Simone (2012) show, actors perceived technology affordance “in virtue of the previous knowledge they applied and acquired during similar activities on how these affordances could support their current activity” (p. 15). They are able to recognize an affordance as they link it with the specific properties of the technology as well as their own experience and practical goals (Pozzi et al., 2014, p. 7). Technology affordance is recognized by an actor prior to technology use.

These last few years, some IS scholars examine the practical and immediate usability of affordance, exploring the process of realizing the value of a technology affordance (Bernhard et al., 2013; Strong et al., 2014; Burton-Jones & Volkoff, 2017; Lehrer et al., 2018; Leidner et al., 2018; Du et al., 2019; Chan et al., 2019; Dremel et al., 2020). The authors distinguish affordance from its actualization. The actualization of affordances occurs when actors “take advantage of one or more affordances through their use of the technology to achieve immediate concrete outcomes in support of organizational goals” (Strong et al., 2014, p 70). By stressing that affordance and actualization are different, such contributions refute the idea that technology affordance is *de facto* actualized (e.g. Mettler et al., 2017). Instead, they advance

that the perceived potential of a technology – perceived affordance or being aware of the existence of an action possibility – can be actualized – realized or turned into action –when an actor effectively uses a technology to achieve his practical goals (Burton-Jones & Volkoff, 2017; Chan et al., 2019, p. 580).

Strong et al. (2014) provide a thorough contribution thereon, studying the effects of an Electronic Health Record (EHR) on work practices in a multisite medical group. They develop the Affordance-Actualization Theory (AAT), which explains the process of transformation of affordances into uses (goal-oriented actions) taken by actors to realize those potentials. From the discovery of 8 affordances, Strong et al. describe the way the actors and EHR interact in use to actualize each of these affordances. For example, affordance 1 – capturing and archiving digital data about patients – is actualized through the interaction of a specific use – recording all appropriate data about patients and interactions with them in the EHR – and specific immediate concrete outcomes – including avoiding legal liabilities and providing high quality and safe patient care. With their research, Strong et al. show that actors interact with the system in developing purposeful uses needed to actualize an affordance.

Notwithstanding the relevance of AAT and affordance-actualization contributions broadly, there is still a need to better distinguish affordances and the actualization process of affordance (Du et al., 2019). Moreover, the literature on affordance has been so far “inconsistent in carefully distinguishing the outcome of affordance actualization from the affordance itself” (Leidner et al., 2018, p. 119). In spite of a conceptual separation between these two elements in word, they are often mingled and not always clearly posed in the IS literature (Bernhard et al., 2013, p. 5). Such inconsistencies complicate the comprehension of affordance-actualization interactions. Especially, it is difficult to understand how affordances are actualized, and what actors concretely do with the technology to achieve outcomes. Given such limitations, Du et al. (2019) recently refined the AAT. Focusing on blockchain technology, they explain how designers and future users explore use cases of a blockchain, before its implementation in organization, during what they call an “experimentation phase”. This exploration aspect of affordance is not covered in the AAT as the Strong et al. theory is not be readily applicable to the implementation of emerging technology. The Du et al. (2019) contribution thus paves the way for future research interested in opening the black box of the affordance-actualization interactions.

In line with this purpose, our article aims at providing a conceptual framework of the affordance-actualization process which show what actors do when they interact with a predictive system to actualize affordances. To do so, the article develops a case study related to a predictive policing system newly implemented in eleven territorial department units of the French Gendarmerie – that is military Police in France – and labelled PAVED.

### **3 Research context and methods**

#### **3.1 The French predictive policing system, PAVED**

“Predictive policing refers to any policing strategy or tactic that develops and uses information and advanced analysis to inform forward-thinking crime prevention” (Uchida, 2012, p. 1). The overall purpose of predictive policing is to provide police forces with crime mapping data and analysis about futures crimes. Based on learning algorithms techniques, future crime maps are extracted from historical data and previous crime patterns (Tayebi & Glässer, 2016).

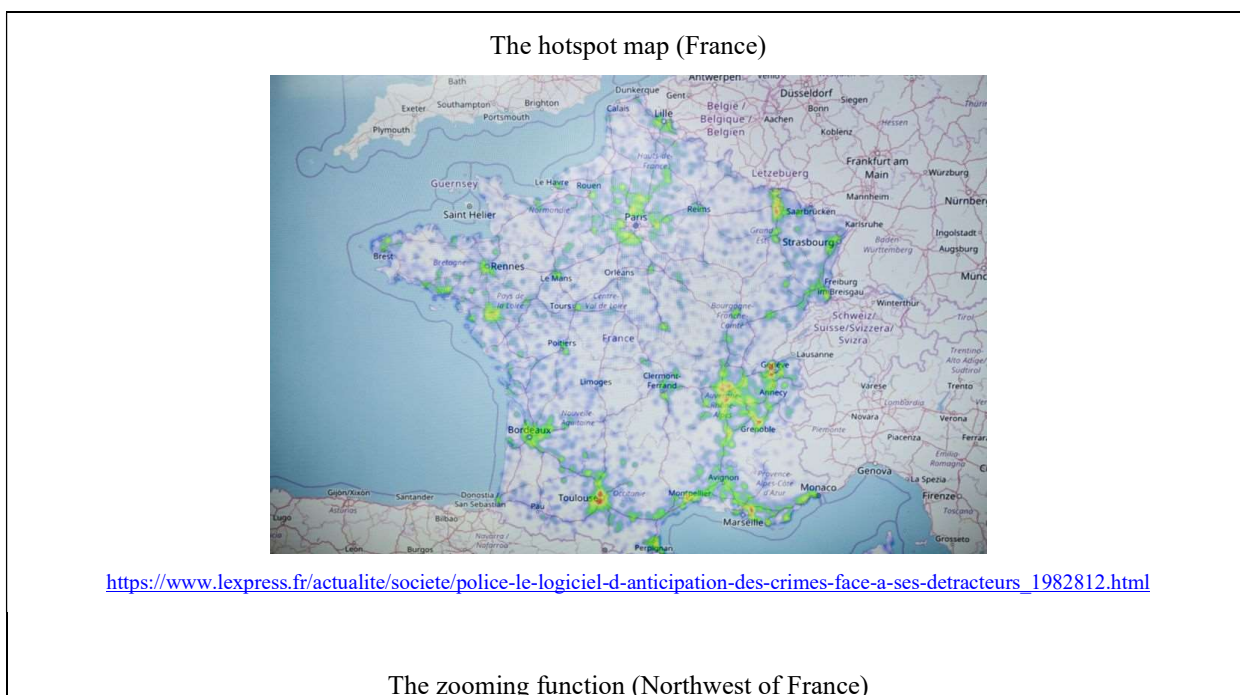
Predictive policing systems are mostly based on the near-repeat theory (Ferguson, 2012), which posits that once a particular location has been subject to a crime, it is statistically more likely that this location will be subject to additional crimes during a brief time frame (Farrell & Pease, 1993; Ratcliffe & Rengert, 2008). The statistical processing of historical data relating to specific crimes produces spatio-temporal clusters (called hotspots) localized on a map. Clusters suggest an inference that these crimes are likely to occur in the near future and around the same location.

As Ferguson (2012) shows, “if police can identify a location of potential crime and understand the relevant environmental factors for that predicted crime, then police can focus their resources on those

locations as future problem areas for police attention” (p. 275). For example, lowlight conditions at night in a secondary residence district are environmental factors that can explain why the area is identified as a hotspot on the predictive map. Provided with these maps, police officers are supposed to shift from a passive or a reactive stance characterized by answering calls for service and random patrol to a proactive approach by developing specific solution using careful analysis of local problems and conditions (Coldren et al., 2013).

In September 2017, 11 territorial departments (out of a total of 101) units of Gendarmerie – the French military police – have been fitted with a predictive policing system labelled “PAVED”. In the French Gendarmerie, a territorial department consists of one headquarter, five to six Gendarmerie compagnies and dozens of brigades, that is hundreds of potential users (PAVED is not a mandatory system: police officers have the choice to use it or not in their daily operational activities). The system has been designed by the Central Service of Criminal Intelligence, a French Ministry of Interior service. As most of the predictive policing system, PAVED is based on the near-repeat theory: the system produces spatio-temporal hotspots from the statistical processing of historical data. Two main types of data are processed by the system: closed data coming from the French Ministry of interior databases, related to the entire facts of domestic and commercial burglaries as well as car thefts over the last seven years; and open data provided by INSEE (the French national institute of statistics and economic studies) databases, referring to socio-economic factors. For example, the system processes data related to space and building year of private home, number of private homes by district, number of vehicles owned by households, etc. Data is monthly updated. The data treatment process is based on different stages of data collection and cleaning, data analysis and modelling (from a supervised learning algorithms), and visual representation.

PAVED focuses on domestic and commercial burglaries as well as car thefts. The system consists of three main predictive data visualization functions (Figure 1). A hotspot map depicts coloured areas, indicating the level of risk of a burglary or a car theft in the near future around different locations. Areas coloured in red or orange indicate high-risk zones, while green and blue areas show lower risks zones. In addition to the hotspot map, research of specific areas in clearly defined time slots as well as zooming functions allow acquiring a localized and detailed view of districts and streets. Due to a regular refreshing of data, the hotspot map is monthly updated. Users have an anytime access to PAVED, but from their professional desktop computer only.





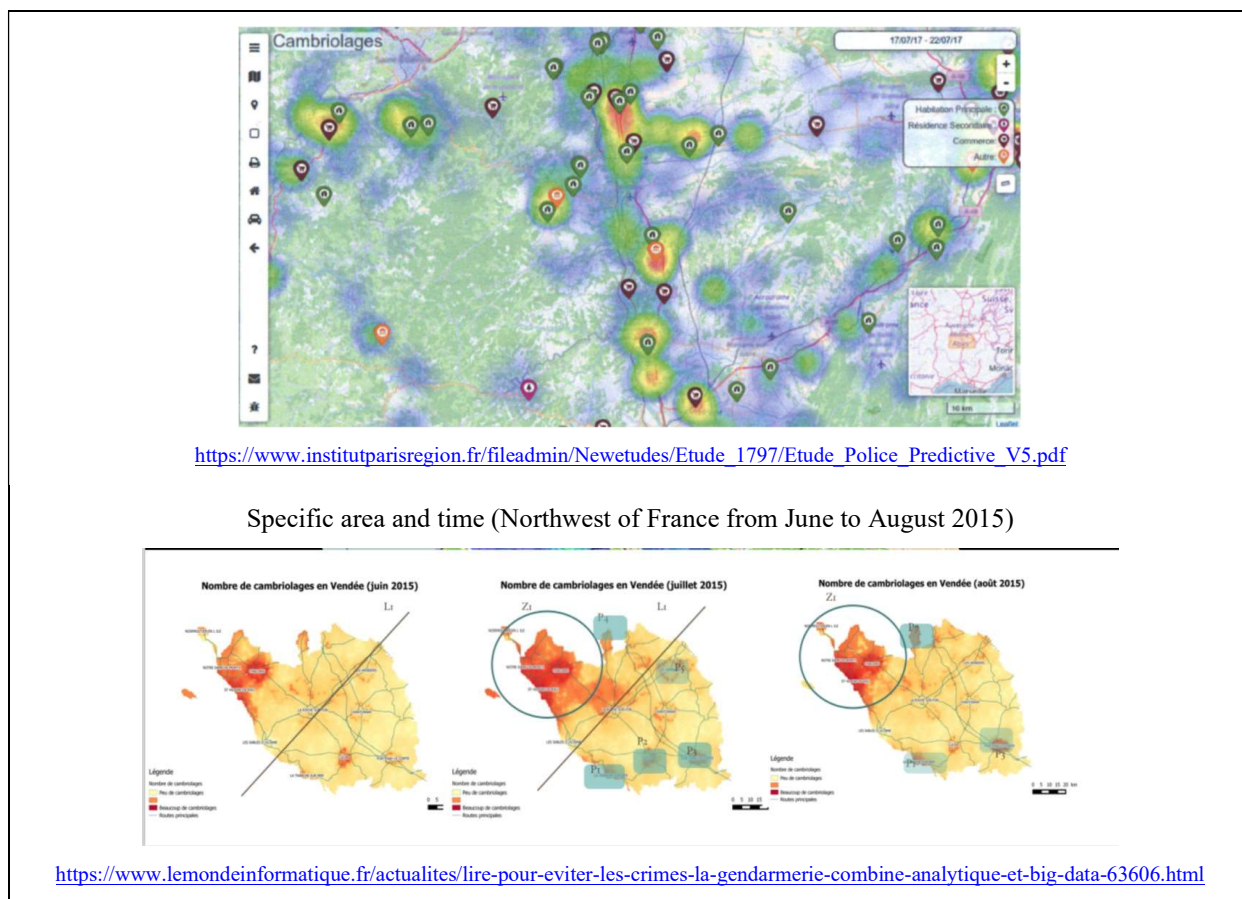


Figure 1. Examples of the PAVED material properties

Although some other European and American countries are used to fight crimes using predictive policing (i.e. Predpol in the US and UK), the French ministry of interior has never implemented predictive policing before September 2017. Police officers are the first to benefit from such a system. Despite this new technological context, police officers we have met have a huge experience in fighting domestic and commercial burglaries and car thefts. They are used to fight crime and take action to reduce offending. All of them were able to perceive the potential of PAVED in virtue of their professional experience and knowledge. For those we have met, they were able to perceive how, when, and why use PAVED, and they knew where and how to quickly find needed data (coloured areas and exact locations). Moreover, the police officers we have interviewed have a prominent position in the Gendarmerie (they were Commander, Deputy-commander and experienced data scientists trained on PAVED); as a consequence, they all have the skills and authority to take actions based on data collected through the system.

### 3.2 Methods

We employed an exploratory, multisite case study approach to develop a conceptual framework of the affordance-actualization process that is grounded in the analysis of data. We gathered datasets over an 18-month field study conducted in French Gendarmerie units. We went out (excluding two phone interviews) and met with some of the police officers who have been fitted with PAVED in September 2017. They were located in 4 different territorial departments among the 11 in question. They were commander and deputy commander of gendarmerie units (headquarter, company and brigade) as well as data scientists trained on PAVED (Table 1).

Our sample first consists of 14 individual semi-structured interviews (included two phone interviews). All lasted between 45 and 135 minutes and were fully transcribed. The interviews were loosely structured to leave space for each informant to develop personal opinions and reflections. The interview



guide mainly focused on the possible actions of PAVED perceived by our informants on the one hand, and the different PAVED uses they developed in achieving their professional goals on the other hand. Second, from visits of 9 different gendarmerie sites, we collected on-site direct observations of the PAVED system interface, requests and uses. The observations were opportunities to gather information through informal conversations. They were all transcribed in a field-diary. Finally, we gathered archival records from professional and press articles addressing the PAVED system, as well as the official presentation form distributed to the gendarmes. These data sources allowed the gathering of a vast amount of multifaceted information (Table 1).

Interview number (time and total duration)	Participants' position	Shadowing observations number	Archival data (total number)
Interview 1 (June 18; 1h15)	Headquarter commander	Visit 1	PAVED official presentation form (1)  PAVED press articles (13)  PAVED professional articles (10)
Interview 2 (June 18; 1h)	Data scientist (headquarter)		
Interview 3 (Oct. 18; 2h00)	Data scientist (headquarter)	Visit 2	
Interview 4 (Oct. 18; 1h45)	Data scientist (headquarter)		
Interview 5 (May 19; 1h30)	Headquarter commander		
Interview 6 (Nov. 19; 45')	Headquarter commander		
Interview 7 (June 18; 1h30)	Company commander	Visit 3	
Interview 8 (June 18; 45')	Company commander	Visit 4	
Interview 9 (June 18; 1h30)	Company deputy commander	Visit 5	
Interview 10 (Oct. 18; 1h15)	Company commander	Visit 6	
Interview 11 (Oct. 18; 1h)	Company deputy commander		
Interview 12 (Oct. 18; 1h)	Company commander	Visit 7	
Interview 13 (Oct. 18; 2h15)	Brigade commander	Visit 8	
Interview 14 (Oct. 18; 45')	Brigade commander	Visit 9	

Table 1. Interview and shadowing observation data (June 2018 – November 2019)

Once we had collected our data, we conducted a qualitative content analysis of the interviews, field-diary (observations) and archival data. We organized and coded the data while we focused on reading and interpreting it. During the whole coding process, an iterative and comparative approach was followed to identify regularities and foster the emergence of main categories and sub-themes: perceived affordances (apprehension and prevention) and process of actualization (uses, outcomes and actualization). As our analysis progressed, we continuously refined our empirical material in a cross-fertilization interplay between data, ideas and concepts (Maanen et al., 2007). The results from this analysis were discussed between coauthors, who went back and forth between data analysis and the conceptual framework development.

## 4 Findings

In what follows, we describe the result of our analysis of perceived affordances, uses and patterns of use of PAVED, in order to better understand how the affordances of the predictive system are non, partially or fully actualized. These results are synthetized in the figure 2, presented after the findings description.

### 4.1 PAVED perceived affordances

Whatever the type of affordance, many respondents show an interest in the predictive properties of the tool, although aware of its limitations in predicting the unknown. One question asked to our respondents

was: “What did you expect from PAVED?”. The analysis of their answers reveals two main perceived affordances of the predictive system.

### ***Perceived affordance 1. Improving apprehension operations (IAO)***

Apprehending thieves means catch them in the act of stealing, for example in flagrante delicto inside a house, or right before getting in. “*Our goal is to apprehend our suspects, arrest them and stop the criminal network.*” (Interview 8). Such oriented goals entail methods and tools dedicated to spinning and arresting operations. PAVED is then viewed by policemen as a way to bypass some laborious and time-consuming actions such as surveillance and spinning.

### ***Perceived affordance 2. Improving prevention operations (IPO)***

Preventing crimes is different from apprehending criminals and is linked to another objective. Preventing means discouraging thieves before taking action. “*For us, the system is a tool to help prevent facts from being committed. Prevention is the heart of the job of the gendarme; the system goes in this direction*” (Interview 1). “*This is our job here: encouraging thieves to give up their theft intentions.*” (Interview 5). Moving or static police patrol are sent around or in a specific area to control vehicles and people on a random basis. “*Our main expectation from PAVED is crime reduction through the improvement of our prevention operations*” (Interview 1), a policeman explained. According to the material properties of PAVED, that prevention affordance is not surprising. As one of the officers in charge of the system design in the early stage told us, “*PAVED aims at preventing the facts from happening, so it’s definitely a proactive tool*” (Interview 13).

## **4.2 Actualization processes**

This section first presents the different PAVED uses and then distinguishes the actualization process for the two main perceived affordances described above.

### **4.2.1 PAVED uses**

After having questioned about the expectations of our respondents from PAVED, they were asked to detail their uses of the predictive technology. Our datasets analysis reveals three different and complementary uses of PAVED (Figure 2).

- Use 1. Tactical representation (TR)

“Tactical representation (TR)” is a very widespread use among the policemen we have met. As described above, the PAVED hotspot is based on ease of use data visualization and data analysis tools (coloured area, zooming, specific area and time selection, etc.). Police officers appreciate the ease of use but also the speed to generate these heat maps compared to their other decision tools. Thus, they first used PAVED to strengthen or deepen their representation of the territory and clarify subsequently their tactical mindset. As a result, the predictive hotspot map suggests areas of intervention that may confirm or contradict their knowledge of the territory.

Moreover, depending on the type of affordance, tactical representation may be used for different purposes and thus give rise to contrasting assessments depending on the context of use. Considering the IPO affordance, we often observed that those of our respondents who developed the tactical representation use were also those who were quite confident toward predictive policing systems in general, and toward PAVED in particular. That certainly helps them to quickly integrate PAVED into their tactical schemes and actions: “*The use of heat cards with time slots, coupled with a discreet radio system, finally give us all the necessary elements to counter burglars.*” (Interview 7); “*my thinking used to be about municipalities, now I’m doing it about neighbourhoods. So, I’m more specific. In the construction of my tactical mindset, I am more precise too*” (Interview 12“). Although some believe it does not necessarily add value but only confirms what they already know: “*Finally, what PAVED is telling me is what I expected*” (Interview 7).

For the IAO affordance, respondents point out a gap between the map provided by PAVED and police officers' representations in spatial and/or temporal locations. As one of them explained: *“Screenshots of the heat maps were distributed to the units. There was a discrepancy between the place indicated and the situation in the field, but also a time lag. The burglaries were committed outside the places indicated to us. The thermometer (that is to say the colours) is not reliable. After several tests, we have not managed to make the link with the reality on the ground.”* (Interview 8). These police officers regret that the tool is not enough precise (in terms of area and time slots) and that they do not integrate human behavior into the analysis to allow to arrest suspects in the action.

- Use 2. Tactical planning (TP)

Even though tactical representation is illustrated by many comments, especially for prevention affordance, the PAVED uses are not limited by the cognitive emulation coming from the tool and provide an extended use grounded into action. We called this second use “tactical planning (TP)”. Tactical planning refers to an important use as it allows to explore the territory specificities and to assess if they are compatible, or not, with the tactical action plan: *“I get a coherent picture of the situation that helps me to design a tactical schema. [...] For example, when zooming in on hot spots, we can see where and how to place the forces, depending on the location of natural obstacles (bridges, highways, etc.)”* (Interview 12); *“What's helpful is that I can see exactly which streets in the neighbourhood to target. I can position my patrols well.”* (Interview 13)

It is also a means of meeting one of the professional goals of ensuring efficient use of resources in a context of increased criminal activity in certain areas. For example, they use maps in addition to other tools indicating situation points to make the action more reliable so as not to unnecessarily mobilize patrols: *“Where I have no element, I wait. To place patrols until something happens is over”* (Interview 12). However, this use is very restricted for IAO affordance.

- Use 3. Tactical briefing (TB)

With “tactical briefing (TB)”, the predictive system is used as a support to facilitate and accelerate the learning of the territory for those who do not have necessarily a good knowledge of it, namely municipal police officers and reservists or new gendarmes: *“The predictive map is [...] useful for temporary reinforcement officers who locate the targets very quickly.”* (Interview 11); *“I also communicate PAVED to municipal police officers and my reservists (...) it avoids taking 1/2h to explain the problem to them, they quickly grasp the territory”* (Interview 13); *“PAVED is for people who do not have the expertise and knowledge of the territory”* (Interview 14). Concretely the map is printed to be communicated to the patrols or posted in the meeting room for a given period of time so that all staff can consult it they need to: *“Larger map display to see global effects”* (Interview 13).

These maps can sometimes even be used for retrospective analysis of the facts: *“This helps to better understand why such a manoeuvre is being done.”* (Interview 5); *“I use it not in anticipation but in fact analysis; it helps me understand the delinquent facts”* (Interview 10) *“Heat zones to understand what happened before – for those who don't know the riding it's perfect because it's very specific”* (Interview 13).

Finally, it is also a briefing tool in the context of communication with legal forces (magistrates): *“It is not a tool but a device. It is the first step in raising awareness to combat delinquency.”* (Interview 5).

Considering these 3 types of uses, we will now analyse their role in the actualization process for each perceived affordance.

#### 4.2.2 Actualization process for IAO affordance

According to Strong et al. (2014), the actualization process results from an interaction between goal-directed actions and outcomes.

Our data analysis first reveals that in the case of the IAO affordance, individuals do not combine different uses of PAVED but relies exclusively on tactical representation or tactical planning uses. Regarding the former, police officers developed high expectations before they received the predictive analytics system. They notably considered that the hotspots and the zooming function could directly support them to target the correct area and apprehend thieves. However, policemen quickly recognized that PAVED has some limitations for apprehension goal: *“While the ergonomics are pleasant and the handling very easy, the system is based on past data and not on data which would allow us to coordinate in real time.”* (Interview 8); *“In the interpellation action, PAVED is useless to me, I need more web tools, I am in the instant”* (Interview 12).

The latter use (i.e. tactical planning) in this context leads also to the same observation as regards the tool’s inability to fully meets expectations because of its material properties: *“The important thing was to see the positioning of the burglaries on my area, over the month, so that I could anticipate by planning my patrol on a given area. We appoint a referee on property damage who records burglaries in his sector (how to operate, type of theft, type of property) we had this system before PAVED and at the end of each week or each month, the referee knew how to tell us that sector is the most sensitive, and how to reorient my patrols. And that, PAVED doesn’t do it. (...) it helps me to design a tactical scheme to apprehend (...) but we apprehend without PAVED”* (Interview 12). Here the tool is not sufficient, and it is not used in the action (in the present moment) but to design and analyse it. In that case, it is often used as a complement to other data sources in order to identify a convergence of facts.

As these concrete outcomes are not consistent with their professional goals, after several attempts, police officers adopt two type of behaviours. Some of them have abandoned PAVED, while others use it from a different perspective: they coupled PAVED with other non-predictive but existing technologies to conceive the tactical scheme of apprehending.

#### 4.2.3 Actualization process for IPO affordance

Even though IPO affordance relies on common uses with the improving apprehension operations, it differs due to the richness of the patterns of uses, which is based on a variety of combinations of uses in terms of number and type. and to the effectiveness of the affordance actualization. Thus, our analysis highlights three consistent combinations of two and three different uses, detailed below.

One of these three patterns of uses shows synergistic effects between the tactical representation and the tactical planning uses: *“The PAVED hotspot is very simple. I get a coherent picture of the situation and that helps me to design a tactical schema.”* (Interview 12); Police officers highlighted how PAVED supports the pre-positioning of forces in “hot” areas in order to prevent crimes: *“I use the PAVED hotspot both to anticipate future burglaries trends and to plan my tactics and resources.”* (Interview 13).

We also observe a combination of tactical representation with tactical briefing uses as second pattern of PAVED uses: *“We could also imagine the system as a learning tool for novices, who can use it to “learn” their area”* (Interview 2) *“The hotspot is very good because zooming in to the neighbourhood and we realize where to act precisely. I use this hotspot to show my reservists who don’t know the territory. What is important for me is not necessarily what the tool will predict but to know the territory well”* (Interview 14). Police officers who combined these uses appreciate the ability to quickly and easily generate accurate heat maps that can then be used to inform reservists. It is also sometimes simply a way to stimulate reflection on the action plans to be carried out to prevent delinquency based on knowledge of the territory: *“We want the gendarmes, from the hotspot, to think about the means of action they have at their disposal in these risk areas”* (Interview 5).

As an extension of this pattern, IPO leads to a last pattern comprised of the three uses: *“What is useful is that I see the streets of the neighbourhood to be targeted. I can well position my patrols. (...) I also communicate PAVED to municipal police officers and reservists. (...) For me, PAVED is a decision support”* (Interview 13). The aim here is to take advantage of the complementary of uses. PAVED is then perceived as a real decision support system.

Whatever the patterns of uses for this affordance, each corresponding outcome improves prevention operations, which thus, can be considered as actualized.

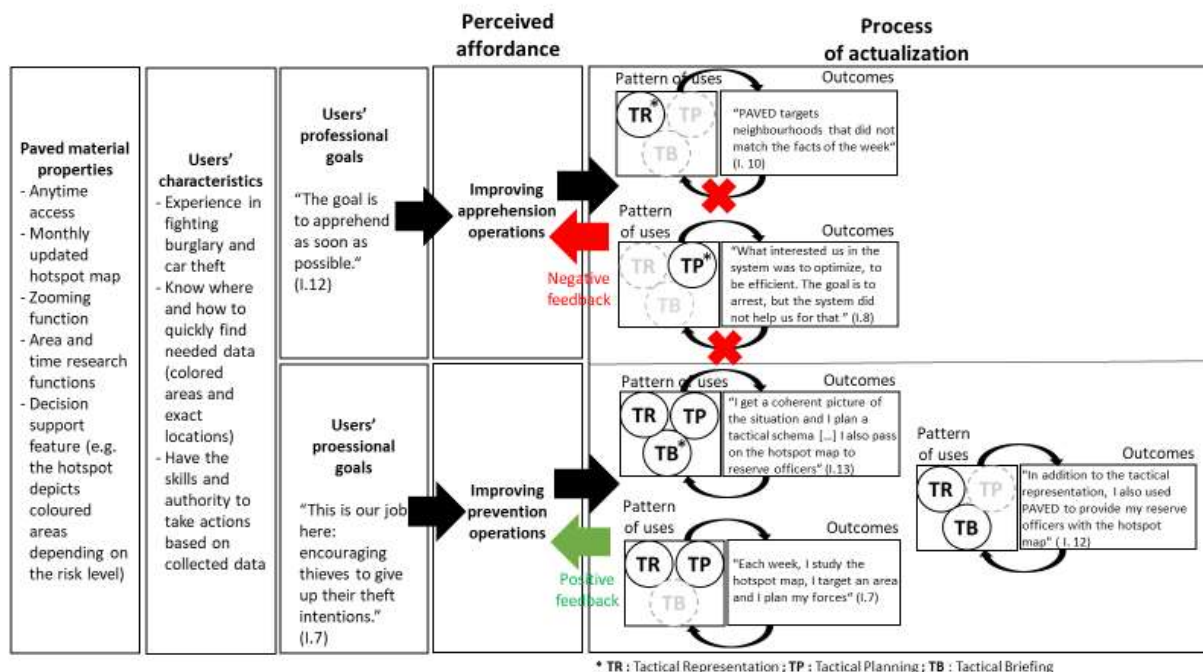


Figure 2. The PAVED affordance-actualization process

Ultimately, we observe contrasting outcomes depending of the type of perceived affordance and distinctive processes of actualization that lead to contrasted affordance effects. The fine-grained description of the interactions between patterns of uses and corresponding outcomes, let us to better understand why and how an affordance may or may not be fully actualized. This is precisely what we shall endeavour to develop in the discussion in the light of these results and through the lens of the theoretical framework mobilized.

## 5 Discussion and conclusion

Stemming from our research question, “how do the affordances of a predictive analytics are actualized?”, we refine recent empirical contributions (Strong et al., 2014; Burton-Jones & Volkoff, 2017; Leidner et al., 2018; Du et al., 2019) by showing that the actualization process of affordance rests on different patterns of uses developed by police officers in interaction with associated outcomes. We further highlight how these patterns-of-uses-outcomes interactions result in non, partial or full actualization of perceived affordances.

In the case of the IPO affordance, our findings reveal that the interactions between the patterns of uses and the outcomes lead to a positive feedback and consequently contribute to the actualization of the affordance. On the contrary, we show that the actualization process of the IAO affordance leads to give up on using PAVED, or to use it in combination with other existing but non predictive technologies.

Moreover, while PAVED is initially designed as a system to predict crimes, we observe that the IAO affordance is far from its purposes. We noticed that it leads to few patterns-of-use-outcomes interactions and is ultimately not fully actualized by outcomes that contradict the associated affordance. The troubles encountered to actualize this affordance can also be attributed to the fact that the software may not contain enough conventional constraints, leading to irrelevant affordance (Norman, 1999). According that “a convention is a constraint in that it prohibits some activities and encourages others” (Norman, 1999: 41), the conventional predictive-prevention features of PAVED are probably not enough readily perceivable for some policemen who consider apprehension as a professional goal.

## 5.1 Theoretical contributions

First, our results reveal the role played by what we call “pattern of uses”. Especially for the IPO affordance, patterns of uses are observed when the predictive analytics system is closely linked to professional practices. The combination of two or three different uses is not associated with an activity overload but rather with a consistent articulation of old and new uses to reinforce the actualization of the perceived affordance. In contrast, non or partial actualization of the IAO affordance shows a unique use associate with an outcome. Although these results do not necessarily imply causal relationship between the richness of patterns-of-uses-outcomes interactions, it would be interesting to deeper investigate this relation in order to highlight the potential effect of patterns of uses on the affordance actualization.

Second, our research goes a step further than those that opened the black box of the AAT (e.g. Leidner, 2018; Du et al., 2019), shedding new light on the affordance-actualization process. Even though material properties of the system, professional goals and past individual experience influence the actualization process, our results also show how, for a given affordance, interactions between patterns of uses and outcomes lead to non, partial or full actualization. Following the recommendations of Leidner et al. (2018), our study carefully distinguishes affordance from outcomes and its actualization. For each affordance, previous empirical researches (Strong et al., 2014; Du et al., 2019) describe which outcome is associated to its corresponding goal-oriented action but did not really explore the interplay between them, nor how this interaction leads to actualization. Our article suggests an affordance-actualization framework which reveals the key role played by the patterns-of-uses-outcomes interactions in the non, partial or full actualization of affordance.

Finally, our study contributes to the IS literature by enriching studies on predictive analytics, especially in an original research field, that of the French military police. Except for research on transformative effects of predictive analytics on work and organizing (e.g. Orlikowski & Scott, 2016; Faraj et al., 2018), empirical studies on implementation of such technologies in organization are few, especially in the affordance literature. We thus participate in bridging this gap by showing that, unlike other IT artefacts, predictive analytics seem to generate actualization failures.

## 5.2 Limitations and avenues for future research

The present study suggests that a fine-grained decomposition of uses-outcomes interactions might help to disentangle the puzzling actualization process of affordance. In contrast with past research, our approach focused on uses and patterns of uses to explain how actors move from affordance to partial or full actualization. It offers a new reading grid to deepen our understanding of this process. Admittedly, patterns and configurations approaches are not new, but applied to observation of the affordance-actualization process, it finds a promising way to dig into this topic.

Even though we shed new light on affordance-actualization process, it would be useful to investigate further in order to confirm that actualization of affordance is persistent. An extension of the study, adopting a longitudinal approach, would probably clarify this issue.

This research could represent an initial attempt to build a model for research interesting in how users move from affordances to actualization through patterns of uses. We do not claim to be exhaustive in our efforts here. Rather, we seek to inspire future research in this potentially rich avenue.

Finally, based on a unique case study of a specific predictive analytics system, this research suffers from common methodological limits and could be strengthened through a multi-case methodology for two main reasons. First, a comparative case study might be a consistent way to consolidate the identified patterns of uses in other policing contexts or in other sectors (e.g. health). Second, it could offer the opportunity to use a qualitative comparative analysis tool that could fit particularly well with equifinal patterns or configurational approaches (Fiss, 2011).

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