# ZSAM – Federated Semantic Search System

## Operation Guide (Expanded Version)

ZSAM, which stands for **Zero Silos, All Meaning**, is a federated semantic search platform designed to unify search experiences across multiple open data sources. The system does not just return keyword-based matches but is structured to support meaningful and context-aware results. The project integrates two key technologies: WordPress for the frontend and Node-RED for the backend, with responses normalized into the DCAT format for consistency and interoperability.

## System Architecture Overview

The ZSAM system is composed of two major layers. The first is the frontend, which is implemented using WordPress and the Elementor plugin. This choice was made to ensure accessibility compliance, fast content delivery, and ease of use for content editors. The second layer is the backend, which is built using Node-RED. This layer is responsible for receiving search requests, routing them to the correct external data sources, transforming the raw responses into a unified format, and then returning them to the frontend for display.
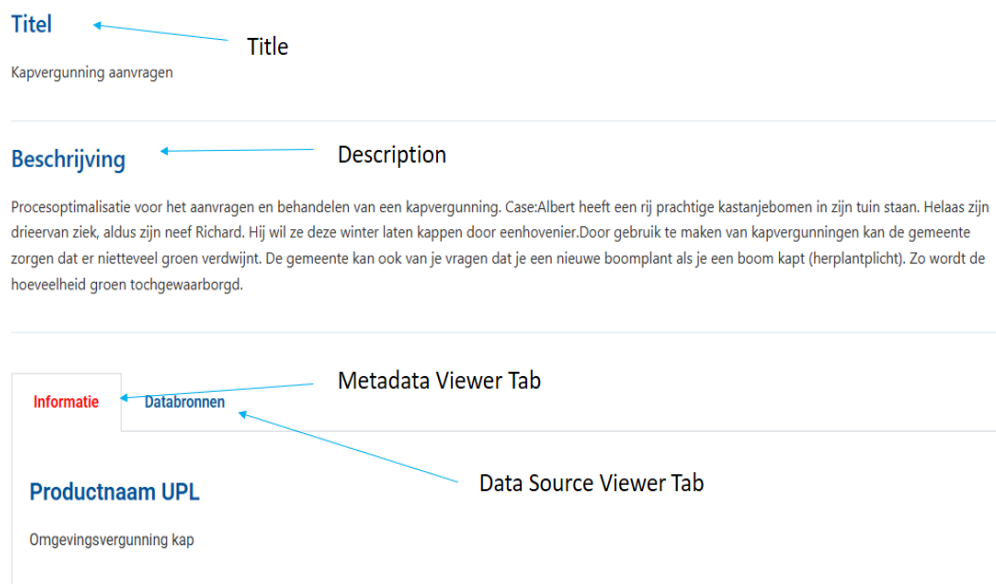
## Frontend Operation

The frontend interface consists of two key pages. The first page is the search interface, where users can input a search query into a prominent search bar. This page also includes dynamic filtering options, such as categories and themes. These filters are not hardcoded but are generated dynamically from the metadata in the search results returned by the backend. Once the user enters a keyword and submits the query, the frontend sends this request to the backend via a RESTful API endpoint.

The backend processes the query and returns structured results in real time. These results are rendered on the same page, along with dynamic facets that allow the user to further refine

their search. When users interact with these filters, the frontend re-submits the query with updated parameters, and the backend fetches the filtered data accordingly.
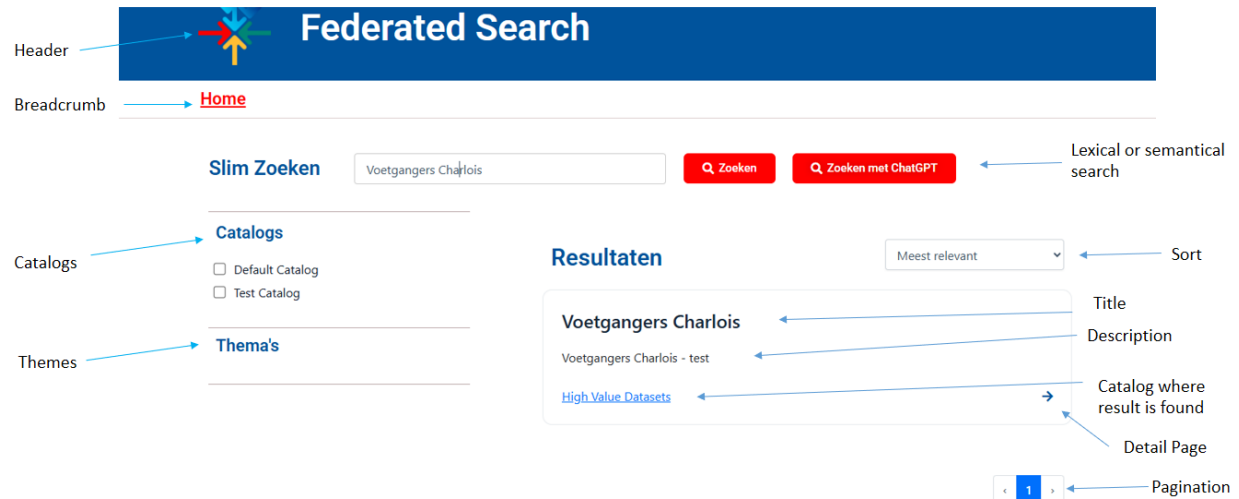


If the user clicks on a specific result, they are taken to a detail page. This page is designed to show extended metadata about the selected dataset or publication. It includes three structured sections: the first displays the title and description, the second contains metadata such as version, year, license, and theme, and the third section lists the available data sources such as downloadable files, APIs, or linked schemas.

# Backend Operation
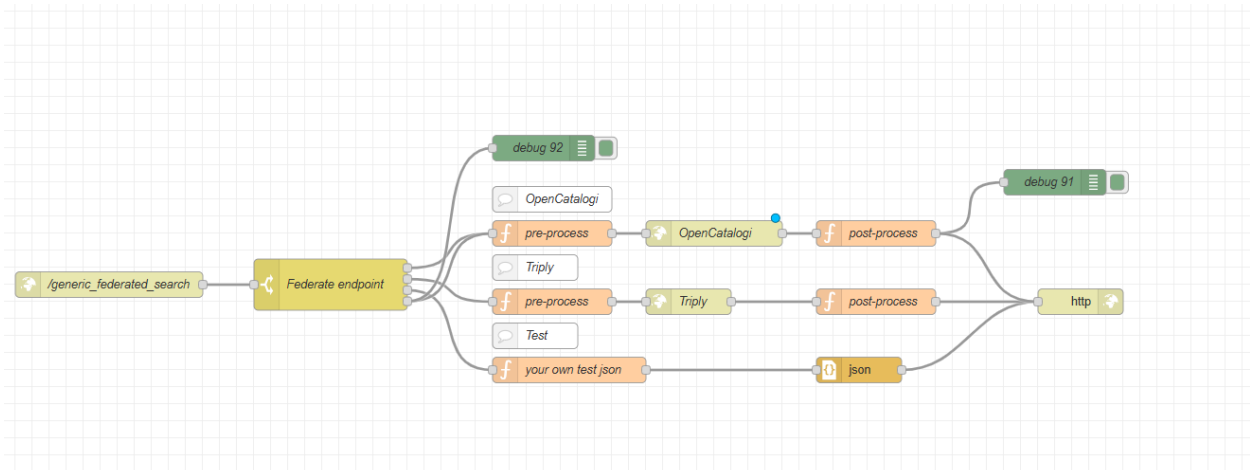


The backend is implemented using Node-RED, a flow-based development environment for visually wiring together APIs and services. The core logic of the search system is built as a modular flow that can easily be extended to support additional data sources.

The process begins at the /generic_federated_search endpoint, which is an HTTP IN node configured to accept various query parameters including the search term, pagination data, selected catalog or theme, and the federation source. The next step in the flow is a switch node that checks the value of the "federation" parameter. Based on this value, the system decides which data source should handle the query.

Currently, the flow supports the OpenCatalogi API. This segment of the flow handles the actual API call using an HTTP Request node. Once the external API responds, a Function node is used to normalize the response. This transformation converts the source-specific structure into a standardized DCAT format, ensuring uniformity regardless of the origin of the data.

The response is then sent back to the frontend via an HTTP OUT node, where it is displayed in a user-friendly format. The entire Node-RED flow is modular. This design makes it easy to add new sources in the future without affecting existing logic. For example, integrating Triply or SPARQL endpoints would only require adding a new branch and adjusting the routing logic.

# Project Status

The current implementation marks the successful completion of Phase 1 of the project. This phase included implementing the core lexical search functionality, integrating the OpenCatalogi

API, building a responsive and accessible frontend using WordPress and Elementor, and ensuring that all responses are normalized to DCAT. The system supports dynamic filters, detail pages, and robust backend routing.

# Handover and Deployment

As part of the project delivery, the handover will include a complete GitHub repository containing all source code and configuration files. This will be accompanied by a Docker-based deployment guide for setting up the WordPress environment. In this setup, WordPress runs in a containerized environment managed through Docker Compose, ensuring it is portable, consistent, and easy to replicate on different servers.

Additionally, the handover includes Node-RED flows exported in JSON format. These flows can be imported into any Node-RED instance to replicate the backend logic. The documentation also outlines how to start and manage the Docker containers, configure the database, and connect the frontend to the backend API.

# Future Roadmap

Although Phase 1 focused solely on lexical search, the roadmap includes several exciting additions. In Phase 1b, the system will introduce natural language processing capabilities. This means if a user's query returns no results, the system can suggest alternative queries using semantically similar terms. This will improve recall and ensure that users are guided to the most relevant data.

In Phase 2, the system will evolve into a fully semantic search platform. This includes integration with PromptQL or other LLM-supported engines. Furthermore, a conversational UI will be introduced, making the search process more intuitive and user-centric. This phase will maintain compatibility with the existing WordPress frontend while also offering a CALM-style dialogue interface.

# Summary

The ZSAM project is a powerful, flexible, and scalable federated search platform designed for the public sector. It demonstrates how WordPress and Node-RED can be combined to deliver a standards-compliant, modular system that queries multiple data catalogs and presents results in a structured and user-friendly way. With future enhancements planned for semantic understanding and conversational UI, ZSAM is well-positioned to become a reference implementation for federated search across open government data ecosystems.