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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

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DECLARATION (ERKLÄRUNG)

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Frankfurt a.M., 16. April, 2026

Hendrik Gruber

ABSTRACT

Lorem ipsum ...

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ACRONYMS

AI	Artificial Intelligence
AR	Action Research
EA	Enterprise Architect / Architecture
EAM	Enterprise Architecture Management
GenAI	Generative Artificial Intelligence
IT	Information Technology
PAR	Participatory Action Research
RAG	Retrieval-Augmented Generation

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 EAs 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 heterogenous nature of an application landscape [11, pg. 6]

Erwähnen, dass eine Herausforderung des EAs es ist, dass die vorzunehmenden 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].

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[15] "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.

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 prozessmanagment 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-AUGEMENTED 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 [17] 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]

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 [16] 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*

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.

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.

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

Masutā 達人 - Your Enterprise Architecture Assistant

Using SpeedParcel Data

You

I want to remove the application StatManPlus. What do I have to look out for as an enterprise architect?

Agent

Summary

When considering the removal of **StatManPlus**, you need to assess its impact on the business and IT landscape. StatManPlus directly supports seven Level-2 core business capabilities, notably in areas like Transport Management (Spot Management, Planning and Coordination, Freight Management, Delivery Management) and Sorting Center Management (Parcel Sorting, Inspection of Incoming Returns, Restocking). At present, there are no recorded incoming or outgoing application data flows for StatManPlus, which simplifies some aspects of its decommissioning.

Key Considerations

- **Business Capabilities Impacted:** Removing StatManPlus will affect the above-mentioned core business capabilities. Ensure that alternative solutions or transitional plans are in place for these areas, or clearly communicate any lost functionality.
- **Redundancy or Orphan Status:** Check if StatManPlus is redundant (i.e., other applications fully cover these capabilities) or truly an orphan. If not, removing it could introduce capability gaps.
- **Business Ownership:** Establish clear business ownership for the capabilities currently supported by StatManPlus. If there is no business stakeholder responsible, risks increase regarding missed requirements and transitions.
- **Decommissioning Process:**
 - Decommissioning in enterprise environments should be run as a formal project, involving multiple stakeholders, as highlighted in the guidance chunks.
 - Validate there are no hidden (undocumented) integrations, manual workarounds, or critical users reliant on the application.
 - Review and update documentation, such as capability maps, business support matrices, and application roadmaps, to reflect the planned removal.
 - Plan for user migration, communications, and staff retraining where needed.

Practical Guidance

- **Successor Applications:** If redundancies exist, formally designate the successor systems and update all mapping artifacts to prevent capability gaps.
- **Project Approach:** Decommissioning should be planned and executed as a managed project, including communication and change management for affected users (as noted in guidance: decommissioning is not just IT "switch off", but impacts people and processes).
- **Documentation & Roadmaps:** Update all architectural documentation (roadmaps, capability maps, support matrices) to reflect the change and the transition timeline.
- **Risks & Mitigation:** Carefully analyze for potential orphan capabilities and document the rationale if a capability is intentionally left unsupported, to avoid downstream business disruption.

References

You can find best practices and recurring themes in the following extracted guidance:

- Shutting down an application must ensure no dependencies remain and business processes are updated (see Section "Managing Enterprise Architecture").
- Decommissioning must be run as a project (not a quick IT operation); ensure all stakeholders are informed (see Section "Managing Enterprise Architecture").
- Decisions should reflect business relevance and ensure ownership is clarified (see Section "Motivation" and business ownership notes).
- Application roadmaps should clearly indicate decommissioning timelines and replacement/transition strategies.

If you need more detail regarding potential overlaps with other applications, or the existence of replacement systems, further application and capability mapping will be required. Always follow a thorough impact analysis before initiating decommissioning.

Copy Cypher

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_management", "cap_l2_58_parcel_sorting", "cap_l2_59_inspection_of_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_management", "cap_l2_58_parcel_sorting", "cap_l2_59_inspection_of_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').", 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').", 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 licences). 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" }]	[{ 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 licences). 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).

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?

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?

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Part II

APPENDIX



ACTION RESEARCH PROTOCOL

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A.1 APPENDIX SECTION TEST

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INSTRUCTION MANUAL FOR MASUTĀ

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B.1 DOWNLOADING MASUTĀ

Instructions on how to download the application and prerequisites (e.g. Docker)

B.2 FIRST TIME SETUP

Instructions for the user's first time setting up and running Masuta.

B.3 RUNNING THE APPLICATION

How to start Masuta after the setup and how to use it. A tour of the application and its features.

B.4 EXAMPLE QUESTIONS

A list of example questions from each 3 of the categories. Also a list of questions that can be asked to the SpeedParcel database.

B.5 INSPECTING THE GRAPH DATABASES

How to view the graph databases that are running in the background.

MASUT Ä CODE SNIPPETS

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C.1 APPENDIX SECTION TEST

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MASUT Ā EXAMPLE QUESTIONS AND ANSWERS

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D.1 APPENDIX SECTION TEST

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