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Co-Designing Sociotechnical Systems for Workplace Communication Regulation: Technical Insights and Data Challenges

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Abstract. The widespread adoption of communication technologies in professional contexts has significantly transformed workplace communication practices, often leading to communication overload and negatively impacting Quality of Life at Work (QLW). This paper presents the VERTUOSE project, which aims to develop a Socio-Technical System (STS) for regulating workplace communication. Utilizing a co-design approach that integrates sociological, IT, and co-designers' perspectives, the technical part of the system aims to be open and adaptable. The STS provides tools for managing communication practices through customizable policies. Key challenges such as data privacy, ownership are addressed through transparency of data handling and informed user consent mechanisms.

Introduction

The widespread adoption of communication technologies in professional contexts has profoundly transformed communication practices and multiplied both the communication channels and the amount of information to be processed by the employees, impacting negatively their Quality of Life at Work (QLW) (Morand et al., 2023). Existing solutions often fall short, as individual strategies may shift communication burdens onto receivers, while charters and guidelines are often disregarded. Purely technical solutions may not align with practices and fail to adapt to evolving needs due to their rigidity (Lewkowicz and Liron, 2019). Thus, we propose a *Socio-Technical System* (STS) helping the employees in managing their communications (Baxter and Sommerville, 2011). This STS is designed following a co-design and interdisciplinary approach, involving sociological and IT skills (Koskinen, 2011). The technical part of the STS serves two primary objectives. Firstly, it aims to provide raw data, meaningful metrics and visualizations to help employees assessing their communication practices. In addition, the system acts on the IT infrastructure, adapting it autonomously in response to evolving individual, collective, or organizational users' demands. To this end, we capitalize on progress in network infrastructure programming, drawing from concepts, paradigms and tools such as *Policy-Based Management*, *Software-Defined Networking* (SDN) and *Network Function Virtualization* (NFV) (Sloman, 1994; Strassner, 2004; ETSI, 2014).

Focusing on the technical part of the STS, we present the background and related work. Following, we introduce our use case, the VERTUOSE project, that involves the participation of a voluntary company. Finally, we describe the technical approach of data collection, processing, and use within the project.

Background and Related Work

Acting on a Software-Defined Communication Infrastructure, for Quality of Life at Work

Communications such as email or instant messages are carried out via IT infrastructures composed of heterogeneous devices including network equipment. Nowadays, management and control of such infrastructures is increasingly facilitated by a set of efforts aimed at making it programmable. SDN offers dynamically customizable routing and traffic processing / monitoring capabilities. The use of dynamically deployable *Network Functions* (NF) enables communications processing up to the applicative layer (ETSI, 2014). These tools are traditionally used to improve performance and reduce operational costs (e.g., SDN to simplify control of the network, NFV for dynamic deployment of proxies or firewalls).

Diverging from these performance-focused applications, we are more interested in performing operations on communications for QLW enhancement

purposes. Examples of QWL-oriented actions include deferring emails, defining unavailability periods during which an automatic response is sent, adding tags to a communication based on custom criteria, etc. Direct actions on users' terminals are also enabled using custom Software Agents as well as web browser and mail client extensions.

Using Policy-Based Management and Policy Representation

The automation of infrastructure control requires a representation of the objectives, rules and constraints guiding the control of managed objects. In the domain of networking, these objectives were traditionally formalized using knowledge objects known as *policies*, deployed within policy-based systems (Boutaba and Aib, 2007). Policies typically take the form of "ON (Event) IF (Condition) DO (Action)" (ECA) rules. Expressed by diverse actors, they can be formulated at distinct levels of abstraction, depending on the actors' expertise level (Strassner, 2004). The highest policy level usually involves human actors having the least knowledge of the underlying infrastructure. This "*business view*" or "*goal / corporate / high-level user-specified policies*" are generally articulated using ECA rules with terms that can be understood by non-expert users (Plate et al., 2013). However, the vocabulary used to formulate these policies is generally to, e.g. "*bandwidth*", "*reliability*", or "*node*" for policy-based network management systems. Generally specialized in specific applications, these policy models and associated systems are not directly transferable to our goal of enabling non-experts to articulate demands that are related to the technological mediation of communications within professional contexts.

Use Case Description

This work is part of a research project named VERTUOSE, which involves a voluntary French organization dedicated to improving working conditions, particularly in small and medium-sized enterprises, meaning its participation is particularly valuable. The target organization comprises around fifteen members. Addressing communication overload, we propose a STS, co-designed by sociologists, IT experts, and employees. The social component of the STS relies on discussion forums, reflection sessions, and conventions to change communication practices.

The technical part of the system should allow precise manipulation of communications, targeting groups of communications based on user-friendly criteria like recipient, urgency, or availability, increasing adoption chances. Targeting users in a situation of communication overload, the system is designed not to add burden, being user-oriented, adaptable, and autonomous. Assuming a programmable communication infrastructure, the system is guided by policies formulated by users. It monitors and acts on communications using software

agents on devices, SDN-switches in the network as well as data centers capable of hosting dynamically deployable VNFs.

Internally, the technical system relies on a hierarchical *policy continuum* composed of three layers. At the highest level, a *Structured User Policy* (SUP) model structures knowledge objects representing the employees' requests to the system regarding mediated communications. These SUPs are mapped to concrete actions through iterative refinements into *Operational Policies* (OPs) that are refined into *Adaptation Actions* (AAs). Through OPs, this architecture offers an intermediate view of the internal functioning of the system, enhancing openness.

Data from the Workplace, for the Workplace

The VERTUOSE project is anchored in a democratic and participatory framework, reflecting the values associated with Participatory Design, which emphasize equalizing power relations and democratic practices to support the inclusion of diverse values and perspectives in the design process (Van Der Velden and Mörtberg, 2015). From a technical standpoint, we are committed to ensuring data ownership and transparency throughout the system's operations, aligning with the project's values of accountability and user empowerment.

Data inputs

We are primarily interested in the data produced during co-design workshops. Informing the design of the system itself and resulting from collective efforts, we deemed important to explain how these efforts contributed to our technical approach. As part of this effort, a short explanatory video was produced, in which the technical details and ongoing questionings were explained to participants.

Concurrently, using the outputs of participatory workshops, potentially relevant data were collectively identified, including but not limited to:

- Employee schedules;
- Call logs, including date and duration of VoIP and traditional calls;
- Email related data, such as metadata (e.g., sender, recipient, and timestamps), with the potential inclusion of email content, subject to privacy and consent constraints;
- Visited website URLs;
- Overall data usage and the volume of data per type (e.g., email, video conferencing), or specific application (e.g., Teams, Zoom, or WhatsApp);
- Types of communications, for example synchronous (e.g., video calls) or asynchronous (e.g., emails) communication;
- Duration of communication sessions;
- Devices used (e.g., smartphone or laptop), associated purpose and context (e.g., business trip, work from home) potentially identified using geolocation.

The system could potentially have access to a wide array of data, but what is actually collected and made available to users will depend on several factors: utility, collective decisions, individual preferences, and the development and implementation efforts required.

Further analysis of these data will focus on identifying high activity periods, patterns and individual differences and similarities in communication practices to support the collective building of conventions and mutual learning.

Constraints and Challenges

Non-technical constraints include user interactions and the risk of oversolicitation. Data collection often requires user interaction, yet individuals using our system frequently experience cognitive overload. Thus, balancing essential data collection for system functionalities with the risk of overburdening users is crucial.

Privacy concerns are also significant, as collecting and handling personal data like call logs and email headers must comply with privacy regulations and respect user consent. Consent must be informed, meaning we must justify data collection and explain data processing clearly.

Overall, the system should provide meaningful ways of interacting with data, in terms of collection, processing and visualization. This involves creating activity and communication models that align with user perceptions. In VERTUOSE, technical experts are the ones initially correlating functionalities with the necessary data, but engaging users in the decision-making process regarding data collection is vital. Given access to raw, low-level data, such as packets, MAC addresses, and traffic amount, it can be difficult to correlate these with the conceptual models users employ to think and discuss about communications. Bridging this gap is not neutral and involving users in the co-construction of common representations is crucial to ensure appropriation of the system and relevance of data collection.

In addition, assuming that participants are experts in their evolving working conditions, we intend to involve them in the bridging of the gap between data and user representations **during the deployment** of the system. Thus, users can manipulate data using dedicated policies called *Knowledge Operational Policies* (K-OP). A user could express a K-OP such as “*IF I frequently change my foreground windows, THEN it means that I’m in a situation of cognitive overload*”. Following, this user could define another policy that uses this custom state to modulate communications, e.g., “*IF I’m in a situation of cognitive overload, THEN emails from external organizations should be delayed*”. In this example, and since the translation between the raw data and the state is direct, the person could give informed consent to the monitoring of the foreground window.

Parallel to these non-technical constraints, technical constraints must also be considered, such as resource consumption and potential service degradation. Data collection processes can consume substantial system resources, impacting overall performance and user experience. It is necessary to mitigate these issues and maintain high service quality during data collection.

Data outputs

The system provides data to researchers about how the system is used. Understanding system usage helps assess how well the STS is appropriated by users. This evaluation identifies gaps between envisioned practices during design and actual practices, potentially informing system improvements.

The system relies on policies (i.e. IF-THEN statements) that are evaluated using on collected data, meaning that actions on communications are an output of collected data. In addition, representations of links between monitoring, actions, and policies should be constructed to ensure openness of the system.

Considering the system must offer configurable data visualizations to facilitate both individual and collective reflection on workplace communication practices, visualizations must consider privacy and avoid information overload. For collective insights, anonymization addresses privacy concerns. For individual insights, the focus is on providing actionable information without overwhelming users.

To address these challenges, several avenues are being explored. Configurable data collection allows users to customize what data is collected and how it is represented. Privacy-preserving techniques such as anonymization protect user privacy while still providing valuable collective insights. Efficient data processing algorithms mitigate technical constraints, ensuring minimal impact on system performance. A participatory design approach ensures that data visualizations and models are intuitive and aligned with user expectations, enhancing understanding, creating a sense of ownership, and facilitating appropriation.

Conclusion

This study presents the co-design of a STS, focusing on its technical part that addresses the technological mediation of communications within professional contexts in order to improve Quality of Life at Work (QLW). By integrating sociological, IT and co-designers' perspectives, the approach addresses the limitations of existing solutions. Participants are involved in the technical design process to facilitate appropriation and ownership of the artifact. Data collection and privacy concerns is a key component of data management within the system, transparency and informed user consent. This approach highlights the importance of user involvement and interdisciplinary collaboration, ensuring the system remains relevant and effective in managing workplace communication challenges.

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