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Optimising Interdisciplinary Research through the Implementation of an Automated Collaborative Working System

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Abstract

In the context of interdisciplinary research in the social sciences and computer science, researchers face growing challenges relating to data management, communication and innovation. The increasing volume of big data complicates these processes, making it necessary to adopt effective solutions. This study addresses the issue of improving the efficiency of interdisciplinary research through the implementation of an Automated Collaborative Work System (ACWS). The aim of this article is to assess the impact of an ATS on communication between researchers, the management of administrative tasks and the quality of research outcomes. To this end, we selected a sample of interdisciplinary research projects and implemented a methodology combining automation tools and data analysis software. The tools used include project management platforms (Trello, Asana) and analytical tools (R, Python). The method involves dividing the research teams into two groups: one using the ATS and the other operating without these tools, and then analysing variations in performance over a defined period. The expected results suggest that the group utilizing the ACWS should see a reduction in time spent on administrative tasks, an improvement in the quality of communication among team members, and the production of richer research outcomes that integrate both qualitative and quantitative approaches.

Keywords

Automation, Data Management, Efficiency, Interdisciplinary Collaboration, Innovation

1. Introduction

The contemporary research landscape is becoming increasingly complex, neces-

sitating interdisciplinary collaboration. Projects combining the social sciences and computer science bring together qualitative and quantitative methodologies, distinct epistemological paradigms and a variety of tools. Whilst this diversity is a source of richness, it also presents challenges in terms of communication, coordination and data management. Traditional tools (such as email and basic file sharing) are often inadequate. This article proposes an Automated Collaborative System (ACS), tailored to interdisciplinary projects in the fields of social sciences and computer science, with four main objectives:

1) To improve interdisciplinary communication.
2) To automate project management tasks.
3) To facilitate access to resources and data.
4) To assess the impact of collaboration on scientific quality and innovation.

The article is structured as follows: Section 2 presents the state of the art; Section 3 presents the proposed model: SCA; Section 4 presents our simulation; Section 5 combines the expected results with a discussion; and Section 6 concludes the article with a summary and possible futures directions.

2. State of the Art

The development of automated collaborative working systems in the fields of social sciences and computer science is underpinned by recent advances in three areas: i) human-AI collaboration, ii) the orchestration of automated workflows, and iii) FAIR data governance and the assessment of collaborative impact.

2.1. Human-AI Collaboration

Several research approaches have been proposed in the field of human-Artificial Intelligence (AI) collaboration. Among these studies, we cite the authors of [1]. The authors observed that AI helps to generate more coherent content in collaborative writing tasks. However, this synergy is not automatic and depends heavily on the interface design and human supervision. The work in [2], meanwhile, presented a CHAI-T (Collaborative Human-AI Trust) framework for measuring trust and collaboration. However, this conceptual approach, based on a preprint, has received little large-scale empirical validation.

As for the work in [3], the authors investigate the effect of human-AI co-learning on adoption and performance. However, their experiments remain confined to laboratory settings and have therefore not yet been tested in complex interdisciplinary contexts (social sciences + computer science). These shortcomings in the research literature have therefore led the authors of [4] to propose explainable interactive systems to improve human-AI collaboration. However, this work remains focused on simulation environments rather than on real interdisciplinary research projects.

2.2. Orchestration of Automated Workflows

In the field of automated workflow orchestration, a number of approaches are

used [5]-[7]. The authors of [5] presented a multi-agent system driven by LLMs to orchestrate cross-domain workflows. However, this is merely a preprint, implemented in a laboratory setting, and therefore requires validation in real-world interdisciplinary projects. The authors of [6], meanwhile, propose a scale-out architecture for efficiently executing distributed AI workflows. However, their approach is focused on technical performance and optimisation, meaning that usability and adoption by non-computer-science researchers are given little consideration. The "Orchestrated Distributed Intelligence" paradigm proposed by the authors of [7] is conceived not in terms of isolated autonomous agents, but as cohesive, orchestrated networks operating in tandem with human expertise. For the time being, this paradigm remains conceptual and therefore requires practical experimentation on real-world interdisciplinary projects.

2.3. Data Governance and FAIR

Data governance refers to the set of processes, policies and standards that govern the collection, storage, use and security of data within an organisation. It aims to ensure that data is managed effectively and ethically, whilst maximising its value to the organisation. The FAIR principles—which stand for "Findable, Accessible, Interoperable and Reusable"—are a framework designed to improve the management of scientific data. It is in this spirit that the authors of [8] present the FAIR Implementation Profiles (FIPs) for the social sciences. However, their contribution is primarily methodological, and the evaluation of automated integration into a comprehensive collaborative system remains limited. They are continuing their research whilst detailing use cases for FIPs in collaborative projects; however, certain steps remain manual (annotation, verification), meaning that full automation has not yet been demonstrated [9]. We cannot address this area of research without considering the following aspects: human oversight and ethics. These are crucial elements in the context of optimising interdisciplinary research through the implementation of an automated collaborative working system.

2.4. Human Oversight and Ethics

In this section, we identify two main approaches to human oversight of AI systems: supervised human oversight and human-machine teamwork. It examines how each of these approaches defines and guides the operational interaction between human behaviour and that of the system in order to ensure the effectiveness of AI systems throughout their deployment. The authors of this article emphasise the importance of human supervision in order to avoid over-automation and bias. However, they offer general recommendations without conducting direct experimentation on a comprehensive interdisciplinary collaboration system [10].

2.5. Summary and Identified Gaps

Despite recent advances, there is as yet no unified, automated platform capable of effectively supporting interdisciplinary scientific collaboration (social sciences +

computer science) whilst incorporating impact assessment and ethical oversight.

3. Proposed Model: Automated Collaborative System (ACS)

3.1. Objectives

The ACS is designed to address the needs identified in the state of the art: to strengthen interdisciplinary communication, to automate repetitive project management tasks, to centralise and facilitate access to scientific resources and data (FAIR principles), and to assess the impact of collaboration.

3.2. General Architecture

The SCA architecture follows the microservices pattern, with an API Gateway acting as the single point of entry. It is divided into four main layers: the Presentation Layer (user interface), the Data Access Layer (API Gateway), the Business Services Layer (microservices) and the Data Persistence Layer (databases and storage).

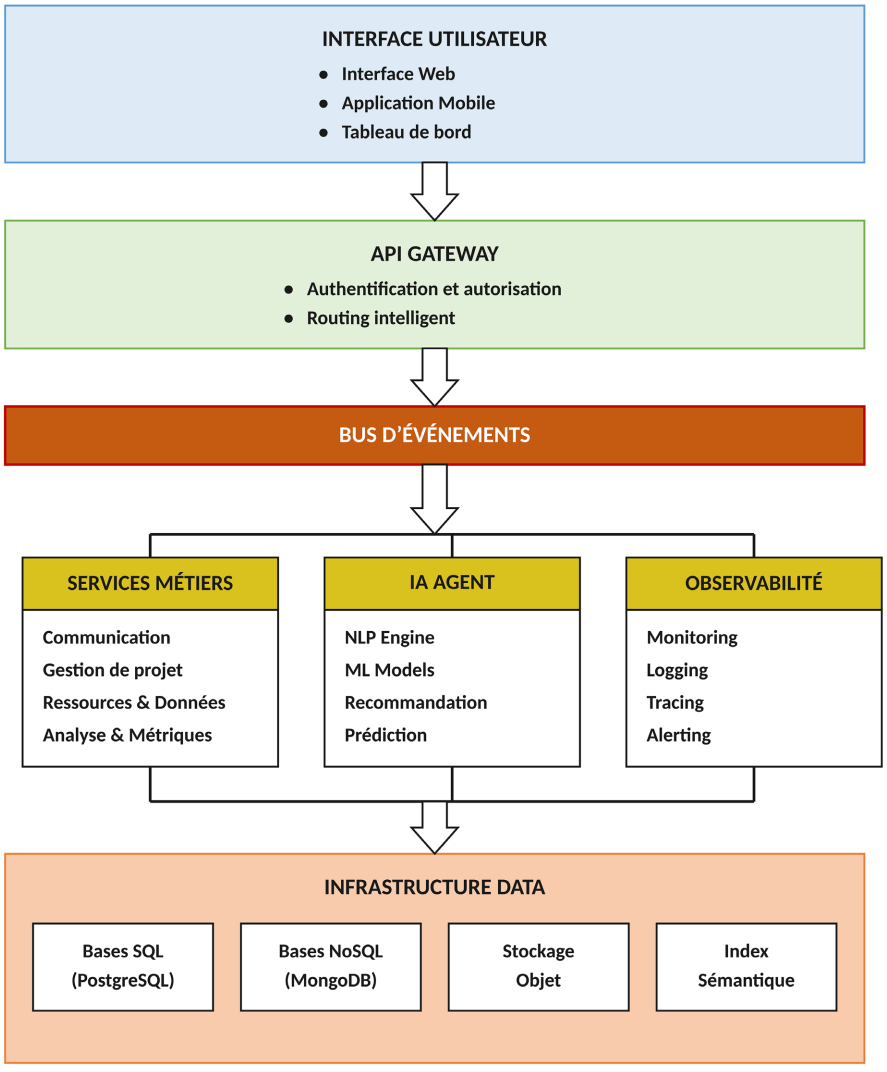


Figure 1. Modular microservices architecture of the automated collaborative system (ACS).

Figure 1 illustrates the modular organisation of the SCA: the Presentation Layer (user interface) is the point of interaction (web, mobile); the Access Layer (API gateway) handles authentication and request routing; the Event Bus facilitates asynchronous communication between services (Mediation, Orchestration, etc.), and the Data Infrastructure manages persistence (SQL/NoSQL databases, semantic indexing).

3.2.1. Architecture Components

a) Présentation Layer

This comprises the web application (developed using React or Vue.js) and the mobile application (developed using React Native). These applications communicate with the API Gateway via HTTP/HTTPS calls and use WebSockets for real-time functionality.

b) API Gateway

A single entry point that handles authentication, rate limiting, logging and routing to the appropriate microservices.

c) Microservices

These comprise the three main services:

- Collaboration Service: Manages projects, tasks, discussions and workflows, and implements the automation engine.
- Data Management Service: Manages the resource repository in accordance with the FAIR principles, with metadata extraction and semantic search capabilities.
- Analytics and Impact Service: Collects and analyses usage metrics and calculates impact indicators.

d) Persistence Layer

It uses specialised databases: a relational database (PostgreSQL) for structured data, a document database (MongoDB) for logs and search documents, as well as a cache (Redis) and a search engine (Elasticsearch).

3.2.2. Communication and Algorithmic Functionality

Services communicate via REST or gRPC calls for performance reasons. A message queue (RabbitMQ or Apache Kafka) is essential for asynchronous events (e.g. notifications, file processing), acting as the Event Bus within the architectural schema. In particular, this bus enables the automation steps to be executed.

The automation engine (within the Collaboration Service) allows "If…Then…" rules to be defined. These rules drive the algorithmic functionalities:

- Intelligent Assignment: If a new task is created, automatically assign it to the relevant expert.
- Mediation and Alerting: If a deadline is approaching with no progress, send a notification or alert (a mechanism also used for terminology mediation and dependency tracking).

4. Simulation

4.1. Deployment Protocol

The deployment of the Automated Collaborative Work System (ACWS) follows a

progressive, "living lab" approach, designed to observe usage patterns under real-world conditions. The evaluation centers on a targeted pilot sample:

Size and selection: The pilot study involves a sample of four interdisciplinary research projects (combining social sciences and computer science), comprising a total of 24 researchers (6 participants per project). Projects were selected based on strict criteria: a balanced mix of disciplines, demonstrated data complexity, and a comparable volume of initial administrative tasks.

Group allocation (comparative framework): To rigorously measure the impact of the ACWS, the research teams are randomly assigned to two parallel groups over a controlled three-month period:

- The experimental group (2 projects, 12 researchers) utilizes the full range of ACWS features (task automation, FAIR data management, dynamic glossaries, and dashboards).
- The control group (2 projects, 12 researchers) operates using traditional collaboration methods (standard file sharing, email, and decentralized tools lacking integrated automation).

Stages of the experiment: The protocol consists of four distinct phases: (i) selection and initial baseline assessment; (ii) a preparation and technical training phase for users in the experimental group; (iii) a controlled deployment lasting 2 to 3 months; and (iv) the secure collection of quantitative data and qualitative feedback (via semi-structured interviews).

4.2. Objective-Based Evaluation Methods

The evaluation follows a process structured around the four design objectives, combining quantitative and qualitative measures with socio-technical indicators (see table below).

Objective	Quantitative Indicators	Qualitative Indicators
1) Improved communication	Number of messages exchanged, diversity of interlocutors (social network analysis).	Perception of ease of use, usefulness and adoption of the automated glossary.
2) Task automation	Average task completion time, number of tasks automatically reassigned.	Satisfaction with the reduction in administrative burden; relevance of automatic alerts.
3) Facilitating access to data	Access rate to centralised repositories, number of reused resources.	Perceived ease of access to information; relevance of automatic suggestions.
4) Impact on results	Number of deliverables produced; adherence to deadlines.	Perceived quality of scientific output; Measuring interdisciplinary innovation.

4.3. Analysis of Results

The evaluation of the STCA's effectiveness relies on a mixed-methods approach, combining socio-technical indicators, statistical analyses, and thematic coding of qualitative data. This framework aims to measure observed changes relative to the initial baseline and the results of a control group, based on pre-defined operational criteria.

4.3.1. Operational Definition of Indicators

Four dimensions are used to assess the effects of the STCA: administrative workload, quality of communication, scientific quality, and interdisciplinary innovation.

1) Administrative workload. This refers to the weekly time—expressed in hours—that each researcher spends on activities not directly related to scientific production, such as coordinating meetings, tracking deadlines, entering and formatting metadata, and following up on tasks. It is measured using system activity logs (for the experimental group) and daily time-tracking records provided by participants in both groups, which are then validated by project managers.

2) Quality of communication. This concerns the fluidity of interdisciplinary exchanges and the reduction of terminological ambiguities between the social sciences and computer science. It is assessed based on the density and diversity of interactions—using Social Network Analysis (SNA)—as well as a questionnaire regarding the use of a dynamic glossary and the frequency of requests for terminological clarification.

3) Scientific quality. This relates to methodological rigor, data consistency, and the extent to which deliverables meet scientific requirements. Its evaluation combines the degree of compliance with FAIR principles (Findable, Accessible, Interoperable, Reusable), the rate at which shared resources are reused, and an independent, double-blind expert review. The latter relies on a standardized rubric using a five-point Likert scale.

4) Interdisciplinary innovation. This refers to the teams' ability to develop methodological approaches that integrate both qualitative and quantitative methods. It is assessed based on the number of hybrid methodological proposals identified in the final deliverables, as well as through a thematic analysis of interviews conducted at the end of the projects.

4.3.2. Comparison between Benchmark and Statistical Analysis

The comparative evaluation is based on two benchmarks: the initial situation, measured prior to the deployment of the STCA, and the performance of a control group using traditional methods over the same period. This dual comparison allows for an examination of changes over time and differences between the two groups.

The statistical analysis includes the calculation of means, medians, and standard deviations, as well as the estimation of 95% confidence intervals for variations in quantitative indicators—specifically, time spent on administrative tasks and productivity. Differences between the groups are examined using Student's *t*-test for independent samples (when the necessary assumptions are met) or the non-parametric Mann-Whitney test (when they are not). The threshold for statistical significance is set at $p < 0.05$.

5. Results and Discussion

5.1. Expected Results

We anticipate several significant results:

- Communication: An increase in the frequency of interactions, thanks to a reduction in terminological misunderstandings facilitated by the dynamic glossary, and a reduction in the time taken to clarify concepts.
- Project management: A reduction in administrative workload through automatic task allocation and report generation, leading to better adherence to deadlines.
- Data access: Increased use of centralised repositories and reuse of resources, and an improved perception of the efficiency of access.
- Impact: Increased productivity, improved scientific quality and the emergence of new interdisciplinary methodologies.

5.2. Discussion of Expected Results

The integration of automation and AI is expected to have a multiplier effect on the productivity and quality of interdisciplinary research. By facilitating communication and management, the SCA enables teams to focus on creativity, whilst reducing the cognitive load associated with coordination.

Potential limitations: Challenges include resistance to change, ethical and privacy issues arising from the analysis of collaborative data, the risk of over-automation, and the limited observation period of the initial evaluation.

Implications: The SCA serves as an experimental platform for testing new methodologies for interdisciplinary collaboration, influencing the design of future tools and the application of FAIR principles.

6. Conclusions

This article has outlined the design, deployment methodology and evaluation of an Automated Collaborative System (ACS) intended for interdisciplinary projects in the fields of social sciences and computer science.

The ACS aims to: improve communication between these two disciplines, automate management tasks, facilitate access to data, and assess the impact of collaboration. Its modular architecture and the integration of AI provide flexibility and scalability suited to distributed teams.

Outlook: Future directions include the integration of advanced AI (detection of methodological conflicts, suggestions for hybrid research designs), interdisciplinary expansion (humanities, health), improvements to the user interface, longitudinal evaluation, and the development of connectors for interoperability (OSF, JupyterHub).

Author Contributions

Kouamé Appoh: Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing—original draft preparation, writing—review and editing, visualization, funding acquisition. **Kra Lagasane Ouattara**: Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing—original draft prep-

aration, writing—review and editing, visualization, supervision, project administration, funding acquisition. **Moussa Koita**: investigation, resources, data curation, writing—original draft preparation, writing—review and editing, funding acquisition. **Pascal Olivier. Kouame Asseu**: validation, formal analysis, writing—original draft preparation, writing—review and editing, visualization, supervision, project administration.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding the publication of this article.

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