OPEN ACCESS

ISSN: 2835-6764

Trad A (2026) 1897
American J Sci Edu Re, 2026; 5(1):100292
DOI: 10.71010/AJSER-2026-e292

Research Article

American Journal of Science Education Research

Academic Transformation Projects-The Roles of Trustworthy Artificial Intelligence, Project and Problem Based Learning on Educational Cycles (RTAI_PBL)

Antoine Trad*, PhD

IBISTM, Paris La-Defense, France

***Corresponding author:** Antoine Trad, Email: antoine.trad@ibistm.org

Citation: Trad A (2026) Academic Transformation Projects-The Roles of Trustworthy Artificial Intelligence, Project and Problem Based Learning on Educational Cycles (RTAI_PBL). American J Sci Edu Re: AJSER-292.

Received Date: 13 December, 2025; **Accepted Date:** 27 December, 2025; **Published Date:** 06 January, 2026

Abstract

This article's main focus is on Academic Transformation Projects (ATP) and on the roles of Artificial Intelligence (AI), and Trustworthy AI (TAI) on educational cycles. Where TAI adopts mainly a qualitative method founded on Problem-based Learning (PBL) approach in the context of Project-based Learning (PrBL). But ATPs are of major importance for academic institutions, research centres, and business organizations. But unfortunately, ATPs are very complex and have extremely high failure-rates, mainly because of the lack of profile which have Polymathical mind-set, real-world interdisciplinary, information technology, and TAI background, expertise-capabilities, and skills. The RTAI_PBL proposes a Polymathics based academic, educational, and research (and development) approach, which are associated with a curriculum and a roadmap. Optimally, such a profile is detected in the Primary or the Secondary schools or Cycles (PSC), then is enhanced in the University or Higher-education Cycles (UHC) (Bachelor, Master, and Doctorate levels). Later in the person's Professional Life Cycle (PLC), there is the need for continuous upskilling periods [1]. ATPs need an In-House Implemented (IHI) Human-Centric (HC) Transformation (and Adoption) Framework (IHIHCTF) in which a Natural Language (NL) and related Processing (NLP) environments are used to define, (re)engineer, integrate, and manage PBLs in the contexts of PrBLs. PBLs in ATPs (and common projects) are associated to specific PrBL's requests, needs, and requirements to be solved.

Keywords: *academic transformations; polymathics, AI; trustworthy AI; problem-based learning; educational cycles; enterprise architecture.*

1. Introduction

There is the lack of experienced ATP and AI related fields Polymathic professionals; and PSCs can be the starting point the for RPBAI based RTAI_PBL, because during this cycle Polymathical profiles can be detected. And that needs the RTAI_PBL based Polymathical Interdisciplinary Core and Concept (simply Core) which support educational-sustainability and the preparation of professionals which can cope with complex interdisciplinary projects. The Core includes domains related to Information and Communication Systems (ICS), business engineering AI (algorithmics, data-management, data-architectures), mathematical modelling, Enterprise Architecture (EA), changes' management, finance, project management (simply Core-topic).

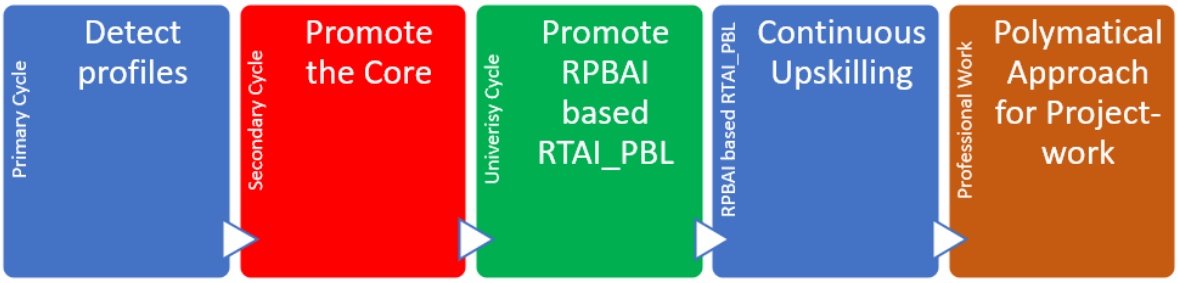

Figure 1: Core and RPBAI based RTAI_PBL related Cycles.

The RTAI_PBL include PBL and PrBL which in-turn use team-based collaboration learning and Problem-Types (PT) Solutions (PTS) processing. The RPBAI based RTAI_PBL uses a Polymathic concept that promotes interdisciplinary Roadmap for complex projects' team-members who can be a student, engineer, manager or analyst (simply Person). The RPBAI based RTAI_PBL, combines various academic, educational, and professional Core-topics which are used simultaneously and not sequentially. This article is a continuation of previous author's works and ATP related findings, to propose a Core for academic and professional cycles (simply Cycle). A Core has: (1) Mandatory Core-topics which Persons must attend; (2) A Polymathic and interdisciplinary project group work in complex projects (simply Project-work); and (3) Defines the linkage to various Cycles as shown in Fig. 1. The Core supports all types of Cycle's activities, and uses avant-garde technics, standards, methodologies, and actual legacy academic system (which is siloed). RPBAI based RTAI_PBL links various Core-topics and can add dynamically subjects like business analysis. The Core's Polymathical approach is crucial because complex transformation projects face eXtremely High Failure Rates (XHFR). Such complex projects fail because of the lack Polymathical profiles and required educational system, knowing that such profiles are very rare and frequently discriminated because of their natural qualities. When detected, Polymathical profiles need an "optimal" Core and PBL-PrBL based Learning Process (PPLP), because they are *very hard to spot* and many of them leave studying... The mentioned rareness because Cycles force Persons to specialize and ignore the upskilling of Polymathical capacities, which requires highly qualified academic staff who should be tolerant, and can manage complex Project-work as shown in Fig. 2 [1,2,xx3].

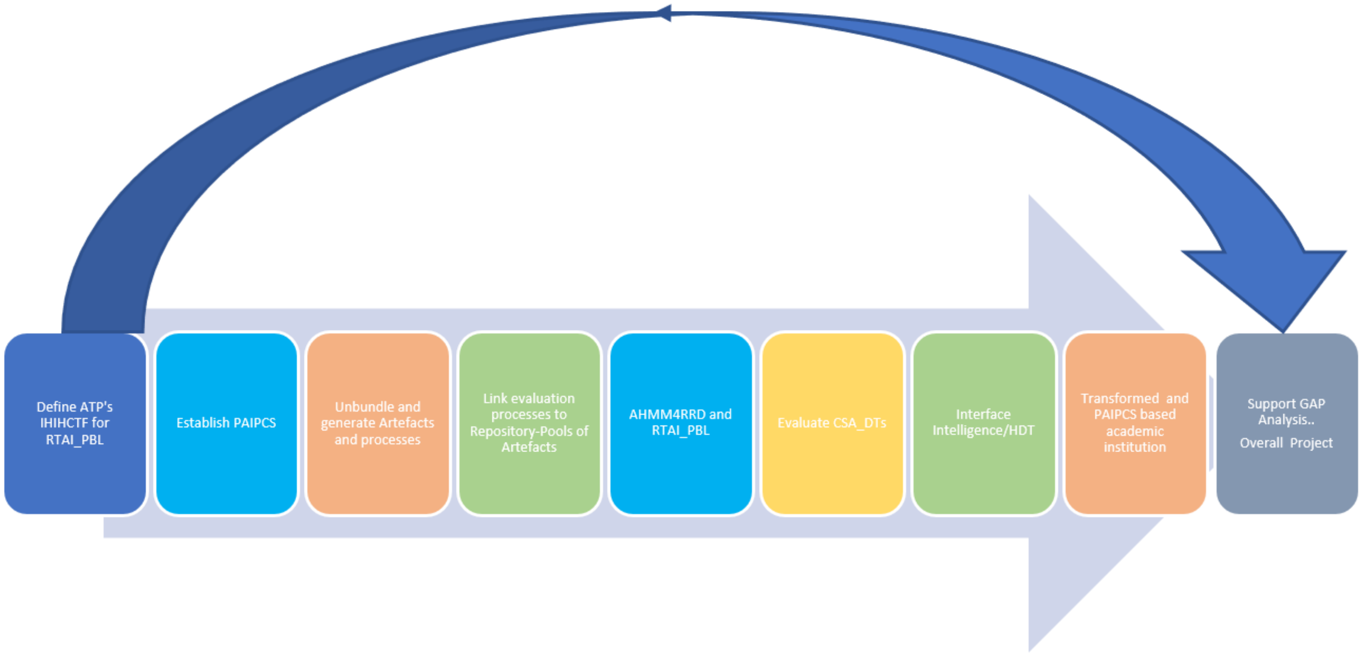

Figure 2: Links to various Cycles.

PTS' processing, PrBLs, and PBLs in ATP's context (and other types of projects) are associated to real-world complex project specific requests, needs, and requirements (simply Requirements). And as shown in Fig. 3. Project's Requirements' management are central to a real-world project, and hence the Person can through project's Requirements intervene in various project's parts and phases. And to achieve that the Person needs Polymathical skills and background. The Core must take into account that the evolution of collecting and engineering project Requirements, went from verbal communication, to written documents, and finally to the usage of modelling methodologies, because written prose could be interpreted in many different ways; where concrete models reflected and depicted concise solutions. With the emergence of AI Products, Core-topics, and Subdomains (AIPCS) and NL Implementation Environments (NLIE), where are somehow back to a pseudo prose-age, in which Requirements' prose (or documents) is interpreted or generated by AIPCSs. The main question is: Can the RTAI_PBL and its Core propose an NLIE based automated approach, to be more precise than, that Requirements written by traditional (and qualified) specialists? The evident answer is "it is complex"; and then what would be the feasible manner to use trustworthy AIPCSs, NLIEs, and modelling environments for projects' Requirements' management? This article will try to propose a feasible IHIHCTF, and a realistic project Requirements management approaches to be included in the Core, and a Polymathic AIPCS (PAIPCS) approach.

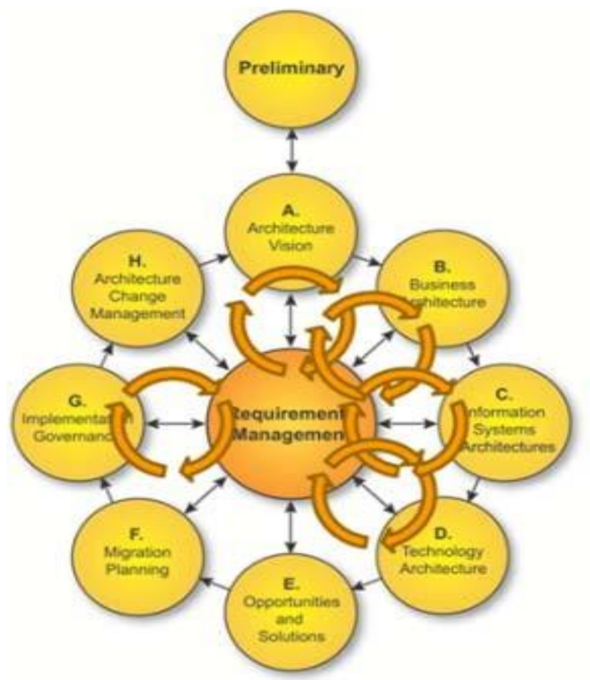

Figure 3: AEP's cycle in TOGAF's ADM [4].

2. The PAIPCS Approach

The ATP, Core and the roles of RTAI_PBL are this article's main focus; knowing that ATPs are very complex transformation-processes. The integration of AIPCSs makes ATPs even more complex, because AIPCSs include a wide-range of heterogenous AI topics and especially Generative AI (GenAI). GenAI is used to automate capturing Requirements (Requirement) Relations, Diagrams, and Artifacts (RRDA) Generation (RRDAG) in various APplication or Specialized Functional Domains (APSFD), and RTAI's contexts. In this article, it is assumed that the PAIPCS clones the Human Brain's (HB) (or user's) Factors (HBF) behaviours and activities. The word 'cloning' is over-valuated, because the PAIPCS manages and generates RRDAs and then 'converts' them to a well-defined format. To simplify the over-complex ATP and RTAI_PBL, it is recommended to use the PAIPCS concept, where GenAI is its central component. The RTAI_PBL applies an avant-garde, and Polymathic approach and uses Enterprise Architecture (EA) based Aggregated Generic Models (AGModels). AGModels include RRDAG's elements, different Requirement-formats, and adapted conversion-interfaces. An ATP, business, or other types of transformation-processes, apply AGModels to manage RRDAs and RRDAGs. RRDAs are generated by using NLP Environments (NLIE), to support different ways to use AIPCSs and GenAI in RTAI_PBL's context. The RTAI_PBL uses different AIPCSs, like Large Language Models (LLM), Small Language Models (SML), NLP, Deep Learning (DL) and Machine Learning (ML) and other fields, which require specific setup and pre-trained "models" to offer 'operational usable models' The mentioned models are pre-trained on accumulated and experienced actions and operations, and are then stored as PPLPs that are related to data buffers (or arrays) that are managed and accessed through Dynamic and Adaptive In-Memory DataSets (DAIDS). PAIPCS is used for AI-based integrations and interactions required to inter-relate different fields like DL, ML, NLP, DAIDSs, and other [6]. The PAIPCS is a "generalized intelligence" vision, which is antagonistic with the today's popular commercial-products' vision, which privileges a specialists AIPCS-approach that is applied in specific and precise ATP's context. PAIPCSs have many capabilities, like: 1) NLIEs' integration and interfacing; Image-text recognition processes; 2) Just-In-Time (JIT) Decision-Making Processes (JIT_DMP); 3) Generating EA Models (EAM), and AGModels; and Heuristics-reasoning, which are used in different APSFDs' Engineering Process(es) (AEP) processes. AIPCSs are related to Artificial Generic Intelligence (AGI), as presented in Fig. 4, that is supported by the ICS to: 1) Run PPLP for RRDAG and RRDAs; 2) Ensure needed performances for RRDAGs; and 2) Manage experiences based PPLPs which with HBF Intelligence (HBFI). PAIPCS helps AIPCSs based ATP (and hence the RTAI_PBL) in integration processes and to use Polymathics and inter-disciplinary concepts that are included in the Core.

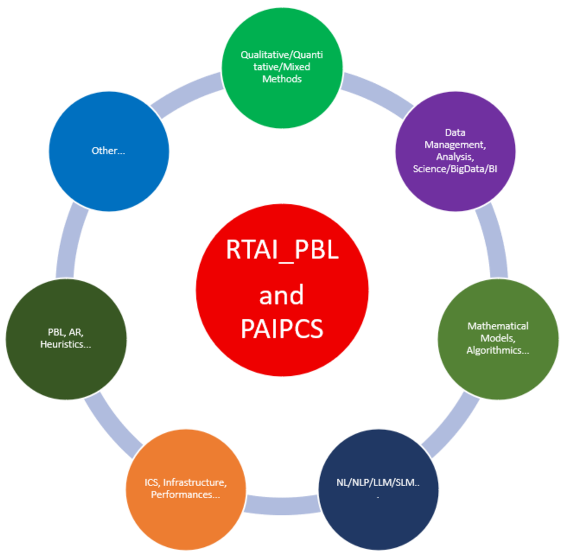

Figure 4: The RTAI_PBL's concept and PAIPCS' interactions.

ATP starts with a successfully finalized Digital Transformation (DT) undertaking which should be the 1st strategic goal of the ATP and is defined in RTAI_PBL's Vision and Roadmap (RVR); to enable ATP's or PAIPCS based transformation and (re)engineering to implement IHI concepts, solutions, and to avoid external AIPCS that are commercial-products, which guarantee too-fast progress and high-costs. Simultaneously, the PAIPCS privileges Polymathic-capabilities other than the strictly AIPCSs [7]. External AI services, and products based RTAI_PBL solutions are incompatible with IHI-solutions, which use AGModels to integrate 'loosely-coupled' external solutions. PAIPCS' interacts with the RTAI_PBL to enable frequent ATP changes, and to enable also:

- The usage of IHI-concepts for the RTAI_PBL's and AIPCSs' integrations.

- The management of RTAI_PBL's delimiters/interfaces, and RRDAGs' operations.
- AIPCSs based RRDAG processes to automate Requirements, and RRDAs by using DL/NL, NLP, ML, and other AIPCSs.
- To manage PPLP Repository (simply the Repository-Pool) that persists Requirements' related experiences, choreographies, and solutions.
- The Repository-Pool tries to proactively predict ATP's PTs, risks, and possible problems and even XHFRs.
- Robust ATP's architecture(s), and AGModels to offer PTSs (solutions) by using EA-methodologies.
- Decision-Making (DM) Systems (DMS) which try to process and solve PTs, and to mitigate risks and to execute enhancements' RRDAs' Actions (RRDAA).
- A specific research mixed-method and Polymathics for complex undertakings, like the RTAI_PBL.
- RRDAAs are applied in all RTAI_PBL's actions, that are requested by AGModels and previewed in the RVR, to successfully achieve ATP's goals-objectives.
- RRDAAs are used in choreographies like Business Processes (BP) Models (BPM), or other types of WorkFlows (WF) modules, and ICS' components.
- RRDAAs are a collection of semi-manual and automated actions.
- To support PBL, PrBL, and PPLPs.

This article focuses on ATPs and therefore, can be seen as a complex article; and for that reason the author advises the reader to refer to his (IHI) Polymathic Transformation Framework (IHIHCTF) related articles/works, and guides, like: The IHIHCTF-Guide [8]; The IHIHCTF-Glossary [9]; A related core-syllabus [10]; The AHMM4PROJECT [11,12]; The AI-based transformations concept [13]; and this article's abbreviations section which can be found at the article's end.

As the author has developed many works related to the AI, PAIPCS, ATPs, and PPLPs, in this article, he is trying to define of RPBAI based RTAI_PBL's context and to offer recommendations.

3. Defining the Context of RPBAI based RTAI_PBL

A. *The ATP's Development Method and the Cycles' Basics and Interactions*

The ATP, RPBAI based RTAI_PBL, PAIPCS, PPLPs, need the Architecture Development Method (ADM) [4] that is a part of The Open Group's Architecture Framework (TOGAF), for their integration and implementation activities.

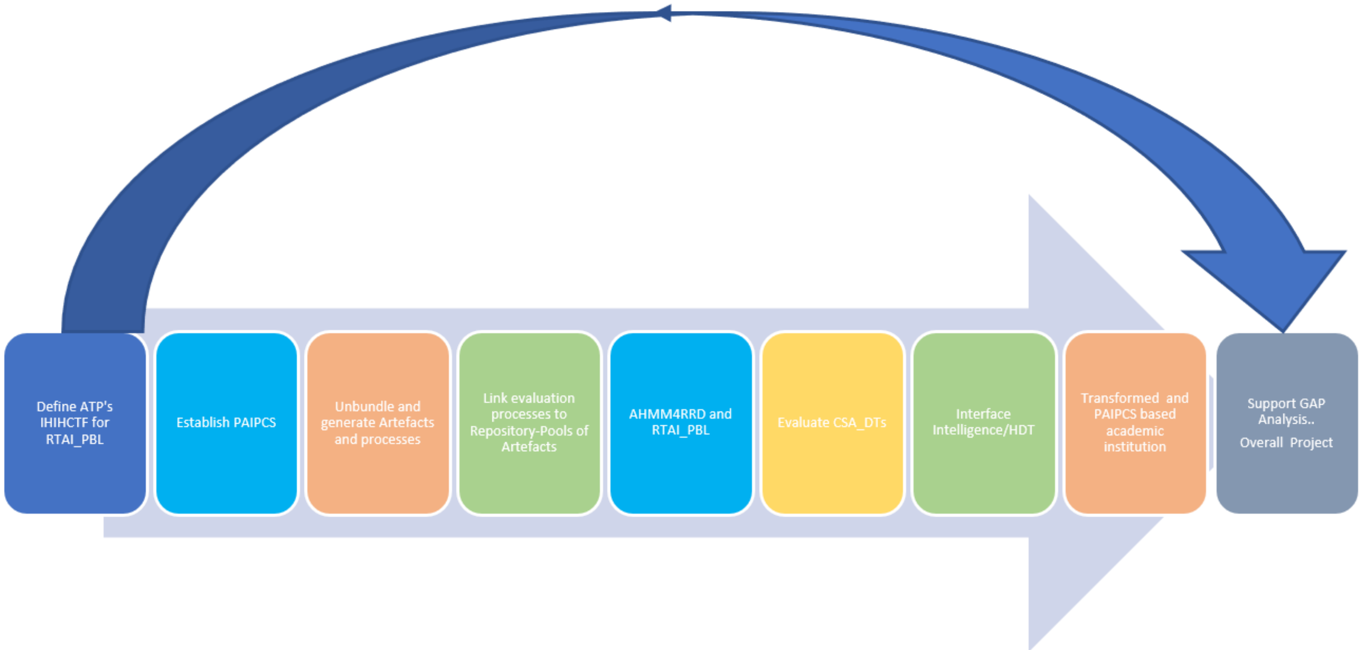

Figure 5: ATP's organisation of Cycles and Persons' evolution.

TOGAF is ATP's transformation enabler and an PAIPCS' designer. The IHIHCTF synchronizes Project's with ADM activities. The AI generated Cores support Polymathical profiles' development and Cycles' executions by offering [1,14,15,16]:

- The Core is independent of ATPs, and Cycles; and the PSC detect Polymathically capable Persons.
- The RPBAI based RTAI_PBL and ATP need experienced Polymathics staff and coaches to manage Core's complex and inter-disciplinary topics.
- The Core links complex PAIPCS-topics and (re)defines their interactions, like in the discipline of Architecture (in civil-engineering) that makes Persons capable of designing complex sky-scrapers design.
- Staff and coaches have the capability to support 'very' different types of strongly related Core-topics (courses), activities, and complexities. And to deliver resultant models.
- RPBAI based RTAI_PBL is based on: 1) ADM and EA models; 2) IHIHCTF and the Applied Holistic Mathematical Model (AHMM) for RRDA (AHMM4RRDA); 3) Transformed services pool; 4) Various Cycles templates, documents, and patterns; 5) A scalable ICS for agile PrBL-work and PPLPs; 6) A dynamic Core (based on the Business Transformation Project's Architect's Profile-BTPAP); and 7) PBL and PTS exercises.

- Action Research and PAIPCS based Educational Heuristics Decision Tree (EHDT) that is optimal for continuous education, and PTs' solving.
- The PrBL related activities are: 1) Integration of mandatory Core-topics; 2) Apply change frequencies; 3) Define team's activities; and 4) Interaction with BTPAP like staff.
- RPBAI based RTAI_PBL, Core, and Cycles' evolution needs EAMs, PAIPCS, and experienced staff.
- Capacity to identify Polymathical profiles who are traced through all Cycles as shown in Fig. 5.
- Cores incorporate needed diversity, multi-cultural, multi-technological, and cross-functional Core-topics.

Cycles require capable staff and coaches with Polymathical background and skills, who can coordinate Core-topics and apply RTAI_PBL.

B. *The Role of Polymathics*

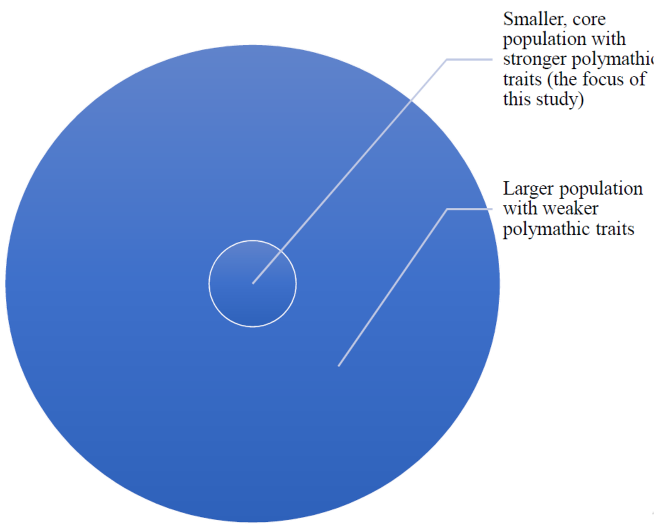

Figure 6: The relation between Polymathical Persons groups [17].

Polymathical capacities and skills for the mentioned Core-topics and hence for the RPBAI based RTAI_PBL. As AI related Core-topics are evolving fast and such profiles must be capable of performing simultaneously various complex tasks which have important impact, as shown in Fig. 6 [18]. In general, Polymathical profiles are open to interdisciplinary experiences, Polytechnical fields, autonomous learning-upskilling, creative work, cross-functional teams, system thinking, and diversity-oriented environments. Since the 14 century Polymathical thinking has exceled and there are many known scientists like: Nikola Tesla, Michelangelo, Albert Einstein, and many others. They all have a common feature, and that is that they were all excellent and exceptional mathematicians, and is why mathematics and Mathematical Models (MM) are fundamental for the Core, ATPs, and this research article. The minority of Persons have Polymathical predispositions and capacities but they have disadvantages, like the time that is needed to learn, inter-connect, and apprehend different Core-topics. Polymathicians are practically always underestimated, ignored, and even marginalized, because academic, government, or business organizations (simply Entity) estimated Persons with single-field expertise or specialists [17,19]. There are common Polymathic features like [17,19]: 1) Experts in various Core-topics; 2) May have complex identities; 3) Have an important Return on Experiences (ROE); 4) Define a straight-forward career-paths; 5) Shaped by teams and societies; 6) Lifelong and voracious learners; 7) Always confident; 8) Highly creative and excellent designer; 9) Excellent mathematicians; and 10) Ambitious and never satisfied. And their upskilling needs a continuous learning process, specific team work, and adapted Core [20,21]. The mentioned Core' can include: 1) Concepts of evolutive PAIPCS; 2) Interdisciplinary ICS and AI implementation teams; 3) Reusage of different transformation projects, ICS and AI solutions; 4) Cycles' bridging; 5) Persons' (re)orientation, continuous upskilling…; 6) Inter-linking projects and experience to all Core-topics; 7) Design, and architecture, activities; 8) Abstract or concrete mathematical modelling; and 9) Usage different level of interfaces. Core's evolutions and related PPLPs depend on various constraints like ROE, ISCs' (and AI's) evolutions, Speed of Changes (SoC), Agility concepts, and Cycles implications. Therefore, the ATP and associated Cores must adapt to the mentioned constraints, especially the SoC [21,22]. And that implies that the RPBAI based RTAI_PBL must link to: 1) Managing and enhancing ROEs; 2) Real-world project's work fields; 3) DMS' features, 4) PBL and PTs' solving; and 5) PAIPCS' Core-topics.

C. *PAIPCS' and Core-Topics*

PAIPCS' has many subdomains like statistics, linguistics, vision, planning, Robotic Process Automation (RPA), NL/NLP, DMS (decision sciences). And as illustrated in Fig. 7, PAIPCS major Core-topics are [1,23,24,25]:

- ML domain and algorithms are continuously trained so that the "machine", applies Supervised, Unsupervised or Reinforcement Learning.
- Neural Network (NN), integrate cognitive capacities in 'machines' to execute tasks.
- NLP processes human language(s), by interpreting and analysing data and text.
- DL applies learning by analysing data and identifying an acceptable output.
- Cognitive processing-computing enhances Human-Machine Interaction (HMI) to achieve complex tasks and solve PTs.
- Computer vision is used to identify visual objects or inputs.
- Expert systems have human-like decision-making capabilities which include inference rules to solve complex PTs.
- RPA executes a sequence of actions, where Persons are in control.
- Fuzzy Logic solves PTs by returning either "true" or "false".
- Large Language Models (LLM) are prepared and trained on divers sources to deliver conclusions.
- PBL, PrBL, and PPLPs in AI subdomains.

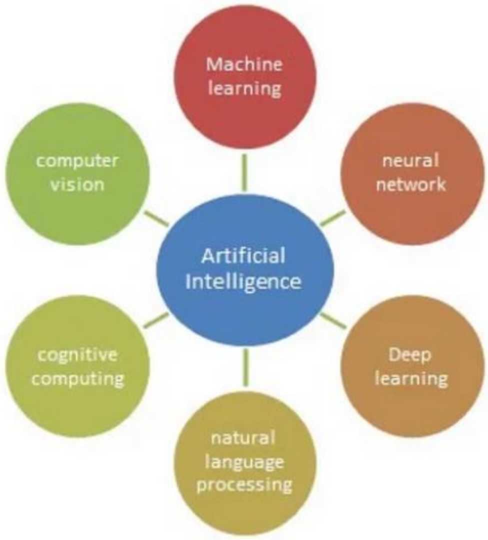

Figure 7: PAIPCS' and AI Core-topics.

The already mentioned XHFRs and Polymathical concepts, added to that PAIPCS, PPLPs, and the RTAI_PBL specific implementations, make ATPs very complex. That requires a team with Persons that can confront complexities and risks; and also capable of abstracting them.

D. *The Roles of Complexity and Risks-And their Abstraction*

The mentioned complexities, risks, and Polymathical constraints (simply Constraint) makes Cores forced to forge Polymathical constructs to upskill students to manage complexities. Complexities are associated with to PAIPCS, cross-functional integration activities, (re)engineering, and ICSs' implementations. Persons' predispositions and their intellectual capacities to confront such Constraints is the most determinant ATP's Success Factors (ATPSF). ATPSFs related to Constraints are [26]: (1) The long list of Core-topics and real-world tasks; 2) The heterogenous nature and characteristics of PAIPCS' modules; 3) Needs complex architecture and modelling capabilities; and 4) Persons' inter-dispensary abstraction, design-architecture, and implementation capacities. The ATP can use a variant of the Complexities Management Strategies (CMS) to manage Constraints and to apply audit, trace and accountability mechanisms [27]. The IHIHCTF manages Constraints and enables: 1) A cohesive ATP and RTAI_PBL strategy; 2) The use the EHDT; 3) To implement an IHI variant of the *Global Simplicity Index*, for reducing Constraints' impacts; and 4) The IHI Research Mixed-Method Approach (IHIRMMA). Knowing that it is optimal for Research and Development (RD) Projects (RDP).

4. The RDP for the RTAI_PBL

A. *Fundaments and Literature Review*

This RDP's related methodology, implementation (or prototype), and article use the following artefacts, assumptions, facts, and conditions [28,29]:

- The Research-Question (RQ) is: "How can the RTAI_PBL support ATPs, RRDAs, and RRDAGs?". And the related Auxiliary-Question (AQ) is: "How can GenAI, AIPCSs, and PAIPCS support RRDAGs' and RTAI_PBL's automated (re)generation processes?".
- Uses a Polymathic research mixed-method approach, which is fundamentally a qualitative heuristics concept based on PBLs and PLPPs.
- The use of sets of configured, initialized, and hard-linked Critical Succes Factors (CSF), Critical Success Areas (CSA), Key Performance-Indicators (KPI), and ICS' source-code (NLIE, or ICS' programming-language) VARiables (VAR).
- A selected CSA maps (1 to 1) to RTAI_PBL's important sections (this article is built on sections); and the 1st CSA (and hence the 1st section) is the RDP section.
- CSFs and CSAs are used to process and evaluate RTAI_PBL's feasibility, and generative capacities.
- The evaluation is enabled and checked by the AHMM4RRDA and IHIHCTF's components.
- The evaluation and processing approaches, are supported by the DMS, and Knowledge-Management System (KMS) (simply Intelligence).
- The selected CSFs, CSAs, KPIs, and VARs are ATP's sets of Factors; and these Factors are evaluated by Intelligence's EHDT.
- Uses generated services (that map to EHDT actions), to process and solve ATP's and RTAI_PBL's PTs, and to offer solutions.
- It is assumed (which is a hypothesis that relate to the mentioned RQ), that ATP's 'generated' services are stocked in Blocks to be called by ICS', RRDAs', and AIPCS' requests.
- It is assumed that ATP's Refined, Unbundled (and transformation) Processes (RUP) of Legacy Requirements (LUR), ICS's components, and other resources, were successfully terminated; and that the needed services were generated.
- Non-conventional modelling technics like EA Modelling (or Models, EAM), RRDA Modelling (RRDAM), Composite AI Models (CAIM), ICS Models (ICSM), and Intelligence's interfaces.
    - The used CAIMs contain EAMs, RRDAMs, and other types of models (which are simply AGModels). That implies that an AGModel is a mixture the models.

The PLRP is based on IHIHCTF's existing knowledge Repository-Pool and authors' works related to this article's RQ, like:

- The Educational Transformation Project's Remote Group Work (BTPRGW) [30].
- The Transformation framework-The role security in the global education system [31].
- The role of artificial intelligence in the global business education (RAIGBE) [32].
- The Role of Information and Communication Systems' Standards on Diversity in Educational Environment [33].
- Academic and Educational Transformation Projects-The Role of Skills in Academic Polymathics Fields (RSAPF) [34].
- The Role of Upskilling and Reconversion (RUR) [35].
- Machine Learning Integration for Projects (MLI4P) [36].

This RDP confirms a major research gap for the RQ, which is mainly due to the following findings and facts: 1) There isn't an identical RDP and IHIHCTF related approaches; 2) The XHFRs have been researched; 3) No adequate Core of Polymathics; 4) The exclusive focus on business, finance, and accountant's profiles as ATP managers, which is the origin of XHFRs and the cause of PTs like Resistances to Change (R2C); 5) PAICS' and AI topics are very siloed and dissociated from ICS components; 5) Lack of modelling and abstraction; and 6) The lack of Cores' description(s) which focus on Polymathical profiles and skills. The mentioned RDP's gap was located by using existing professional projects made experiences, existing academic-educational Cores, sources on ATPs, and XHFRs, and RPBAI based RTAI_PBL like models and concepts, simply are inexistant. This RDP checks RPBAI based RTAI_PBL's impacts and feasibility in (re)engineering and improving Cores by using heuristics and PPLPs [37].

B. *RDP's Advanced Topics*

As shown in Fig. 2, the RDP contains the following steps and phases [28,29]:

- The Polymathic PLRP that is an in-depth checking and analysis of the used resources. And has proven that aren't any similar frameworks and concepts, that use terms and technics like RRDAG, RUP, AHMM4RRDA, AGModels... And more specifically the Polymathical approach.
- There aren't any relevant scholar-references which analyse the presented article's RQ, hypothesis-assumptions, and CSAs (or sections).
- ATPs and RRDAGs, are very-risky and have XHFRs, that has already been proven in previous author's RDPs and PLRPs. And this major fact is the most relevant one that support's this article's and RDP's flow and conclusions.
- RQ's most important gap and weakness is that there is a major lack of Polymathic skills, concepts, profiles, and hence frameworks, that are essential for AIPCSs, RRDAGs, and it is recommended to apply the PAIPCS approach.
- The PLRP consulted resources like: 1) Articles, books (and chapters), and resources associated with RRDAs, RRDAG, (P)AIPCSs, AGModels, CAIMS, EAMs, ICSMs, AHMM, and RUPs; 2) Author's previously published articles, consulting projects, and IHIHCTF; 3) RTAI_PBL's architecture models and feasibility; 4) Various RRDA and RRDAG topics; and 5) The application of the Polymathic Empirical Engineering Research Model (PEERM).
- A significant research-gap was confirmed and that implies that there is a need for RTAI_PBL's research-analysis.
- RDP's main phases are: 1) Setting up the IHIHCTF; 2) Phase "1" uses CSA's Decision-Tables (CSA_DT), and is RDP's heuristics-based evaluation-phase; and 3) Problem-types' processing and solving-phase.
- And as shown in Fig. 3, the main problem and complexity is how to integrate various AISs in the enterprise model and ICS.

C. *The Framework-IHIHCTF*

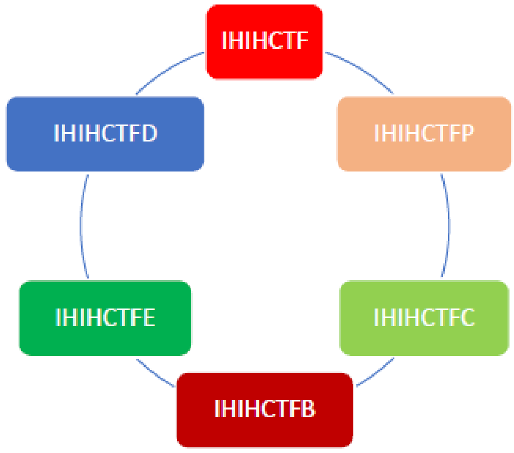

Figure 8: The IHIHCTFSs.

ATP's (and RTAI_PBL's) main aim is to provide solutions (in the form of recommendations), patterns/concepts, and an RVR. Where the RVR includes ATP's timeline that depicts the integration of RTAI_PBL's components like RRDA's WFs (RRDAWF). The RTAI_PBL uses a well-established method the ADM [4] that is TOGAF's main method. TOGAF is an ATP's transformation-enabler and an AISs modeller. TOGAF's ADM based IHIHCTF contains various Sections (IHIHCTFS), as shown in Fig. 8: 1) Support ATPs and RTAI_PBL's integrations; 2) Offers IHIHCTF's Platform (IHIHCTFP) and infrastructure; 3) Offers IHIHCTF's Cases (IHIHCTFC); 4) Offers RUP's transformed Blocks (IHIHCTFB); 5) Offers IHIHCTF's Dictionary (and Syllabus) (IHIHCTFD); and 6) Has an implementation/development IHIHCTF Environment (IHIHCTFE). The ATP and RTAI_PBL, need IHIHCTFSs, which provide the following:

- The IHIHCTFB that offers pools of (generated) Blocks (and unbundling-concepts), and relates to existing EA methodologies, artefacts, and legacy-resources; like TOGAF's ADM.
- The IHIHCTFCs illustrate ATPs' and RTAI_PBL's Reusable Applied Case-Studies (RACS) that support the Conceptual Proof of Concept's (CPoC).
- The IHIHCTFD is ATP's reference dictionary; and some abbreviations can be found at the end of this article.
- The IHIHCTFE presents a transformation-concept and associated environment.
- The IHIHCTFM is a methodology which enables ATP's and RTAI_PBL's to interface ICS', AIPCSs' components, and external methodologies.
- The IHIHCTFP shows ATP's and RTAI_PBL's usages of ICS' platforms and infrastructures.

The IHIHCTFM applies AGModels to support ATPs and standard methodologies, like TOGAF, Unified Modelling Language (UML), and other. The RTAI_PBL requires all the presented sections to be used; but where the IHIHCTFM, IHIHCTFC, and IHIHCTFE are the most strategic ones.

D. The RACSs

The RACSs are inter-connected with a common EAMs and ADM oriented RACS that was developed by the Open Group, which covers ATP's and transformations' basic EAMs, linking KPIs, and basic transformation technics with AI and ICS variables; and is an insurance RACS [4]. Other RACSs represent PAIPCS topics and subdomains. The IHIHCTF's EDHT is used the 1st ATP's iteration and then (re)evaluated by using subsequent ADM coordinated iterations. The selected Factors (and especially CSFs) are linked to RACSs which are:

- A list of problem types must define especially when using Project-work teaching environments. The response to quality mass education is to integrate cross-functional student groups and the RPBAI based RTAI_PBL supports Polymathic teaching and learning. This RACS is related to Entity's approach by offering Project-work based combined courses. Educators of Project-work based courses must be (re)skilled with needed core capabilities. The usage of Project-work was successful and the students and educators did find it complex [38].
- The use of Polymathic/cross-functional skills and Cycles cases curriculum [39,40].
- RACSs from various companies using AI-topics to solve problems and challenges; where they have generated and stored huge data-volumes on their customers… It is complex to manage data over distributed ICS. AI supports such configurations and transforms Entities practices [41].
- Measuring Core's impact (like in Stanford Online's impact RACS) does not lie in the courses themselves but in the staff's innovation and revolutionary concepts, which lead to groundbreaking Core's advancements [42].

E. The PEERM and RDP's Central Phases

This RDP's applicable phases are: 1) Phase "1" (Ph1) uses CSA_DTs, and is RDP's empirical phase, which evaluates selected CSAs, CSFs, and their outcomes are summarized in Fig. 19. This RDP's and article's CSAs are: a) The RDP for the RTAI_PBL; b) The usages of distributed ICS, EA, AGModels, and basic technologies; c) The roles of AIPCSs, NLP, AIA, and GenAI; d) The roles of RRDAs, RRDAGs, and RTAI_PBL; and e) RACSs and CPoC usages; and 2) Phase "2" (Ph2), presents how to solve a concrete RRDA PT(s), by using of Intelligence and its embedded EHDT. This RDP applies the PEERM, which is optimal for ATPs, RTAI_PBL, AIPCSs, and NLIEs. The CPoC's final outcome, is synthesized in Fig. 19; and the IHIHCTF supports the RTAI_PBL's implementation and offers a set of solutions, and recommendations, which include an RVR. As already mentioned, the RDP applies the IHIRMMA that is different from popular and conventional (that are mainly quantitative and statistical) disciplines, and is mainly a qualitative research-model. The IHIRMMA includes [11,12]: 1) The EHDT that is a heuristics reasoning engine; 2) Specific and limited usages of Quantitative (Qn) Methods (QnM) for risks' mitigations; 3) The dominant Qualitative (Ql) set of Methods (QlM) for RTAI_PBL's and ATP's common PTs solving; 4) The EHDT based dynamic PPLPs, that are based on the pseudo-Action Research's (AR) learning approach; and 5) The AHMM4RRDA, which supports and checks RTAI_PBL's and enables its operations, like calling the EHDT's and Intelligence's actions and processes. The RDP, IHIRMMA, EHDT, and other mentioned components are complex and they use performances' intensive processes that need powerful ICS', EA's, AGModels' very performant distributed-architectures and basic-technologies.

5. The Optimal Usages of Distributed ICS, AGModels, and Technologies

A. Related Concepts

In this CSA's presents an integration concept for enterprise's ICS, EA methodology, AGModels resources, to deliver an optimal platform and infrastructure. Knowing ICSs, RTAI_PBL, AIFDs, and ATPs heavily use AGModels (that include EAMs, ICSM, CAIMs and other models), repositories (for services/Blocks and resources) which are exchanged using different formats. The mentioned exchanges require robust RTAI_PBL on different ATP's levels and includes:

- The optimization of ICS' modules and components' performances like, central processors, memories, comm-buses, multi-threading…
- The optimization of DAIDS' usage to improve the data-accesses performances especially when they are huge.
- The optimization of Central Processing Units' (CPU) usages' concepts that need to be configured.
- The optimization of AGModels' performances by applying well-designed diagrams.
- The checking of ICS' and related components', availabilities, and scalabilities.

The mentioned optimizations processes use the AHMM4RRDA and its internal MetaModels; where the AHMM4RRDA ensures integrity-checking, Gap-Analysis (GAPA), Risk mitigation-management, and other operations. A MetaModel is a set of related DAIDSs, QlMs, and QnMs; and as shown in Fig. 9 modules like GAPA uses IHIHCTF's Factors Management System (FMS) and the Polymathic Rating-Weighting Concept (PRWC) for weightings' evaluations.

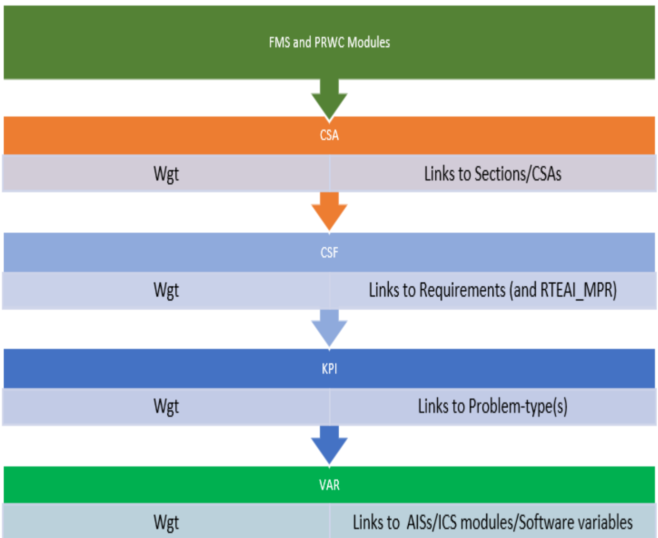

Figure 9: PRWC's evaluations for IHIHCTF and CSA_DTs.

The AHMM4RRDA is links to MetaModels which can identify and set the initial collections of Factors to support the RTAI PBL in applying the PRWC, FMS; and Factors to be used by NLIEs and DAIDSs.

B. Integrating and Interfacing DAIDs

RRDAGs use IHI DAIDS (IDAIDS) based Architecture (IDAIDSA) which improves the classical (or legacy) and "slow" Boolean Algebra based Architectures (BAA). The IDAIDSA organizes ICS' resources which generally very-busy processing static IDSs, and large strings; which implicates too frequent and unnecessary types and contents conversions which can be hindered. Therefore, IDAIDSA's enhances AIPCSs', RRDAG's, and hence ICS' performances. And IDAIDSA's main characteristics and capabilities are:

- It can enhance a BAA and simplifies ICS' architectures.
- Improves all ICS' processing and platform operations.
- Enables the processing of AGModels, and other types of operations and models.
- Enhances ICS' Programming Languages (PL) usages and performances…
- An IDAIDSA abstracts and simplifies RRDAG's integration, interfacing, and management.

RRDAGs Processing (RRDAGP) enhancements and management, by using interface classes like the RRDAGP_Class, as shown is Fig. 10, where RRDAGP's abstractions are mapped to concrete PL classes.

```
RRDAGP_Class
{
   Set W= RRDAGP_Weigting();
   …
  VAR cIDA=getPerformances(IDA);
  VAR cDML=getPerformances(DML);
  VAR cICO =getPerformances(ICO);
  VAR cPLA=getPerformances(PLA);
  …
  V=cIDA+cDML+cICO+cPLA ;
  …
  V=W*V;
};
```

Figure 10: The RRDAGP class.

The ATP, and PAIPCS use a combined methodology, and has a mixed-composite structure. The RRDAGP's Abstract Mathematical Model (AMM) abstracts Entities, and its attributes, which have the following descriptions, characteristics, and Constraints:

- W is a Weighting is set and used by variables (VAR).
- VARs are evaluated, and then the resulting performances value V is returned.
- IDA represents IDAIDSA's artefacts.
- MDL represents various types of models.
- CST represents a Constraint.
- ICO represents ICS', RRDAG's, and PAIPCS', operations.
- PLA represents Programming Languages (PL) Activities and NLP's also.
- SKL represents a Person's skill and/or a Core-topic.
- & is the mathematical sign for AND.
- | is the mathematical sign for OR.
- Δ is the mathematical sign for GAPA.
- PHS represents an ATP phase.
- Itr represents a PHS iteration.
- PRC represents RRDAGP's processing value.
- EVAL represents PRWC's processing value.
- E1 and E2 are intermediary variables.….
- $PRC(PHS)=IDA+\sum MDL+\sum ICO+\sum PLA+\sum CST$ (1)
- $Core(PHS)=IDA+\sum SKL$ &| $\sum$Core-topic… (2)
- $EVAL(PRC)=\sum PRC(PHS) + Core(PHS)$ (3)
- $E1=EVAL(PRC[Itr-1])=\sum PRC[Itr-1](PHS)$ (4)
- $E2=EVAL(PRC[Itr])=\sum PRC[Itr](PHS)$
- $\Delta(RRDAGP(Itr))=E1-E2$ (5)
- $ATP\_Status=\sum \Delta(RRDAGP(Itr))$ (6)

The AMM abstracts an ATP and related Core(s) where the AMM an is a "high-level" generalized, conceptual basis and representation of a (sub)system or PT using a mathematical language that includes variables, equations, structures… The AMM is a model that is stripped of specific concrete (real-world) facts and details, and focuses on the underlying relationships to understand, analyse, and proactively foresee various (sub)systems' behaviour across various categories or CSAs. An AMM can be instantiated to become a concrete real-world object. The AMM abstracts (simplifies) end-system's complexities by including important artefacts, features, and that helps Framework's support that is applicable to ATPs and distributed RRDAGP [43,44].

C. The Distributed RRDAGP

The RRDAGP needs a distributed ICS or the Cloud, and such a Cloud-based RRDAG(P) is as a collection of deployed-hosted RRDAGPs on the IHI hosting solution, in which the enterprise manages RRDAGPs [45,46]. RUP unbundles and transforms enterprise's siloed legacy components and resources into AIPCS enabled components in RRDAG's context. RUP's based transformations enable the auto-generation (and refinement) processes which are RRDAG's basic activities. RRDAG can also regenerate applications' roadmaps, RVR, and various types of cartographies. RRDAG's auto-generation processes use existing EA's modelling language's environments like the EA oriented Archimate Modelling Language (EA_AML) [47]. For the RDP the EA_AML is used for RRDAG's activities like auto-generation, refinements, and classifications; applying the various types of RRDA Diagrams (RRDAD) and other assisting diagrams [4,5,48]. The distributed ICS' (or Cloud) enables IDAIDSA and AGModels implementation for all APSFDs. Cloud-based RRDAGs use PAIPCS engines like the Google Cloud Platform's (GCP) AI-Engine, includes ML-Models (MLM) and support: Prepare, Build, Validate, and Deploy activities [50,51]. RRDAGs require efficient technologies that include [49]: 1) Distributed ICS resources like CPUs, memory, hard-disk, and other; 2) Real-Time (RT) Operating Systems (OS); 3) Serverless RRDAG-platforms; and 4) RRDAG-functions for event-driven and serverless installations. Distributed ICSs are very important for applying RRDAGs for different APSFDs.

D. RRDAGs and APSFDs

RRDAGs in APSFD's contexts can offer: 1) A generic-platform approach based on "On-demand" self-services, Requirement-resources' planning, availability, and Cloud-services models: 1) Infrastructure as a Services (IaaS); 2) Platform as a Services (PaaS); and 3) Software as a Services (SaaS). Which are enforced by AI(FS) as a Services (AIaaS). ATPs uses AIaaSs to support RTAI_PBL's activities in a specific APSFD; and for an APSFD, RRDAG's evolution, can be evaluated using the PRWC. SaaSs and AIaaS-based RRDAG ensure: Scalable; Secured; and Reliable Cloud-platforms that can [52]: 1) Synchronize and streamline AEP processes; 2) Manage RTAI_PBL's activities; 3) Balance APSFD's efficiencies and performances; 4) Ensure AEP's continuous developments; 5) Enhance sustainability; 6) Automate RRDAGs and software integration processes; 7) Support accessibility of quality of DAIDSs; 8) Streamlines RRDAs with applications and their components; 9) Enforce governance, compliance and audits; 10) Supports the management of innovative Requirement-concepts to generate RRDADs. AEP is an engineering method (and process) that extracts, defines, documents, and maintains ATP's or it modules requirements or needs, which also includes related relations, associations, methods/functions, and constraints. It is an APSFD activity and not a classical Software Engineering (SE) one, and is a very critical ATP phase, because it ensures that the final transformed ICS and components meet the defined needs/requirements. The requirements are defined by and actor which can be an APSFD analyst, user, or stakeholder. And AEP's main characteristics are [4,5,53,54,55]:

- The elicitation sub-phase is responsible for gathering information about the final ICS' Requirements from different actors.
- The analysis sub-phase is responsible for analyses clarifies, and refines gathered Requirements and information.
- The specification sub-phase is responsible for documenting Requirements by using EA_AML diagrams (or other) in a synchronized, concise, and unambiguous way.
- The validation sub-phase is responsible for ensuring that the depicted or documented Requirements are accurate and can be integrated in the ICS.
- The management sub-phase is responsible for tracking, string, and controlling well-organized Requirements' changes that are managed by ATP's implementation's lifecycle.
- Map AEP artefacts (or RRDAs) to other ATP's resources.
- In essence, an AEP bridges the gap between real-world problems and functional software or system solutions and components.
- It ensures that the ATP or the final-product is technically robust but that its also meets users' Requirements/needs and expectations.
- Uses modelling languages like the EA_AML to create or generate RRDADs.
- The RTAI_PBL uses the Requirement Management Process (URMP) that interacts with EA methodologies like TOGAF and ADM, to enable to implement Requirements.

E. RRDADs and AEPs Cycles

The AEP starts with the request for 'organizational change' or ATP, as such complex undertakings cannot be treated as starting from scratch (or greenfield), but must transform legacy resources like LURs, as shown by the EA/architecture model A1. Which means that Requirements (or goals) defined the 'requirements model M' must be defined as 'relative' to EA/architecture A1, to enable the requested changes. Therefore, EA/architecture A1 behaves as a PT oriented AEP. Then, a new version of EA/architecture A2 is designed and implemented to support Requirements and goals integration in model M. Which means that EA/architecture A2 is a design-artifact that results from a solution-oriented AEP. The AEP decomposes Requirement in 3 steps [4,5]:

- Problem-type investigation focuses on the PT, like 'organizational change', by analysing the causes and by defining goals to manage these changes.
- Investigate solution possibilities or alternatives, to refine defined goals to find possible or realistic solutions. And also analyses to predict gaps between refined-goals and realizations.
- Solutions' validation of possible solutions and tries to select the 'optimal' one.

The AEP can have generic approach and its cycles can be repeated in TOGAF's ADM phases and the related identification, analysis, and refinements of possible solutions come in the 2nd-step". That needs methodologies like EA and ADM.

F. Using EA, TOGAF, and ADM

Fig. 7 shows the application of AEP's cycle in EA's ADM phases; where the AGModel is in ADM's centre. A cycle illustrates Requirement's models that are created (or generated) during the SE cycle. After the elicitation step of a goal in a given ADM cycle, doesn't have to be refined to become a solution in the current cycle, and can wait until the right-design phase to be refined. And there are other possibilities for AEP's cycles, that are structured by ADM's phases. The AEP cycle can be applied to practically all ADM's phases. The AEP cycle does not replace TOGAF's URMP; but it offers realistic guidelines to URMPs. All these operations must be pre-defined in Vision and Roadmap Viewpoint's (VRV) architecture vision, where AEP-related objectives: 1) Must validate the defined business-goals: 2) Defines relevant stakeholders and their concerns; 3) Define ATP's goals and Requirements that tackle the mentioned concerns; and 4) To implement the architecture vision which is the 1st solution. The VRV and its architecture vision are a 'high-level' view of the baseline and target architecture.

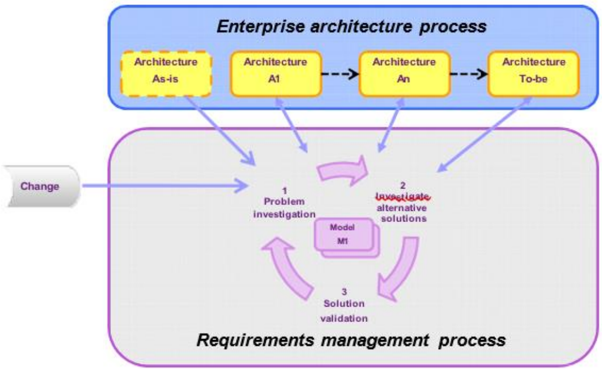

Figure 11: Application of AEP's cycle(s) [4,5].

And VRV and architecture vision are validated by GAPA. During the PT analysis process, business goals are also investigated, and stakeholders concerns are localized. And depending on these goals, Requirements are extracted to the 1st 'high-level' of architectural vision's elements. ADM's business, information systems, and technology architecture phases contain AEP like activities. And these ADM phases elaborate a 'high-level' baseline and target architecture at business, information systems, and technology levels. That implies that there is the need for in-depth analysis of stakeholders' needs and their concerns, and to refine of business goals and Requirements to answer the mentioned concerns. Which forces the ATP to classify Requirements, like functional, non-functional, assumptions, and constraints; and all these operations are validated using GAPA. Validation processes enable the analyst to choose between offered solution-alternatives. The business, information systems, and technology architectures are continuously refined by ADM's reference method. The business architecture phase outcomes are used as the jumpstart for PTs analysis of the information systems architecture phase, and then the outcomes of the information systems architecture phase are the jumpstart of the technology architecture phase's PT analysis process. These operations are complex and risky, therefore there is the need to use PAIPCSs, NLP, GenAI, and AIA's to support RRDAGs and ADM phases.

6. PAIPCSs, NLP, AIA, and GenAI's Support

A. PAIPCSs', NLIEs, LLMs, and Unified Communication

This CSA describes the applied AIPCSs, NLIEs, LLMs, GenAI, and unified communication that are needed to support RRDAGs and EA/ADM's automated processes. Because such complex processes are needed to facilitate AEP's and ADM's phases interactions and to avoid XHFRs. And the mentioned fields are stubs for future RRDAGs related processes. The PAIPCS can be built on modelled and inter-related AIPCSs that support RRDAGs through automation processes. Such processes use NLP scripts and Models (NLPM), JIT_DMP… As shown in Fig. 12, PAIPCSs' main topics are [23,24,25,56,57]:

- NLP processes NLs and processes IDAIDSs by applying: Classifications; Searching; and Analyzing data-from input-streams.
- NLPs and associated AIPCSs enhancing RRDAGs by enabling automated RRDAGs and managing IDAIDSs.
- LLM are applied for different types of NLs to mimic HBF's interpretations.
- NLPs and LLMs are different but they are changing HBFs' interactions with AIPCSs and RRDAGs.
- LLMs are AI-Models which can analyze, understand, and apply RRDAGs.
- In AEP's contexts' analysis, the NLP processes sentences, and lacks the capability to understand extended-text, on the other-hand LLMs, use transformers to track across the text to deliver cohesive Requirements or RRDAs.
- In fact, NLP and LLMs are complementary that can work together; like in Intelligent Document Processing (IDP) where NLP extracts entities or attributes, whereas LLM refines text's -understanding to manage ambiguous/unstructured content.
- ML applied algorithms to support ICS' components to support: Supervised; Unsupervised; or Reinforcement Learning actions for Requirement's management.
- DL uses Data-Analysis (DA) for (self)learning, and offers usable results.
- DA processes IDAIDSs and interfaces structured data-storages.
- BigData (BD) manage huge data-volumes and applies the 3 Vs: Volume, Velocity, and Variety.
- The Model Context Protocol (MCP), as shown in Fig. 12, is a unified communication-environment for AIPCSs and Agentic AI (AIA).
- AIAs support RRDAGs by: Generating RRDADs; Generating Code; Summarizing reports; and Communicating HBFs.
- NLIEs and related NLP-Scripts manage ICS' resources and NLPMs, which in-turn analyze, and understand NLs to generate RRDAs).
- AIA WFs (AIAWF) support RRDAGs' processes, by applying automated-choreography, such an automated-choreography is optimal for the EHDT, PBLs, and PPLPs.

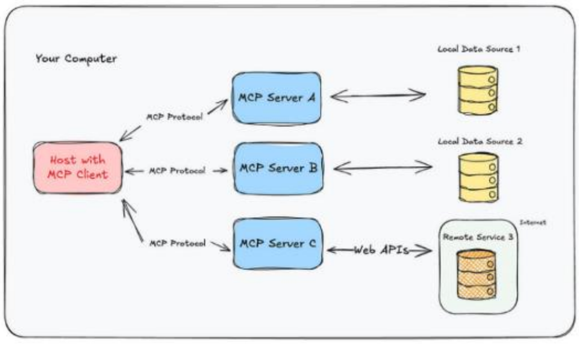

Figure 12: MCP's unified communication [56].

B. Using AIAs, AIAWFs' for RRDAGs

As shown in Fig. 13, the ATP, RTAI_PBL, and RRDAGs use the AIA which offers [58,59,60]:

- Application Programming Interfaces' (API) management.
- Tasks-operations management and that requires to design WFs.
- Prompts to support AIAWFs' actions to enable GenAI Models (GenAIM) to generate RRDAs.

- A Multi-AIA (MAIA) interface which supports RRDAGs and related PTs solving.
- To share experiences and enhance linked PPLPs.
- AIAWFs deliver decisions with non-HBF's commanding and synchronizes RRDAGs.
- AIAWFs offer a concept for complex PTs that require an iterative approach.
- AIAWFs major steps are: 1) Understanding APSFD's PTs and gathering information for AEPs; 2) Applying checking and diagnostics for RRDAs; 3) Using tools for RRDADs; and 3) Finalizing and learning.
- AEP Activities like: Planning; Tools/development; and Actions to complete RRDADs and RRDAGs.
- An AGModels based AIA Architecture(s) (AIAA).
- AIAAs supports "thinking", learning, based on IDAIDSs, and made experiences to refine RRDADs.
- Continuous processes to tune RRDAGS by improving PPLPs and GenAI's processing.
- Adapts autonomously to new contexts and situations based on PPLPs, and delivers RRDADs.

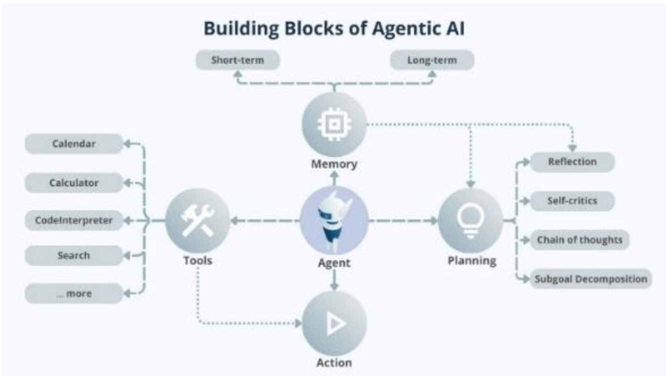

Figure 13: AIA's main blocks [62].

C. Using PPLPs and Applying GenAI for RRDADs

For different APSFDs high-quality RRDADs are important for important for supporting ATPs and for ensuring less labour intensive, minimizing HBF's interventions (and expertise), improving maintenance processes, and continuous enhancements of URMPs. The RTAI_PBL is supported by GenAI and LLMs, which enable enhancements, by [57]: 1) Streamlining RRDAG processes; 2) Offering AIAWFs which support DAIDS-processing, retrieval, and evaluations; 3) Reengineer Requirements and RRDAs; 4) Refine LURs to deliver RRDADs; 5) Intelligence offers RT-actions deliver insights: 6) Improves RRDAs' and RRDAGs' effectiveness; 7) Uses the NLP, to optimize DAIDS ; 8) Offers multi-tasking, and specialized analysis; and 9) Offering deployment-processes for AEPs. GenAI is applied to generate or create new Requirements' contents, which can include: texts and/or images, based on defined conversion-patterns. And then LLMs generate HBF-like texts, and can be supported by Small Language Models (SLM) which carry out specific tasks which require less efforts and IDAIDSs. And at last, the Retrieval-Augmented Generation (RAG) enhances the processes models by extracting detailed information. There are various GenAI tools that can support in RRDAGs by using [3,53,61]:

- Text Generation (TG) which applies MLMs to generate new texts based on Requirement-patterns.
- Image Generation (IG) which applies DL-algorithms that generates Requirement diagrams.
- Video or presentation Generation (VG) uses -algorithms to generate Requirements related presentations as videos.
- Technological-transformations (or ATPs) which apply AIPCSs, and GenAI that are changing how EA and AEP-tasks are done.
- Occupational impacts on AEP-skills and tasks that have varying exposures to GenAI. Employment and skills are related to EA traditional-skills, but evolution presses major changes.
- Governance which has profoundly changed by AIPCSs' usage that incorporate also EA_AML, and frameworks to manage Requirements.
- Iterative ADM phases and GAPA for AEPs, because according to 'Harvard Business Review' more than 50% of ATPs face failure because of weak-management.
- Besides weak-management, one of the major Factor for failure is URMPs and RRDAGs can improve success rates, and supports the analyst to solve PTs.
- RRDADs that captures Requirements and transforms them into Requirements.
- RRDAG classifies and prioritizes Requirements and automated the AEP, which is an iterative process in which actions are executed in all ADM phases.
- The elicit Requirements generation in which all the key information related to the ATP are well-defined and known.
- Requirements' specification concepts which manage and document functional and nonfunctional Requirements are gathered. RRDAGs generate RRDADs (like flow-diagrams) and information architecture (like front-ends).
- Requirements' verification and validation processes to acknowledge if ATP's goals were achieved.
- The URMP which combines other AEP-processes which run simultaneously. And it analyzes, documents the collected Requirements.
- Common errors detection and corrections; such errors can be: 1) Scope-creep which are the result of "minor changes" which can cause major problems; 2) Over-engineering can have negative impacts on Requirements; 3) Insufficient information and feedback; and 4) Various types of resistances
- Integration of AEP in SE processes improves communication and inputs.
- TAI to URMPs efficient and hence implies that the transformed ICS becomes trustworthy.

D. Enabling TAI for RRDAGs

TAI are AI-systems that have the following Factors, robustness, fairness, explainable, interpretable, transparent, safe, and secured. The mentioned Factors (or qualities) generate trust and confidence in AI-systems among ATP's actors like engineers and users. And offers the following [49]:

- Mitigates potential risks that are related to AGModels and CAIMs, such risks which can negatively influence users, enterprises and other.
- Guide enterprises in their development, integration, and evaluation of AIPCSs, and there are frameworks to supports such activities like the ones from: 1) The National Institute of Standards and Technology (NIST) AI Risk Management

Framework; 2) EU's Ethics Guidelines for Trustworthy Artificial Intelligence; and 3) Organization for Economic Co-operation and Development (OECD) AI Principles.
- A better understanding how ICSs and AIPCSs are crucial for trusting their efficacy, but AIPCSs, MLMs, DL models, are used as black-boxes with practically no-transparency.
- Presenting real-world cases of AIPCSs that produced errant or harmful results in high-stakes implementations, which create AI-trust concerns. And a known case is related to healthcare in which AIPCS failed to diagnose sepsis, in more than two-thirds of patients.
- Proactive detection of CAIMs which underperform or generate harmful outputs, which undermine trust.
- Offering guiding-principles and goals for TAI which can include: Accountability, Explainability, Fairness, Interpretability (and transparency), Privacy, Reliability, Robustness (and security), and Safety.
- Accountability entails holding AIPCSs actors accountable for the proposed AI solution.
- Explainability verifies CAIM's outputs and delivers explanations.
- Fairness is an equitable treatment of users, people, and groups.
- Interpretability and transparency support users or people to better understand the used JIT_DMPs.
- Privacy is about the protection of personal (or sensitive) data-information that is used.
- Reliability which is intended to function without failures, for a defined period.
- Robustness and security offer protection mechanisms to block adversarial-attacks and unauthorized-access, minimize cybersecurity risks and vulnerabilities.
- Safety refers to AIPCSs which protects HBF's life, health, property, and environment.
- The list of potential risks' categories which can harm: People, Enterprise, and Ecosystem.
- Detect and prevent dire scenarios and consequences, by mitigating risks.
- Clarifying the differences between the terms TAI, Ethical AI (EAI), and Responsible AI (RAI) which are frequentl
- interchanged.
- TAI is an AI-system or AFSs that establish trust in an enterprise or ATP.
- EAI, is an AI-system that has ethical considerations, which reflecting HBF values and moral perceptions.
- RAI is an AI-system that encompasses and embeds ethics in AIPCSs and AIAWFs.

ATPs, can apply a specific strategy to achieve TAI, where AI-systems, AI-algorithms, and DAIDS, respect TAI principles and by applying [49]: 1) Assessing AIAWFs; 2) Continuous monitoring for problems detections; 3) Risk management by using a risk-management framework; 3) Applying automated documentation; 4) Using AI governance frameworks; and 5) Build an IHI concept for TAI and EAI.

E. TAI and EAI

An enterprise or a ATP must establish an EAI for TAI which should include the following key requirements [63]:

- Lawfulness which refers to respecting all applicable laws, conventions, and regulations. Where ethics are the main driver.
- Ethics which refers to respecting HBFs' ethical principles and values.
- Robustness which refers to both the technical viewpoint and considering its societal environment.
- Human agency and oversight refer to an AI-system which empowers HBFs to enable them to foster their fundamental rights.
- Technical Robustness and safety refer to an AI-system that is resilient and secured.
- Privacy and data governance refer to an AI-system that respects: Privacy and data protection; Adequate data governance; and Legitimized access to data.
- Transparency refers to an AI-system and its data that are transparent and traceable.
- Diversity, non-discrimination and fairness refer to an AI-system that avoids biases.
- Societal and environmental well-being refer to an AI-system which benefits HBFs, and future generations.
- Accountability refers to an AI-system that ensures responsibility and accountability.
- Enable Polymathical TAI approaches to integrate complex environments like RRDAs, RRDAGs, and RTAI_PBL.

F. Integrating EA_AML, URGAs, and AEP Technics and Concepts

EA_AML is used for AEP which is represented as part of EA_AML's motivation aspect, which is in its Requirements domain. And focuses on understanding the stakeholders and users' needs, expectations, and for managing associated EAMs and AGModels' implementations. EA_AML offers a structured manner to build RRDADs, that include their associations, relationships to other artefacts like goals, principles, and constraints. Integrating EA_AML (and their RRDADs), URGAs, and AEP technics and concepts support ATPs by [64]:

- Stakeholders' specific RRDADs can be modelled in detail.
- Realizing by using various EA elements (like business services, applications, infrastructure).
- Using relationships like 'realization' and 'aggregation' to link Requirements with other EA elements and to present how Requirements are unbundled or combined.
- Using Viewpoints like the Requirements Realization Viewpoint, which is used to design/model how Requirements are implemented by various EA elements.
- Using extensional (what) and intentional (how) properties, where Requirements are part of intentional aspects, that focus on how EA AGModels and RRDADs behave to fulfill Requirements or Requirments.
- Applying the motivation aspect is important for understanding the 'why' of the proposed RRDADs, including their goals, principles, and Requirements.
- Applying a clear-communication, alignment, and traceability so that RRDADs are contained in RTAI_PBL's context.
- Using proactive validation to receive feedback, and that reduces the risk of implementing erroneous Requirements.
- As shown in Fig. 14, using the Requirements Realization Viewpoint (RRV) which enables the architect or designer to model Requirements' realization(s) by using

EA/EA_AML's core elements, like business actors, business services, business processes, application services, application component… Commonly Requirements result from the Goal Refinement Viewpoint (GRV).
- Using the GRV to refine Requirements into more detailed Requirements and the aggregation-relationship is applied for Requirements related tasks.

Attribute	Value
Stakeholders	Enterprise and ICT architects, business analysts, requirements managers
Concerns	Architecture strategy and tactics, motivation
Purpose	Designing, deciding, informing
Scope	Motivation

Figure 14: Manage Requirements' details during design stage [64].

G. ***The Roles of PBL, PrBL, PPLPs, and PAIPCSs-NLP, AIA, and GenAI's Support***

AR, PPLPs, and PBLs is crucial in education and offers an AI teaching concept that is based on [68,69,70,71]:

- AR and PBLs, can be used to improve PPLPS and related ROEs.
- The improvement of educational outcomes in sciences and mathematics, and needs a corresponding Core-topics based on PAIPCS and advanced ICS technics.
- Introducing basic technology concepts, vocabulary and history of science generally and AI specifically in a manner that emphasises Persons' engagement.
- Adding AI to the Curricula and practices, and it is important to integrate PTs' solving concepts in broader educational activities.
- The PAIPCS and ICS syllabus are parts of a whole of Core's approach to studies that integrates, various Core-topics and enriches experiences through empirical-evidence or ROE.
- AR, PPLPs, and DMS improves and tunes the Core in and incremental manner.
- Such a Core fits Cycles' policies guidelines.
- IHIHCTF's EHDT applies a spiral model which implements AR and PPLPs steps.
- The spiral model matches perfectly with RPBAI based RTAI_PBL's iterative approach, which is an empirical reasoning algorithm, and fits education; hence Cycles.
- AR = action and research which corresponds to EHDT's (tree) nodes process and calls to AI or common services.
- The AR based EHDT implementation is cyclic (and spiral) where each cycle corresponds to the creation (or modification) of an Intelligence tree-node.
- Iterations extend across EHDT's processing; where each cycle (or new node) defines the set of problems (related to Factors and actions) to be solved.
- These problems are processed-solved by a defined set of actions.
- That mapping concept defines analytical AR's inter-related actions/steps.
- AR based EHDT can be considered as a Qualitative AI Core-topic; and that should be added to the Core.
- The EHDT supports the RPBAI based RTAI_PBL in decision making and PTs' solving processes.
- The EHDT PTs' solving processes are supported by a dynamic tree algorithm.
- PBL and PPLP emphasize the process of inquiry, collaboration, and reasoning. Where they enable the integration of conceptual understanding, procedural fluency, and real-world work (and application).
- PBL enable Persons to link between abstract models, like the AMM and practical PTs' solving; and engages Persons in the acquisition process of mathematical skills and competency
- PBL supports critical thinking, enhances Persons' adaptability to change and SoC, independent work, communication skills, continuous learning, and design capacities.
- PBL enhances learning, thinking, and communication among teams and Persons.
- PBL can be used as a central Core's brick.

7. The Core

A. *The Core's Main Characteristics*

A PBL oriented Core includes the following features and topics [1,39,65,66,67,72]:

- Explaining and applying quantitative, qualitative or mixed approaches in Core-topics.
- Explaining and applying data-structures, communication, interfaces, mixed/algorithms, (A)MMs, and AMMs.
- Explaining and applying ICS and AI technics for like domain programming.
- Explaining and applying Core-topics and their relations, common fields, and differences.
- Time issues can limit the number and type of elective Core-topics (or courses).
- Implement interdisciplinary activities in cross-functional topics, like ICS, AI, mathematics, purchasing, marketing/sales, transformation-innovation, robotics/ manufacturing, …
- Promote Polymathic topics, that need collective-activities to deliver real-world solutions, and patterns which bring-up new educational paradigms, and improving creativity.
- Promote collaborative interaction, design exchanges, and diversity that are inspired by the industry.
- Assembles Polymathic interdisciplinary/cross-functional teams of Persons which benefits diversity and exchange.
- Make a long list of different Core-topics in graduate and undergraduate levels, and encourage AI oriented Polymathism.
- Offer various PAIPCS topics, ICS technics, business engineering, human-sciences, media and support ROEs' implementations in PPLPs.
- Review Core-topics' outcomes to deduce new change to the Core.
- Interactions, communication, and relations between Core-topics, enable the optimized use of (re)sources across all teams or classes.
- Interaction with external partner's interactions by using projects and applying system's thinking.
- Polymathic system's thinking that includes: Holistic systemized-model; Solving complex problems as shown in Fig. 15; Different viewpoints; and IHIHCTF.

- Use of evolving advanced ICS/technologies and AI, have created an important transformation paradigm-shift.
- Core-topics are integrated in ICSs, that needs Polymathical thinking that relates to multiple domains.
- Includes advanced skills, like: Critical thinking, PPLPs, creativity, adaptability, architecture…
- Apply PBL and PrBL based ROEs using refinement.
- Use APM, EA models and Project-work based LPs.
- Enable the implementation of Polymathic student projects.
- Supporting students' Polymathic capacities from persisted ROEs.
- Sharing collective ROEs/experiences and enforcing ethical principles.
- Includes topics like STEM, AMMs, and other complex Core-topics.
- Persons' project interactions are enforced by: Architecture/EA_AML, brain-storming, managing-commination, modelling patterns, planning tasks, coordinating activities...
- Modelling of complex inter-related Core-topics, PBL, and PT solving operations.
- Use AR, PBL, EHDT to improve staff's teaching technics.

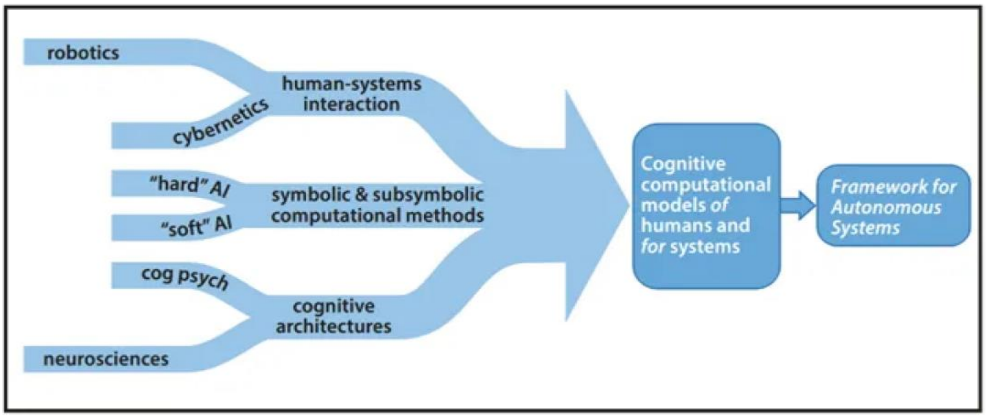

Figure 15: Complex Persons' projects in autonomous systems [65].

B. *The Core's Specific Issues*

Core's specific issues and subjects are [73,74,75,76,77]:

- Define Core-topics' policies and related professional focus-domains, that include PAIPCS topics, critical-thinking, collaboration-communication, EA_AML based modelling, and PT solving skills.
- Complex PAIPCS topics are to be controlled and precisely linked related to cross-functional fields.
- Use a Polymathics based Persons' Lab-project for ROEs (simply Lab), that relates and enhances ROEs and PPLPs.
- Labs uses real-world compound PTs to be solved by the DMS.
- Labs supports Persons' in modelling, planning, communication, and implementation of ICS, PAIPCS, and domain components and modules.
- Lab is a synchronized design and development process that enhances Persons'' empirical knowledge that is translated into ROEs.
- Lab's main goal is to mimic risks, unpredictability, and complex design, by using modelling technics to depict PT types and assignments.
- RPBAI based RTAI_PBL needs flexible and adapted Cores, in which Polymathic Core-topics are dynamically managed and modified, as shown in Fig. 16.
- ATPs need Dynamic Core (DCore) which are adapted to Persons having exceptional Polymathical capacities.
- The DCore supports: 1) Cycles with especially disseminating technological/ICS development; 2) Integration of quality topics; 3) Use real-world Labs or projects; 4) Apply critical-thinking; 5) Enforce responsibility; 6) Mimic R2C and recommend solutions; and 7) Develop complexities, risks, and uncertainty scenarios.
- Interface AI and PBL external frameworks to support PPLPs and PAIPCS.
- Apply specific didactics for interdisciplinary and deductive thinking, which can be used in Lab's CPoC.

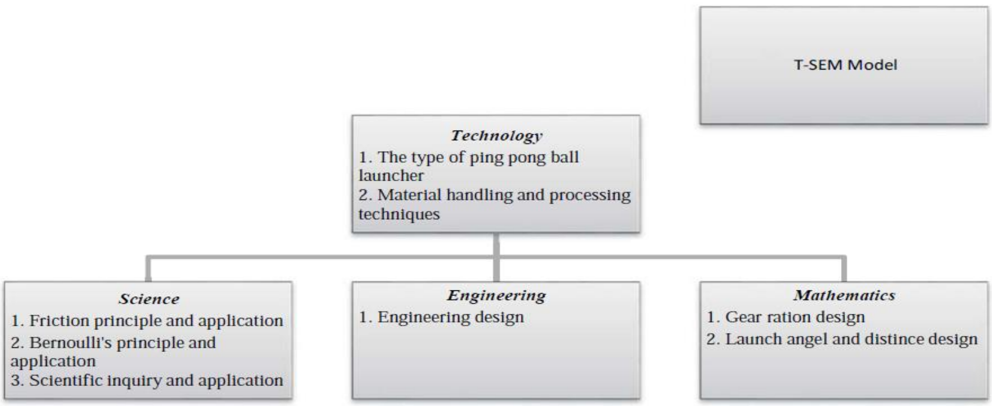

Figure 16: A Polymathic Core [76].

8. The RACSs and CPoC

A. Preparation-RUP, GenAI, AIPCSs, LLM, and NLP RACSs

This last section applies different types of presented RACSs, and the 1st type is associated with the common ATP's Requirements, URGAs, and AEP. GenAI is changing URMPs by automating: Requirements' related processes; IDAIDS/data accesses; Personalizing patterns; Using AIPCSs for RRDAGs; and Generating AEP reports. The LLM, DL, and NLP basic RACSs are used to support the following [78,79]:

- Chatbots and LLMs support users' experiences to understand messages/prompts.
- LLMs help with RRDAGs based on prompts or by inspecting structured-data.
- LLMs are applied for NLs' translations to produce accurate RRDADs.
- LLMs support PPLPs' updating by analysing RRDAGs' modifications…
- LLMs automate the generation of Requirements' descriptions, and improves data catalogues.
- NLP supports search-engines to analyse designers' or users' requests, to modify RRDADs.
- NLP uses speech-to-text and vice-versa, which can support RRDAGs
- Transforming LURs can be based on legacy-information (or resources) extractions and design-documents' summarizations
- NLP parse unstructured legacy text-files and data-volumes to generate RRDAs and eventually RRDADs.
- The sharing of RRDADs and AGModels to support: 1) Comparing existing RRDAs and RRDADs; 2) Applies a strategy to detect progress; and 3) Adjusting RRDADs and RRDAGs.

B. URRDAG and AEP RACSs

- The RRDAG's, and AEP's RACSs are used to support the following [29]:
- Various ICS fields are witnessing a hyper-evolution that is mainly due to advancements in AIPCSs, and especially in GenAI and LLMs; which in turn effects URMPs.
- AEP is a very critical ATP's phase and involves the classification, gathering, and defining Requirements (and RRDAs).
- This RACS examines the application, of GenAI in AEP, with the main goal to analyse the practical implications, identification of current research scopes/trends, and showing topics for further improvements and developments.
- This RACS applied a systematic literature review that has addressed 3 RQs and analyzed 44 studies.
- GenAIMs, and specifically LLMs, are extensively used various AEP's tasks, showing the versatility and LLMs' capabilities in improving AEP's processes.

C. The Setup and CPoC's Environment

The CPoC that is presented in Fig. 17, was developed using the IHIHCTF, PAIPCSs, GenAI, and the following environments: 1) IHIHCTF's NLP; 2) Microsoft Visual Studio; 3) Java Enterprise Edition (JEE)tools/ environments; and 4) Various AI-libraries like ML.NET. The executed PLRP that is RDP's kernel part of Ph1, which analyzed various relevant (re)sources of articles, documents, references, and links, which were verified using IHIHCTF's repository. Afterwards the collections of selected Factors (CSAs, CSFs; and KPIs) were tuned, linked to IHIHCTF's NLP-scripts.

Figure 17: CPoC's phases and interfaces.

The CPoC's and RACSs' preparations included the following technics, features, and tools/environments [29,80,81]:

- The previously presented set of RACSs.
- The analysis of Open Group's RACS (ArchiSurance) that presents a case of a RUP, DT, EA/AEP-technics, and EA_AML activities.
- The set of Factors were initialized-tuned, and integrated; and then the IHIHCTF (and PRWC) was synchronized with TOGAF's ADM.
- The set of CSAs were linked to sets of CSFs and RRDAs (and RRDAGs).
- The design and development of AGModels that represent the used AIPCSs, AIAs, AIAWFs, and the integration of RRDAs (and RRDADs).
- Ph1, is used for evaluation of Factors and the outcomes/results are presented in Fig. 19.
- The CPoC includes three phases, and if Ph1 was successful, then a RTAI_PBL PT is evaluated and processed to be solved in Ph2.
- KPIs' values originated from (pre)defined IHIHCTF's enumerations; which were persisted in the CSA_DT's Tables Weighting and Rating Enumerator (CTWRE) or Fig. 18's column 2.
- The CPoC (or Ph2) tries to solve a specific PT; and offers a set of solutions and recommendations.

D. CPoCs Ph1

CTWRE Label	Limit's Value	Description	Color
Proven, Mature	9.01-10.00	Success	Green
Possible, Feasible	8.51-9.00	Success	Green
Risky	8.01-8.50	Important Risk	Yellow
Complex	7.01-8.00	Unclear	Red
VeryComplex	5.01-7.00	Will probably fail	Red
Impossible	0.00-5.00	Failure	Red

Figure 18: CTWRE's defined-values.

A randomly chosen Factor (or CSF) links to a set of actions, which is then executed by the EHDT based Intelligence. And then Intelligence offers a set of possible solutions to the mentioned RTAI_PBL PT. As shown in Fig. 19, the AHMM4RRDA, EHDT/Intelligence, and PRWC use the evaluation's definition-scheme or the CTWRE.

CSA Category of CSFs/KPIs	ATP/Transformation Capability	Average Result	Table
CSA_Approach	Proven-Mature	From 1 to 10. 9.25	1
CSA_Context	Important-Risk	From 1 to 10. 8.25	2
CSA_RDP	Proven-Mature	From 1 to 10. 9.25	3
CSA_Tech	Important-Risk	From 1 to 10. 8.25	4
CSA_PAIPCS	Important-Risk	From 1 to 10. 8.20	5
CSA_Core	Important-Risk	From 1 to 10. 8.30	6

Evaluate First Phase

Figure 19: CPoC's Ph1 outcomes.

The RDP's, and CPoC's set of defined CSAs are:

- The PAIPCS Approach (CSA_Approach).
- Defining the Context of RPBAI based RTAI_PBL (CSA_Context).
- The RDP for the RTAI_PBL (CSA_RDP).
- The Optimal Usages of Distributed ICS, AGModels, and Technologies (CSA_Tech).
- PAIPCSs, NLP, AIA, and GenAI's Support (CSA_PAIPCS).
- The Core (CSA_Core).

The EHDT uses a tree-based heuristics (which applies the 'rule of the thumb') and also applies the PRWC and FMS to enable PTs solving processes. These processes use the 'iterative trial and error' concept. The RTAI_PBL applies the AHMM4RRDA to setup, check, validate, manage, and support PAIPCS' and associated RRDAs' (and RRDAGs) validations. The selected and tuned Factors were initialized and set by Intelligence to support the RTAI_PBL. The PLRP and associated evaluations' NLP-scripts (used in CPoC's Ph1) integrate the mentioned Factors and delivers results which are presented in Fig. 19, these results have the estimated average of (rounded to) 8.60. And that means that an ATP (and contained RTAI_PBL) is a "Feasible or Possible" undertaking. With the mentioned average the CPoC continues with executing Ph2, in which a selected RTAI_PBL PT is analyzed and processed by the EHDT to offer possible solutions; that also means that PLRP's processes were partially successful, and that Ph1 ends, and that Ph2 starts.

E. CPoCs Ph2

In Ph2, the EHDT (and its associated actions), tries to solve an RTAI_PBL PT (the PRB_RTAI_PBL) that is related to RDP's RQ. Then the PT is linked to selected Factors (mainly CSFs) and their collections of actions; and afterward the EHDT is executed from the tree's root node. The selected PT, like the PRB_RTAI_PBL, is linked to a CSF, and also relates to the following actions: ACT_RTAI_PBL_Define_ProblemType, ACT_RTAI_PBL_Verify_ProblemType, ACT_RTAI_PBL_Match_ProblemType, and

ACT_ RTAI_PBL_Validate_ProblemType. And for Ph2, the CSF_RTAI_PBL_Integration CSF was selected with the aim is to offer a set of (possible optimal solutions).

9. Conclusions

PAIPCS like GenAI can be used to generate Entity's contents like Cores Labs' resources, and other. Today we are witnessing a hyper-evolution as new evolutionary ICS, AI, electronical technologies which are redefining ATPs, Entities evolutions, AGModels, and PAIPCS' concepts. It can be considered that AI based PPLPs and GenAI are ATP's is pivotal subdomains, because they offer innovative possibilities, but they also introduce new risks, especially in the domain of defining Cycles and staff's feelings on selecting Polymathical profiles. PAIPCS use AI based PPLPs and GenAI, to (re)generate and (re)adjust Requirements' based upskilling by automating various types of contents, and that offers staff the possibility to create AGModels for the ATPs. This RDP proposes a set of recommendations on how to use RPBAI based RTAI_PBL where Core-topics support various ATP's and Core's phases. The most important recommendation that was generated by the previous research phases was that the Manager must be a Architect of Adaptive Business Information System (AofABIS) or Business Transformation Project's Architect's Profile (BTPAP), which can describe Entity's staff. The recommendations for the RPBAI based RTAI_PBL are based on the processing of Factors to assert its capabilities, coordination, and effectiveness. RPBAI based RTAI_PBL characteristics are needed to be integrated in the Core. Because of the low score, 8.60, from Table 1, shows that RPBAI based RTAI_PBL's integration is feasible but also contains complexities; and the resultant recommendations are: This RDP, CPoC, and hence article offer the following RTAI_PBL's recommendations and conclusions [1]:

- This article's focuses AI/PAIPCS, TAI in the context of ATP, where an ATP needs an IHIHCTF and a Core.
- This RDP focuses on RTAI_PBL, AEP, RRDAs, RRDAGs, AIAs, AIAWFs, ADM, and AGModels; and also uses an IHI mixed research-method.
- This RDP's CPoC outcome means that the RTAI_PBL is a feasible process, because of the result, (rounded to) 8.60.
- The author uses his IHIHCTF to show how and Entity can build an inhouse framework for Projects.
- This RDP uses an innovative concept, which includes: 1) An RDP; 2) The IHIHCTF; and 3) A methodological approach to EA and AGModels.
- The literature review proved the existence of an important RPBAI based RTAI_PBL knowledge gap.
- To use AMMs (like the AHMM4RRDA) and EHDT, to support DMS' operations.
- The EHDT supports the RDP is used to create the initial RPBAI based RTAI_PBL concept.
- To define a RVR that supports ATP's AEP strategy to automate and optimize URGAs.
- The IHIHCTFM uses existing methodologies like TOGAF's ADM, and also other frameworks.
- TOGAF's ADM supports RTAI_PBL's processes and activities, and AGModels' developments.
- The RTAI_PBL interfaces the IHIHCTF and PAIPCSs.
- PAIPCSs include a range of heterogenous AI topics and GenAI, which is used to automate Requirements, RRDAs, and RRDAGs.
- AIPCSs, RRDAGs, and up-to-date ICS-technologies to replace LURs and associated ICS' components.
- The RTAI_PBL and RRDAs (and RRDAGs) replace manual LURs' conversion processes.
- Requirements based AGModels, and AEPs' automation, efficiencies, and sustainability, depend on RTAI_PBL's and IHIHCTF's integrational capacities.
- An ATP (and associated RTAI_PBL) has to adopt a clear Polymathic (and holistic) concept (like the PAIPCS) to use AGModels, and especially RRDADs.
- The DMS manages AEP's risks and tries to solve risks' generated PTs.
- AGModels support AIAWFs' and AIPCSs' integration; and RT PPLPSs' contents management.
- RTAI_PBL supports PAIPCS' RRDAs (and RRDAGs) integration for cross-enterprise needs' creation processes.
- The RRDAG generates Core-topics that are based on Requirements is today a complex process, and a ATP and enterprise must balance between RRDAG's automation-processes and Persons' and HBFs' quality procedures.
- Apply the TAI and EAI for capturing Core-topics detailed information and major Requirements which is this article's main focus.
- An AGModel includes EAMs, ICSM, CAIMs, RRDADs, LURs and other models.
- RDP's CPoC applied the selected Factors' which were associated to RRDAGs, ATP resources; AIAWFS, Intelligence, RQ, and AIPCSs.
- The applied domain are Cycles, but the RPBAI based RTAI_PBL can be applied to any other domain.
- Entities and Cycles are dominated by single-disciplinary experts and concept, and this fact has very negative implications on ATPs, Cores, and RPBAI based RTAI_PBL.
- Academia and hence Cycles must encourage the development of interdisciplinary and Polymathic experts.
- Cross-functional and Polymathic skills building are mainly based on common, mathematics, and mandatory Core-topics.
- Traditional learning concepts, cannot cope with complexity of modern heterogeneous ICS, AI, business engineering, and other Core-topics. Therefore, there is a need for a cross-functional Core.
- A Core's content and sequence of Polymathic common, PPLPs, PAIPCS, AMMs, and ICS-subjects taught and assessed.
- DMS and EHDT are based on RPBAI based RTAI_PBL.
- The RPBAI based RTAI_PBL coordinates Cores integration to deliver educational blueprints, patterns, best-practices…
- Supports Persons learning concepts that are recurrent in all Cycles (primary, secondary, university…).
- Staff or educators must have the needed set of skills and experience (academic, pedagogic, and professional).
- As RPBAI based RTAI_PBL was modelled and the PoC checked its feasibility, and it can replace the Learning.
- The Core promotes Polymathism, critical-thinking, and opinion-based concepts.

- The RPBAI based RTAI_PBL integration is very complex but critical for the industry.
- The CPoC proved RDP's feasibility and delivered the recommendations on how to integrate the RPBAI based RTAI_PBL.

Acknowledgment

ATPs and other types of transformation projects are complex and have a high rate of failure, that is why the author has implemented an adapted reseach concept the preferred spelling of the word "acknowledgment" in America is without an "e" after the "g." Avoid the stilted expression "one of us (Requirement. B. G.) thanks.". Instead, try "Requirement. B. G. thanks.". Put sponsor acknowledgments in the unnumbered footnote on the first page.

References

1. A. Trad. Educational and Public Administration Transformation Projects: The Role of Polymathics Based Artificial Intelligence (RPBAI). Source Title: AI Deployment and Adoption in Public Administration and Organizations. Pages: 42. 2025. ISBN13: 9798337322728|ISBN13 Softcover: 9798337322735|EISBN13: 9798337322742. DOI: 10.4018/979-8-3373-2272-8.ch004
2. A. Trad. Academic and Educational Transformation Projects-The Role Team-Based Learning in Polymathics (RTBLP). IGI-Global. USA. 2023.
3. A. Trad. Academic and Educational Transformation Projects-The Role Team-Based Learning in Polymathics For University Cycle (RTBLP4UC). IGI-Global. USA. 2024.
4. The Open Group. Architecture Development Method. The Open Group. USA. 2011.
5. W. Engelsman, H. Jonkers, and D. Quartel. Supporting Requirements Management in TOGAF™ and ArchiMate. The Open Group. 2010.
6. M. Cranmer. Polymathic AI: Foundation Models for Science. University of Cambridge, 2023.
7. Envisioning. Polymathic AI. Envisioning. 2025. https://www.envisioning.io/vocab/polymathic-ai
8. A. Trad. The In-House Polymathic Transformation Framework (IHIPTF)-The Guide. IBISTM. France. EU. 2024. https://www.ibistm.org/docs/PRWC.pdf
9. A. Trad. The In-House Polymathic Transformation Framework (IHIPTF)-The Glossary. IBISTM. France. EU. 2024. https://www.ibistm.org/docs/Glossary.pdf
10. A. Trad. The In-House Polymathic Transformation Framework (IHIPTF)-The Syllabus. IBISTM. France. EU. 2024. https://www.ibistm.org/docs/Syllabus.pdf
11. A. Trad. The Applied Polymathical/Holistic Mathematical Model for Enterprise Transformation Projects (AHMM4PROJECT). IBISTM. France. EU. 2024.
12. A. Trad. AI based Transformation Projects. IBISTM. France. EU. 2024.
13. A. Trad. Polymathic Approach for Enterprise Transformation Projects: Implementing a Business Meta-model that Respects Environmental Sustainability (PETP-IBMMES). Book: Financial, Economic, Educational, and Technological Determinants of Environmental Sustainability. Cambridge Scholars Publishing. 2024.
14. H. Pushpakumara, P. Jayaweera, and W. Manjulan W. Using the Open Group Architecture Framework (TOGAF) for Quality Assurance in Higher Education Teaching and Learning. January 2021 SSRN Electronic Journal. DOI: 10.2139/ssrn.3808691.
15. M. Aksoy, and T. Ceylan. An Action Research on Improving Classroom Communication and Interaction in Social Studies Teaching. Volume 2021 | Article ID 9943194 | https://doi.org/10.1155/2021/9943194.
16. EURSC. Organisation of studies. Office of the Secretary-General of the European Schools. 2022. https://www.eursc.eu/en/European-Schools/studies/studies-organisation#:~:text=The%20European%20School%20system%20consists,seven%20years%20of%20secondary%20education
17. A. Cotellessa. In Pursuit of Polymaths: Understanding Renaissance Persons of the 21st Century. Department Human and Organizational Learning and International Affairs. The Faculty of The Graduate School of Education and Human Development of The George Washington University, USA. 2018.
18. O. Brayer. Is Polymath Thinking the Answer to Thriving in the AI Era? Medium. 2023. https://medium.com/@opher.brayer/is-polymath-thinking-the-answer-to-thriving-in-the-ai-era-d269000163a3
19. P. Burke. The Polymath a Cultural History From Leonardo Da Vinci To Susan Sontag. Yale University Press. New Haven and London. UK. 2020.
20. V. Crittenden, and E. Wilson, E. An Exploratory Study of Cross-Functional Education in the Undergraduate Marketing Curriculum. April Journal of Marketing Education 28(1):81-86. 2006. DOI: 10.1177/0273475305284643
21. J. Burke. Group Work in the Classroom: Types of Small Groups. CENTRE FOR TEACHING EXCELLENCE. University of Waterloo. 2022. https://uwaterloo.ca/centre-for-teaching-excellence/
22. B. Satterlee. Continuous Improvement and Quality: Implications for Higher Education. Warner Southern College (FL). USA. 1996.
23. Rancho Labs. 6 Major Sub-Fields of Artificial Intelligence. Rancho Labs. Medium. 2021.
24. M. Garanhel. What are the top 7 branches of artificial intelligence? AI Accelerator Institute. 2023.
25. M. Riedl. A Very Gentle Introduction to Large Language Models without the Hype. Medium. 2023.
26. T. Bryce. Managing Complexity. Modern Analyst Media LLC. 2015. https://www.modernanalyst.com/Resources/Articles/tabid/115/ID/3354/Managing-Complexity.aspx
27. S. Heywood, R., Hillar, and D. Turnbull, D. Insights into organization-How do I manage the complexity in my organization? Organization Practice. McKinsey & Company. 2010.
28. A. Trad. Organizational and Digital Transformation Projects-A Mathematical Model for Building Blocks based Organizational Unbundling Process. IGI. USA. 2023.

29. P. Vasudevan, and S. Reddivari. The Role of Generative AI Models in Requirements Engineering: A Systematic Literature Review. ACMSE 2025: Proceedings of the 2025 ACM Southeast Conference. Pages 188 - 194. 2025.
30. A. Trad, and D. Kalpić, D. Educational Transformation Project's Remote Group Work (BTPRGW). Book: Shaping Online Spaces Through Online Humanities Curricula. Pages: 175-207. IGI Global. 2023.
31. A. Trad. The transformation framework-The role security in the global education system. Journal: International Journal of Higher Education Management. Volume 8. Issue 1. Centre for Business & Economic Research. 2021. ijhem.com
32. A. Trad. The business transformation enterprise architecture framework for innovation: The role of artificial intelligence in the global business education (RAIGBE). Journal: The Business & Management Review. Volume: 12, Issue 1, Pages: 82-97. Centre for Business & Economic Research. UK. 2021. cberuk.com
33. A. Trad. The Education Transformation Project: The Role of Information and Communication Systems' Standards on Diversity in Educational Environment. Book: Global Citizenship and Its Impact on Multiculturalism in the Workplace. Pages: 274-307. IGI Global. USA. 2023.
34. A. Trad. Academic and Educational Transformation Projects-The Role of Skills in Academic Polymathics Fields (RSAPF). IGI Global. USA. 2024.
35. A. Trad. Educational and Continuous Learning Transformation Projects-The Role of Upskilling and Reconversion (RUR). IGI Global. USA. 2024.
36. A. Trad. Business Transformation and Enterprise Architecture Projects: Machine Learning Integration for Projects (MLI4P). Book: Unmanned Aerial Vehicles and Multidisciplinary Applications Using AI Techniques. Pages: 188-240. IGI Global. USA. 2022.
37. A. Smith. Educational Engineering: Heuristics for Improving Learning Effectiveness and Efficiency. Engineering Education, v77 n5 p274-79 Feb 1987. ERIC.
38. G. Postle. Online Teaching and Learning in Higher Education: A Case Study. Department of Education, Science and Training. University of Southern Queensland, USQ. Canberra. Australia. 2003.
39. W. Clark, K. Johnson, and C. Turner. Cross-Functional Student Teams as a Teaching Tool for Enhanced Learning. East Tennessee State University, Johnson City. 2004.
40. D. D'Souza, D. Bement, and K. Cory. Cross-functional integration skills: Are business schools delivering what organizations need? EMPIRICAL RESEARCH. Open Access. First published: 02 April 2022. https://doi.org/10.1111/dsji.12262. Decision Sciences. Journal of Innovative Education
41. N. Savage. 5 AI Case Studies. VKTR. 2024. https://www.vktr.com/ai-disruption/5-ai-case-studies/
42. S. Milanese. The Polymath's Compass: Charting a Course Through the World's Premier Learning Resources. 2024. https://stevenmilanese.com/blog/the-polymaths-compass-charting-a-course-through-the-worlds-premier-learning-resources
43. Z. Guangcheng, W. Lei, and L. Long. Abstract mathematical model of general management information systems. Information technology, database. Computers & Industrial Engineering, Volume 31, Issues 3–4, December 1996, Pages 893-895. https://www.sciencedirect.com /science/article/abs/pii/S0360835296002720
44. G. Doncean, M. Doncean, and M. Sulenco, M. Abstract mathematical models used in colour management. Journal of Public Administration, Finance and Law. 2021. https://doi.org/10.47743/jopafl-2021-22-13
45. Charles. Hosting and Cloud Software Delivery modelled in Archimate. Agile Enterprise Architecture. 2017.
46. The Open Group. Cloud Computing for Business. The Open Group. 2021.
47. The Open Group. The ArchiMate® Enterprise Architecture Modeling Language-About the ArchiMate Modeling Language. The Open Group. 2025.
48. Togaf-Modeling. Application communication diagrams. Togaf-Modeling.org. 2020.
49. A. Gomstyn, A. Jonker, and A. McGrath. Trustworthy AI? IBM. 2024. https://www.ibm.com/think/topics/trustworthy
50. J. Green. Google Cloud GCPAIE: Hyper-Accessible AI and Machine Learning. Towards Data Science. 2020.
51. D. Sullivan. Official Google Professional Cloud Architect-Study Guide. John Wiley and Sons, Inc. USA. 2020.
52. IBM. IBM Engineering Requirements Quality Assistant as a Service. IBM. 2025.
53. K. Sajna. Everything you should know about Requirements Engineering. Codilime. 2025. https://codilime.com/blog/requirements-engineering/
54. K. Gaydamaka. Archimate-Based Approach to Requirements Engineering. Article in International Journal of Mathematical Engineering and Management Sciences. 2019. DOI: 10.33889/IJMEMS.2019.4.4-066.
55. K. Ronanki, B. Cabrero-Daniel, J. Horkoff, and Ch. Berger. Requirements Engineering using Generative AI: Prompts and Prompting Patterns. University of Gothenburg, Gothenburg, Sweden. 2023.
56. E. Lisowski. MCP Explained: The New Standard Connecting AI to Everything-How Model Context Protocol is making AI agents actually do things. Medium. 2025.
57. U. Khan. NLP vs. LLM: An In-Depth Comparison. Astera. 2024.
58. C. Stryker, and A. Gutowska. What are agentic workflows? IBM. USA. 2025.
59. FabriXAI. Introduction to Agentic AI and Agentic Workflow. FabriXAI. 2025.
60. V. Winland, J. Bozorg, and C. Stryker. What is agentic architecture? IBM. 2025.
61. Generativeai. GenAI. Generativeai. 2025. https://generativeai.net/
62. J. Matuszewska, J. Top Applications of Generative AI in Media and Entertainment. Miquido. 2024.
63. EU. Ethics guidelines for trustworthy AI. EU. 2019. https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai
64. Visual-paradigm. ArchiMate Viewpoint: Requirements Realization Viewpoint. Visual-paradigm. 2025.
65. M. Woudenberg, and C.J. Unis. Systems Thinking-Skills and Insights to Resolve Wicked Problems. Systems Thinking. 2023. https://www.polymathicbeing.com/p/systems-thinking
66. K. Hayashi, S. Shibata, E. Inoue, S. Adachi, and T. Iba. Online Education Patterns, Part 1: Patterns for Linking Separate Worlds. EuroPLoP'21: 26th European Conference on Pattern Languages of Programs, July 2021 Article No.: 26 Pages 1–16. 2022. https://doi.org/10.1145/3489449.3490003

67. G. Pisonia, H. Gijlersc, T. Ha Nguyend, and H. Chene. Collaboration patterns in students' teams working on business cases. CEUR Workshop Proceedings (CEUR-WS.org). 2021.
68. C. Heinze, J. Haase, and H. Higgins. An Action Research Report from a Multi–Year Approach to Teaching Artificial Intelligence at the K–6 Level. Proceedings of the Twenty-Fourth AAAI Conference on Artificial Intelligence (AAAI-10). 2010.
69. A. Trad. The Selection and Training Framework for Managers in Business Innovation and Transformation Projects-Overview of the development of the empirical model. RECENT ADVANCES in BUSINESS ADMINISTRATION, MARKETING and ECONOMICS. Proceedings of the 2013 International Conference on Business Administration, Marketing and Economics (BAME 2013). 2013.
70. B. Dick. Action research: action and research. 2002. http://www.scu.edu.au/schools/gcm/ar/arp/aandr.html
71. R. Tarmizi, M. Tarmizi, N. Lojinin, and M. Mokhtar. Problem-based learning: engaging students in acquisition of mathematical competency. Procedia - Social and Behavioral Sciences, Volume 2, Issue 2, 2010, Pages 4683-4688, ISSN 1877-0428, https://doi.org/10.1016/j.sbspro.2010.03.750.
72. O. Orayer. Is Polymath Thinking the Answer to Thriving in the AI Era? Medium. 2023. https://medium.com/@opher.brayer/is-polymath-thinking-the-answer-to-thriving-in-the-ai-era-d269000163a3
73. J. M. Fitzgerald. A case study of a high school's development of teacher collaboration through interdisciplinary curriculum planning (Publication No. 3173664) [Doctoral dissertation, Boston College]. 2005. ProQuest Dissertations and Theses Global.
74. T. Tuononen, H. Hyytinen, K. Kleemola, T. Hailikari, I. Männikkö, and A. Toom. Systematic Review of Learning Generic Skills in Higher Education—Enhancing and Impeding Factors. Frontiers in Education. SYSTEMATIC REVIEW, published: 26 May 2022. doi: 10.3389/feduc.2022.885917
75. M. Page, S. Schagen, K. Fallus, J. Bron, Ch. De Coninck, B. Maes, W. Sleurs, and Ch. Van Woensel. Cross-curricular themes in secondary education-Report of a CIDREE collaborative project. Consortium of Institutions for Development and Research in Education in Europe. 2005.
76. F. Banks, and D. Barlex. Teaching STEM in the Secondary School-Helping Teachers Meet the Challenge. Second edition. Routledge, Oxon, USA. 2021.
77. B. Syahri, et al. AI-PBL Framework: Innovative Problem Based Learning Model Supported by Artificial Intelligence Technology. Compendex. 2025. DOI: https://doi.org/10.56294/dm20251116. https://dm.ageditor.ar/index.php/dm/article/view/1116
78. X. Yao, et al. Smart Audit System Empowered by LLM. Machine Learning Research. 2024.
79. B. Lopomo, B. How GenAI is Transforming Marketing: 7 Case Studies. 2024.
80. D. Paul, and J. Cadle. Business analysis, 4th edn. Swindon, U.K: BCS Learning and Development Limited. 2020.
81. H. Jonkers, I. Band, and D. Quartel. ArchiSurance Case Study. The Open Group. 2012.