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Ye. B. Shapovalov,
V. B. Shapovalov,
T. V. Rudakova,
Ya. V. Rybalko

AUTOMATION OF DOCUMENT PREPARATION WORKFLOW IN SCIENTIFIC ACTIVITIES: PRACTICAL APPROACHES AND USING OF ONTOLOGIES

Abstract. *Scientific research demands significant time for administrative tasks, particularly document preparation, which detracts from core investigative work, especially in evolving academic systems like Ukraine's. While automation tools exist, they often lack specificity for diverse scientific documentation needs, which frequently involve dynamic data such as academic titles and affiliations. Current approaches like standardized templates and systematic review tools offer limited efficiency gains or are not designed for document generation. Institutional and individual strategies also fail to automate these repetitive tasks directly. This paper proposes a novel method utilizing a structured database of scientist information combined with auto-filling templates to automate the generation of various scientific documents (e. g., applications, reports, requests). By analyzing the existing document preparation workflow ("As-Is") and designing a streamlined process ("To-Be") leveraging this database, the proposed system aims to drastically reduce preparation time from hours or days to minutes. Furthermore, the paper explores the use of ontologies as a robust structure for storing and managing scientific data, enabling semantic interoperability and more intelligent automation of workflows beyond simple template filling. This approach addresses the limitations of current systems and offers a tailored solution to enhance research efficiency and quality in the Ukrainian scientific context and beyond.*

Keywords: *automation, scientific workflow, document generation, research administration, database systems, ontologies, semantic data modeling, business process reengineering, Ukrainian science.*

1. Introduction

1.1. The role of the automatization in the scientific routine processes

The evolving demands of scientific work increasingly burden researchers with administrative tasks, detracting from their primary focus on investigation and innovation, a challenge acutely felt in transitioning academic systems like Ukraine's post-Soviet scientific community. Beyond conducting research, scientists must adapt to shifting regulatory frameworks, master global publishing standards, and manually prepare repetitive documentation, all of which erode time available for hypothesis generation and analysis. Automation has emerged as a critical tool to mitigate these pressures, with studies demonstrating its capacity to enhance efficiency and quality in scientific workflows, yet existing solutions often lack the specificity needed for document creation in the scientific sphere. Standardized templates, for example, consistently improve document quality — raising discharge summary completeness from 86.1 %

to 90 % and guideline adherence in breast cancer care from 65 % to 89 % — but their efficiency gains vary, with operative report availability improving from 22,440 to 28 minutes in some cases, while others report prolonged encounter times [1–4]. Similarly, automation tools for systematic reviews reduce literature search time by 62.5 % (3 versus 8 hours) and review time by 71.4 %, yet struggle with accuracy trade-offs, such as RobotReviewer's 11.2 % error rate compared to 9.8 % for manual methods [5–7]. These findings suggest that while automation offers substantial benefits, its application to the repetitive, data-intensive task of scientific document preparation remains underexplored.

Complementary strategies to simplify scientists' workloads further reveal the limitations of current approaches and the need for targeted automation in document creation. Institutional efforts, such as performance-based incentives using relative-value units, boost research output but risk overemphasizing quantity over quality, while structured mentoring enhances grant success without addressing administrative overhead [8; 9]. Individual tactics like time management and task breakdown improve focus and planning accuracy, and collaborative writing groups increase publication output, yet neither directly tackles the time sink of manual document drafting [10; 11]. Technology integration, such as adapting familiar tools during disruptions like the COVID-19 lockdown, streamlines routine tasks, but general-purpose systems like ASCOD or Megapolis — common in Ukrainian institutions — require significant manual input and lack specialization for scientific documentation needs [10]. In Ukraine, where 97.5 % of publications in fields like ion exchange are in English — a language historically deprioritized in Soviet science — and where document preparation involves dynamic data (e. g., academic titles, degrees), the absence of an automated, context-specific solution exacerbates these challenges [12].

To illustrate the gaps in existing approaches, Table 1 compares current automation and simplification methods across their applicability to document creation, efficiency gains, and adaptability to scientific contexts. Standardized templates and systematic review tools offer efficiency but are not designed for the diverse, dynamic documents scientists routinely produce, while institutional and individual strategies fail to automate repetitive tasks directly. Cost-effective solutions like MAG-enabled workflows (£3,179 weekly savings) and screening prioritization (71.2 % workload reduction) demonstrate automation's potential, yet their focus on review processes rather than document generation limits their relevance to this problem [13; 14]. Barriers such as limited database access, integration challenges, and user training needs further underscore the inadequacy of off-the-shelf systems for scientific document workflows [7; 15; 16]. This study proposes a novel method — a database-driven system with auto-filling templates — to address these deficiencies, automating the creation of standardized scientific documents by leveraging structured scientist data. By reducing preparation time from hours to minutes and aligning with Ukraine's evolving academic standards, this approach aims to enhance research efficiency and quality, offering a tailored solution where existing methods fall short.

1.2. An issue of the automatization of the document's generation in Ukraine

Summarizing the above, the modern scientist in Ukraine, in addition to his main tasks, has a number of additional tasks that require time. Such tasks include familiarization with updates of the regulatory framework, studying examples of scientific articles in highly rated publications, gaining experience in using electronic submission systems for scientific publications, gaining experience in preparing supporting documents for submission to highly rated journals and learning English. In fact, under such conditions, it is quite difficult for scientists, taking into account the aforementioned factors, to allocate time to get acquainted with modern scientific literature due to the sheer lack of time. Thus, the development of tools that will save scientists' time is relevant, which will improve the quality of their research. In addition to the above, scientists are constantly forced to prepare documents and regularly coordinate them. This process is problematic and also consumes a lot of time due to the lack of automation and constant manual data entry in text editors (Word). Such documents very often refer to dynamic data of scientists. For example, it is typical that such documents have a "header" where the fields "from" and "to" are indicated. Moreover, in the text of such documents there are often different combinations of scientists' regalia in different forms. For example:

- "name position",
- "name (position, degree)",
- first line: "name"; second line: "degree, rank, position".

Table 1

Comparison of Existing Approaches to Automation and Simplification of Scientists' Work

Approach	Examples	Applicability to Document Creation	Efficiency Gains	Adaptability to Scientific Contexts	Limitations
Standardized Templates	Discharge summaries, treatment plans (Valles et al., 2013; Farrugia et al., 2015)	High for specific document types	Variable (e. g., 28 vs. 22,440 min)	Low — limited to predefined formats	Context-dependent efficiency, manual adjustments needed
Systematic Review Tools	RobotReviewer, LiteRev (Arno et al., 2022; Orel et al., 2023)	Low — focus on review processes	High (e. g., 62.5 % time reduction)	Moderate — task-specific, not generalizable	Accuracy trade-offs, not suited for document drafting
Institutional Support	Performance incentives, mentoring (Akl et al., 2012; Williams et al., 2022)	None — indirect support only	Moderate (output increase)	High — broad institutional focus	No direct automation, quantity bias
Individual Strategies	Time management, writing groups (Ahmetoglu et al., 2021; Johnston et al., 2014)	Low — enhances planning, not creation	Moderate (improved focus)	High — flexible across disciplines	Manual effort remains, no automation
General Document Systems	ASCOD, Megapolis	Moderate — broad applicability	Low — manual input persists	Low — not specialized for science	Lack of dynamic data integration
Proposed Method	Database with auto-filling templates	High — targets diverse scientific documents	High (hours to 10–15 min)	High — tailored to scientific needs	Requires initial setup, training

The text in such documents is standardized, however, such letters are printed, reviewed by a number of staff members, and corrections are made to change the order of the scientists' regalia in accordance with the form of such documents. In addition, such documents may require additional information about scientists, for example, the number of higher education diploma, PhD, passport data, data of the registration number of the taxpayer's account card (RNACTP).

Thus, the preparation of documentation for various events takes precious time from scientists and such a process (unlike the previously mentioned ones) can be automated, since it is possible to create a database of scientists where to indicate the regalia of scientists in a structured form and then use such information for automatic entry into standard document templates by scientists' identifier.

The documents that can be generated automatically include:

- documents prepared when applying for postgraduate /doctoral studies,
- documents generated during postgraduate / doctoral studies,
- documents required for the procedure for obtaining an academic title,
- documents required within the framework of the scientist's activity in the institution: promotion, transfer to other departments, business trips.

It is worth noting that today there are various electronic document management systems (for example, ASCOD, Megapolis, paperless), however, they are not specialized and require a significant amount of manual work, which does not solve the problem completely. Thus, the hypothesis of the study is that it is possible to build a database of scientists and a set of templates that would automatically generate documents. The objectives of the study are: to substantiate the possibility of such generation, to determine the types of documents that can be generated automatically and to visualize the general business processes related to the preparation of documents in science, to build a database scheme that would be used for such purposes, to describe the process of automated generation of documents in science.

The National Electronic Scientific Information System (URIS) serves as a cornerstone for digitizing Ukraine's scientific landscape, yet its potential extends beyond data aggregation to streamline administrative workflows, such as document preparation investigated and proposed in this paper.

Integrating such automation into URIS enhances its role as a tool for open science policy, as noted by Zharinov et al. [17]. For instance, URIS modules like the state attestation of scientific institutions [18] could incorporate auto-filled templates to simplify submission processes, aligning with the system's goal of transparency and efficiency.

This synergy is reinforced by Zharinov et al. [19], who explore URIS's development as a CRIS system facilitating European integration. Combining ontology-based data storage with URIS's existing infrastructure could automate complex workflows, reduce administrative overhead, and support Ukraine's alignment with the European Research Area. By adopting these practical approaches, URIS can evolve into a comprehensive digital tool, amplifying research productivity and quality while addressing both local and global scientific demands.

2. Research methods

General scientific methods were used for the research: analysis and synthesis as well as deduction and induction. To describe the reengineering of processes occurring in the workflow and modernization of such a process, we used the generally accepted technique in information technology, business and public sector As-is and To-be processes [20; 21]. Business Process Model and Notation (BPMN) was used to describe business processes [22] and then based on this, we provided simplified schemes shown in this paper. Entity Relation Diagrams were used to describe the proposed database. The database structure was designed using the online application drawSQL.

3. Results

3.1. Workflow automatization processes and data

As of today, little attention is paid to how documents in the field of science are actually prepared. Most documents do not specify who prepares them. For example, the Law "On Scientific and Scientific-Technical Activity" [23] only declares the roles in scientific institutions, the Order of the Ministry of Justice of Ukraine No. 1000/5 of 18.06.2015 "On Approval of the Rules for Organizing Records Management and Archival Storage of Documents in State Bodies, Local Self-Government Bodies, Enterprises, Institutions, and Organizations" [24]

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declares the composition of regulatory and business documentation. There are also more specialized orders (e. g., Order of the Ministry of Education and Science of Ukraine No. 1359 of 13.12.2021 "On Approval of the Regulations on the Specialized Academic Council for Awarding the Degree of Doctor of Sciences") [25], however, they also declare only the list of documentation required for obtaining certain achievements (e. g., titles or degrees).

Thus, the legislation does not regulate who and how should prepare the documentation. In fact, the documents are prepared by a researcher (of any position) who is interested in the preparation of such documentation. The business process of document preparation has the following stages:

1. Search for a sample of documents (from the head, HR department or academic secretary.
2. If a sample of such documentation is not found, then such a document is written "from scratch" (optional, but if there is no sample, it usually takes even more time to coordinate such a document with stakeholders).
3. Entering basic information into the created sample document.
4. Approval and regular adjustments (when preparing in paper form, signatures are also obtained manually).

Thus, the business process of preparing documents in science is complex and can be significantly accelerated by using modern information systems. Today, the approval process can even take up to several days due to a significant human factor and errors in manual data entry, as well as the fact that employees change their regalia (academic titles, degrees, positions, etc.). A detailed scheme of the business process of document preparation is presented in Fig. 1.

Considering the utilization of modern information and telecommunication systems, alongside the prevalence of specific document templates, the process of document preparation can be significantly streamlined by accessing employee information from a regularly updated database. By implementing a database that stores entities such as "document template", "employee", and "specific document prepared by the employee", the preparation process can be expedited. The "employee" entity includes attributes such as a nique identifier,

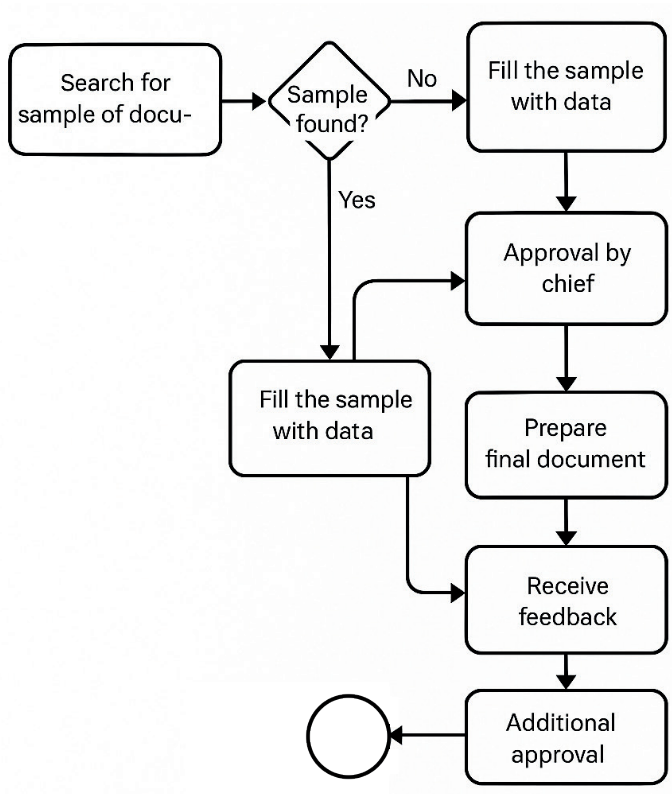

Fig. 1. Scheme of the business process of document preparation

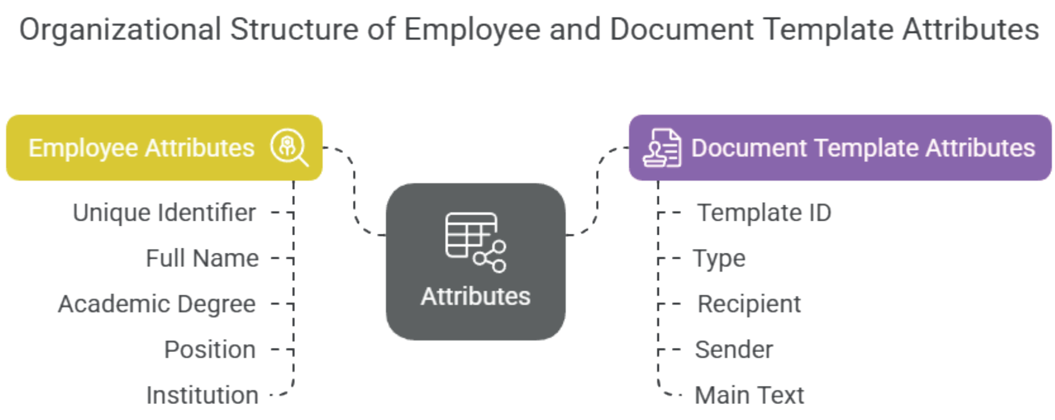

Fig. 2. The scheme of the required fields (data) to automate document generation

full name (comprising arrays of last name, first name, and patronymic in Ukrainian and English), full name in the genitive case (arrays in Ukrainian and English), type of academic degree (e. g., Doctor of Philosophy, Doctor of Science), degree field (e. g., economics, technical sciences, pedagogy, military sciences), position, department, institution, and academic rank (an array specifying type, such as associate professor, senior researcher, or professor, and specialty). The "document template" entity encompasses attributes including a unique identifier, recipient details, sender information, the main text of the letter (blank), and data required for generating the letter (tailored to each template, e. g., authors of a publication, name of a conference, or city of a business trip).

Considering the utilization of modern information and telecommunication systems, alongside the prevalence of specific document templates, the process of document preparation can be significantly streamlined by accessing employee information from a regularly updated database. By implementing a database that stores entities such as "document template", "employee", and "specific document prepared by the employee", the preparation process can be expedited. The "employee" entity includes attributes such as a unique identifier, full name (comprising arrays of last name, first name, and patronymic in Ukrainian and English), full name in the genitive case (arrays in Ukrainian and English), type of academic degree (e. g., Doctor of Philosophy, Doctor of Science), degree field (e. g., economics, technical sciences, pedagogy, military sciences), position, department, institution, and academic rank (an array specifying type, such as associate professor, senior researcher, or professor, and specialty). The "document template" entity encompasses attributes including a unique identifier, recipient details, sender information, the main text of the letter (blank), and data required for generating the letter (tailored to each template, e. g., authors of a publication, name of a conference, or city of a business trip). The scheme of the required fields (data) to automate document generation is shown in Fig. 2.

Programmatically, this system can be implemented using a relational database or dataset in structured form implemented by some specific software. The structure of the database is shown in Fig. 3.

The presence of such entities allows us to use information about document templates and scientists' data for automatic document generation. In this case, unique entity identifiers are used to speed up the generation of the document. That is, the user selects a template with a specific identifier and an employee with a specific identifier. At the same time, all stakeholders of the document preparation do not need to "proofread" and regularly edit the document. Simultaneously, the template will be automatically changed in case of changes in requirements and legislation, and the information of the authors will be automatically updated in the database when they change and will be automatically inserted into the document in the current state and in the required form. Additionally, it is important to note that internal dictionaries will be additionally used, for example,

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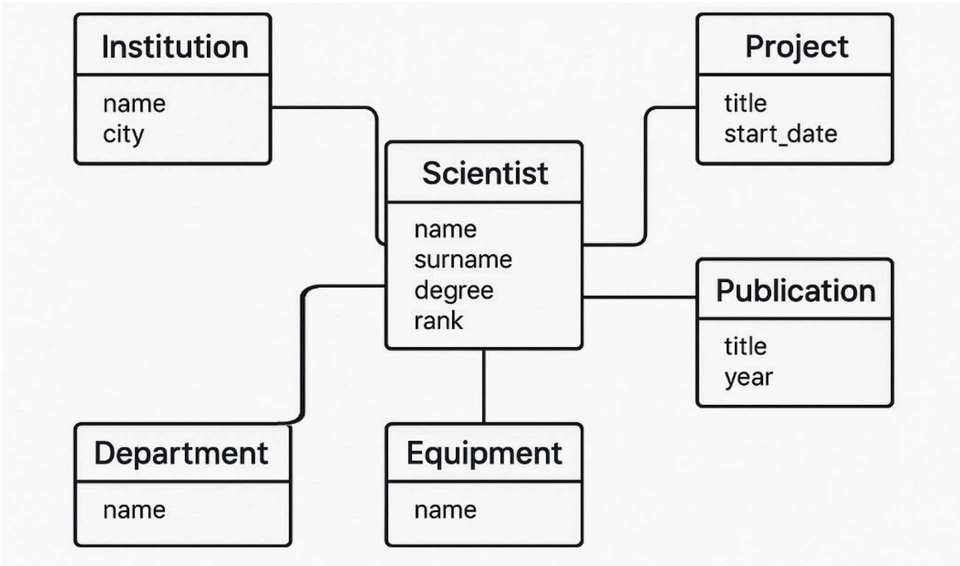

Fig. 3. The scheme of the database that is the core to provide automatization of the documents filling process

dictionaries of specialties, academic titles and degrees and others, as well as will allow to generate new attributes by coincidence, for example:

Academic degree level: Candidate of Science; Academic degree direction: Technical Sciences → Candidate of Technical Sciences.

Thus, the business process will be greatly simplified and will consist in choosing a template, selecting the sender, recipient and specific fields of the document (authors of the publication (set of fields), conference name, city of business trip, etc.). The generated document will be up-to-date in accordance with the requirements and, in fact, the signatures will perform their real role, namely, the permissive one. This approach will reduce the time of document preparation to 10–15 minutes instead of several hours or even several days. A detailed diagram of the business process of document preparation after reengineering and using ITS is shown in Fig. 4.

3.2. Ontologies as the way to store data for workflow automatization

The increasing administrative burden on researchers necessitates efficient solutions for managing scientific information and automating routine tasks, such as document preparation. While automation offers significant potential to improve efficiency and quality in scientific workflows, existing tools often lack the specificity required for

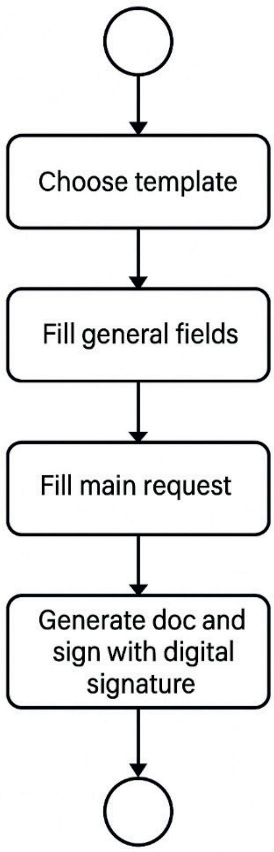

Fig. 4. Detailed scheme of the business process of document preparation after reengineering and using ITS

tasks like generating complex scientific documentation from structured data. Traditional methods often rely on human-readable formats, which makes automated processing and knowledge extraction challenging. Simply using standardized templates or basic metadata, while helpful, doesn't fully address the need for deeper semantic understanding and interoperability required for advanced workflow automation.

Ontologies offer a powerful paradigm to overcome these limitations by providing a formal, explicit specification of a shared conceptualization. In the context of scientific workflow automation, ontologies serve as structured knowledge systems capable of representing complex information, relationships, and constraints within a domain in a machine-readable format. By defining concepts, properties, and relationships relevant to scientific activities (e. g., researchers, institutions, publications, projects, methods, results), ontologies create a semantic framework that facilitates data integration, sharing, and reuse across different systems and processes. Example of storing data and keeping links related to scientistic conferences as example of storing scientific data is shown in Fig. 5.

Storing scientific data within an ontological structure enables significant advancements in workflow automation. Instead of relying on siloed databases or unstructured documents, information can be stored as interconnected entities within an ontology graph. For example, information about a scientist (their affiliations, publications, projects, expertise) can be linked semantically. When generating a report or filling out a form, automated systems can query this ontological graph, retrieve the necessary interconnected data points, and populate the document accurately and consistently. This approach moves beyond simple template filling to a more intelligent process aware of the meaning and context of the data.

Several approaches [26–29] leverage ontologies for scientific data systematization. One promising method involves structuring scientific studies based on established formats like IMRAD (Introduction, Methods, Results, and Discussion). By mapping the core components of research papers onto an ontological structure, key elements like objectives, methodologies, parameters, findings, and discussions can be captured as distinct attributes or nodes within the ontology. This structured representation facilitates not only automated document generation but also advanced search, retrieval, and analysis of scientific information. Researchers, especially those new to a field, can more easily find specific methods or results across multiple studies by querying the ontology.

Furthermore, ontologies support semantic interoperability, allowing different systems and tools

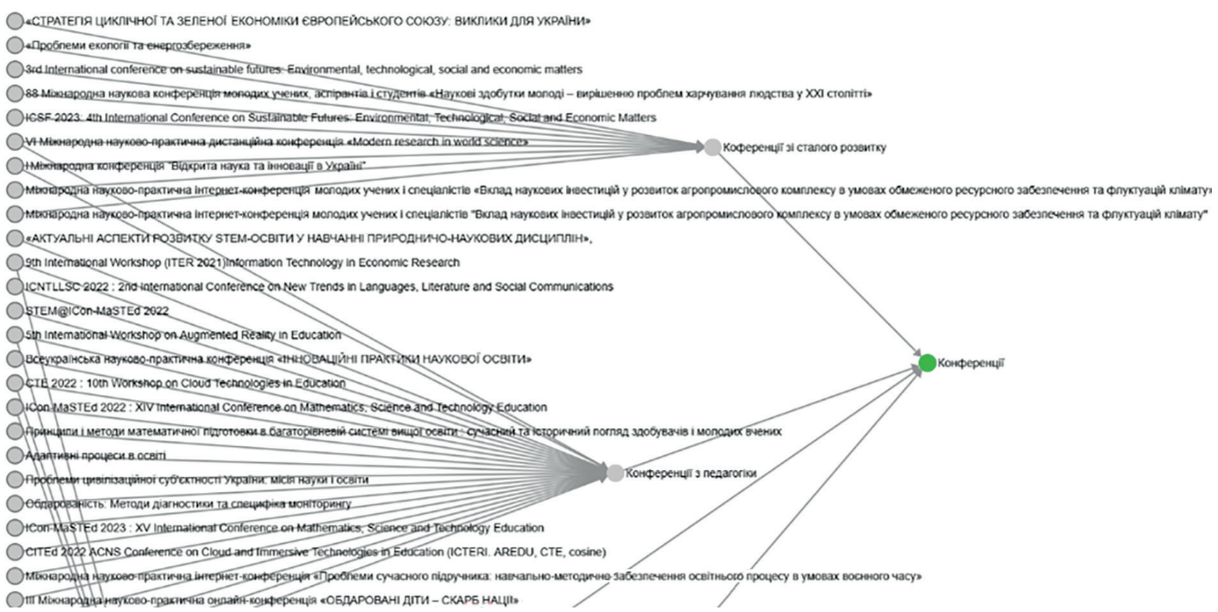

Fig. 5. Example of storing data and keeping links related to scientistic conferences as example of storing scientific data

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within the scientific ecosystem to understand and exchange data meaningfully. This is crucial for consolidating information from various sources, such as institutional repositories, publication databases, and researcher profiles. Platforms like the CIT Polyhedron utilize ontology-based models to consolidate and structure information resources, employing concepts like narrative ontology to organize information across disciplines and enhance knowledge coherence. Such systems aim to unify semantic processes, enabling more integrated and efficient data management and knowledge dissemination compared to simple data integration based on shared attributes. By representing the semantic properties of information resources, ontologies provide the foundation for building intelligent automation tools, such as the "Polyhedron Researcher", designed to assist scientists in organizing their activities and managing data effectively.

Adopting ontologies as the underlying structure for storing scientific data provides a robust foundation for workflow automation. It enables machine-readable representation of complex information, facilitates semantic interoperability and data consolidation, and supports intelligent querying and retrieval. This approach addresses the limitations of traditional methods and offers a pathway to significantly reduce the administrative burden on scientists by automating the generation and management of scientific documentation and information.

Conclusions

This study identifies significant inefficiencies in the manual preparation of scientific documents, a process often consuming substantial researcher time due to repetitive data entry and complex approval stages, particularly within the context of Ukrainian academia. Existing automation tools and simplification strategies provide only partial solutions, often lacking specialization for the dynamic and varied nature of scientific documentation.

The proposed solution, centered around a structured database containing detailed scientist information and a system of auto-filling document templates, offers a viable method to automate this workflow. By reengineering the document preparation process (visualized through "As-Is" and "To-Be" BPMN models), the system can retrieve up-to-date information and populate standardized documents automatically, reducing preparation time significantly, potentially from hours or days to approximately 10–15 minutes. This automation minimizes manual errors and streamlines the approval process.

Furthermore, integrating ontologies provides a more advanced framework for managing scientific data. Ontologies enable a machine-readable, semantic representation of complex information and relationships within the scientific domain (e. g., linking researchers, publications, projects). This structured knowledge system supports enhanced data integration, interoperability between different systems, and more intelligent automation capabilities compared to traditional databases or simple templates. Adopting ontology-based data storage can further reduce the administrative burden on scientists, facilitating more efficient knowledge management and dissemination. The successful implementation of such database-driven and ontology-enhanced systems holds promise for improving research productivity and quality by freeing researchers to focus on their primary scientific endeavors.

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Є. Б. Шаповалов,
В. Б. Шаповалов,
Т. В. Рудакова,
Я. В. Рибалко

АВТОМАТИЗАЦІЯ ДОКУМЕНТОПІДГОТОВКИ В НАУКОВІЙ ДІЯЛЬНОСТІ: ПРАКТИЧНІ ПІДХОДИ З ВИКОРИСТАННЯМ ОНТОЛОГІЙ

Анотація. *Проведення наукових досліджень передбачає серед іншого виконання адміністративних завдань, зокрема підготовку документів, що відволікає від основної дослідницької роботи. Особливо це характерно для академічних систем, що розвиваються, як-от українська. Наявні інструменти автоматизації не завжди спроможні задовольнити різноманітні потреби під час підготовки наукової документації, що часто включає динамічні дані, такі як наукові звання та приналежність. Сучасні підходи, як-от стандартизовані шаблони й інструменти систематичного перегляду, забезпечують обмежену ефективність або не призначені для створення документів. Інституційні та індивідуальні стратегії також не можуть безпосередньо автоматизувати ці повторювані завдання. У цьому дослідженні пропонується новий метод, який використовує структуровану базу даних інформації про науковців у поєднанні з шаблонами автоматичного заповнення для автоматизації створення різноманітних наукових документів (наприклад, заявок, звітів, запитів). Аналізуючи існуючий робочий процес підготовки документів («As-Is») і розробляючи спрощений процес («To-Be»), що використовує цю базу даних, запропонована система має на меті значне скорочення часу підготовки з годин або днів до хвилин. Також у статті досліджується використання онтологій як надійної структури для зберігання та керування науковими даними, що забезпечує семантичну взаємодію та більш інтелектуальну автоматизацію робочих процесів, крім простого заповнення шаблонів. Цей підхід усуває обмеження існуючих систем і пропонує індивідуальне рішення для підвищення ефективності та якості досліджень в українському науковому контексті та за його межами.*

Ключові слова: *автоматизація, науковий робочий процес, генерація документів, адміністрування досліджень, системи баз даних, онтології, семантичне моделювання даних, реінжиніринг бізнес-процесів, українська наука.*

INFORMATION ABOUT THE AUTHORS

Shapovalov Ye. B. — PhD in Engineering, Senior Researcher, Leading Researcher, Sector of Development and Research of Scientific Information Systems, State Scientific and Technical Library of Ukraine; Senior Researcher of the Department of Education and Thematic Knowledge System Creation, NC “Junior Academy of Sciences of Ukraine”, Kyiv, Ukraine, sjb@man.gov.ua; ORCID ID: https://orcid.org/0000-0003-3732-9486

Shapovalov V. B. — PhD, Leading Researcher of The Department of European Integration and International Cooperation, State Scientific and Technical Library of Ukraine; Senior Researcher of the Department of Education and Thematic Knowledge System Creation, NC “Junior Academy of Sciences of Ukraine”, Kyiv, Ukraine, 2429920@gmail.com; ORCID ID: https://orcid.org/0000-0001-6315-649X

Rudakova T. V. — PhD in Engineering, Senior Researcher, Head of the Scientific and Organizational Department, State Scientific and Technical Library of Ukraine, Kyiv, Ukraine, rudakovatati@gmail.com; ORCID ID: https://orcid.org/0000-0002-7017-735X

Rybalko Ya. V. — Senior Researcher of the Administration Sector of the National Electronic Scientific Information System of Department of Support and Development of the National Electronic Scientific Information System, State Scientific and Technical Library of Ukraine, Kyiv, Ukraine, r@kneu.edu.ua; ORCID ID: https://orcid.org/0009-0001-9564-7653

ІНФОРМАЦІЯ ПРО АВТОРІВ

Шаповалов Євгеній Борисович — канд. техн. наук, старший дослідник, провідний науковий співробітник сектору розробки та розвитку науково-інформаційних систем, Державна науково-технічна бібліотека України; старший науковий співробітник відділу створення навчально-тематичних систем знань, НЦ «Мала академія наук України», м. Київ, Україна, sjb@man.gov.ua; ORCID ID: https://orcid.org/0000-0003-3732-9486

Шаповалов Віктор Борисович — д. філос., провідний науковий співробітник відділу європейської інтеграції та міжнародного співробітництва, Державна науково-технічна бібліотека України; старший науковий співробітник відділу створення навчально-тематичних систем знань, НЦ «Мала академія наук України», м. Київ, Україна, 2429920@gmail.com; ORCID ID: https://orcid.org/0000-0001-6315-649X

Рудакова Тетяна Василівна — канд. техн. наук, старший науковий співробітник, завідувач науково-організаційного відділу, Державна науково-технічна бібліотека України, м. Київ, Україна, rudakovatati@gmail.com; ORCID ID: https://orcid.org/0000-0002-7017-735X

Рибалко Ярослав Всеволодович — старший науковий співробітник сектору адміністрування Національної електронної науково-інформаційної системи відділу супроводження та розвитку Національної електронної науково-інформаційної системи, Державна науково-технічна бібліотека України, м. Київ, Україна, r@kneu.edu.ua; ORCID ID: https://orcid.org/0009-0001-9564-7653

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