Effects of Team Structure in the Implementation of Potentially Disruptive Innovations

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Introduction

Unmanned Aerial Vehicles (i.e. drones) are increasingly used across sectors and industries for a range of different purposes such as surveying, algae removal and emergency delivery of defibrillators. Drones typically form part of technical constellations involving advanced software, and sometimes even artificial intelligence. Thus, drones typically manifest complex technical assemblages: a fact which has generated different narratives. In the context of the popular media, they relate to the fear that such applications come with high social and human costs (e.g., Brichet & Hastrup, 2019). In the academic context, conversely, drone technology is often presented in a positive light, such as being an important driver of Industry 4.0 (Javaid et al. 2022). Yet, what unites both narratives is the assumption that drone technology is *disruptive* (as per innovation theory; see Christensen, 2013). Thus, when being implemented in organizational settings, drones are expected to affect the workflow in a radical, groundbreaking manner. However, the deterministic logic underpinning such narratives has long been rejected by information systems scholars (e.g., Orlikowski & Baroudi, 1991). Following alternative logics, scholars have shown that the nature and intensity of organizational change are a function of the way in which new technologies interrelate with existing organizational operations and structures (e.g., Wessel et al., 2021).

Granting that organizational consequences of innovations are caused by both technological features and *social organizing* (Secchi, Gahrn-Andersen, & Cowley, 2022), we ask how potentially disruptive innovations may be integrated into existing organizational structures without leading to functional breakdowns. We present the case study of Denmark's largest utility company that introduced drones in their maintenance operations a few years ago. Being equipped with thermographic cameras, the company uses the drones for surveying their network of heating pipes. The drones are potentially disruptive in the sense that they provide the utility company with certainty about leakages; a certainty which would normally be accumulated over more than 20 years by using traditional means for leakage detection. While the drones presented some challenges and required minor adjustments to existing work practices, the company did not experience organizational disruption as such. On the contrary, a new, leakage-detection practice has gradually emerged, and it has come to co-exist in a close relationship with the other domains of the maintenance work-practice.

With the purpose of uncovering the conditions that have made the new leakage-detection practice possible, we study how the maintenance department is organized. The assumption is that the fluid team constellations give enough flexibility to routine work such that new practices and collaborative synergies can emerge. The enquiry is conducted through an innovative methodology that merges ethnographic research with agent-based computational simulation modeling (ABM) – we call it *computational ethnography*. One of the main advantages this method offers is to be able to simulate actual organizational behavior after the empirical data and, at the same time, generate alternative "realities" (or counterfactuals) by artificial manipulation of the working conditions (parameters). Through this lens, this paper seeks to establish a better understanding of how organizations can structure their operations around innovative technology without suffering disruptions.

Short Summary of the Case

The organization operates in the utility market by offering a range of services related to water, heating and gas to ca. 2.7 million customers with approximately 6,500 km of pipes. The total revenues in 2021 were kr. 4.97 bln (€ 668 mln) and the net result a loss of kr. 637 mln (€ 85.6 mln), classifying it as Denmark's largest utility company. A significant part of the company's operations relates to maintenance of the district heating network (approximately 2,888 km of pipes), including leakages and other malfunctions. The organization underwent restructuring in 2015. In this context, the maintenance work was reorganized from district-based operations to task-based teams to allow for more flexibility in terms of resource allocation. In 2016, the drones were introduced with the purpose of enhancing the leakage detection process thus effectively making it possible for the company to establish a stand-alone leakage-detection practice (see, Gahrn-Andersen, 2020; 2021; Cowley & Gahrn-Andersen, under review). Traditionally, leakages are detected by alarm threads, scheduled maintenance, and vigilant customers. However, these methods are insufficient to provide an overview of all leakages in the network and allow for rather reactive responses to leakages and malfunctions. To afford a proactive approach to network maintenance, drone-based thermographic surveillance has been added to these traditional sources.

The Maintenance Department (MD) is organized in three teams, and the work of team members is divided across cases. While the leader of each team is responsible for overseeing specific areas of the maintenance operations (e.g., acute leakages, scheduled maintenance, thermography), the work of individual team members is not restricted by team function. Rather, employees across teams work on similar tasks within and across cases – depending on their roles and area of expertise. Each team consists of several employees with different functions and levels of responsibilities. For example, operation and maintenance engineers and team coordinators are responsible for, amongst other things, case supervision, subcontractor coordination and case documentation, and have high decision-making autonomy. Technicians, on the other hand, are in charge with carrying out the tasks specified by the case coordinators (whether it being an engineer or a team coordinator), and they seldom exercise autonomy in their work. Team members of all levels of responsibility are allocated to cases and tasks based on technical skills, expertise and availability. Work scheduling is done on a weekly basis, usually with a 6-week oversight, where changes in human resource allocation can be made for the previous week, current week, as well as for the following four weeks, offering high flexibility in terms of scheduling and resource allocation.

When the drone technology was first introduced, the goal of the MD was to successfully handle five drone cases per week in addition to the maintenance cases normally handled. This has proven to be difficult, especially because most cases take longer than a week to completion. Nonetheless, the MD has managed to successfully integrate the emerging leakage-detecting practice into its daily operations without (1) increasing its workforce, (2) reducing its existing workload, or (3) experiencing disruption in its work practices and organizing. Rather, the introduction of drone technology has at times worked to strengthen existing structures and tasks, as MD employees found new and creative ways to use the thermographic surveillance data in existing work practices, such as corroborating data from traditional sources, enhancing the precision of digging areas or negotiating project accountability and budget allocation. Overall, the introduction of drone technology has been handled particularly well by the structure in place at the company.

Agent-Based Simulation Modeling

As anticipated, the enquiry is conducted by mean of ABM. This is an advanced technique (and approach) that allows to model the complexity of team and organizational dynamics (Fioretti, 2013; Secchi, 2015) on a multitude of parameters, variables, and mechanisms (Secchi & Neumann, 2016). One of the features of these simulation models is that uncertainty and ambiguity can be embedded in their workings at any level (e.g., from employee learning practices to routines, from team dynamics to cultural elements). Another key feature is that they usually work dynamically, over time (Gilbert, 2008).

The purpose of the simulation is twofold. On the one hand, it aims at illustrating the connection between the current team structure in the MD and the successful handling of cases coming from the different sources. On the other hand, the model aims at defining which, among different alternative settings, can result in an improved or decreased effectiveness in case handling. From this information, a case for or against disruptiveness can be easily made.

Overview of the model

Agent-based models are defined through their basic *entities* – i.e. the agents –, the *environment* in which these agents operate, and through the *mechanisms* that define the rules for behavior, interaction, evolution, etc. This type of simulations is particularly effective when costs and other constraints do not allow for experimentation, data collection, or testing (Edmonds & Meyer, 2017). The case of examining how different team structures relate to the coming of age of new technology in the workflow is exactly one such cases.

The model uses a mix of data inputs as setup. Data from the organizational structure (i.e. the organigram), as well as data on case completion and time comes from both interviews with managers and from hard data in the form of spreadsheets. The characteristics of agents, their affiliation with teams, allocation in tasks and projects are derived from ethnographic observational data (mainly note-taking) and from casual and more systematic dialogues with those involved. ABM formalizes this information by setting team structures as its environment and determining agent characteristics through the behavioral (and thinking) patterns observed during the ethnographic fieldwork. This allows the modeler to assign *likely* attitudes as well as roles, expertise, and competence to team members. Given the flexible nature of human behavior, ABM allows for attributions that may manifest or not, depending on dispositions, social settings, timings, and other mechanisms. This last element constitutes the rules of operation and it has a direct link with the qualitative data gathered for the case study. In fact, the mechanisms require an understanding of why, how, and when agents behave and think the way they do.

An example of how the model is structured can be offered by looking at its initial settings. Here, there are two types of agents in this model: *workers* – i.e. the employees and managers of the MD; and *cases* – i.e. pipe/network malfunctions, leakages, or else that requires an action from the MD. For example, each *case* (c_i) can be dismissed if the problem has been solved or archived (not solved but simply overlooked; in the tradition of Cohen, March, & Olsen, 1972; Fioretti & Lomi, 2010). When a case is solved, it disappears from the system (environment); when it is overlooked, it becomes hidden or latent – it waits until someone (or a team) takes it on again. Hence, each agent-case has a *timeline* (t_c) in which they are active and an importance rating (i_c), depending on how urgent they are. As time goes by the case's i_c may remain the same or increase, if it is not acted upon. Each agent-case has a specific type – not all pipes are the same – and, as a starting point, the model categorizes them as P_A, P_B, and P_C. Also, the agent-case is not necessarily requiring the same type of maintenance, hence is defined by the type of action that can be performed. Again, the starting point is that of having three: T_A, T_B, and T_C. Finally, each *case* has a location, depending on the area where it manifests itself (A_1, A_2, …, A_9). The type of pipe and/or the area may belong to different *projects* while the type of maintenance indicates a different *task* to be performed. Finally, a case is different depending on whether it comes from a traditional source (i.e., reactive approach to leakage detection) or from drone data (i.e., proactive approach). The simulation can control for the degree with which connections are made exclusively within the teams or across teams.

Concluding remarks

ABM is used as a way to explore how different team/departmental structures affect the handling of information coming from drone-based digitalized sources. The complexity of the activities in the MD makes up for a non-trivial analysis of alternative cases. By the time of the workshop, the verification, validation, and calibration processes will have been performed and results from the simulation can be presented.

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