Coordinative Objects: supporting coordination in globally distributed projects

Dr Francois Roubert

This is an electronic version of a paper presented at the International Conference on Innovations in Info-business & Technology (ICIIT2022), Colombo, Sri Lanka 18 Feb 2022.

Coordinative Objects: supporting coordination in globally distributed projects

Francois Roubert
School of Computer Science & Engineering
University of Westminster
London, UK
F.Roubert@westminster.ac.uk

***Abstract*— The paper explores the roles of information objects to support coordination in globally distributed work in scientific research. First, it outlines key challenges to coordination in globally distributed work. Then, an empirical study of a globally distributed project in nanoscience is presented. It focuses on the practices of organizing and coordinating scientific research across multiple locations, organizations, and disciplines. The findings emphasize the key utilizations of the experimental protocol as a key information object to support the interconnection of scientific activities across the project. The experimental protocol is conceptualized as a '*coordinative object*' that has key *affordances* to support global coordination: *interpretation*, *alignment*, and *boundary-crossing*.**

Keywords— globally distributed projects, information object, nanoscience, coordination, experimental protocol, coordinative object, affordances.

I. Introduction

Work is increasingly *globally distributed*. It is ever more organized in highly-changing projects that bring together multidisciplinary teams of highly specialized individuals, often from multiple organizations, operating remotely to resolve complex problems [1]. This is particularly significant in the context of the global COVID-19 pandemic since 2020 that has made this form of work even common. However, coordinating globally distributed work activities across complex multi-layered projects is a huge challenge. [2,3,4,5]

The aim of the paper is to investigate and understand the roles of information objects in supporting coordination practices in a *globally distributed project* in the scientific field of nanomedicine. We begin by outlining the coordination challenges in complex global projects where partners are separated geographically, work in different organisations and operate in diverse disciplines. Then, we closely examine coordination practices in a specific globally distributed scientific project in nanomedicine, NanoArth. We identify the experimental protocol as an essential information object that is used by partners to interconnect and integrate their scientific practices. Subsequently, we conceptualise the protocol as a *coordinative object* i.e., an information object that can be used, designed and shaped to help achieve global coordination across the project. Finally, we identify three *affordances* of the *coordinative object* as key capabilities that help navigate through and address the global coordination challenges highlighted earlier.

II. Background

Globally distributed projects refer to a complex form of projects that require for collaborators from cross-disciplinary and geographically dispersed teams to work interdependently across organizational boundaries [1] on dynamic co-operative projects [6]. If global projects have gained increasing prominence since the advent of internetworked technologies three decades ago, the COVID-19 pandemic has made them even more prevalent and worthy of investigation. However, organizing and integrating work activities across global dynamic projects distributed between actors who work in different institutions and disciplines to achieve common action present several essential problems. This section first reviews the challenges that globally distributed projects pose on coordinating work operations and summarizes them in tabular format.

A. *Coordination challenges in globally distributed projects*

Globally distributed projects can be essentially characterized as projects that are dispersed (1) geographically, (2) across organizational boundaries, and (3) across disciplines. The challenges on coordination in these projects are explored by reviewing the literature along these three dimensions.

1) Geographical Dispersion: A first obstacle for the coordination of global projects emanates from the geographical dispersion of activities. The general diffusion and adoption of networking technologies in the past 30 years has enabled new global projects in which actors conduct their activities and cooperate remotely across distances, typically using digital tools [1]. The challenges of working projects that are geographically dispersed are considered in the following paragraphs.

Geographic distance has been often identified as a key disruptive factor on coordination. Spatial dispersion can restrict frequent and spontaneous communication [3,7]. Even though synchronous interactions can be easily supported by digital technologies, the effectiveness of communication can be diminished by the loss of contextualization [3]. For Olson and Olson [8], distance makes it difficult to organize complex work that requires multiple interactions both synchronous and asynchronous. Setting up such complex systems of interactions can be done when people share a same location but becomes very challenging when working remotely. Four factors need to be considered when coordinating work at distance: (1) c*ommon ground* – the knowledge that collaborators have and that they know to have in common; (2) *coupling of work* – the type of communication required and its intensity; (3) *collaboration readiness* – the extent to which the co-workers are willing to cooperate and share; and (4) *collaborative technology readiness* – the availability of collaborative technology as a shared resource [8].

Other factors, tightly related to distance, can also come into play. These include time differences, demographic and cultural differences, organizational configurations, and reliance on technology [3,9]. O'Leary and Cummings [7] suggest there are three types of geographical dispersion that make the organization and integration of work activities problematic. If s*patial dispersion* diminishes spontaneous communication, *temporal dispersion* reduces the ability to solve problems in real-time. Nonetheless, it is *configurational dispersion*, the number of sites and their isolation from each other, that significantly increases the complexity of coordination. It makes the managing of interdependencies difficult [10], reduces the reciprocal awareness of each other's work and increase the chance of conflicts, thus making the interconnection of work activities challenging. Malhothra and Majchrzak [1] draw attention to the exclusive reliance on ICT as one key aspect of geographical dispersion that has bearings on the alignment of distributed activities. Some of the negative effects can include a reduction of awareness [11,12] and the increased difficulty to establish common ground [3] i.e., the knowledge that co-workers have in common and that they know they share [4,8]. The distribution of projects across organizational boundaries is considered next.

2) Organizational Dispersion: In globally distributed projects, actors can co-operate not only over distance but across several organizational units or institutions with often different modes of operation. This is prevalent in innovation projects that requires for the actions and efforts of different parties to be combined to resolve complex problems. Scientific research is a prime example as multi-institutional collaborative projects are actively encouraged by funding agencies [13,14].

These cooperative projects set up across complex organizational boundaries pose their own coordination challenges, beyond those of distance. Several factors can be responsible for hindering the alignment and integration of operations distributed across different organisational units. These can include variations in organizational structures [15], managerial styles [13], differences in priorities and levels of involvement [16], and inability to share information effectively [17,18]. The effects can be delays in projects [19], inefficiencies and a reduced success of the overall collaborative outcome [15].

Supporting coordination in projects that interlink heterogeneous organizational units requires additional efforts and resources. For Cummings & Kiesler [14], it involves two key operational aspects. First, additional ad-hoc coordination arrangements need to be established to foster co-learning and personal interactions, such as seminars, presentations or workshops. Second, devising and continuously maintaining alternative synchronous communication channels and common dedicated platforms is key to facilitate and improve information sharing. Staffing and managerial changes may also need to be made to compensate for the decentralization and lessened control that emanate from multi-sited cooperations [15]. This can involve additional training to specifically manage this type of complex work setups [15], the introduction of human mediators to help align tasks and plans [13] or the establishment of informal hierarchy in the structure of groups interactions to foster better interchanges between the different parties (Hinds & McGrath, 2006) [17].

Issues of alignment of multiple perspectives in pluralistic contexts, in which different and dispersed stakeholders have different views, have also been identified [21] as potentially problematic. Multiple stakeholders having diverging perspectives can put additional pressure on collaboration and potentially on coordination [22,23] Closely related are issues of cross-disciplinarity that are explored next.

3) Disciplinary Dispersion: Cooperators in globally distributed projects may work in separate and remote organizations but also can come from different disciplines and perspectives. Medical practice, emergency and relief and scientific research are typically areas where cross-disciplinary projects are particularly widespread [24,25]. Cooperating on projects set up across disciplines and multiple perspectives creates another set of problems for coordination. Issues may emanate from differences in situated practices [26], the local use of representations [27] and pre-established epistemic cultures [28]. Knorr Cetina [28, p.363] defines *epistemic cultures* as "those sets of practices, arrangements and mechanisms bound together by necessity, affinity and historical coincidence which, in a given area of professional expertise, make up how we know what we know". The consequences may be communication barriers between the different partners [29], difficulties of interpretating the knowledge under consideration [30] and ultimately issues with the integration of novel ideas across the diverging perspectives [31].

For Ben-Menahem et al. [32], supporting complex cross-disciplinary coordination is challenging because it involves having to manage a key tension between formalization and informal arrangements. On one hand, it requires establishing formal structures to organize collective action in a controlled manner, while, on the other hand, it necessitates setting up informal coordinative arrangements to assist with the integration of disparate tasks. In fact, the authors advocate an integrative model in which these two facets – formally designed coordination structures and informal coordination practices – are mutually constitutive. Formal structures need to be set up to assist coordination by clustering and prioritizing interactions between co-workers from different disciplines and perspectives [33]. However, within these structures, strong efforts need to be made to flexibly adapt roles, redefine routines and procedures and reorganize interdependent activities to handle ever-changing interdependencies and constantly arising contingencies [34].

Lastly, knowledge differences have also been recognized as a key barrier for the cross-disciplinary coordination of work [5], particularly in regard to innovation work in which new knowledge is produced [5,35] which is highly relevant for this paper. Carlile [35] highlights the difficulties of and the needs for finding ways to support the crossing of multiple boundaries for knowledge creation, sharing and innovation in complex projects.

B. Summary of coordination challenges

We highlighted three dimensions to characterise globally distributed projects: (1) *geographical dispersion*, (2) *organizational dispersion*, and (3) *disciplinary dispersion*. For each of these dimensions and based on our review of the existing literature, we identified key challenges, as shown in table 1.

TABLE I. COORDINATION CHALLENGES FOR GLOBALLY DISTRIBUTED PROJECTS

Dimensions	Coordination Challenges
(1) Geographical dispersion	Loss of contextualization [3]. Increased complexity of synchronous and asynchronous interactions [8]. Spatial dispersion: decrease of spontaneous communication [7]. Temporal dispersion: reduction in real-time problem solving [7]. Configurational dispersion: increase in isolation [7]. Reduction of awareness [11,12] Increased difficulty to establish common ground [3, 4, 8].
(2) Organizational dispersion	Variations in organizational structures [15]. Disparities between managerial styles [13]. Differences in priorities and levels of involvement [16]. Inability to share information effectively [17,18]. Diverging perspectives [21, 22, 23].
(3) Disciplinary dispersion	Differences in situated practices [26]. Variations in use of representations [27]. Divergences in epistemic cultures [28]. Communication barriers between partners [29]. Difficulties of interpretating knowledge [30]. Issues with the integration of novel ideas across diverging perspectives [31]. Differences in knowledge [5, 35].

Having reviewed the key challenges to coordination, we suggest that these can present serious obstacles (geographical, organizational, and disciplinary) to the successful running of globally distributed projects. Defective coordination practices in such complex settings can lead to serious delays and potentially detriment the successful and timely completion of a project. Thus, it is necessary to find ways to mitigate these issues. We posit that information objects play key roles in supporting coordination. Therefore, understanding these coordinative roles in a global project can ultimately help find ways to improve coordination towards the completion of the goals of the project.

III. Research Design

A. Data collection

We conducted an empirical study to probe the coordination practices and the coordinative roles of information objects in a globally distributed scientific project. Our research design concentrated on the Nanodiagnostics for Arthritis project (NanoArth), a globally distributed European project in the area of nanodiagnostics. Nanodiagnostics is a sub-discipline of nanomedicine that investigates the use of nanomaterials (materials in the nanorange, smaller than 100 nm) to develop innovative detection methods for a range of diseases [39]. The NanoArth project ran for four years from 2010 to 2014 and developed a nanomaterial-based diagnostic tool to detect the molecular causes of joint disorders, such as rheumatoid arthritis and osteoarthritis. The tool relied on synthesizing SuperParamagnetic Iron Oxide Nanoparticles (SPIONs) to image the inflammatory events of arthritis to identify the biomarkers associated with these conditions.

NanoArth was based on a consortium of 14 partner organizations from 7 European countries as follows: 2 nanotechnology SMEs (Switzerland); 2 nanotechnology and pharmaceutical MNCs (Germany and Sweden); 2 material science university labs (Switzerland); 5 university research centers in rheumatology, and musculoskeletal biology (Germany, Austria, Netherlands, Sweden, and Estonia); a hospital imaging unit (Switzerland); a polymer manufacturer (France) and a nanomedical project management firm (Switzerland). Thus, the NanoArth project was dispersed (1) geographically, (2) organisationally and (3) cross-disciplinary and provided the complex settings for our enquiry.

Our empirical investigation was based on a longitudinal qualitative case study that took place between March 2012 and January 2014 that and consisted of five main stages: (1) initial interviews and focus groups with the representatives of the management of the NanoArth project; (2) first on-site visit of the lab in Lausanne to observe the nanosynthesis, functionalization and toxicity testing of the SPIONs; (3) follow-up on-site visit to conduct additional participant observations; (4) remote interviews with scientific partners using SPIONS in their scientific work on NanoArth, and (5) participatory exercises with management to discuss the coordinative use of experimental protocols. The interviews were mainly semi-structured. An interview guide was used in a flexible manner to drive the qualitative enquiry into the scientific practices of the respondents and their use of information objects to share experimental data and coordinate their activities. The focus groups were also loosely based on a guide that allowed the dynamic exploration of a multitude of possible interactions to generate rich data. Participant observations enabled the active examination of the experimental practices of the scientists *in-situ*. The experimenters were asked to verbalize their actions during their experiments to explain their actions and use of information objects. Additional interviews followed immediately to provide additional clarifications.

To sum up, a range of techniques were relied upon to elicit data: semi-structured interviews, participant observations, verbalizations during interviews, contextual interviews following observations, analysis of documentation and different participatory activities. Overall, 17 separate events were held to collect rich in-depth qualitative data.

B. Data Analysis

Analytically, our approach drew from *thematic analysis* [40] to make sense of the rich data collected, develop themes and identify meaningful concepts.

All transcripts were run through multiple times to identify the sections that shed light on the design and conduct of scientific activities in the NanoArth project, on the ways they were organized across the different project sites, on the interactions and exchanges that occurred around these activities, and on the ways in which information objects were used to coordinate these activities. Several areas of scientific activities and interactions were identified to frame our analysis. For each of these, we closely examined the scientists' work practices, their social interactions, their utilizations of information objects, the meanings they allocated to situations and the difficulties they encountered. Therefore, analytical focus was essentially on the practices adopted by scientist to organize and manage their scientific activities and on the ways in which information objects were created and modulated to align and integrate these practices. Our findings are discussed next.

IV. Findings

Early in our study of the NanoArth project, it became clearly apparent that the scientists' global practices and interactions were driven and mediated by the collective use of a key information object: the '*experimental protocol*'. In essence, an experimental protocol is a written specification that stipulates a detailed sequence of tasks and operations that need to be undertaken to carry out a scientific experiment. It usually features equipment, reagents, steps to be performed, as well as sometimes additional tips or troubleshooting techniques. Thus, experimental protocols rapidly became a key focus of our enquiry and data collection. The next subsections explore how the NanoArth scientists collectively designed and maintained experimental protocols within and between the project sites to drive scientific work and to interconnect their experimental activities to achieve coordination across the project.

A. *Protocol as a driver for experimental co-design*

When probing distributed scientific work in the global NanoArth project, it became rapidly apparent that the protocols were used to share key information about the design and conduct of scientific experimental activities i.e. the experiments carried out by the scientists on the project. This was explained for instance by the Bone Biologist in Geneva who gave a revealing account of some of the interactions that took place around experimental protocols:.

> "*After the first couple of meetings we started to get a rough idea of how we were going to put together our protocols for our bit of the work package. So, when we got back in the lab, we wrote draft versions and tried experimenting with them. Then we emailed them to the other guys, either to check things with them or just because they wanted to have a look at them to see how we were doing things."* (Bone Biologist, Geneva site)

This showed that the protocol played a key role beyond just defining experimental activities, and that it was a key vehicle for multiple interactions between project partners to organize their work collectively. In fact, the protocol took different symbolic meanings for different people depending on their roles within the project. For the scientist who conducted experiment *at the bench*, the experimental protocol was indeed the main tool relied upon to *do science*. It is seen as a dynamic artefact, carefully designed, tested multiple times and continuously developed. This point is illustrated by the Nanoparticles Developer in Lausanne, when queried about how she set up her own experimental work during the first participant observation:

> "*When I do an experiment, the first thing I think about is how I am going to write my protocol. I try to put one together and when I have a rough version, I test it in the lab to see if it works. Then I test it many more times until I get something I am really happy with. It can take a while and I carry on testing it and modifying it until I get there*". (Nanoparticles Developer, Lausanne site)

This exemplified how, for many experimenters in the NanoArth project, like this Nanoparticles Developer, the protocol was seen as a fluid and changing information object. It was continuously modified and tinkered with, until it reached a somehow permanent state that could help capture the scientist latest understanding of their experimental work. For the scientists who worked directly with others (the vast majority), the protocol was viewed as an *information artefact* that captured their counterparts' experimental practices. It was used to shed light on their partners' experimental practices, the methods they adopted, and the type of results they obtained. Hence, the protocol was used support *awareness* [11, 12, 16] and the alignment of work practices. The Biomechanics Engineer in Berlin explained how accessing her partners' protocols helped her understand their experimental work so that she could align her own investigation with theirs:

> "*I wanted to find out how they imaged the mice [injected with the SPIONs] in Geneva. So, I asked them to send me their protocols so that I could get a feel of which MRI sequences they used. Even though it is very different, it helped me with developing my own MRI sequences for the scanning of patients' joints.*" (Biomechanics Engineer, Berlin site)

This is one of the many instances in which the experimental protocol was used to get a snapshot of a partner's scientific enquiry practices and draw inspiration from it. Thus, the protocol played a key role in *knowledge creation*, *knowledge sharing* and *interpretation* [5, 3, 6]. Referring to their partners' protocols allowed scientists to develop an overall understanding of the various methods and techniques deployed in the co-design of experimental work and helped them to adapt and adjust their own work accordingly. This is a meaningful example of the use of the protocol to create a collective understanding of the experimental design, and thus to support key *awareness.*

B. *Protocol as a driver for cross-sited and cross-disciplinary coordination*

Several instances of scientific work in NanoArth were globally distributed and required for experimental activities to be designed and conducted across sites and disciplines. A key revealing example involved *in-vitro* toxicity testing in the Rheumatology Department in Berlin to assess the impact of the nanoparticles on immune cells. This work required the SPIONs to be created by a complex process of *nanosynthesis* at the Material and Powder Lab in Lausanne. The following intervention by the Rheumatology Scientist in Berlin illustrates the interactions they had with their partners in Lausanne.

> *"We had many exchanges with the [nanoparticles and reactor engineer] and [nanoparticles developer] in Lausanne to discuss the particles we needed for our toxicity tests on the immune cells. We put together some very early protocols and from these we could define and discuss our requirements with them for the particular type of SPIONs, with the right characterization for our toxicity tests."* (Rheumatology Scientist, Berlin site).

The two statements below exemplify the ways the scientists at the research center in Lausanne linked up with their counterparts in Berlin and how the protocols were used to drive these exchanges.

> *"Once we had a good idea of the specific tox[icity] tests they wanted to do [in Berlin] and how they wanted their SPIONs to do their tests, we wrote our initial production protocols and sent it to them [in Berlin] so that they could see how we were going to synthesize the particles to fit in with their work"* (Nanoparticles and Reactor Engineer, Lausanne site).

> "*I asked [the rheumatology scientist] to send me his early draft protocols so that I could just get a feel of how he was going to do his tox tests and how he wanted his particles. I find it helps me understand what they are trying to do and helps me think how I can develop the SPIONs they want, characterized exactly as they want them… but it was not always possible, and we needed to discuss lots more we could both be happy with them and improve our*

protocols on both sides" (Nanoparticles Developer, Lausanne site).

The Rheumatology Scientist in Berlin also exposed some of the key interactions that took place between the two teams.

"In light of the many discussions we had with them… negotiations in a way… we were able to make good progress and put together decent protocols for our tox tests." (Rheumatology Scientist, Berlin site).

These accounts are enlightening in several ways. First, they show how the protocols were used to align the expectations of the scientists conducting the toxicity tests with what was technically feasible in Lausanne – and the other way around – and thus helped define *common ground* between both cooperating parties [3,4,8]. Second, the protocols were relied upon by each team to construct an understanding of the methods and techniques used by their partners to help drive and link up their own experimental design accordingly. Third, the protocol helped mediate the interactions between the collaborators to establish common ground and the alignment of practices. Finally, these accounts illustrate how the protocol was continuously negotiated and modified to reflect the changes made to the experimental procedures to fit in with a partner's experimental activities. In fact, this process of continuing negotiation and experimental cross-sited design continued further until both parties were satisfied with the outcome of the collective experimental work.

V. DISCUSSION

This analysis has highlighted several utilizations of the protocol *in practice* i.e. as it is being developed and used in the context of a globally distributed scientific project. It is a fluid information object that continuously evolves and take multiple meanings to accommodate multiple perspectives across the project and multiple shapes as the project progresses. We draw on practice-based perspectives [41,42] to make sense of the rich data collected to conceptualize the experimental protocol as a '*coordinative object*'. In addition, we use the concept of *affordances* to define the key characteristics of *coordinative objects*. Affordances are capabilities in action assigned to an object by an to individual [43] and we use it as a lens to identify the features of the *coordinative object* that can help navigate the coordination challenges outlined in section II. B.

First, the experimental protocol as a *coordinative object* can help address the challenges linked to *geographical dispersion*. The analysis has shown that sharing protocols at all stages of their design and development plays a key role. It facilitates greater communication (both synchronous and asynchronous) between partners at different locations [7], support the collective solving of problems along various time scales [7], raise awareness of each other's work [11, 12] and help find the necessary common ground to work together [3,4,8]. This means that, in terms of affordance, the inherent flexibility of the protocol allows the scientists to interpret and allocate relevant meaning to their partners' experimental work so that to integrate it with their own practice and thus to support coordination. We posit it this affordance of *interpretation* that help address the issues of geographical dispersion particularly in relation to spatial, temporal, and configurational dispersion [7], awareness [11, 12] and the definition of common ground [3, 4, 8].

Second, the experimental protocol as a *coordinative object* can help manage organizational dispersion. In the co-conduct of scientific work, the protocol provides scientists with useful information on their partners' experimental design to understand the partners' expectations, negotiate with them and adjust their own activities to achieve alignment. In this sense, the protocol plays the role of a *coordination mechanism* [45] that can handle ever-shifting complex interdependencies by identifying and providing a workable set of options for coordinative actions in any situation. It may play the softer role of a map in a distributed decision-making situation and be used as a guide to problem-solving. It may play a stronger script-like role in a situation which is defined by clear sequential or temporal interdependencies. In this sense, we suggest that it is the affordance of *alignment* of the protocol that allows it to accommodate continuously emerging interdependencies [32] and the constant reorganization of routines and processes [34] and thus help address the issues of organizational dispersion.

Third, the experimental protocol as a *coordinative object* can help mitigate disciplinary dispersion. The analysis shows that the protocol mediates the sharing of knowledge and co-learning across boundaries that divide specialized practices and disciplines [26, 29]. The protocol is used to share and access relevant scientific information without the need to have a complete understanding of the knowledge of the partners in their specialized field [38]. Hence, we posit that the protocol can be seen as a *boundary object* i.e., an object that exists at the junction between different communities and that is used to translate ideas across boundaries [44]. Exchanging protocols helped reach out across sites and *epistemic cultures* [28] to define that *common ground* [3,4, 8] and ultimately coordinate practices. Therefore, we suggest that it is the affordance of *boundary-crossing* of the protocol that help interconnect diverging disciplinary knowledge and practices and thus address the challenges related to disciplinary dispersion.

VI. CONCLUSIONS

Our study contributes to Information Systems (IS) through an improved understanding of coordination in globally distributed work characterized by geographical dispersion, multiple organizations and cross-disciplinarity. Previous studies have outlined coordination as challenging, emphasizing the need for improved coordination and the use of IS in such contexts. In this paper, we outline the key challenge areas of globally distributed work which are: *geographical dispersion, organisational dispersion,* and *disciplinary dispersion*. Through the study of the NanoArth global project, we identify the experimental protocol as the key *coordinative object* that can be used, designed and shaped to support global coordination. Its unique affordances are *interpretation, alignment,* and *boundary-crossing*. Ultimately, we suggest that this conceptualisation may be transferrable and applicable to other *globally distributed* contexts where global coordination pose essential challenges, such as global software development, healthcare, engineering, and disaster management. Our study could potentially help technologists design a range of key c*oordinative objects* including protocols, processes, and Standard Operating Procedures to best support the coordination of distributed teams and address the dispersion challenges in these complex global settings. This is even more significant in the current context of the COVID-19 (post-)pandemic situation in which innovative ways need to be found to better support distributed coordination and improve the completion of global projects.

REFERENCES

[1] Malhotra, A., and A. Majchrzak, "Enhancing performance of geographically distributed teams through targeted use of information and communication technologies", Human Relations 67(4), 2014, pp. 389–411.

[2] Cummings, J.N., J.A. Espinosa, and C.K. Pickering, "Crossing spatial and temporal boundaries in globally distributed projects: A relational model of coordination delay", Information Systems Research 20(3), 2009, pp. 420–439.

[3] Espinosa, J.A., S.A. Slaughter, R.E. Kraut, and J.D. Herbsleb, "Team Knowledge and Coordination in Geographically Distributed Software Development", Journal of Management Information Systems 24(1), 2007, pp. 135–169.

[4] Srikanth, K., and P. Puranam, "Integrating distributed work: comparing task design, communication, and tacit coordination mechanisms", Strategic Management Journal 32(8), 2011, pp. 849–875.

[5] Majchrzak, A., P.H.B. More, and S. Faraj, "Transcending Knowledge Differences in Cross-Functional Teams", Organization Science 23(4), 2012, pp. 951–970.

[6] Gardner, H.K., F. Gino, and B.R. Staats, "Dynamically Integrating Knowledge in Teams: Transforming Resources into Performance", Academy of Management Journal 55(4), 2012, pp. 998–1022.

[7] O'Leary, M.B., and J.N. Cummings, "The Spatial, Temporal, and Configurational Characteristics of Geographic Dispersion in Teams", MIS Quarterly 31(3), 2007, pp. 433–452.

[8] Olson, G.M., and J.S. Olson, "Distance matters", Human-Computer Interaction 15(2), 2000, pp. 139–178.

[9] Ceci, F., and A. Prencipe, "Does distance hinder coordination? Identifying and bridging boundaries of offshored work", Journal of International Management 19(4), 2013, pp. 324–332.

[10] Crowston, K., "A Coordination Theory Approach to Organizational Process Design", Organization Science 8(2), 1997, pp. 157–175.

[11] Leinonen, P., S. Järvelä, and P. Häkkinen, "Conceptualizing the Awareness of Collaboration: A Qualitative Study of a Global Virtual Team", Computer Supported Cooperative Work (CSCW) 14(4), 2005, pp. 301–322.

[12] Steinmacher, I., A.P. Chaves, and M.A. Gerosa, "Awareness support in distributed software development: A systematic review and mapping of the literature", Computer Supported Cooperative Work (CSCW) 22(2–3), 2013, pp. 113–158.

[13] Nomura, S., J. Birnholtz, O. Rieger, and G. Leshed, "Cutting into collaboration: understanding coordination in distributed and interdisciplinary medical research", Proceedings of the ACM 2008 conference on Computer Supported cooperative work - CSCW '08, 2008, 427–436.

[14] Cummings, J.N., and S. Kiesler, "Collaborative research across disciplinary and organizational boundaries", Social Studies of Science 35(5), 2005, pp. 703–722.

[15] Cummings, J.N., and S. Kiesler, "Coordination costs and project outcomes in multi-university collaborations", Research Policy 36(10), 2007, pp. 1620–1634.

[16] Weisband, S. "Maintaining awareness in distributed team collaboration: implications for leadership and performance". In: Hinds, P., Kiesler, S. (Eds.), Distributed Work. MIT Press, Cambridge, MA, 2002, pp. 311–334.

[17] Hinds, P.J., and M. Mortensen, "Understanding Conflict in Geographically Distributed Teams: The Moderating Effects of Shared Identity, Shared Context, and Spontaneous Communication", Organization Science 16(3), 2005, pp. 290–307.

[18] Hoegl, M., and L. Proserpio, "Team member proximity and teamwork in innovative projects", Research Policy 33(8), 2004, pp. 1153–1165.

[19] Espinosa, J.A., and E. Carmel, "The impact of time separation on coordination in global software teams: A conceptual foundation", Software Process Improvement and Practice 8(4), 2003, pp. 249–266.

[20] Hinds, P., and C. McGrath, "Structures that Work: Social Structure, Work Structure and Coordination Ease in Geographically Distributed Teams", Proceedings of the 2006 conference on Computer supported cooperative work - CSCW'06, (2006), 343–352.

[21] Simeonova, B., J. Morton, A. Wilson, M. Marabelli, and R.D. Galliers, "Aligning Practices in a Pluralistic Healthcare Context using a Performance Improvement System", International Conference on Information Systems - ICIS, (2018), 1–9.

[22] Jarzabkowski, P., and E. Fenton, "Strategizing and Organizing in Pluralistic Contexts", Long Range Planning 39(6), 2006, pp. 631–648.

[23] Denis, J.L., A. Langley, and L. Rouleau, "Strategizing in pluralistic contexts: Rethinking theoretical frames", Human Relations 60(1), 2007, pp. 179–215.

[24] Majchrzak, A., S.L. Jarvenpaa, and A.B. Hollingshead, "Coordinating Expertise Among Emergent Groups Responding to Disasters", Organization Science 18(1), 2007, pp. 147–161.

[25] Oborn, E., M. Barrett, and E. Davidson, "Unity in diversity: Electronic patient record use in multidisciplinary practice", Information Systems Research 22(3), 2011, pp. 547–564.

[26] Sole, D., and A. Edmondson, "Situated Knowledge and Learning in Dispersed Teams", British Journal of Management 13(S2), 2003, pp. S17–S34.

[27] Boland, R.J., and R. V. Tenkasi, "Perspective Making and Perspective Taking in Communities of Knowing", Organization Science 6(4), 2008, pp. 350–372.

[28] Knorr Cetina, K., "Culture in global knowledge societies: knowledge cultures and epistemic cultures", Interdisciplinary Science Reviews 32(4), 2007, pp. 361–375.

[29] Bechky, B.A., "Sharing Meaning Across Occupational Communities: The Transformation of Understanding on a Production Floor", Organization Science 14(3), 2003, pp. 312–330.

[30] Cramton, C.D., "The Mutual Knowledge Problem and Its Consequences for Dispersed Collaboration", Organization Science 12(3), 2001, pp. 346–371.

[31] Okhuysen, G.A., and K.M. Eisenhardt, "Integrating Knowledge in Groups: How Formal Interventions Enable Flexibility", Organization Science 13(4), 2002, pp. 370–386.

[32] [32] Ben-Menahem, S.M., G. von Krogh, E. Zynep, and A. Schneider, "Coordinating knowledge creation in multidisciplinary teams: evidence from early-stage drug discovery", Academy of Management Journal 59(4), 2016, pp. 1308–1338.

[33] Puranam, P., M. Raveendran, and T. Knudsen, "Organization design: The epistemic interdependence perspective", Academy of Management Review 37(3), 2012, pp. 419–440.

[34] Okhuysen, G.A., and B.A. Bechky, "Expecting the Unexpected? How Swat Officers and Film Creams Handle Surprises.", Academy of Management Journal 54(2), 2011, pp. 239–261.

[35] Carlile, P.R., "Transferring, Translating, and Transforming: An Integrative Framework for Managing Knowledge Across Boundaries", Organization Science 15(5), 2004, pp. 555–568.

[36] Faraj, S., and Y. Xiao, "Coordination in Fast-Response Organizations", Management Science 52(8), 2006, pp. 1155–1169.

[37] Okhuysen, G.A., and B.A. Bechky, "Coordination in Organizations: An Integrative Perspective", The Academy of Management Annals 3(1), 2009, pp. 463–502.

[38] Swan, J., M. Bresnen, S. Newell, and M. Robertson, "The object of knowledge: The role of objects in biomedical innovation", Human Relations 60(12), 2007, pp. 1809–1837.

[39] Roubert, F., M.G. Beuzelin-Ollivier, M. Hofmann-Amtenbrink, H. Hofmann, and A. Hool, "'Nanostandardization' in Action: Implementing Standardization Processes in a Multidisciplinary Nanoparticle-Based Research and Development Project", NanoEthics 10(1), 2016, pp. 41–62.

[40] Braun, V., and V. Clarke, "Using thematic analysis in psychology", Qualitative Research in Psychology 3(May 2015), 2006, pp. 77–101.

[41] Nicolini, D., "Practice as the Site of Knowing: Insights from the Field of Telemedicine", Organization Science 22(3), 2011, pp. 602–620.

[42] Orlikowski, W.J., "Knowing in practice: Enacting a collective capability in distributed organizing", Organization science 13(3), 2002, pp. 249–273.

[43] Leidner, D.E., E. Gonzalez, and H. Koch, "An affordance perspective of enterprise social media and organizational socialization", Journal of Strategic Information Systems 27(2), 2018, pp. 117–138.

[44] Star, S.L., and J.R. Griesemer, "Institutional ecology,translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39", Social studies of science 19(3), 1989, pp. 387–420.

[45] Schmidt, K., Cooperative work and coordinative practices: contributions to the conceptual foundations of computer-supported cooperative work (CSCW), Springer-Verlag, London, 2011.