Edinburgh Napier UNIVERSITY

School of Computing, Engineering & the Built Environment

Towards AI-Enabled Training Needs Analysis Using Dual AI-Agent Collaboration – A Position Paper

Nikilkumar Patel, Peter J Barclay, Janice McMillan, David McGuire

What is Training Needs Analysis (TNA)?

Training → Human Resource Development

Needs → Organisational or Industrial Context of why is training required

Analysis → Scientific and Data driven understanding

- 350 Billion USD global corporate training market in 2023
- TNA is
  - Tool for organisational growth
  - Deciding factor for addressing “know-do” gap, knowledge -> Action

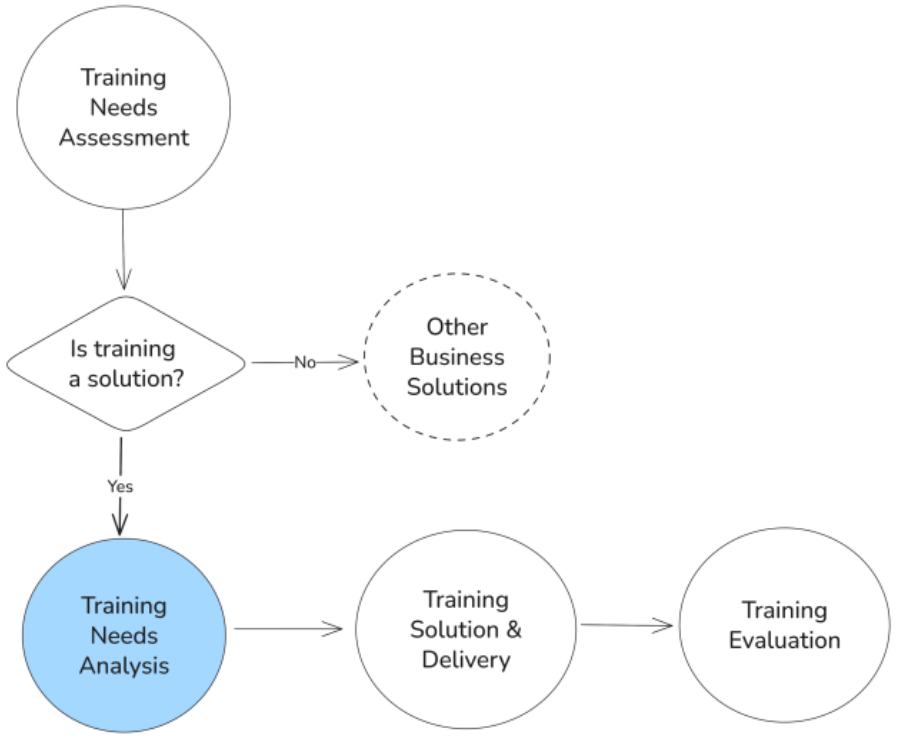
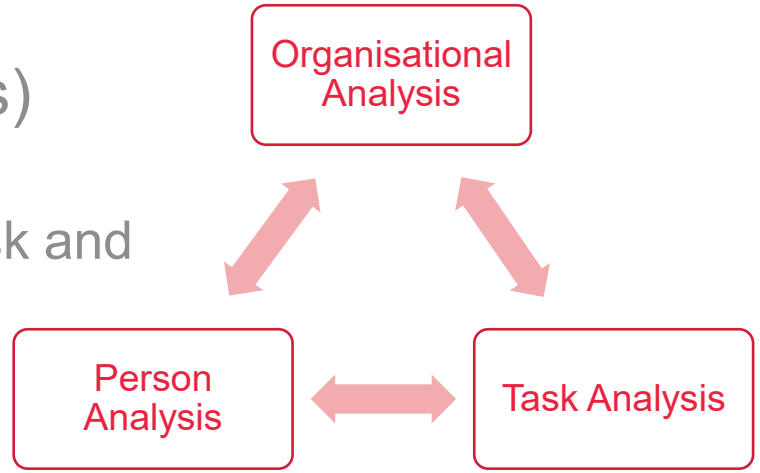


Figure 1: A high-level overview describing the position of TNA within the organisational training programme.

Training and TNA in Industry

- Training in organisations is mostly reactive than proactive, especially in SMEs
- More agile organisations = less resources
- To automate and scale TNA process using AI (mainly LLMs) for industrial implementation
- To empower human professionals with data-driven insights and scientific methods that complement their tacit knowledge and practices – Human centric AI
- OTP - Widely used TNA Model (and its variants)
  - McGehee, W., & Thayer, P. W. (1961)
  - Relational understanding between Organisation, Task and Person
  - Multistep analysis



Edinburgh Napier UNIVERSITY
School of Computing, Engineering & the Built Environment

Related Works

Very similar - Effective Needs Analysis in Knowledge Management using RAG (Su et al., 2025)

LLMs in Training and Learning Applications

- A Virtual training coach provided near human sports coaching advice with minimal historic data (Silacci et al., 2020).
- Multitasking capabilities of LLMs helped improve learners' performance (Baillifard et al.,2025), in medical learning, sports training, and other HR processes (Wei et al.,2021).
- Transforming wide range of HR processes with personalised learning experiences with IBM's Watson AI, Engazify, Google's Project Oxygen, Clustree, Visier, and platforms such as eDoer and Duolingo's Birdbrain(Benabou and Touhami, 2025).

LLMs applications in Professional Consultancy

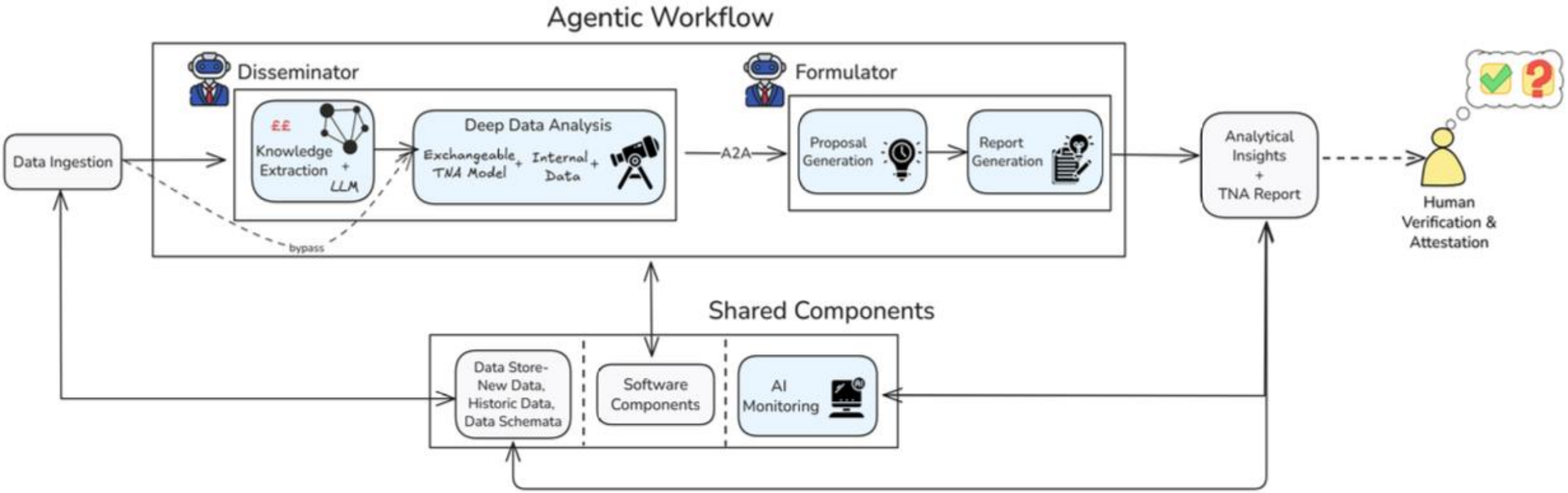
- The financial consulting industry is rapidly adopting GenAI integration with examples from IBM and others (Mohamad Ali, 2024).
- Strategic advising in management consulting by providing reliable decision-making support (Malberg et al., 2025).
- Encouraging success in medical consulting, although *challenges such as accurate interpretation of numerical data remain unsolved* (Dell'Acqua et al., 2023).
- Significantly improved Q&A results on complex datasets such as US tax law with RAG and few-shot prompting (Nayet al., 2024).

Challenges in Industry

- World Economic Forum, 2025 Demand trends: 85% of employers to prioritise workforce upskilling, including hiring for new skills (70%), internal role reallocation (50%), and, in some instances, workforce reduction due to skill obsolescence (40%). – will require significant resources for training
- Market survey- Existing TNA products or platforms are either deployed for in-house usage or lack cognitive and creative aids, are inflexible, and mostly rely on a conventional approach to conduct TNA.
- Key attributes for any HR system: Fairness, Explainability, Transparency, Data Privacy, and Human Inclusiveness – often ignored due to technological and practical issues
- Unique HR challenges, such as conflicts between human management and AI automation
- Major limitations of LLMs:
  - Hallucinations, fabrication of facts via knowledge overshadowing, and ethical risks with AI-enabled Knowledge Management (Rhem, 2021).
  - Challenges in compliance, data processing, system evaluation (Brehme et al., 2025)
  - Limited understanding of the impact of context retrieval on answer correctness (Joren et al., 2025) limit simple RAG implementations for knowledge intensive use-cases.

Edinburgh Napier UNIVERSITY
School of Computing, Engineering & the Built Environment

Proposed Design



Disseminator: Knowledge Extraction (**NER**) | Deep Data Analysis (**Reasoning & Tools**)

Formulator: Proposal Generation (**Idea Generation & Creative Planning**) | Report Generation (**Structured Output**)

Edinburgh Napier UNIVERSITY
School of Computing, Engineering & the Built Environment

Disseminator A2A→ Formulator

1. Knowledge Construction: Knowledge Graphs

Why knowledge graphs (KG)?

- Disseminates unstructured contextual data for Global Search (Sensemaking) over Local search (Edge et al., 2024) and for its relational understanding
- Outperforms prompt based methods for extraction and interpretation of unstructured scientific text (Dagdelen et al., 2024)
- Empirical knowledge evidence

Problems with graphs

- Resource intensive and high maintenance (Peng et al., 2024, Hofer et al., 2024)
- Optional for less knowledge intensive use cases

2. Deep Data Analysis: Deep Research

- Analysis of training needs based only on the constructed knowledge artifacts
- Multiturn analysis with pluggable TNA models
- Includes tools: Data Processing & Visualisation, Data transformation, Reasoning over numeric data etc

3. Proposal Generation

- Novel idea generation for training, LLMs as idea-machine with near-human creative capabilities of LLMs are leveraged (Girotra et al., 2023)
- The Novelty – utility trade off to keep in mind (Wang et al., 2025)

4. Report Generation

- Structured output generations (json, xml, office docs, MD) with dynamic data schema configuration
- Embedded with business assets such as policies, branding etc. and reviewable by human experts for business use
- Office software/downstream HR process friendly reports

AI Monitoring

- Enterprise applications MUST have LLM observability
- For real-world applications, LLMs often underperform, in large part due to hallucinations caused by long-tailed data and the lack of robust publicly available evaluation benchmarks (Patel et al., 2025; Shi et al., 2025) Leading to disparity in expectations between system developers and stakeholders (Calderon and Reichart, 2025).
- To avert the impact of threats such as prompt injections, jailbreaks, misinformation, invalid use, etc using AI Guardrails (Fu et al., 2024; Zhong et al., 2025).
- To track inference costs, system logs, and other software engineering metrics for effective technical maintenance (Pradeep Kumar Sambamurthy, 2024), capture business metrics, real-time and non-real-time feedback, organisational KPIs.(Ma et al., 2024; Gupta et al., 2024; Niimi, 2024).

Proposed System Evaluation

- Crucial for real-world AI implementation success, but existing benchmarks have limitations for business specific uses (Alonso and Church, 2024; Eriksson et al., 2025).
- Modular system design and AI agents are harder to evaluate due to their context sensitivity, autonomy, and inherent stochastic nature of LLMs (Moshkovich et al., 2025).
- Business-specific datasets curated with the help of training professionals to ensure alignment and compliance with business policies.
- Focus is on qualitative measurements at the task level (Shavit et al., 2023) , in addition to manual evaluations by experts and quantitative metrics such as task completion times, accuracy rates, resource utilisation, user satisfaction scores, ROI figures, and others (Prashant D. Sawant, 2025).

Edinburgh Napier UNIVERSITY
School of Computing, Engineering & the Built Environment

Future Work

- Implementation of the proposed system is ongoing
- Scan this QR to see sample outputs by the proposed design prototype:

  Demo website - https://fieri-leadership.github.io/AI-Enabled-TNA/

- Work to be considered:
  - Organisation compatible data schemata
  - Real-world evaluation datasets with the help of experts from our industrial partner Fieri Leadership.
  - Investigate - data and user privacy concerns, regional legal compliance, cost and compute optimisation, and improving product economics.
  - May also explore alternative hybrid setups with open-weighted SLMs with larger proprietary LLMs (Belcak et al., 2025).

Acknowledgments

Innovate UK | Knowledge Transfer Partnerships

Edinburgh Napier UNIVERSITY | The Business School

Edinburgh Napier UNIVERSITY

School of Computing, Engineering & the Built Environment

napier.ac.uk/scebe

Q&A

Edinburgh Napier UNIVERSITY

School of Computing, Engineering & the Built Environment

Connect with me