Closing the Algorithmic Black Box: Breakdowns and Patching Strategies in a Public Service Media

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Abstract

This article examines the organizational trajectory of a news recommender system developed within RTBF, Belgium's public service media. Based on thirteen months of ethnographic fieldwork, it conceptualizes the algorithm as a black box in the making and investigates how breakdown–repair cycles shaped its embedding and eventual stabilization within the organization. The study identifies two major breakdowns and demonstrates that the subsequent repairs functioned less as transformative solutions than as *patching strategies*: targeted adjustments that resolved immediate issues while simultaneously reinforcing the system's legitimacy. By foregrounding these patching strategies, the article contributes to Science and Technology Studies (STS) by extending the literature on breakdowns and repair. It shows that such practices not only address technical vulnerabilities but also reconfigure organizational relations, contain dissent, and gradually contribute to the closure of the algorithmic black box.

Keywords: Algorithms, Black box, Breakdowns, Repairs, Patching strategies, Public service media

Introduction

The widespread adoption of algorithms has significantly transformed the public sector (Andrews, 2019; Levy et al., 2021; Meijer et al., 2021; Wenzelburger et al., 2024). Within public service media (PSM), these technologies are now extensively used to personalize content access, promising increased audience satisfaction and loyalty (Álvarez et al., 2020; Murschetz, 2021; Mitova et al., 2022). Research nevertheless shows that implementing such recommender systems poses major challenges. Confronted with critiques of these systems and their potential harms to users, PSM organizations, on the one hand, seek to distinguish themselves from major private platforms by incorporating public service values in the design of their algorithms (Schwarz, 2015; Sørensen, 2020; Hildén, 2022; Carillon, 2024). On the other hand, by disrupting traditional methods of content promotion and distribution, they can also generate tensions within the organizations that deploy them (Diakopoulos, 2019; Hansen and Hartley, 2021; Bastian et al., 2021; Blassnig et al., 2024).

Because most research focuses either on design or on use, few studies provide empirical evidence on how these 'intelligent technologies' (Bailey and Barley, 2020) evolve over time in relation to the organizational context in which they are embedded. Moreover, long-term ethnography is

often presented as the best way to capture the algorithm–organization nexus holistically (Seaver, 2017; Lange et al., 2018; Christin, 2020). Nevertheless, it remains rare in PSM studies even though the literature highlights the value of longitudinal, context-sensitive approaches for penetrating algorithmic opacity (Ziewitz, 2016; Seaver, 2019; Christin, 2020). To address this gap, I conducted thirteen months of participant observation inside a Belgian PSM organization, examining the development, implementation, and internal use of a news-recommender system.

In this paper, I frame the algorithmic system as a *black box in the making*. The black box metaphor, widely employed in Science and Technology Studies (STS), describes here an artefact once the surrounding controversies have been resolved (Pinch and Bijker, 1984; Pinch, 1986; Latour, 1987). Traditionally, scholars have opened black boxes through socio-historical analyses that uncover the negotiations, debates, meanings, and power dynamics leading to its stabilisation (Hsu et al., 2008). Instead of opening a fully formed box, I invert the perspective to follow *in situ* the processes that close it. Specifically, I analyse the breakdowns and repair practices that shape the system's biography (Pollock and Williams, 2011; Glaser et al., 2021). These cycles serve as a lens through which to examine how such events reconfigure the relations constituting the system and redefine its organizational standing.

The analysis shows that breakdowns and repairs are not merely instances of material disorder, but moments when underlying organizational tensions and power struggles surrounding the system come to the surface. These incidents reveal not only the algorithm's technical limitations but also the dynamics that have shaped its development and implementation: internal conflicts, competing priorities, and power relations. Furthermore, the data indicate that repairs take the form of *ad hoc* fixes that do not aim to resolve these deeper organizational causes. On the contrary, they are strategically deployed to reinforce the system's legitimacy within the organization and sustain innovation in the face of resistance—a process I analyse as 'patching.' Then, rather than questioning the system's functionalities or authority, patching strategies tend to consolidate its legitimacy and entrench its role within the organization, thereby contributing to the gradual closure of the black box.

This article makes two contributions. First, by foregrounding patching, it enriches the breakdown-and-repair literature, showing that such events can also drive a broader closure process in which a technology's operational logic and authority are reaffirmed and reinforced. Second, the study provides insights into how public organizations manage and legitimize algorithmic systems, revealing that the black boxing of algorithms can stem from organizational strategies intended to institutionalize them as such.

Conceptual framework

Algorithmic system as black box in the making

The black box metaphor is commonly used in algorithm research to underscore the opacity of these systems (Pasquale, 2015), whether resulting from deliberate choices or technical design (Burrell, 2016). In this work, I draw more specifically on the work of Pinch and Bijker (1984) and Latour (1987), who interpreted the metaphor to account for the ways in which artefacts become stabilized and taken for granted over time.

The black box metaphor in STS, as discussed by Hsu et al. (2008), is closely linked to the development of the Social Construction of Technology (SCOT) framework by Pinch and Bijker (1984). Central to SCOT is the idea that technological artefacts and scientific facts are shaped by socio-technical processes. Pinch and Bijker expanded the black box metaphor into an analytical tool for understanding how (arte)facts achieve stability and appear unquestionable. For instance, their renowned study of the development of the bicycle illustrates how different social groups influenced its design and meaning over time.

For Pinch and Bijker, the black box metaphor is both programmatic and critical. Their primary aim is to "open the black box," uncovering the layers of negotiation, debate, meanings, and power dynamics that lead to the stabilization of artefacts. In this framework, black boxes are not natural endpoints but rather temporary resolutions of controversy. A controversy denotes

a situation in which a dispute arises among multiple actors, each mobilizing specialized forms of knowledge, without any party being able to establish definitive truths (Latour, 2006; Callon, 2013). Such controversies are marked by a dense entanglement of heterogeneous stakes, empirical facts, and normative values. They are also distinguished by the simultaneous negotiation of both technical definitions and social meanings (Callon, 1994, 2013). As Pinch (1986) explains, a black box symbolizes the moment when controversies surrounding an artefact are settled.

Almost simultaneously, Latour, in *Science in Action* (1987), elaborated on a similar conception. According to Hsu et al. (2008), this convergence may have resulted from an exchange of ideas between the two authors during the drafting of their respective works. Latour integrated the black box metaphor into Actor-Network Theory (ANT), redefining it as a complex network of actants that temporarily operates as a cohesive and stable "whole." This reinterpretation reflects Latour's view of science and technology as shaped by interconnected actants, both human and more-than-human, rather than unique entities.

This conceptualization of the black box highlights an important aspect of power in Latour's framework. Indeed, as black boxes become increasingly closed (meaning their internal workings are accepted as reliable and no longer questioned), their authority becomes harder to challenge. Reopening a black box to scrutinize its internal processes or foundational assumptions thus requires significant effort and resources, making such attempts increasingly costly and improbable over time. In this context, the need for understanding the artefact fades into the background as it gains authority and the box becomes 'black.' As Akrich (2006: 173, my translation) notes, "it is precisely when [an artefact] nears stabilization that it becomes, through its disappearance, an instrument of knowledge." In the same vein, Beyes et al. (2022: 1007) argue that "the computer calculates and in doing so it makes itself absent from discussion, and if successful it becomes a black box, fundamentally invisible because inevitable and inscrutable." In other words, as the black boxing process unfolds, the artefact fades from view, and the authority of its outputs strengthens.

While the black box metaphor has been widely used to investigate the historical formation of black boxes, this paper proposes to reverse the perspective by considering the algorithmic system as a black box in the making, in order to examine, *in situ*, the processes that lead to its closure. This theoretical framework provides an effective way to examine how the system evolves over time in relation to the organizational context in which it is embedded. Building on Latour's call (1987: 21), the idea is then to shift our focus "from finished products to production" and therefore "from 'cold' stable objects to 'warmer' and unstable ones [...] before the box closes and becomes black."

On breakdowns and repairs

Breakdowns and repairs are central concepts in infrastructure studies (Star, 1999; Henke and Sims, 2020). In this paper, I use the breakdowns and repairs as an analytical lens. These moments help identify key turning points in the history and evolution of the recommender system at various stages of its lifecycle. By focusing on these events, we gain insight into the system's role and status within the organization, its materiality (Graham and Thrift, 2007; de la Bellacasa, 2011), its vulnerabilities (Denis and Pontille, 2023), and the transformations it undergoes.

Breakdowns refer to specific incidents that occur when a system encounters the limits of established protocols and practices (Jackson, 2013: 228). In doing so, they reveal the underlying structures and relationships that ensure the smooth functioning of infrastructures. This insight underscores their relational nature: infrastructures are shaped by a web of sociotechnical relationships that both sustain their operation and render them invisible. As Star (1999: 382) notes, "the normally invisible quality of working infrastructure becomes visible when it breaks." In other words, breakdowns serve as conceptual tools that allow us to explore the often-hidden aspects of infrastructures, such as the relationships they rely on, the invisible labour and practices that sustain them, and the meanings that have become embedded within them.

Repairs, by contrast, refer to the sociotechnical efforts undertaken in response to a breakdown, with the aim of resolving it. Far from being

peripheral, these interventions are an essential component of the innovation process. As Henke and Sims note, innovation rarely follows a linear path of design and implementation. Instead, it emerges through "messy processes of implementation, breakdown, problem-solving, and repair" (Henke and Sims, 2020: 14). Within this framework, repairs do more than restore a previous state: they can serve as catalysts for creative recombination and the formation of new relationships, potentially leading to the emergence of new entities. (Jackson, 2013). As such, repair offers a valuable analytical lens for understanding how systems evolve over time and how these transformations reshape their roles within broader organizational structures.

In this context, an equally important aspect of the analysis is how actors collectively address a problem previously identified as such and work to resolve it, as well as how these cycles can become arenas for power struggles. As Henke and Sims (2020: 24) emphasize, repair entails restoring not only material components but also social relationships: "A successful repair is not only a material accomplishment; repair also creates a shared narrative of what went wrong and how it was fixed, persuading participants that local sociotechnical order has been restored." Beyond the material dimension, breakdown and repair cycles become pivotal moments where power dynamics are made visible and potentially reconfigured. During these episodes, the authority embedded within a system and the power relations surrounding it may be renegotiated, reaffirmed, or contested (Henke, 2019). Yet, as Henke and Sims (2020: 20) point out, "once people believe a breakdown has been resolved […] these aspects tend to recede into the background once again".

Similar to Seaver's (2017) proposal to use 'infrastructure ethnography' to study algorithms, a conceptual parallel can be drawn between black boxes and infrastructures. Indeed, beyond their shared relational nature, these two concepts exhibit several common characteristics. Firstly, both black boxes and infrastructures tend to obscure the underlying relationships that support their functioning and existence. As their operations become taken for granted, these relationships fade into the background. Secondly, both exert a form of authority by inscribing and solidifying certain meanings, values, or worldviews within their structures and operations. Finally, the existence of black boxes and infrastructures is generally only questioned when disruptions occur. These disruptions often serve as moments where power dynamics come to the forefront. This parallel underscores the idea that breakdowns and repairs offer a valuable lens for examining the formation of black boxes and the role these events play in shaping them. As Neyland and Möllers argue (2017), 'looking for trouble'—moments of breakdown—is productive for emphasizing the centrality of associations and decentring the question of the power of the algorithm itself.

Contextual background

Algorithmic systems in PSM

Since the end of public monopolies, PSM have encountered numerous challenges. The digital age has transformed the media landscape, intensifying competition from commercial outlets and social media platforms (Jakubowicz, 2007; Donders, 2012). This shift has forced PSM to rethink their strategies, adopting new technologies to better meet evolving consumer expectations and remain competitive (Bardoel and d'Haenens, 2008; Burri, 2015). One promising approach to tackling these challenges is the adoption of recommender systems, which are now widely implemented in PSM (Álvarez et al., 2020).

These algorithmic systems deliver relevant content to users based on predefined criteria, such as individual preferences or online behaviour. Various methods are employed, including content-based filtering, collaborative filtering, popularity-driven algorithms, and hybrid models that combine multiple techniques (Hildén, 2022; Møller, 2022). By personalizing content distribution, these systems not only enhance the user experience but also provide media organizations with valuable insights into audience behaviour (Murschetz, 2021), allowing them to promote their content more effectively and broaden their reach (Álvarez et al., 2020; Fieiras-Ceide et al., 2023; Møller, 2022; Hildén, 2022).

However, the use of such algorithms also raises ethical concerns. Their potential to shape how

people access information and engage in public discourse is a growing issue (Sørensen, 2011; Joris et al., 2022). Risks like 'filter bubbles' (Pariser, 2011) are especially concerning, as they may limit the diversity of perspectives that users encounter. While these risks remain debated in the scientific literature (Flaxman et al., 2016; Haim et al., 2018; Ross Arguedas et al., 2022), studies on PSM show that they are aware of these challenges and are working to address them (Schwarz, 2015; Van den Bulck and Moe, 2018; Hildén, 2022). As a result, some PSM are differentiating themselves from private platforms by integrating public service values into their systems, with varying success (Schwarz, 2015; Sørensen, 2020; Hildén, 2022; Carillon, 2024).

The adoption of these systems can also create tensions within the organizations that implement them. Scientific literature, particularly through newsroom studies, has explored the conflicts arising from the changes these systems impose on the roles and practices of journalists (Bucher, 2017; Bastian et al., 2021; Diakopoulos, 2019). By reshaping how content is promoted and distributed, these algorithmic systems can be perceived as a threat to the journalistic profession. On a broader level, these systems also tend to crystallize tensions between two opposing visions of the role and place of PSM in society (Van den Bulck and Moe, 2018; Sørensen, 2019). On the one hand, a techno-optimistic perspective views algorithmic systems as an opportunity for PSM to expand their audience and foster greater audience loyalty. On the other hand, a more pessimistic perspective sees these systems as inherently incompatible with the ethics and values of public service.

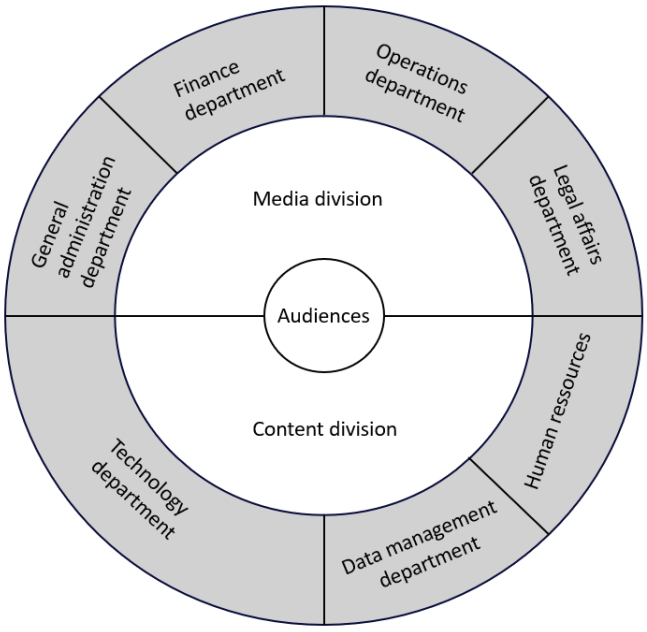

Figure 1. RTBF organizational structure adopted in 2018. (The diagram is based on information available at https://www.rtbf.be/entreprise/a-propos/detail_notre-modele-d-entreprise?id=10003887).

Case study

RTBF is the public service broadcaster for Belgium's French-speaking community. Based at its Brussels headquarters known as "Reyers," the organization employs around 2,000 people. It manages nine radio stations (excluding web-only channels), three television channels, a dedicated news website (rtbf.be), and the digital platform Auvio, which offers catch-up TV and free video-on-demand (VoD) services. Governed by a board of directors reflecting the political composition of Belgium's French-speaking Community, RTBF is led by Jean-Paul Philippot. Its strategic direction and funding are redefined every five years through the negotiation of a 'management contract' with the government.

In 2016, RTBF launched its strategic plan titled "Vision 2022," aimed at modernizing its operations and adapting to the new habits of media consumers. At the core of this vision was the launch of the Auvio platform, which centralized all its content into a single digital platform. At the same time, RTBF focused its efforts on data-driven innovation to develop new approaches to content personalization and distribution.

In 2017, the organization began developing the first version of a recommendation algorithm specifically designed for the Auvio platform, in collaboration with external partners. In addition, RTBF also developed a centralized data management platform. This period marked RTBF's public commitment to the development of "public service algorithms."

Momentum continued into 2018, as RTBF implemented significant organizational changes. Shifting away from its traditional hierarchical structure, the organization adopted a circular organizational model, creating a data management department to oversee and coordinate its

growing portfolio of data-driven projects. As illustrated in Figure 1, this new organization is centred around a core consisting of audience management, a media division responsible for content distribution, and a content division responsible for content production, which together encompass RTBF's editorial functions. This core is supported by a range of departments (shown in grey in the figure) that cover so-called "support" functions. These include the technology department, the largest of them, and the data management department.

After facing challenges with external partners in developing the recommender system for Auvio, the project was brought in-house and assigned to the data management department. Previously focused on overseeing projects and producing analyses, the department's role evolved into that of a producer of recommender systems. A few months later, the development and implementation of a new version of the Auvio recommender system coincided with the launch of a new data governance framework, led by the data management department. Several specialized committees were formed, including the data committee, algorithms committee, metadata committee, and GDPR committee. These groups fostered collaborative discussions, guided the design of data-driven projects and established key performance indicators (KPIs) to measure the success of ongoing initiatives.

Building on this success, RTBF then launched a new project to implement a recommender system for news articles on its rtbf.be website, with the development once again entrusted to the data management department. The goal was to provide a more personalized experience on the platform, increase user engagement, and strengthen their connection with the news produced by RTBF.

Methods

Data collection

Methodology plays a pivotal role in discussions about the contextualized study of algorithms. In recent years, ethnographic methods have gained significant traction for analysing algorithmic systems, as they provide a holistic approach to understanding their complexity. However, one significant issue, as Christin (2020: 904-905) notes, is the limited access ethnographers have, focusing only on observable practices and spaces. The seeming opacity of algorithms also further complicates efforts to centre the analysis on the algorithms themselves. Additionally, the relational nature of algorithmic systems poses another challenge, as their relational nature spreads analytical elements across various temporal and spatial dimensions (Seaver, 2019).

Despite these challenges, Christin emphasizes that ethnographic methods and detailed descriptions remain essential for studying 'associations,' particularly in the realm of technology (2020: 905). Ethnography offers a means to uncover the often-hidden relationships that characterize algorithmic systems, making it a valuable approach in organizational contexts. Building on this idea, Christin (2017, 2020), Seaver (2017), and Lange et al. (2018) propose a variety of data collection strategies designed to "make algorithms ethnographically tractable" (Seaver, 2017: 7). These strategies aim to address the opacity and relational complexity of algorithms by shifting the analytical focus to their broader sociotechnical environments.

One central recommendation from these scholars is to prioritize the interactions between the components of sociotechnical networks, paying close attention to the practices, relationships, and processes that surround algorithms. By examining how algorithms are embedded within and interact with diverse fields (often disconnected from one another), researchers can gain a more nuanced understanding of how these systems "come into being" (Neyland, 2015) and exert power. To complement this approach, Seaver (2017) advocates for the inclusion of diverse materials (the 'heteroglossia') in the ethnographic analysis, such as press releases, social media updates, organizational documents, and public communications.

Building on these insights, I conducted a 13-month participant observation at RTBF, spending one to two days per week embedded within the organization from May 2022 to June 2023. This long-term approach served three key objectives: to deeply immerse myself in the organization's daily activities, to closely observe partici-

pants' practices, and to collect a comprehensive and robust dataset. Acting as a "right-hand man" to the Data Management Director, I gained significant access to various aspects of RTBF's operations. However, a few limitations emerged. I was not permitted to attend Executive Committee meetings (one of RTBF's two governing bodies) and had access only to their meeting minutes. Similarly, I was excluded from private discussions between the Data Management Director and the CEO.

Despite these limitations, my position provided a unique vantage point. I was immersed in the internal dynamics of the data management department during the development and implementation of the news recommender system. More importantly, I also found myself at the centre of a network of activities where various departments and actors—the technology department, platform management team, website management team, journalists, legal services, the Data Protection Officer (responsible for GDPR compliance), and the customer relationship management team—converged around the recommender system project. This central role also allowed me to attend a wide range of meetings with key external stakeholders, including service providers (for software or data storage solutions), technical support teams, and even representatives from other public service media and regulatory bodies. In practice, I participated in every meeting, briefing, informal conversation, or presentation I could physically attend. While my observation was geographically anchored to a single location, it afforded me significant mobility within RTBF, enabling me to witness interactions not only among internal actors but also with external collaborators beyond the organization's formal boundaries.

The research generated a wealth of data, including observation notes, around 900 pages of internal documents (such as presentations, meeting minutes, and technical documents), 400 pages of external documents (annual reports, management contracts, social media updates, press releases, and charters), as well as numerous photographs, screenshots, and six hours of recorded interviews with the key stakeholders of the project.

Data analysis

The collected data were first analysed through a biographical lens. Drawing on the principle that "an algorithmic assemblage should be studied as it evolves across contexts and over time" (Glaser et al., 2021: 12), this approach invites researchers to identify and then analyse 'key biographical moments' in the system's evolution. Rather than attempting to account for every factor and actor involved—something that is not "feasible let alone desirable" (Hyysalo et al., 2019: 16)—the focus is placed on pivotal moments that unfold the system's multifaceted dimensions and its evolving relationship with its organizational environment. The biographical approach thus serves a dual purpose: it helps navigate the complexity generated by in-depth ethnographies of technology, and it avoids the pitfall of analysing the artefact as a static snapshot, instead following its trajectory through time and space (Pollock and Williams, 2011).

Given the developments outlined in the previous sections, breakdowns and repairs stand out as strong candidates for identifying these moments. To this end, the material was coded using a multi-thematic approach (Ayache and Dumez, 2011) to: (1) compile all the breakdowns and repairs encountered during the development and implementation of the recommender system, (2) link each repair to its corresponding breakdown, and (3) delineate the temporal boundaries of each resulting breakdown-repair cycle in the system's biography.

Once these cycles were established, I applied Nicolini's (2009) zooming-in/zooming-out strategy. *Zooming in* probes the fine-grained texture of practice, capturing both the situated activities of actors and the artefacts and material arrangements that support those activities. *Zooming out*, by contrast, broadens the frame to trace how these practices connect across moments, revealing the associations that link them over time.

Practically, I first zoomed in on each cycle individually. Cycles were analysed through open coding, generating first-order codes rooted in participant terminology. After several iterations, these codes were synthesized into broader second-order themes, highlighting the practices

and dynamics within each cycle. By zooming out to compare the cycles and their respective themes, I was then able to identify patterns regarding the causes of the breakdowns, the objectives pursued during repairs, and their broader implications for the system and the organization.

Finally, these insights were triangulated with the 'parse corporate heteroglossia' identified by Seaver (2017) ensuring the robustness and coherence of the interpretation.

Findings

The analysis identified four major breakdown-repair cycles (Figure 2). The first concerned a technical malfunction triggered by a software update. The second involved issues related to the temporal relevance of the articles recommended by the system. The third stemmed from the accidental deletion of a critical segment of code essential to the functioning of an API. The fourth cycle revolved around the symbolic and editorial implications of the recommendations generated by the system.

As shown in the results presented in Figure 2, these breakdown-repair sequences do not all offer the same analytical depth. The first and third cycles were limited to ephemeral technical failures that were addressed through simple fixes aimed at restoring system functionality. By contrast, the second and fourth cycles gave rise to deeper forms of friction, involving repair processes that unfolded over an extended period and engaged both technical and organizational issues. Following Jackson's (2013) insight that breakdowns and repairs often exceed mere functional restoration and open spaces for reflection, redefinition, or reconfiguration, the discussion that follows focuses on these two cycles.

When the algorithmic system breaks: Uncovering organizational disorders

Two major breakdowns significantly impacted the biography of the recommender system. The first (second cycle) occurred after several months of development, when the initial version of the system was launched on the platform. It operated for a few weeks before complaints started pouring into the data management team. Both platform and editorial teams expressed frustration with the quality of recommendations, claiming the "algorithm was broken."

Interactions with various stakeholders quickly pinpointed the issue: the organization produces a significant volume of articles tied to fleeting events, such as sports results or daily weather forecasts. However, the recommender system,

	Description of the breakdown	**Description of the repairs**	**Timeline**
First cycle	The system crashed due to a missing software update	- Identified the software - Software update applied	2 days
Second cycle	The system generated outdated recommendations	- Manual annotation project to determine the temporal relevance of articles - Development and implementation of a "timeliness" algorithm for the recommender system - Establishment of the Editorial Algorithm Committee (EAC) to address issues related to the recommender system	3 months
Third cycle	The system crashed due to the loss of part of an API's code	- Reconstructed the missing code using available technical documentation	5 days
Fourth cycle	The system generated inappropriate recommendations	- Temporarily disabled the system - Developed business rules to exclude sensitive topics - Introduced a decision tree system for recommendation validation - Development of a "non-recommendable" flag in the content encoding tool (Cryo)	2 months

Figure 2. Summary of breakdown and repair cycles identified through multi-thematic analysis.

which relied on both content similarity and user data, failed to account for the temporal aspects of articles. Consequently, a significant portion of the recommendations were already "outdated." For instance, the system continued recommending the launch of the government's COVID-19 app, long after the pandemic had subsided.

A second major breakdown (fourth cycle) occurred a few months later when the organization published a series of articles about a journalist who had committed suicide at the Reyers headquarters, as I noted in my observation notes:

> The organization published a series of articles about a journalist who committed suicide at the Reyers headquarters. The day after the publication, a wave of panic swept through the teams. A team member, visibly distressed, explained the issue: the recommender system, in connection with the articles about the journalist's death, was only suggesting content related to employee well-being and workplace abuse. The symbolism of these recommendations was particularly concerning. It implied that RTBF was somehow responsible for the tragedy, creating a negative perception of the organization's work environment. To prevent further harm and potential reputational damage, the decision was made to temporarily disable the recommender system.

At first glance, these two breakdowns appear to be purely technical failures: in the first case, the system generates outdated recommendations because it does not account for temporal relevance, and in the second, it produces inappropriate recommendations due to a lack of contextual filtering. Both cases highlight limitations in the system's design, particularly its reliance on content similarity. However, a deeper analysis reveals that these breakdowns are not just technical disruptions but also manifestations of organizational tensions, particularly related to power dynamics surrounding the introduction of the algorithmic system.

> [Stakeholder]: From the very beginning, the project faced resistance…
>
> [Researcher]: How so?
>
> [Stakeholder]: When the [Committee] had to approve the project, it was clear that the editorial team representatives were sceptical… let's just say they weren't exactly enthusiastic. There were lengthy discussions about how the algorithm would function and where it would be placed on the website's homepage. Eventually, we reached a compromise: the widget would initially be positioned at the bottom of the page, and if it performed well, we could move it higher. It wasn't ideal… after all, no one really sees it unless they scroll all the way down… but it was better than nothing.

This excerpt from an interview illustrates how the project encountered resistance from the outset. The decision to position the recommendation banner at the bottom of the homepage was a strategic compromise, limiting its visibility while still integrating it. This move reflects a clear effort to maintain editorial control and reduce the algorithm's influence on the user experience.

This tension reappears multiple times throughout the algorithm's biography. Initially, the project to develop the algorithm was envisioned as a cross-functional initiative, bringing together the support teams—particularly the data management team—and the editorial teams. The support teams' role was to translate the editorial teams' needs and expertise into technical rules for the algorithm's operation. However, as the project progressed, editorial teams gradually distanced themselves, leaving the support teams to handle most of the development. This disengagement was not accidental. As one interviewee noted:

> We tried to invite them several times [to meetings], but it's complicated… They don't seem very interested, actually.

Another interviewee elaborated:

> I think the motivations were quite varied. For some, it's a clear opposition: they simply don't want to hear about it. For others, it's a matter of not having enough time to truly participate… And for some, I think it's a combination of poor communication and a feeling of not being legitimate.

From the beginning, the support teams anticipated the resistance the algorithm would encounter. As one representative noted during a meeting:

> The algorithm will inevitably cause some friction with the editorial teams, so it's crucial to bring them on board throughout the project. We are fully aware of this. The algorithm is not intended to replace their work but rather to assist them.

Thus, to a large extent, the disengagement of editorial teams can be seen as a response to the perceived threat of the system. As Hansen and Hartley (2021) argue, algorithmic systems introduce a particular vision of what constitutes news, disrupting established editorial processes. Traditionally, editors determined what content was highlighted through a complex interplay of expertise, working knowledge (Harper, 1987), and journalistic values. The introduction of a recommender system, which determines visibility based on algorithmic rules, shifts some of this "truth-telling" power away from human editors, leading to tensions. Glaser et al. (2021) describe this as a conflict between the performativity of algorithmic and non-algorithmic assemblages: the recommender system, with its data-driven logic, challenges the editorial process, rooted in human judgment and professional expertise.

This resistance was clearly expressed when, at the time of the launch of the recommendation algorithm (which also coincided with the renegotiation of the management contract with the government), one of the main trade unions posted a poster in every hallway of the Reyers building (Figure 3). The poster, a caricature, explicitly criticizes RTBF's digital strategy, particularly its focus on datafication and algorithmization processes. The picture of the robot, which symbolizes both the recommender system and, more broadly, the ongoing digital transformations, takes on a specific meaning here: it represents a sense of dispossession and loss of control experienced by the workers.

Figure 3. Caricature displayed in the hallways of RTBF during the launch of the recommender system and the renegotiation of the management contract with the government: "The CEO introduces his successor." The CEO presents a robot that says, "Hello to those who will be digitalized. Goodbye to those who will leave."

The introduction of the recommender system has thus crystallized an opposition between two contradictory narratives about innovation within the organization. On the one hand, the support teams, responsible for technical development and implementation, adopt a more techno-optimistic vision. These teams see the recommender system as a beneficial and desirable innovation for the organization, perceiving it in terms of human-machine collaboration. On the other hand, the editorial teams view the recommender system not as an asset, but rather as a threat to their expertise and role, challenging the editorial work that lies at the heart of RTBF's mission.

Another key illustration of these tensions lies in the issue of metadata. Recommender systems depend on structured and consistent metadata to function effectively. However, metadata tagging was perceived by editorial teams as a burdensome task. Editors prioritized immediate content considerations, while data teams emphasized metadata normalization as essential for system performance. This discrepancy in priorities became a long-standing issue at RTBF, repeatedly hindering personalization efforts. A stakeholder expressed frustration over the lack of metadata quality control:

> We keep telling them that the metadata is crucial, but they don't take it seriously. It's an insoluble problem.

This ongoing challenge further underscores the fundamental misalignment between editorial and support teams. For data teams, metadata is a structural necessity. For editorial teams, it is an additional task that diverts attention from their core responsibilities. This misalignment further deepened the divide, reinforcing the perception that the recommender system was fundamentally incompatible with editorial workflows.

From the perspective of the project managers, the withdrawal of the editorial teams had far-reaching consequences. For them, the system's breakdowns in the second and the fourth cycle were not just technical errors but stemmed largely from a lack of editorial involvement during development. As one stakeholder noted in an interview:

> They are far more knowledgeable than we are on these matters [...] Everything would have been so much easier, and we could have avoided so many problems if we had been able to anticipate…

This statement highlights a decisive point: had the editorial teams been actively involved, they could have offered valuable insights to help prevent and address these issues before they worsened. Their disengagement was not only a sign of organizational tensions but also a direct factor in the system's breakdowns. By stepping back early in the design phase, the editorial teams unintentionally created a void, forcing the support teams to take more control over how information was prioritized in the algorithm's design, despite lacking the necessary working knowledge. For the project managers, the absence of editorial teams ultimately sets the stage for breakdowns, leading to misaligned recommendations and, over time, growing scepticism toward the system itself.

Patching strategies for addressing opposition to innovation

I now take a closer look at the repairs that followed the breakdowns. I show that, beyond simply fixing the technical issues exposed by breakdowns, the repair efforts were primarily intended to reintegrate editorial teams into the project and reinforce the system's legitimacy. In doing so, I argue that these interventions constitute what I call 'patching strategies': rather than tackling the root causes of the breakdowns by questioning the foundations and the authority of the algorithm, they focus on adjustments that preserve the system while mitigating opposition to it.

> We need to be careful. People who don't understand the project can easily dismiss it with a simple counterargument. It's unfortunate, but it's true.

As illustrated by this quote from one of the project managers during a meeting, the support teams were particularly concerned about the occurrence of breakdowns and their potential to jeopardize the project by providing additional arguments to its opponents. Many discussions in repair-focused meetings within the support teams reflected a persistent desire to "bring everyone back into the project," "get people on board, even the most sceptical," or "gather everyone around the table." This recurring theme in the repair efforts highlights two key aspects: first, the breakdowns do not stem solely from the algorithmic technology itself; second, all corrective actions are directed toward a common goal that goes beyond the mere material repair of the algorithm. Indeed, as Henke and Sims (2020: 3) emphasize, material repair "almost always goes along with repairs to other forms of order."

In the second cycle, the solution took the form of a cross-functional project: the development of a "service algorithm" designed to assign a temporal validity to articles in the RTBF catalogue. Once integrated into the recommender system, this algorithm would help prevent outdated suggestions. More than just a technical fix, the project was designed as a catalyst for renewed collaboration between editorial and technical teams. This repair effort was carried out within the newly established "Editorial Algorithm Committee" (EAC), initiated by the Data Management Director. Officially tasked with "finding solutions to editorial challenges related to algorithms," the committee brought together support team managers, content managers, and media managers.

One of its first initiatives was the "news articles annotation" project, aimed at training the algorithm to recognize the temporality of content. Members from all teams were tasked

with manually assigning a relevance lifespan to a representative sample of news articles, allowing the system to learn and generalize these classifications. A dedicated annotation tool was used, and the results were closely monitored. Participants could categorize articles using predefined time frames (24 hours, 48 hours, 15 days, 3 months, cyclical, or timeless).

However, despite the stated goal of editorial involvement, analysis of the project's dynamics revealed that support teams once again carried out most of the annotation work. It was observed during project monitoring that the most actively engaged participants all came from the support teams.

At the same time, the recommender system was also promoted internally through multiple messages on the organization's intranet, as well as to the public. All these promotional messages highlighted the "public service" aspect of the RTBF recommender systems—emphasizing their alignment with the public service mission of the PSM—and their role as a tool designed exclusively to assist or complement the work of editors.

In the fourth cycle, the breakdown exposed a structural weakness of the system through its inability to contextualize recommendations, particularly for sensitive topics. The tragic incident involving the journalist deeply shook all teams within the organization. From the project's perspective, it marked a turning point, prompting the editorial teams—who had previously been cautious—to openly raise their concerns before the EAC. As the discussion progressed, new potentially problematic situations emerged. An editor, for example, highlighted another significant risk of algorithmic bias during a meeting:

> Imagine a user who starts reading articles about the MR [a Belgian political party]. Because the algorithm relies primarily on content similarity, it might continue suggesting more MR-related articles. This could create the perception of editorial bias, especially during elections, potentially violating RTBF's obligation to remain neutral.

To address the issues raised by the breakdown and improve the recommender system, The team introduced a new approach to make the system's decision-making process more precise and better suited to the organization's needs. The main idea was to identify "real-world cases," meaning concrete situations, to refine the algorithm and make it more effective in managing recommendations. This approach allowed for better contextualization of articles and ensured that the recommendations would be more appropriate. In this context, the editorial teams played an increasingly active role. Until then, they had been somewhat detached from the algorithmic management, but this time they were directly involved in defining the new "business rules" for the system. This process required considering more nuanced criteria tailored to the specificities of RTBF's missions, considering the diversity of content and editorial challenges. For example, a rule was established to prevent articles on sensitive topics from triggering further recommendations.

On the technical side, an adjustment was made by introducing an additional filtering layer in the form of a decision tree. This system allowed for the establishment of a set of precise criteria that each article had to meet before being recommended. This new structure enabled better control over the types of content that were being distributed and allowed certain articles, deemed inappropriate, to be excluded from the recommendations. This helped align the recommended content with the organization's editorial values. Meanwhile, the development of a new feature for Cryo, the editorial management tool, was launched. This feature enabled editorial teams to tag certain articles as "non-recommendable" upon publication, giving them more control over the recommendation process. From that point on, the continued involvement of the editorial teams in managing the recommender system was regarded as a success by the project managers.

As a result, each cycle of breakdowns and repairs did not lead to a radical transformation: the repairs, even from a technical standpoint, merely added corrective elements to the existing structure—essentially, patching the system. I adopt the concept of *patching* from the field of software development, where it refers to the application of a corrective piece of code designed to fix a bug, address a vulnerability, or resolve performance issues (Dadzie, 2005). These patching strategies were primarily seen as opportunities

to reintegrate reluctant stakeholders into the project. This process mirrors research using actor-network theory to examine innovation. Indeed, as Akrich (1989) points out, innovation is fundamentally about enrolling an increasing number of allies, whose involvement strengthens the innovation's position. Although these adjustments were intended to address the concerns of the editorial teams, they did not challenge the fundamental logic of the algorithmic system. Rather than creating a space for critical discussion that could have led to questioning the algorithm's existence or its influence on news distribution, these repairs mainly focused on fixing issues while reinforcing the system's legitimacy within the organization.

The main driver of this strategy was the concerted effort to reengage the editorial teams by presenting the repairs as collaborative and inclusive. The creation of the EAC, for instance, provided an institutional platform to incorporate their concerns. However, this consideration took place within predefined limits, ensuring that the system's structure would not be altered. This is explained by the fact that the development of the system required significant resources, and the managers involved in the project were committed to embedding the innovation within the organizational landscape. Thus, what I describe as patching involves targeted adjustments that preserve the existing structure, while addressing the issues that are immediately apparent. Each patch acted as a fix to resolve concrete issues without questioning the system's authority. Despite the improvements made, the underlying power dynamics remained unchanged: editorial teams were reintegrated, but they were not empowered to challenge the fundamental logic of the algorithm.

Closing the black box through breakdown and repair cycles

Having shown how patching strategies operate, I now take a broader perspective to examine how cycles of breakdown and repair have shaped the recommender system's role and standing within the organization. This perspective reveals a counterintuitive finding: by reinforcing a particular narrative of innovation and minimizing opposition, these cycles have contributed to the entrenchment of the system and the closing of the black box. As a result, the system has become both taken for granted and less visible within the organization. This phenomenon not only obscured the system's complexities but also changed the way it was perceived by stakeholders, shifting their focus from breakdowns and repairs to more mundane concerns related to its ongoing use and maintenance.

> [A manager during a meeting]: I'm really happy to see how things have changed. [...] It's great to see that all our efforts are making a difference. [...] I'm noticing a big improvement. Teams are increasingly requesting that we provide insights regarding content publication.

This quote illustrates how the relationship between actors and the system evolved during the repair phase of the second breakdown. In a meeting on platform metrics, a manager expressed satisfaction at the increasing reliance of editorial teams on the system's outputs for determining optimal publication times, signalling a transition from scepticism to greater trust in the system's utility. Despite the system's earlier failures, the ongoing cycles of breakdowns and repairs fostered a sense of improvement, and as each patch was implemented, resistance within the organization lessened. In time, the system moved from being a subject of contention to one that was normalized and integrated into the routine operations within the organization. This aligns with the findings of Cuevas-Garcia et al. (2023: 369), who, in their study of sewer inspection robots, argue that innovation success relies on continuous efforts of 'plausibilization'—the ability to persuade stakeholders of an innovation's value by constructing and maintaining its 'narrative plausibility' within broader imaginaries.

As the repair phases progressed, the editorial teams took on a more active role in shaping the system's functioning. They began to propose refinements to the algorithm's parameters, fine-tuning it to better meet their editorial goals. For instance, they advocated for the promotion of longer articles to enhance user engagement, the spotlighting of timeless content to evoke nostalgia, and recommending local content based on user location. The latter was particularly significant, as it fulfilled a legal requirement for informa-

tion distribution mandated by the management contract. Furthermore, the data produced by the system—including user consumption patterns captured by the platform's trackers and new metrics specifically designed to assess the algorithm's performance—was disseminated within the organization. This data allowed various governing committees to make informed strategic decisions about the next steps in the algorithmic personalization of RTBF's interfaces. For instance, one such decision was the development of a new, fully personalized page titled "My Choice."

The focus on technical failures and their resolution thus gradually receded from the foreground of organizational discussions. As one interviewee noted:

> One of the biggest challenges is stability. Having functional systems is important but maintaining them is just as crucial. [...] Take, for instance, the constant updates to OS [operating systems] across the different devices people use to access the platform. These changes create all sorts of issues, from display problems to page latency. [...] It's a never-ending story.

This quote underscores the idea that system stability is not an absolute condition (MacKenzie, 1993; Orlikowski, 2000) but the result of an ongoing effort, where the management of everyday technical challenges eclipses the dramatic breakdowns that characterized earlier phases. In line with Russell and Vinsel's (2018) assertion, who titled their study "after innovation, turn to maintenance," stakeholders' tasks have shifted from addressing identified breakdowns and implementing repairs to a more routinized approach (D'Adderio, 2011; Murray et al., 2021) focused on sustaining and maintaining the system over time. In this context, editorial teams took on the responsibility of supplying relevant content and metadata, as well as identifying recommendation-related issues and escalating them to the EAC. Similarly, support teams take on the responsibility of ensuring the system's ongoing technical maintenance through regularly scheduled "phases of care."

As this transition unfolded, the system gradually faded from the forefront of discussions and interactions. Conversations about the recommender system, which had once been central to strategic meetings, became less frequent, replaced by other organizational concerns. New priorities, such as generative AI—the first version of ChatGPT being released at the end of my fieldwork—began to capture attention, pushing the algorithm to the background. Editorial teams now interacted with the system pragmatically, integrating it into their workflow. Support teams, which had previously focused on resolving breakdowns, gradually shifted their efforts toward other projects, such as the development of the *My Choice* page or the launch of an automated newsletter. This mirrors my own experience in the field. Toward the end of the fieldwork, the system itself was only briefly mentioned during data management briefings or weekly performance monitoring meetings. My own tasks and the data I collected seemed increasingly removed from the original focus of my research; even though this "absence" speaks volumes from an analytical perspective.

The gradual invisibility of the recommender system, as it became embedded into the fabric of the organization's routine processes, is a direct consequence of its black boxing through breakdowns and repairs cycles. Initially, the algorithm drew significant attention due to technical breakdowns and power struggles surrounding its adoption. However, as the system underwent patching, it stopped being seen as a disruptive innovation and instead began to operate as a black box.

As controversies faded, stakeholders no longer needed to justify or legitimize the algorithm, and the discourse around the system shifted accordingly. Meanwhile, its results were used without the need to understand or even reference the system or how it produced its outcomes. In other words, the recommender system became a 'fact,' as defined by Latour (1987). As Brisset points out,

> "accepted by all as a black box, a fact is only invoked instrumentally within other networked processes of creating [other facts]. To acquire the status of a fact, it must emerge victorious from controversies with competing facts. To do so, it must, on the one hand, prove its resilience [...] in order to establish and strengthen its legitimacy. (Brisset, 2014:222, my translation)"

Discussion & conclusion

The analysis of breakdowns and repairs in the biographical trajectory of the recommender system reveals that these events go beyond the mere identification and resolution of failures. They are embedded in a broader sociotechnical dynamic of closure, playing a role in legitimizing the innovation within the organization. These findings extend existing work on breakdowns and repair practices, particularly within infrastructure studies, where such moments are often seen as revealing tensions and offering opportunities to reconfigure power relations (Jackson, 2013; Henke and Sims, 2020).

To better grasp this process, I introduce the concept of 'patching' as a specific modality of repair. The term originates from software development, where it refers to the insertion of a corrective code snippet designed to fix a bug, address a security vulnerability, or enhance performance (Dissanayake et al., 2022; Islam et al., 2023). A patch is characterized by its targeted and additive nature (Dadzie, 2005): it modifies specific functionalities without overhauling the system's architecture or interrupting its operation. It allows the system to continue functioning while undergoing transformation.

This type of intervention has become central in the video game industry, where patching is now a routine and even structuring practice (Newman, 2012). It supports the post-launch lifecycle of games by adding features, correcting unexpected behaviours, or rebalancing gameplay mechanics (Truelove, 2021). Yet these fixes are far from neutral: they also serve as governance tools, redefining, for example, the relationships between developers and players (Švelch, 2019).

As the case study shows, patching refers to targeted interventions aimed at correcting immediately visible malfunctions without challenging the overall structure of the system. In the biographical trajectory of the recommender system, this included the addition of a service algorithm, the integration of a decision tree, the activation of a non-recommendation option, or the creation of ad hoc entities within the organizational chart. Each of these patches was incrementally incorporated as a new component of the system.

These interventions thus served a strategic purpose on multiple levels. On one hand, they allowed the organization to address concrete and localized issues (e.g., the temporality of recommended content) without questioning the foundations of the innovation. On the other, they helped sustain (if not reinforce) the power relations redefined by the system by diverting attention from more fundamental critiques of the algorithm's role in editorial processes. By reframing dissenting perspectives as mere technical or procedural matters, patches helped translate potentially disruptive forms of resistance into manageable adjustments.

In doing so, patches actively contributed to delineating the boundaries of controversy. They determined what could be problematized and debated, and conversely, what remained outside the scope of discussion. Rather than opening a space for deliberation about the system's legitimacy or relevance, these interventions worked to secure its position within the organization. In this sense, patching operates as a mechanism of containment and consolidation, reinforcing the legitimacy of innovation under the guise of pragmatic problem-solving. As shown in the study by Sims & Henke (2012) on repair strategies within the U.S. nuclear weapons complex, the purpose of repair lies less in restoring technical functionality than in preserving the legitimacy and credibility of a technology. Their analysis highlights that this credibility does not rely solely on material interventions but is also rooted in closely intertwined institutional and discursive dimensions.

Because of its simultaneously strategic and corrective nature, patching occupies a distinctive position in the broader landscape of repair practices. It contrasts, for example, with forms such as tinkering (Harper, 1987) or improvisation (Henke, 2000; Schubert, 2019), which are typically seen as informal, localized responses by frontline actors to contingent disruptions. Patching, as documented here, appears instead as a targeted and orchestrated practice, led by innovation managers who mobilize organizational resources and formal governance mechanisms to implement adjustments aimed at reducing internal friction.

Patching also differs from maintenance practices. Maintenance is typically defined as

a discreet and continuous activity aimed at ensuring the long-term viability of already stabilized systems (Russell and Vinsel, 2018; Denis and Pontille, 2022). It operates within the invisible routines of infrastructural work, as illustrated by the first and the third cycles, which in our case can be understood as maintenance practices. Patching, by contrast, occurs sporadically and visibly at moments of fragility, when the system's stability is still uncertain. Its goal is to prevent the escalation of a breakdown by containing its effects through a visible correction that addresses symptoms without tackling root causes.

Patching thus allows decision-makers to choose which criticisms to address, while avoiding the disruptive consequences of a transformational repair: a comprehensive overhaul undertaken only as a last resort in the face of existential threats or by actors seeking to reorient the system according to different ideals (Sims and Henke, 2012: 327). In the case under study, such a transformational repair would have meant either abandoning the project or completely reconfiguring the architecture of the recommender system and its role in editorial workflows.

These strategies reflect a broader dynamic in which the very categories of 'breakdown' and 'repair' are strategically constructed. In this sense, the findings echo Sorokin's (2023: 100) observation that actors involved in repair not only define what needs fixing but also determine what is deemed "desirable and beneficial" for the organization. In the RTBF case, innovation is assumed to be beneficial by project teams and their internal allies. Consequently, repair is not only aimed at restoring technical functionality but also at protecting and consolidating the institutional position of the innovation, without ever opening a broader debate about the system's overall legitimacy.

In this way, patching strategies align closely with what Graziano and Trogal (2017) describe as a 'politics of repair,' where to repair is to govern: to decide who acts, on what issues, and according to which values. The patching strategies observed at RTBF should therefore not be seen as mere technical adjustments. Rather, they constitute acts of governance that contribute to the institutionalization of a specific sociotechnical order, which may be described as the algorithmization of editorial processes.

Although patching offers a fertile lens for exploring the intermediate zones between controversy and stabilization, the concept remains under construction. A first limitation of this study lies in its single-site design, which calls for comparative research to assess the transferability of the findings. A second limitation concerns the perspective adopted: most data were gathered from actors supportive of the project. As a result, the views of dissenting groups (such as journalists or unions) remain partially in the background, even though they were identified during fieldwork.

By linking patching strategies to the black box paradigm, this study refines our understanding of how organizations manage algorithmic systems through breakdowns and repairs. While Sachs (2019: 1698) notes that repairs are often "folded back into the black box of the algorithm, rendering them invisible and unacknowledged," this study reveals a different dynamic. Breakdowns and repairs are not simply absorbed by the black box: they actively contribute to its very constitution, becoming opportunities to close surrounding controversies.

Organizations often have a strategic interest in producing and maintaining such black boxes. However, the degree to which these systems become closed or remain open depends on evolving and context-specific dynamics, particularly within public administrations and service-oriented institutions, where administrative cultures and approaches to innovation vary significantly (Zhang and Feeney, 2020). As Meijer et al. (2021: 837) emphasize in their study on algorithmization in bureaucratic settings, "the outcome of the process of organizational rearrangement around the use of an algorithm is not determined by its technological features but influenced by social norms." The closure or persistence of black boxes is therefore not a purely technical outcome, but the result of negotiations, constraints, and strategic decisions embedded in broader sociopolitical logics.

This is especially significant in public service organizations, where the legitimacy of algorithmic systems is far from guaranteed (Reddy et al., 2019).

Unlike private companies, these organizations are generally bound by principles such as transparency, accountability, and fairness, and operate within established normative frameworks, which intensify debates surrounding the acceptability and oversight of such technologies.

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