NUS Master of Science in Business Analytics

Capstone Project Proposal

Proposed Duration: Sep 2025 – Feb 2026

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Title of Capstone Project:

Investment Context Engine (ICE): A Lightweight Graph-Based AI Backbone for Cost-Conscious lean Investment Firms

Objective of Project:

The objective of this project is to build a lightweight, graph-native context spine called **Investment Context Engine (ICE)** that transforms a lean investment firm's fragmented research (filings, transcripts, news, emails, notes, holdings) into a compounding, firm-specific knowledge base. ICE seeks to reliably grounds frontier LLMs and interoperates with third-party AI tools via the Model Context Protocol (MCP), powering in-house graph-based **Hyrbid RAG** or other applications that can answer high-leverage investment-related questions—for example: "Which holdings in our portfolio are affected by the recent ban on AI-chip sales to China?"

As LLMs grow more capable, data volume explodes, and MCP makes tools increasingly pluggable, small firms with tight budgets and limited resources are paradoxically falling behind larger incumbents with deeper AI integration capacity. For example, across the EU, AI adoption rises sharply with firm size—11.21% of small, 20.97% of medium, and 41.17% of large enterprises used AI in 2024—a gap Eurostat links to implementation complexity, economies of scale, and the affordability of AI investments for larger firms (Eurostat, 2025). ICE resolves this asymmetry not as yet another point tool, but as the firm's cost-conscious systematized knowledge and reasoning backbone: it engineers high-signal, provenance-tracked context tailored to the firm's mental models and investment logic, then routes that context into foundation models and the firm's connected AI toolchain, maximising the effectiveness of the context in grounding the LLM to produce more complete, firm-aligned and traceable insights at a fraction of the cost of a heavyweight GraphRAG stack. ICE addresses this with a lightweight architecture that uses graph-on-demand retrieval (LazyGraphRAG/LightRAG) instead of a full knowledge-graph stack. Content is normalized into timestamped, provenance-backed entities/events/KPIs; at query time ICE builds the minimal subgraph and routes just-enough context via MCP, with observability for versions, confidence, and citations. The result is an enterprise-grade knowledge spine without enterprise spend—democratizing AI readiness for lean firms and compounding institutional memory over time.

Proposed Scope of Work

Deliver an MVP of the **Investment Context Engine (ICE)**—a phased, compounding, graph-native knowledge base for the fund's internal and external data—together with **ICERAG (MVP)**, the retrieval

layer that queries it to answer firm-specific investment questions. Inspired by HKU's **LightRAG** and Microsoft's **LazyGraphRAG** (delayed open-source release), this project pursues the same direction, to implement a pragmatic, lightweight GraphRAG approach that small firms can afford, rather than a resource-intensive full-KG stack. Development includes sourcing priority datasets (filings, transcripts, financial news, quantitative/qualitative market data) and internal emails; normalizing them into a provenance-tracked entity/event/KPI graph; and implementing a hybrid RAG layer to query the graph and power a portfolio-aware dashboard with a natural-language Q&A box, a portfolio holdings table, subgraph visualizations, and citation-backed answers.

Number of students needed: 1

Pre-requisite (If any): None

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