



Frankfurt University of Applied Sciences

Faculty of Computer Science and Engineering

Implementation and Evaluation of an Enterprise Architect Chatbot Using a RAG-Based Approach

Thesis to Obtain the Academic Degree

Master of Science (M.Sc.)

Submitted by

Hendrik Gruber

Matriculation Number: 1458240

Advisor : Prof. Dr. Jürgen Jung
Co-Advisor : Dr. Rainer Schlör

DECLARATION (ERKLÄRUNG)

I hereby assure that I wrote the present work independently and that I did not use any other sources than those given in the bibliography.

All passages that are taken verbatim or correspondingly from published or not yet published sources are marked as such.

The drawings or images in this work were created by myself or provided with a corresponding source reference.

This work has not been submitted to any other examination authority in the same or a similar form.

Ich versichere hiermit, dass ich die vorliegende Arbeit selbstständig verfasst und keine anderen als die im Literaturverzeichnis angegebenen Quellen benutzt habe.

Alle Stellen, die wörtlich oder sinngemäß aus veröffentlichten oder noch nicht veröffentlichten Quellen entnommen sind, sind als solche kenntlich gemacht.

Die Zeichnungen oder Abbildungen in dieser Arbeit sind von mir selbst erstellt worden oder mit einem entsprechenden Quellennachweis versehen.

Diese Arbeit ist in gleicher oder ähnlicher Form noch bei keiner anderen Prüfungsbehörde eingereicht worden.

Frankfurt a.M., 16. April, 2026

Hendrik Gruber

ABSTRACT

Lorem ipsum ...

CONTENTS

I THESIS	
1 INTRODUCTION	2
1.1 Motivation and Thesis Question	2
1.2 Research Method	2
2 TERMINOLOGY AND TECHNOLOGY	3
2.1 Terminology	3
2.1.1 Enterprise Architecture Management	3
2.1.2 Enterprise Architect	3
2.1.3 Capabilities	4
2.1.4 Value Streams	4
2.1.5 Architecture Diagrams	4
2.2 Technology	4
2.2.1 Large Language Models	4
2.2.2 Graph Database	4
2.2.3 Retrieval Augmented Generation	4
2.2.4 neo4j and the Cypher Query Language	4
2.2.5 Model Context Protocol	4
2.2.6 XML and Transpilers	4
2.2.7 APOC and XPATH	5
3 CURRENT STATE OF THE ART	6
3.1 Enterprise Architecture Management	6
3.2 Large Language Models, Conversational Agents, and Retrieval-Augmented Generation	6
3.3 Comparable Projects and Prototypes	7
3.4 Evaluations and Limitations	7
4 METHODOLOGY	8
4.1 Action Research	8
4.1.1 Preconditions	9
4.1.2 Development Cycles	9
4.2 Data Used	9
4.3 Finished Prototype	9
4.3.1 Finished Architecture	9
4.3.2 Generating Text-to-Cypher Independent of the Database Schema	10
5 EXPERIMENTS	11
6 EVALUATION OF THE RESULTS AND CHALLENGES	15
6.1 Results	15
6.2 Challenges	15
6.3 Limitations	15
7 CONCLUSION AND FUTURE WORK	16
7.0.1 Conclusion	16

7.0.2 Future Work	16
BIBLIOGRAPHY	17
II APPENDIX	
A ACTION RESEARCH PROTOCOL	20
A.1 Preconditions	20
A.2 Cycle 1	20
A.3 Cycle 2	20
A.4 Cycle 3	20
A.5 Cycle 4	20
A.6 Final Meeting	20
B INSTRUCTION MANUAL FOR MASUTĀ	21
B.1 Downloading Masutā	21
B.2 First Time Setup	21
B.2.1 Hard-Resetting Everything	21
B.3 Running the Application	22
B.4 Feature Overview	22
B.4.1 Input Field and Chat History	22
B.4.2 Toggling the Database	22
B.4.3 Resetting the Playground Database	23
B.4.4 Importing Custom Data	23
B.4.5 Inspect Database	23
B.4.6 Chat Context and Building on Previous Answers	23
B.5 Example Questions	23
C MASUTĀ CODE SNIPPETS	25
C.1 System Prompt and Results Explainer	25
D MASUTĀ EXAMPLE QUESTIONS AND ANSWERS	26
D.1 Question xyz	26

LIST OF FIGURES

- Figure 5.1 Raw response returned from the Cypher in listing 5.1. Notice that the response contains both information about the applications themselves as well as textbook information on enterprise architecture management (right-most column). 13
- Figure 5.2 Raw response returned from the Cypher in listing 5.1. Notice that the response contains both information about the applications themselves as well as textbook information on enterprise architecture management (right-most column). 14

LIST OF TABLES

ACRONYMS

AI	Artificial Intelligence
APOC	Awesome Procedures on Cypher
AR	Action Research
EA	Enterprise Architect / Architecture
EAM	Enterprise Architecture Management
GenAI	Generative Artificial Intelligence
IT	Information Technology
MCP	Model Context Protocol
PAR	Participatory Action Research
RAG	Retrieval-Augmented Generation
UI	User Interface

USAGE OF GENERATIVE AI

OpenAI GPT-5 and GPT-5.2 (OpenAI, 2025) were used in order to find sources and summarize them. OpenAI GPT-5 and GPT-5.2 (OpenAI, 2025) were used in order to build both transpilers and the node.js backend server.

Part I
THESIS

INTRODUCTION

1.1 MOTIVATION AND THESIS QUESTION

In the field of define that we are building a RAG system which will be referred to as a chatbot. it is not an agent, as it is not executing anything.

1.2 RESEARCH METHOD

Action Research (AR) was applied in order to gain scientific value out of the developed prototype. The advantage of this research method is that it is very supportive of the development process for information systems. According to Baskerville (1999), all types of action research have the following four characteristics in common: An orientation towards developing, a focus on a specific problem, an iterative process, and a collaboration amongst participants. This is applicable to the work at hand because a prototype is being developed for a specific problem. The development cycle is conducted iteratively and collaboratively with different stakeholders. More details on this are described in chapter [4.1](#) [2]

TERMINOLOGY AND TECHNOLOGY

This chapter goes in detail on the terminology and technology that will be relevant for the reader to have a foundational understanding of the rest of this thesis. Later chapters will build upon these concepts and pieces of technology.

2.1 TERMINOLOGY

2.1.1 *Enterprise Architecture Management*

Enterprise Architecture Management (EAM) can be summarized as being the bridge between the business and IT departments of an enterprise. The goal is to implement information technology that is aligned with the business needs of the company. This is in contrast to the IT department implementing information technology for the sake of implementing information technology, which people in IT are often fond of doing [1]. An unwanted situation would then be when the IT department falls into a siloed way of thinking where they are decoupled from the rest of the company. EAM helps to ensure that the implemented information technology is achieving the right things, namely supporting the business capabilities and processes. [11, pg. 2-3]

Enterprise Architecture can benefit a company in various ways.

Diese Quelle hierfür vielleicht verwenden: [10] Die Quelle hat vor allem eine Menge Fragen aus der echten Welt, was EAAs sich im Alltag fragen. Diese Liste kann als Referenz dienen für meinen Copilot. Diese Quelle hilft da vielleicht auch nochmal um in die Tiefe zu gehen. [3]

2.1.2 *Enterprise Architect*

A common challenge for an EA is dealing with the heterogeneous nature of an application landscape [11, pg. 6]

Erwähnen, dass eine Herausforderung des EAAs es ist, dass die zunehmenden Änderungen zwar von einem high-level POV einfach aussehen, aber in den Details viele Herausforderungen stecken. zB Stakeholder Management (jede Applikation hat einen eigenen verantwortlichen, viele Schnittstellen der Applikationen, etc.)

2.1.3 Capabilities

2.1.4 Value Streams

2.1.5 Architecture Diagrams

2.1.5.1 Application Landscape

2.1.5.2 Capability Support Matrix

2.1.5.3 EAM Modeling Tool - Archi

2.2 TECHNOLOGY

2.2.1 Large Language Models

LLMs are capable of supporting in language-related tasks where text needs to be generated, translated, summarized, analysed, or questions answered [9].

[17] describes what llms are and why they are not good with domain specific information and how that causes them to hallucinate.

2.2.2 Graph Database

2.2.3 Retrieval Augmented Generation

2.2.4 neo4j and the Cypher Query Language

2.2.5 Model Context Protocol

Also explain (maybe in the SOTA) how it is able to understand the schema of the graphdatabase (by calling get-schema when initializing the MCP it knows how my graph database is setup).

2.2.6 XML and Transpilers

As will be shown later in section xyz, the working prototype uses a domain-specific, source-to-source transpiler to turn the archimate-exported XML data into Cypher queries to insert the EA data into the graph database.

This source has a bit of good information on why XML is good as a structure language[16] "Simply speaking, eXtensible Markup Language (XML) is a data architecture connecting meta-data and data. The architecture's defining feature is the hierarchical network of nodes. Every node in the XML structure is connected somehow to any other node; also, being a hierarchy, every node is either subordinate or superordinate to another node, as shown in the tree structure in Figure 1. Further, XML "provides a standard syntax for the mark-up of data and documents" (Watt 2002:1). The syntax along

with the hierarchical network structure make XML documents exhaustively searchable and therefore useful for linguistic research."

More detailed information on the transpiler is described in section xyz.

2.2.7 *APOC and XPATH*

Describe how apoc + xpath work and what this has to do with the neo4j cyphers. this might be better in the methodology section as a quick paragraph, but it has to be described somewhere.

3

CURRENT STATE OF THE ART

Briefly explain why a literature analysis is important. Define the scope (what fields you looked at, which databases, what keywords). Define the research method and how you narrowed it down from x sources to y sources.i

3.1 ENTERPRISE ARCHITECTURE MANAGEMENT

theories, digital twin efforts, EA tool landscapeStandards or frameworks (e.g., TOGAF, ArchiMate, IATA ONE Record, LeanIX). Theoretical foundations (auch auf prozessmanagement eingehen, wie der aktuelle Prozess aussieht, wenn die Landschaft geändert werden soll) Current tools and methods Research prototypes in EA

Authors Jung and Fraunholz 2021 [11] lay foundational work from which many EAM concepts can be derived.

3.2 LARGE LANGUAGE MODELS, CONVERSATIONAL AGENTS, AND RETRIEVAL-AUGMENTED GENERATION

strengths, hallucination issues, graph-RAG enhancements Theoretical foundations Current tools and methods

This paper covers how ai tools are more scalable than manual expertise analysis of things. The source is highly relevant. Look at the summary in notebookLM. 05.10.25 [8]

This 2025 paper has ideas on how changing knowledge-graphs (e.g. through updates) can be handled [12]. It looks at temporal data and how to handle it. This might be relevant since addressing how a changing application landscape can be handled will probably be a challenge.

This paper gives an overview on how to control the dialog sequence and also notes 4 types of dialog options for chatbots in the related works section: [13].

This paper [20] covers how a chatbot can support in task-planning and output generation. Might be helpful in understanding how my chatbot can tell the EA how to conduct changes in the application landscape.

This paper [5] states how proactive dialogue systems work and can be improved. It goes into detail on 3 types of dialogue systems: clarification, target-guided, and non-collaborative dialogues. All 3 of these have a certain relevance for the EAM Chatbot.

RAG: Geh darauf ein, was es für unterschiedliche Chunking methoden gibt, wie man ein Buch runterbringt, und was das alles für vor und nachteile hat. auch welche tools es gibt (neo4j) ist wichtig.

3.3 COMPARABLE PROJECTS AND PROTOTYPES

Proof-of-concepts, research prototypes, industry whitepapers, GitHub projects.

Tools like ChatEA, LeanIX AI features, or Microsoft Copilot integrations in architecture/governance.

A prototypical graph-based RAG approach for text-summarization has been created by Microsoft: y[6]. The accompanying paper is here: [7]
Dragon1 needs to be detailed here!

3.4 EVALUATIONS AND LIMITATIONS

Studies analyzing strengths/weaknesses of RAG, embedding quality, hallucination mitigation.

Papers about user interaction with EA tools, chatbot evaluation frameworks, usability challenges

This paper [19] gives a standardized method and framework for evaluating conversational AI agents.

This paper [14] proposes a benchmark for open-ended multi-turn conversational agents. I think this paper focuses more on evaluating agents and comparing their results, but maybe i can copy their evaluation methods and benchmarks?

METHODOLOGY

This chapter describes how the chatbot "Masutā" (a phonetic adaptation of the English term "master" into Japanese katakana) was developed. It provides further insight into the applied research method and the process through which the prototype was created.

Sequenzdiagramm, projekt plan (timeline), herangehensweise, etc.

4.1 ACTION RESEARCH

Action Research (AR) is a research method which is highly applicable when developing an information system such as the one presented in this paper. The advantage of AR is that a large focus can be laid on the development of a system while still achieving an academic benefit.

Cyclical phases are central to the concept of Action Research. Baskerville [2] describes Action Research as an iterative process consisting of five steps within a single cycle. Other sources, such as Cornish et al. [4], propose variations with fewer phases within a cycle; however these models also boil down to the same concepts. Across the literature, Action Research cycles follow the same structure: planning what should be done in the new cycle, taking action, and evaluating the outcome of the completed cycle before moving on to the next one [2, 4].

The paper at hand applied a cycle using the following steps according to Baskerville [2]: diagnosing, action planning, action taking, evaluating, and specifying learning. This cycle including the preliminary and subsequent steps are summarized in figure **to do create a drawing of the cycles**. Each cycle lasted between three and four weeks. The sources used do not mention how long a single cycle should last. However, a cycle of two to three weeks were deemed as reasonable for the development of Masutā.

Abgrenzen zu Participatory Action Research (was wir auch betreiben) Participatory Action Research (PAR) goes a step further in creating a more collaborative environment between the researcher and client participants. Instead of leaving the theorizing up to the researcher, new information and ideas are thought up together with the client participants, giving both parties an active role. This is beneficial because the client participants often have both theoretical and practical knowledge of the subject matter being worked on. [2]

4.1.1 *Preconditions*

4.1.2 *Development Cycles*

4.1.2.1 *Cycle 1*

4.1.2.2 *Cycle 2*

4.1.2.3 *Cycle 3*

4.1.2.4 *Cycle 4*

The main challenge of this cycle was refactoring the cyphers that get called against the database. the reason being that the previous method for generating text-to-cypher was easy because it was only calling the speedparcel database and the schema of this was entirely known. however, during this sprint we got new data exported from architecture diagrams in archi. this data is well structured but the schema is unknown. this means that the text-to-cypher has to be able to query the graph database agnostic of any schema in it. meaning, the text-to-cypher has to be completely refactored in order to be able to reliable query the dataset with unknown contents.

The source from Wan i 4.3.2 [18] explains how he created a 3-step-preprocessing in order to query the database agnostically. what i did is not 1-to-1 the same thing, but i borrowed the ideas. the main change being changing the CALL db.schema.visualization() from before to the APOC call apoc.meta.schema() which apparently returns more sensible information. that combined with the SHOW INDEXES call give a better result (i assume - i'm writing this before testing just to get my ideas out of my head lol have fun rewriting this. i wrote this in Bremen on 28.12 xoxo)

4.2 DATA USED

4.3 FINISHED PROTOTYPE

Explain here, what the finished prototype is (including architecture diagram, sequence diagram, etc.). or should this be an entirely separate chapter? describing this somewhere here makes sense though before moving on to the experiments done with the prototype.

Mention that this is a "ephemeral conversation memory" and why that is. We will probably need some kind of source on this.

Also mention that we agreed to test my system using exported XML files from Archimate. So other tools like

4.3.1 *Finished Architecture*

Explain in detail here what each component of the finished architecture is and how it all fits together.

4.3.1.1 XML Transpiler

Explain in detail here how the XML transpiler takes an XML file as the input and transpiles it into Cypher. It is model-to-model and thus touches on the subjects compiler construction, model-driven engineering, graph databases, and enterprise architecture tooling.

Show how fine-tuning the system prompt can have an effect on the results. E.g. if in the context it says to answer within 1-2 sentences or to answer in 4-6 sentences. Show examples of how small things in the prompt can have a large impact.

4.3.2 Generating Text-to-Cypher Independent of the Database Schema

Highlight this as the main challenge of the thesis!

This source describes how and why agnostic cyphers can and should be generated. [18] also, check their sources and use those as well. It also mentions that a challenge when giving the LLM the necessary context is that it gets overloaded with information and that the context length may get exceeded (page 5).

This source [15] talks about how natural language text can be used to **create** the knowledge graph. Def use this when explaining how i created my speedparcel imports.

The whole system prompting this is called "in-context learning (ICL)". search for sources that support this.

EXPERIMENTS

What we did with the finished prototype and how we tested it. Prompts we used, cases we built, edge cases, etc.

show some test cases here. break down an answer like "i want to remove the application StatManPlus. What do i have to look out for as an enterprise architect?". the returned answer goes into a lot of depth as this is a level 3 question. break down the result of the query and how the result pulls information about the application but also pulls information from the Lehrbuch database.

```

1 MATCH (a:Application {name: 'StatManPlus'})
OPTIONAL MATCH (a)-[:SUPPORTS]->(cap:Capability)
WITH a, collect(DISTINCT cap) AS caps
UNWIND (CASE WHEN size(caps) > 0 THEN caps ELSE [NULL] END) AS cap
OPTIONAL MATCH (cap)-[:HAS_CHILD*0..]->(desc:Capability)
6 WITH a, caps, collect(DISTINCT desc) AS cap_impacted
OPTIONAL MATCH (a)-[:DATA_FLOW]->(outApp:Application)
WITH a, caps, cap_impacted, collect(DISTINCT outApp.name) AS outgoing_apps
OPTIONAL MATCH (inApp:Application)-[:DATA_FLOW]->(a)
WITH a, caps, cap_impacted, outgoing_apps, collect(DISTINCT inApp.name) AS
    incoming_apps
11 OPTIONAL MATCH (ch:Chunk)
WHERE toLower(coalesce(ch.text,'')) CONTAINS toLower(a.name)
    OR toLower(coalesce(ch.table_summary,'')) CONTAINS toLower(a.name)
    OR toLower(coalesce(ch.title,'')) CONTAINS toLower(a.name)
    OR toLower(coalesce(ch.definition,'')) CONTAINS toLower(a.name)
16 WITH a, caps, cap_impacted, outgoing_apps, incoming_apps,
    collect(DISTINCT {key: ch.key, title: ch.title, snippet: ch.
        table_summary, text: ch.text}) AS app_chunks
OPTIONAL MATCH (guid:Chunk)
WHERE toLower(coalesce(guid.text,'')) CONTAINS 'decommission'
    OR toLower(coalesce(guid.text,'')) CONTAINS 'retire'
21 OR toLower(coalesce(guid.text,'')) CONTAINS 'sunset'
    OR toLower(coalesce(guid.title,'')) CONTAINS 'decommission'
    OR toLower(coalesce(guid.title,'')) CONTAINS 'retire'
    OR toLower(coalesce(guid.title,'')) CONTAINS 'sunset'
    OR toLower(coalesce(guid.definition,'')) CONTAINS 'decommission'
26 OR toLower(coalesce(guid.definition,'')) CONTAINS 'retire'
    OR toLower(coalesce(guid.definition,'')) CONTAINS 'sunset'
    OR toLower(coalesce(guid.table_summary,'')) CONTAINS 'decommission'
    OR toLower(coalesce(guid.table_summary,'')) CONTAINS 'retire'
    OR toLower(coalesce(guid.table_summary,'')) CONTAINS 'sunset'
31 WITH a, caps, cap_impacted, outgoing_apps, incoming_apps, app_chunks,
    collect(DISTINCT {key: guid.key, title: guid.title, snippet: guid.
        table_summary, text: guid.text}) AS guidance_chunks
RETURN a.name AS application,
    [c IN caps WHERE c IS NOT NULL | c.id] AS supported_capability_ids,
    [g IN cap_impacted WHERE g IS NOT NULL | g.id] AS
        impacted_capability_ids,
36     outgoing_apps AS outgoing_data_flows_to_apps,
```

```
incoming_apps AS incoming_data_flows_from_apps,  
app_chunks AS chunks_referencing_application,  
guidance_chunks AS chunks_with_decommission_guidance
```

Listing 5.1: Cypher query to retrieve application impact and decommission guidance

The screenshot shows a web-based application interface for 'Masutā - Your Enterprise Architecture Assistant'. At the top, there's a purple header bar with a menu icon, the app name, and a toggle switch labeled 'Using SpeedParcel Data'. Below the header, a pink rounded rectangle contains the text: 'I want to remove the application StatManPlus. What do I have to look out for as an enterprise architect?'. The main content area has a light blue background and is titled 'Agent'. It contains several sections:

- Summary**: A detailed paragraph about the impact of removing StatManPlus on business and IT landscapes.
- Key Considerations**:
 - Business Capabilities Impacted**: Removal will affect core business capabilities; ensure alternative solutions are in place.
 - Redundancy or Orphan Status**: Check if StatManPlus is redundant or truly an orphan; removing it could introduce gaps.
 - Business Ownership**: Establish clear ownership for capabilities currently supported by StatManPlus; risks increase without clear ownership.
 - Decommissioning Process**:
 - Decommissioning should be a formal project involving multiple stakeholders.
 - Validate for hidden integrations, manual workarounds, and critical users.
 - Review and update documentation like capability maps and roadmaps.
 - Plan for user migration and staff retraining.
- Practical Guidance**:
 - Successor Applications**: Designate successor systems to prevent capability gaps.
 - Project Approach**: Decommissioning should be planned and executed as a managed project, including communication and change management.
 - Documentation & Roadmaps**: Update architectural documentation to reflect changes and the transition timeline.
 - Risks & Mitigation**: Analyze for potential orphan capabilities and document rationale for intentional removal.
- References**: A section with best practices and recurring themes extracted from guidance.
- Copy Cypher**: A button to copy the Cypher code used to generate the response.
- Footer**: A text input field asking 'Ask Masutā something about your enterprise architecture...'.

Figure 5.1: Raw response returned from the Cypher in listing 5.1. Notice that the

application	supported_capability_ids ≡	impacted_capability_ids	outgr	incon	chunks_referencing_application	chunks_with_decommission_guidance
"StatManPlus"	["cap_l2_51_spot_management", "cap_l2_52_planning_and_coordination", "cap_l2_53_freight_management", "cap_l2_54_delivery_mangement", "cap_l2_58_parcel_so rting", "cap_l2_59_inspection_o f_incoming_returns", "cap_l2_60 _restocking"]	["cap_l2_51_spot_management", "cap_l2_52_planning_and_coordination", "cap_l2_53_freight_management", "cap_l2_54_delivery_mangement", "cap_l2_58_parcel_so rting", "cap_l2_59_inspection_o f_incoming_returns", "cap_l2_60 _restocking"]	[]	[]	[{ snippet:null, text:"Capability \"Spot Management\" (Level 2 in band \"Core Capabilities\", under L1 capability \"Transport Management\") is supported by: StatManPlus (flag \"x\"), TrackDB (flag \"x\").", title:null, key:"c7e0b12a9b94ca889c7e13d9e4cea9e504e5e0d2_se_c_transport_management_chunk_spot_management" }, { snippet:null, text:"Capability \"Planning and Coordination\" (Level 2 in band \"Core Capabilities\", under L1 capability \"Transport Management\") is supported by: StatManPlus (flag \"x\"), TrackDB (flag \"x\").", title:null, key:"c7e0b12a9b94ca889c7e13d9e4cea9e504e5e0d2_se_c_transport_management_chunk_planning_and_coordination" }, { snippet:null, text:"Capability \"Freight Management\" (Level 2 in band \"Core Capabilities\", under L1 capability \"Transport Management\") is supported by: StatManPlus (flag \"x\"), TrackDB (flag \"x\").", title:null, key:"c7e0b12a9b94ca889c7e13d9e4cea9e504e5e0d2_se_c_transport_management_chunk_freight_management" }]	[{ snippet:null, text:"This last difference is visible in a lot of companies today. There are software systems available and used by business people, but nobody on the business side feels responsible for them. Responsibility would include maintenance (i.e. conducting projects to perform changes), support and funding (e.g. for licenses). It, furthermore, refers to making decisions on the future of individual software applications, like its decommissioning if it does no longer provide relevant value. Making decisions based on business relevance implies an assessment from the business perspective. In fact, many systems are just handed over to IT so that they keep them running but there is no business ownership. IT people then need to drive changes driven by business requirements. Ideally, these should be driven by business stakeholders. We still have to convince people in business and IT to understand the relevance of each IT system and then make sure the IT system has business relevance. We further need clear ownership within the business to take the responsibility for decisions on this IT system.", title:null, key:"27be2852-75f0-44bc-a0d8-343ee3ed7ce9_10" }

Figure 5.2: Raw response returned from the Cypher in listing 5.1. Notice that the response contains both information about the applications themselves as well as textbook information on enterprise architecture management (right-most column).

6

EVALUATION OF THE RESULTS AND CHALLENGES

6.1 RESULTS

6.2 CHALLENGES

Mention what the limitations of action research are and how you experienced those limitations. use these sources: [2, 4]

Das nicht-deterministische verhalten des LLMs muss doch bestimmt auch probleme gemacht haben, oder? wenn wir jetzt alles nochmal neu aufsetzen in einer frischen DB, dann kommen da ja andere konten und kanten zustande? wenn man die selbe frage dem chatbot 2 mal stellt, bekommt man doch auch unterschiedliche antworten, oder?

Auch, dass die selbe Frage manchmal unterschiedliche antworten generiert zeigt, dass das system nicht-deterministisch ist, was ein großes problem darstellen kann in einem business context.

6.3 LIMITATIONS

Maybe this can go into the challenges section, but one limitation of the application is (probably - i haven't tested it yet) the knowledge graph size. there is def an upper limit to the size that the graph can be before performance takes a hit.

7

CONCLUSION AND FUTURE WORK

Todo

7.0.1 *Conclusion*

7.0.2 *Future Work*

Some ideas for future work: how to improve the challenges mentioned. what other areas this could find utility in. how could access management be handled? e.g. if the database contains customer-information that not every user should be able to see, how can that be differentiated? real-world scenarios that could use my prototype and try out a pilot phase?

BIBLIOGRAPHY

- [1] Shoaib Ahmed, Nazim Taskin, David J Pauleen, Jane Parker, et al. "Motivating information technology professionals: The case of New Zealand." In: *Australasian Journal of Information Systems* 21 (2017).
- [2] Richard L Baskerville. "Investigating information systems with action research." In: *Communications of the association for information systems* 2.1 (1999), p. 19.
- [3] Sandra Castro and Jürgen Jung. "Towards Measuring Success of Enterprise Architecture Decisions: Survey among Practitioners and Outline of a Framework." In: *Enterprise Architecture Professional Journal* (2021), pp. 1–22.
- [4] Flora Cornish, Nancy Breton, Ulises Moreno-Tabarez, Jenna Delgado, Mohi Rua, Ama de Graft Aikins, and Darrin Hodgetts. "Participatory action research." In: *Nature Reviews Methods Primers* 3.1 (2023), p. 34.
- [5] Yang Deng, Lizi Liao, Liang Chen, Hongru Wang, Wenqiang Lei, and Tat-Seng Chua. *Prompting and Evaluating Large Language Models for Proactive Dialogues: Clarification, Target-guided, and Non-collaboration*. 2023. arXiv: 2305.13626 [cs.CL]. URL: <https://arxiv.org/abs/2305.13626>.
- [6] Darren Edge, Ha Trinh, Newman Cheng, Joshua Bradley, Alex Chao, Apurva Mody, Steven Truitt, Dasha Metropolitansky, Robert Osazuwa Ness, and Jonathan Larson. "From Local to Global: A Graph RAG Approach to Query-Focused Summarization." 2024. URL: <https://www.microsoft.com/en-us/research/publication/from-local-to-global-a-graph-rag-approach-to-query-focused-summarization/>.
- [7] Darren Edge, Ha Trinh, Newman Cheng, Joshua Bradley, Alex Chao, Apurva Mody, Steven Truitt, Dasha Metropolitansky, Robert Osazuwa Ness, and Jonathan Larson. *From Local to Global: A Graph RAG Approach to Query-Focused Summarization*. 2025. arXiv: 2404.16130 [cs.CL]. URL: <https://arxiv.org/abs/2404.16130>.
- [8] Jiawei Gu, Xuhui Jiang, Zhichao Shi, Hexiang Tan, Xuehao Zhai, Chengjin Xu, Wei Li, Yinghan Shen, Shengjie Ma, Honghao Liu, et al. "A survey on llm-as-a-judge." In: *arXiv preprint arXiv:2411.15594* (2024).
- [9] Muhammad Usman Hadi, Rizwan Qureshi, Abbas Shah, Muhammad Irfan, Anas Zafar, Muhammad Bilal Shaikh, Naveed Akhtar, Jia Wu, Seyedali Mirjalili, et al. "Large language models: a comprehensive survey of its applications, challenges, limitations, and future prospects." In: *Authorea preprints* 1.3 (2023), pp. 1–26.

- [10] Jürgen Jung. "Purpose of enterprise architecture management: investigating tangible benefits in the german logistics industry." In: *2019 IEEE 23rd International Enterprise Distributed Object Computing Workshop (EDOCW)*. IEEE. 2019, pp. 25–31.
- [11] Jürgen Jung and Bardo Fraunholz. *Masterclass Enterprise Architecture Management*. Springer, 2021.
- [12] Dong Li, Yichen Niu, Ying Ai, Xiang Zou, Binqing Qi, and Jianxing Liu. *T-GRAG: A Dynamic GraphRAG Framework for Resolving Temporal Conflicts and Redundancy in Knowledge Retrieval*. 2025. arXiv: [2508 . 01680 \[cs.AI\]](https://arxiv.org/abs/2508.01680). URL: <https://arxiv.org/abs/2508.01680>.
- [13] Zhigen Li et al. *ChatSOP: An SOP-Guided MCTS Planning Framework for Controllable LLM Dialogue Agents*. 2025. arXiv: [2407 . 03884 \[cs.CL\]](https://arxiv.org/abs/2407.03884). URL: <https://arxiv.org/abs/2407.03884>.
- [14] Xiao Liu, Hao Yu, Hanchen Zhang, Yifan Xu, Xuanyu Lei, Hanyu Lai, Yu Gu, Hangliang Ding, Kaiwen Men, Kejuan Yang, et al. "Agent-bench: Evaluating llms as agents." In: *arXiv preprint arXiv:2308.03688* (2023).
- [15] Nandana Mihindukulasooriya, Sanju Tiwari, Carlos F Enguix, and Kusum Lata. "Text2kgbench: A benchmark for ontology-driven knowledge graph generation from text." In: *International semantic web conference*. Springer. 2023, pp. 247–265.
- [16] Christoph Röhleman and Matt Gee. "Conversation Analysis and the XML method." In: *Gesprächsforschung* (2017).
- [17] Karan Singhal, Shekoofeh Azizi, Tao Tu, S Sara Mahdavi, Jason Wei, Hyung Won Chung, Nathan Scales, Ajay Tanwani, Heather Cole-Lewis, Stephen Pfohl, et al. "Large language models encode clinical knowledge." In: *Nature* 620.7972 (2023), pp. 172–180.
- [18] Yuwei Wan, Zheyuan Chen, Ying Liu, Chong Chen, and Michael Packianather. "Prompting large language models based on semantic schema for text-to-Cypher transformation towards domain Q&A." In: *Decision Support Systems* (2025), p. 114553.
- [19] Anna Wolters, Arnold Arz von Straussenburg, and Dennis M. Riehle. "Evaluation Framework for Large Language Model-based Conversational Agents." In: July 2024.
- [20] Wenshuo Zhai, Jinzhi Liao, Ziyang Chen, Bolun Su, and Xiang Zhao. "A Survey of Task Planning with Large Language Models." In: *Intelligent Computing* (2025). doi: [10 . 34133 /icomputing . 0124](https://doi.org/10.34133/icomputing.0124).

Part II
APPENDIX

A

ACTION RESEARCH PROTOCOL

This chapter contains the full action research protocol.

A.1 PRECONDITIONS

Test: This reference should have a lowercase, small caps A if the option

A.2 CYCLE 1

Todo

A.3 CYCLE 2

Todo

A.4 CYCLE 3

Todo

A.5 CYCLE 4

Todo

A.6 FINAL MEETING

Todo



INSTRUCTION MANUAL FOR MASUTĀ

Masutā is the name of the prototype enterprise architecture chatbot. Follow these instructions to download Masutā, set it up, and learn how to use it.

When executing the commands from the terminal, always execute them from the root folder of the project. The best results are achieved by executing each command individually (i.e. copy-paste the commands individually line-for-line instead of the entire block).

B.1 DOWNLOADING MASUTĀ

In order to get Masutā up and running, a few prerequisites will have to be fulfilled.

The first is to download the application code for Masutā from GitHub:
<https://github.com/HendrikDA/masuta-ea-chatbot-prototype>

The second prerequisite is to download Docker and Docker Compose. You can find instructions on how to set this up on your machine under this link:
<https://docs.docker.com/compose/install/>.

An optional prerequisite is to download neo4j Desktop. This allows the user to inspect the graph database within an interactive desktop application. Neo4j Desktop can be found here: <https://neo4j.com/download/>. However, this is not mandatory and the databases may also be inspected via neo4j's web-application.

B.2 FIRST TIME SETUP

If Masutā is being run for the first time, then two containers need to be setup so that they are populated with the default data. From within the root folder of the project, execute the following commands

```
1 docker compose --profile speedparcel-restore run --rm speedparcel-restore  
docker compose --profile textbook-restore run --rm textbook-restore
```

Once these commands have run through successfully, both databases are populated with the default data and are ready to be used.

B.2.1 Hard-Resetting Everything

If at any time you would like to hard-reset the entire application, you may run the following commands:

```
1 docker compose down  
2 rm -rf $HOME/neo4j/data  
3 rm -rf $HOME/neo4j_empty/data
```

After resetting the application, you will have to restart with the first time setup.

B.3 RUNNING THE APPLICATION

Running Masutā is as simple as running the following command:

```
docker compose up
```

With this command, four containers are started.

- The SpeedParcel neo4j database filled with example data and the textbook
- The playground neo4j database filled with only the textbook
- The MCP-Backend which is the backend node.js which by default runs under `http://localhost:4000`
- The frontend which by default runs under `http://localhost:3000/`

If Docker does not automatically open the frontend in your browser, navigate to it under `http://localhost:3000/`. You are now ready to start using Masutā.

B.4 FEATURE OVERVIEW

This section details the features within Masutā.

B.4.1 *Input Field and Chat History*

At the bottom of the application is an input field where the user may prompt Masutā. Pressing enter sends the prompt. The user's input prompt then appears as a chat bubble bound to the right of the chat-area. The system then starts working on answering the prompt and displays a chat bubble bound to the left of the chat-area displaying "Thinking...". As soon as the application is done thinking, the response is displayed in the same chat bubble.

Masutā's response has a button appended to it which allows the user to copy the cypher which was used to generate the answer. The user may take this copied cypher and paste it into neo4j desktop to inspect the raw response that was used to generate the answer.

B.4.2 *Toggling the Database*

At the top right of the application is a toggle switch. This allows the user to toggle between the SpeedParcel database and the playground database.

B.4.3 Resetting the Playground Database

Under the menu at the top left, the user is presented with the option to reset the database. This option is only available if the playground database is selected via the toggle switch. After confirming the reset in the dialog that pops up, the playground is reset to its default state with only the textbook information. The SpeedParcel database cannot be reset via the UI.

B.4.4 Importing Custom Data

Under the menu at the top left, the user is presented with the option to import their own data. This option is only available if the playground database is selected via the toggle switch. Within the dialog that pops up, the user can add up to 10 files either by selecting them via the file system or by dragging-and-dropping them into the dialog. Only .xml files are accepted.

After clicking the import button, the files are uploaded. If the upload was successful, an alert is shown notifying the user of this. The uploaded data remains within the realms of the Docker containers and is not uploaded to any third-party sources. The data can then be queried via the playground database.

B.4.5 Inspect Database

Under the menu at the top left, the user is presented with the option to view the graph data in neo4j browser their own data. This option is available for both the SpeedParcel and playground database. Clicking this opens another tab under <https://console-preview.neo4j.io/tools/query>. Here, the user can connect to the selected database. The connection string is displayed in a dialog within Masutā. Here, the user can inspect the graph structure and paste the cyphers used for the generated responses.

B.4.6 Chat Context and Building on Previous Answers

Masutā saves the chat history so that the user is able to build upon previous prompts. The chat history is set so that the single previous user prompt and corresponding response is saved. This means that a further question can be asked about the previous prompt or its response. The chat history's context only goes back one prompt and response.

B.5 EXAMPLE QUESTIONS

Questions can be broken down into three categories:

1. Category 1: Textbook questions about enterprise architecture management
2. Category 2: Basic information about the enterprise architecture data

3. Category 3: Questions that span both category 1 and 2 and are more complex than questions in category 2. These require more in-depth information about the data as well as how to deal with it as an enterprise architect.

The following list of questions serve as examples that Masutā can handle. These simply serve as ideas to test the system - the user may input their own thought up questions.

1. Questions in Category 1

- What are the schools of enterprise architecture management?
- How does enterprise architecture relate to town planning?

2. Questions in Category 2

- How many capabilities are supported?
- How many applications are in use?
- Which application supports the most capabilities?
- If I remove application x, which capabilities will be affected?

3. Questions in Category 3

- We plan on removing application x. What do we have to look out for when doing so?
- We wish to implement a new application x which covers the capabilities x, y, and z. Which existing applications may become redundant?
- Which capabilities currently rely on single-point-of-failure applications? How should we deal with this?
- Which capabilities are over-supported by multiple applications?

This concludes the instruction manual for Masutā. Beyond the example questions, users are encouraged to prompt Masutā to explore the example data provided in SpeedParcel or to analyze their own proprietary data after importing it, in order to gain insights into their enterprise architecture.

C

MASUTĀ CODE SNIPPETS

This chapter showcases code snippets which are of special interest as they show how key functionalities of Masutā work. The code snippets do not showcase the full application and may not complete.

C.1 SYSTEM PROMPT AND RESULTS EXPLAINER

The following code snippets showcase what meta-prompts are passed to the LLM in order to generate the cyphers via the natural language text input and how the cypher results are transformed back into natural language.

Todo: Add the system prompts here.

D

MASUTĀ EXAMPLE QUESTIONS AND ANSWERS

This chapter contains screenshots of user prompts and the system's responses. It serves as a showcase of what the application looks like and how it responds to questions.

D.1 QUESTION XYZ

todo