Business transformation projects-polymathics, artificial intelligence, and patterns (PAIP)

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AI, Learning Processes, Patterns, Design Principles, Enterprise Architecture, Business Transformation Framework, Ratings/Weightings Concepts, Polymathics, Enterprise Agile Methods, Organizational Engineering, Mathematical Models, Critical Success Factors, and Performance Indicators.

Abstract
This chapter presents how to design Polymathic Artificial Intelligence (AI) patterns and how to use them in the Design Principles phase(s) (PAIP). AI-based Patterns (AIbP) are designed, architectured, and supported by an in-house Polymathic Generic Learning Process(es) (simply Learning). Learning is transcendent to any transformation domain and AI topic. The transcendent PAIP also uses pattern-based interfaces to support all AI (and related technology) sub-domains, like Data Sciences (DS), Machine Learning (ML), Deep Learning (DL), Operations Research (OR), Qualitative/Quantitative methods, and others. The PAIP uses existing author's research works and a transformation framework that is specialized in Enterprise Transformation Projects (simply Project) (Trad, 2024a). Knowing that Projects have eXtreme High Failure Rates (XHFR), and AI makes it even more complex. PAIP standardized access to AI operations, supports operational activities for the enterprise (simply Entity). Such operations' integrity is supported by the Applied Holistic Mathematical Model (AHMM) for AI (AHMM4AI), which is the product of research in the domains of AI, business engineering, organizational engineering, information technology, and applied mathematics. PAIP applies Polymathics, which is interdisciplinary and is founded on the Polymathic Enterprise MetaModel (PEMM).

Introduction

The PAIP uses a cross-functional and mixed research approach that is supported by a Heuristic Decision Tree (HDT) (Trad & Kalpic, 2019a; Trad, 2019a). The PAIP supports: 1) Empirical Decision-Making System (DMS) and Knowledge Management System (KMS); 2) Action Research (AR) structure; 3) AI-interfacing; 4) Standardised input-output for AI; 5) The integration with EA, Design principles and existing methodologies; 6) Upstreaming of the Entity's knowledge and experiences; 6) A framework for a successful finalization of Projects, PAIPD(P), and AI-modules' integration; 7) Uses the IHI Methodology, Domain, and Technology Common Artefacts Standard (MDTCAS) that is based on EA; and 8) The Management Systems Factor (FMS).

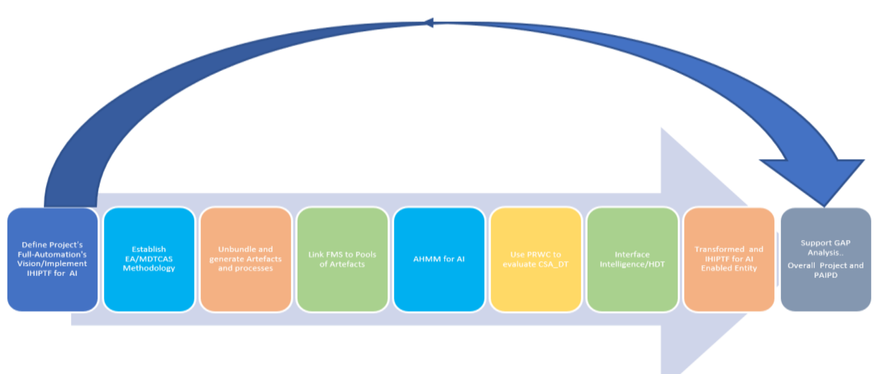

Figure 1. IHIPTF sequence of phases.

PAIP contains sets of patterns and design principles that are a new part of the author's Research and Development Project (RDP) and are a linear continuation of his previous research works, which have the aim of delivering an In-House Implemented (IHI) Transformation Framework (IHITF), as shown in Figure 1. The Polymathic Rating-Weighting Concept (PRWC) uses the FMS that includes: Critical Success Areas (CSA), Critical Success Factors (CSF), Key Performance Indicators (KPI), VARiables (VAR) used to interface Information and Communication Systems (ICS) and DMS. The IHIPTF interfaces with the PRWC, which is based on linking and evaluating sets of CSAs, CSFs, KPIs, and VARs (simply Factors). PAIP uses the AR-based Learning Process (ARbLP), which can learn and persist Project's and operations' experiences.

The Research Development Project
An Innovative, Polymathic, and Unique Concept

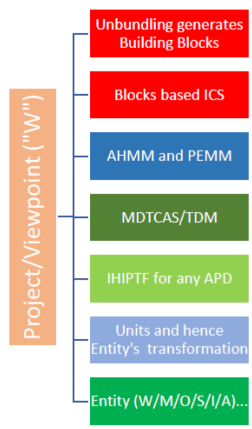

Figure 2. Viewpoint's "M" evolution roadmap

A Project can have many Viewpoints, which can include:

- "A" for EA and ICS-based transformations.
- "C" for complete transformations that combine all Viewpoints.
- "W" for the IHIPTF, which is this article's focus.
- "M" for a Meta or Meta-Meta Model.
- "I" for Infrastructural transformations.
- "O" for Organizational, Enterprise, and Business transformations.
- "S" for Security-based transformations.

Viewpoint "M" combines various Viewpoints and has a roadmap for the PAIP, as shown in Figure 2. The rate of 95% of Projects' XHFRs, and why shouldn't researchers build their own research innovation, vision, research/methods, transformation IHIPTF, and reuse some parts to deliver a coherent overall PAIP concept? (Trad, 2024c). An Anti-Locked-In (ALI) Polymathic Researched Literature Review (RLR) and Gap Analysis (GAPA) are used, and this chapter's Research Question (RQ) is: "Which PAIP characteristics and capabilities are needed to support Projects and DMS?" The PRLR is mainly based on IHIPTF's related works, like:

- The In-House-Implementation of The Polymathic Transformation Framework (Trad, & Kalpic, 2024a).
- The Selection, and Training Framework Selection and Training Framework (STF) for Managers in Business Innovation Transformation Projects–Educational Recommendations (Trad, & Kalpic, 2014a, 2014b, 2014c).
- The business transformation enterprise architecture framework for innovation: The role of artificial intelligence in the global business education (RAIGBE) (Trad, 2021b).
- Organizational and Digital Transformation Projects-A Mathematical Model for Building Blocks based Organizational Unbundling Process (Trad, 2023d). The Unbundling Process (UP) that is followed by a Refinement Process (RP) (simply Disassembling) are Project's critical phase.

- … and many others (Trad, 2024b).

This RDP has identified an important research gap that is because there isn't: 1) Any identical Polymathic approach to a Project and IHIPTF (Trad, 2024c); 2) Projects' XHFRs; 2) Any existing mixed-method like the authors' Quantitative-Qualitative Research Mixed Model (QQRMM); 3) The use of Team's profiles; 4) A concept that takes into account long-term intangible objectives; 5) Concrete FMS and Factors that link to the ICS and IHIPTF; and 6) CSA-DTs processing capabilities, as shown in Figure 3.

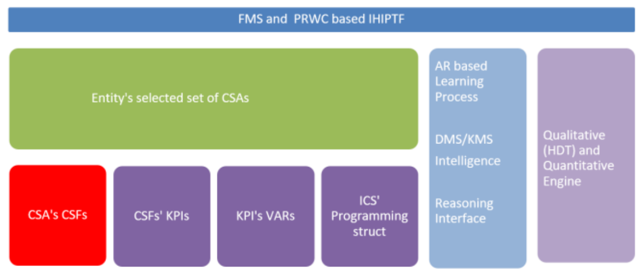

Figure 3. The FMS and PRWC IHIPTF that processes CSA_DTs.

RDP's related Proof of Concept (PoC) includes the Applied Case Studies (ACS): 1) Insurance domain (Jonkers, Band, & Quartel, 2012a), which is used for EA topics; and 2) PoCs from previous works. An RDP has to setup the PRWC a set(s) of Enumerators (PRWCE), which for this chapter has the following values: 1) Proven (that is equal to 10); 2) Possible (that is equal to 8 or 9); 3) Feasible (that is equal to 7 or 6); 5) Complex (that is equal to 5); 6) Very_Risky (that is equal to 3 or 4); 7) Very_Complex (that is equal to 1 or 2); and 8) Failure (that is equal to 0). Enumerators are to be used in all chapter's CSA/CSA_DT processing and resulting findings.

Standard Topics And Domains

Managing Complexities, Skills, and Polymathics

Projects are very challenging but also have many complexities, and the most important ones are related to the conversion and transformation of the Legacy ICS's heterogeneous components. Such a conversion offers an agile, secure, and unbundled ICS and a set of reusable services. The main reason for such XHFRs is the lack of Polymathic capabilities in management and coordination of Projects, which need a well-defined role and profile like the Architect of Adaptive Business Information System (AofABIS) (Trad, & Kalpic, 2021a). This characteristic can be found in a limited number of Team members and people in general. Polymathic skills can be built on a variant of Technocrat's profile; that includes various skills in: 1) Lean EA and patterns-based models; 2) Integrated Development Environments (IDE) for AI development; 3) Requirements analysis integration; 4) Agile Project Management (APM), 5) Applying design principles… Projects influence the way Business Processes (BP) are integrated and how they influence the IHIPTF. The use of BPs will enhance the management of Intelligence and help in the selection of the Team and its APM application. The IHIPTF offers the Architecture Development Method (ADM) based Transformation Development Methodology (TDM) approach. The IHIPTF and its TDM and its fundamental AI integration.

AI's Integration

The European Commission defines AI as a system that shows intelligent behaviour by analysing the targeted environment and that can perform various tasks with autonomy, in order to achieve defined goals (European Commission, 2019). AI has the following fields (McCarthy, 1989; Bohnhoff, 2019): 1) Mathematical models and algorithms; 2) Decision trees; 3) Learning fields, like AR; 4) Automated scheduling and planning; 5) Technology, resilience, and processing environments; 6) Robotism, automation, and recognition; 7) Data based decision or mainly a quantitative approach; and other advanced topics. AR tries to understand underlying causes, which enables future predictions about organizational changes, as an iterative learning process, where AI is a strategy (or concept) and not a product, which needs an interoperability concept (Trad, 2021b). This concept has the following (The Open Group, 2011d): 1) Inter-resources operability is supported by an interchangeable format and various levels/categories of patterns, that makes the Entity's and PAIP's interfaces generic, and standardized; 2) EA tools support the serialization of PAIP/AI processes that use serialized formats and adapted patterns; 3) This interchanges format supports PAIP and other types of interface patterns; and 4) Disassembling processes that constitute the Project's first and most fundamental phase.

Disassembling Processes, Meta-Models, and the PEMM

Polymathic model's basics are (Schmelzer, 2021): 1) Use classifications and unbundling; 2) Learning Processes (LP) and interfaces with PAIP; 3) The IHIPTF supports PAIP; and 4) Apply basic ICS patterns like Gang of Four (GoF) design patterns. There are many approaches for building a PEMM, where a PEMM is essential for Projects and can be based on the Relational DataBase (RDB) that is used in all ICS' subsystems. The main advantage is that RDBs contain all the essential information, structures, integrity-checking controls, and applied MM constraints/constructs (Trad, 2023f). Projects are complex and have XFHRs because they depend on the Composite BBs (CBB) creation process. CBBs are created by the Disassembling process. The Organizational UP (OUP) is a sequential set of Disassembling processes that transforms the Entity's legacies and offers various levels of patterns. Disassembling delivers a Pool of heterogeneous CBBs that are (re)used to build Architectural BBs (ABB) and Solution BBs (SBB) (simply Block), which are APplication Domains' (APD) agnostic. If it fails, the Disassembling process should restart (or the Project is stopped) until it delivers the feasible Entity's Pool of refined BBs, CBBs, and a central Entity's Polymathic Dictionary and Glossary (EPDG) (Trad, 2023d). Blocks can be assembled and choreographed to form a pattern or a Block-based Pattern (BpP) (Buschmann, Meunier, Rohnert, Sommerlad, & Stal, 1996). The needed Elements described in the following section can be found in practically all patterns' categories, even if different Elements are used to abstract them (The Open Group, 2018): Name; Global and Unique ID (GUID); Problem; Context; Forces; Decision Making Capabilities (DMC); A Solution … The evolution of patterns has made it possible to create Architecture and Design Patterns, which are the predecessors of basic patterns.

Implementing Factors, FMS, and PRWC

The FMS is used to integrate various levels of Projects' risks and the FMS is based on CSAs and other categories of Factors, where: 1) Each CSA corresponds to an Entity APD or common functional domain, like for example, logistics, finance; 2) Each CSF maps to a set of requirements and problems, like for example, accounting activities; and 3) Each KPI corresponds to a unique Entity's ICS item that is linked to a VAR (Trad & Kalpic, 2018a). Factors pattern(s) are persisted in IHIPTF's repository, like Blocks, and are (re)used by the FMS and PRWC. The PRWC can use standard/commercial solutions like:

- The Object Management Group's (OMG) (OMG, 2022): 1) The DMN to support CSA_DTs' evaluations; 2) For implementing business decisions and business rules; and is optimal for Project's status checking; and 3) For HDT's operations.
- The weighted criteria matrix that supports: 1) Intelligence to evaluate Projects; and is based on the evaluation criteria (that have been weighted by ratings). By evaluating alternatives based on KPIs with respect to defined criteria, and 2) A decision-making module that evaluates projects based on defined evaluation criteria weighted by ratings.

The ADM-Based TDM

TDM is used to integrate AI and common patterns, and that needs mapping and design principles. PAIP uses the "1:1" mapping, concept tracing, change of requirements, and the usage of Blocks and their granularity (Kabzeva, Niemann, Müller, & Steinmetz, 2010; Trad, 2022a). The TDM synchronizes Project's phases and manages PAIP and the HDT to solve problems (Markides, 2011). The AHM4AI is mainly a qualitative beam-search heuristic tree (Della Croce, & T'kindt, 2002), and in each of its nodes a quantitative call/functions can be executed, with the scopes: 1) Precision or objectivity referring to used data, constraint (or rules); 2) Time (or timestamp) of execution for the tracing system; 3) Space, related to the Entity's space; and 4) Scope of the HDT and hence PRWC. The HDT uses IHIPTF's NLP that can be used for any APD and, in general, for hard systems' thinking that integrates a scripting subsystem

(Moore, 2014). And the next CSA to be analysed is the role of data management, and more specifically, the Data Architecture and Modelling Concepts (DAMC).

Data Management And Access

Data-Management, DAMC, and Data-Transformation Models

The DAMC offers access management for data through a dynamic data architecture, which is a layered group of data models that is based on Data BBs (DBB), which can be represented with class diagrams. The PoC uses the normalisation conversion modules that include a set of tables to automate the data translation process that can be supported by the DSB or patterns (Fodor, Dell'Erba, Ricci, Spada, & Werthner, 2002). Object-Relational Mapping (ORM) can be used for various purposes, like transforming data sets and data models between different DBs. ORM can create a virtual object repository database that is used by Blocks that are linked to Project's requirements, which is offered by the PAIP. The PAIP use the DB Centric concept (DBCC) that offers (Vicente, 2023; Trad, 2024d); 2) A DataBase Centric Implementations (DBCI) which offers capabilities for implementing a central DB (Trad, 2024e); 3) DB Transactions' modelling that can use standards (OASIS, 2009); 4) A Data Lifecycle Diagram (DLD) that manages DSBs; 5) Data-sets are loosely-coupled which allows the usage of common data-models/patterns; and 6) Each data-model/pattern must have its status that contains the transitions and the gaps between phases (The Open Group, 2015a, 2015b).

Specific Data-Management for the PAIP

Specific data-management integration (Veneberg, 2014):

- DataBase Management Systems (DBMS) to access, read, and write in data-sets.
- DBMS types: 1) navigational; 2) Simple Query Language (SQL) based Relational DBMS (RDBMS); and 3) the Post-RDBMS (PRDBMS).
- In RDBMS, data is persisted in two-dimensional tables, and it can be accessed for read and write.
- PAIP like Data-Warehousing (DW) uses operational and historical data.
- Extract, Transform and Load (ETL) integration, where the challenge lies in the real-time data transformation and normalization processes (Tamr, 2014; Trujillo & Luján-Mora, 2003).

EA, DESIGN, MODELLING AND PATTERNS

The Role and Limitations of EA Models

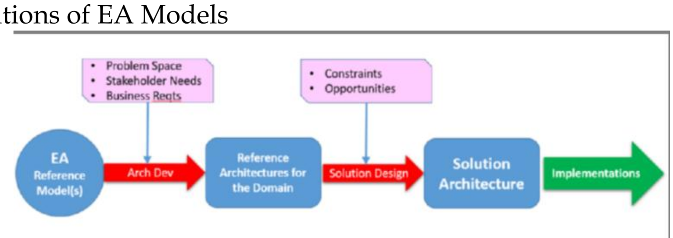

Figure 4. The model's implementation.

EA models' main characteristics and limitations are (Sarkar, 2018; Tamr, 2014):

- Building reusable assets where PAIP needs to implement an EA model.
- Improvement of transformational activities.
- Support data technologies like Data-governance standards...
- Using interoperable Blocks.
- Offers an Application Reference Model (ARM).
- EA models, and data-architecture map APDs to applications.
- ARM is a key for predictive PAIP activities (Doree, 2015).
- As shown in Figure 4, it supports qualitative/statistical analysis.

Applying EA methodologies and Patterns

Methodologies' modelling languages, like OOM, ArchiMate, and Unified Modelling Language (UML) can be used by PAIP to design and model patterns in the following contexts (Sikander, & Khiyal, 2018; The Open Group, 2018; Trad, & Kalpic, 2023b, 2023c):

- To model data concepts and patterns, like the Data Flow Diagram (DFD).
- The DFD provides information on the outputs and inputs of each object model (like a DB table).
- A flowchart can represent operations on data.
- A modelling diagram can illustrate a conceptual behavior or data model.
- Can use the Holistic Enterprise Architecture Pattern (HEAP).
- Pattern techniques are acknowledged to have been established as a valuable architectural design (Alexander, Silverstein, Angel, Ishikawa, & Abrams, 1975).
- A pattern is: …an idea that has been useful in one practical context and will probably be useful in others" (Fowler, 1996).
- The use of Design Patterns: Elements of Reusable Object-Oriented Software (Gamma, Vlissides, Helm, & Johnson, 1994).
- Apply a design-driven development or design-first approach (Escalona, & Koch, 2004).

Integrating Modelling Diagrams

An Entity Relationship Model (ERM) describes interrelated object models (tables) and comprises various object types and relationships. PAIP uses ERMs to represent objects for various types of patterns and abstract data models/interfaces. PAIP uses a data-architecture viewpoint (Merson, 2009), which incorporates various conceptual views, like the Data Dissemination View (DDV). This diagram type includes data services that abstract various data sources (The Open Group, 2015a). The Data Migration Diagram presents the flow of data between the business systems' various data sources; it serves as a view for the Project's data auditing and traceability map. The data migration diagram is enhanced through the Project's iterations (The Open Group, 2015d). A matrix is used to present the mapping relation between the role and the transformed data entity. The data security diagram includes all external accesses that may have access to the business system's data (The Open Group, 2015e). The next CSA to be analysed is PAIP's basic domains.

Paip Basic Ai Domains, Topics, And Patterns

Introduction

PAIPs offer IHI and standardized construction of ICS components and adopt a systematic use of DPs in all AI-subdomains. Knowing that AI-subdomains are used in many APDs and are critical for Entities. But AI-subdomains are complex, and actual ML is just a small part of AI. To support Projects' and PAIPD's clear and structured models, patterns, and efficient maintenance, standardized Blocks are reused in design activities that, in turn, use DPs in AI-subdomains to improve traceability and Polymathic system design. The most popular DPs for AI-subdomains are (Take, Alpers, Becker, Schreiber, & Oberweis, 2021): Pattern adapter, Factory method, Observer, Strategy, and State. As already mentioned, PAIPs are used in many AI-subdomains like Data Analytics (DA) and DS.

Data Analytics

DA's main features are (OMNI-SCI, 2021):

- DA contains the question(s) and the results…
- DA and DS improve performance by the use of data tools.
- DA and DS tools are critical for Entities and also for Big Data (BD) that uses data from multiple sources.
- DA with already processed and proven data sets.
- DS is used before DA, by exploring massive data sets, investigating their potential, identifying trends and insights, and visualizing the results…

Data Science Integration and Modelling

DS is the process of finding patterns-meaning in DBs/data-stores by using AI-domains, like ML, DL, OR, or others. That enhances Entity' LPs; and DS' main characteristics are (Guru99, 2021; OMNI-SCI, 2021):

- Applies discovery, data preparation, data models' planning, model building, operations management, and the communication of results.
- It extracts insights from vast data volumes by using scientific methods
- It extracts knowledge from structured or unstructured Data Bases (DB).
- Includes statistics, visualization, DL, and ML concepts.
- Used for predictions in Business Intelligence (BI).
- Testing is successful when DS produces the desired results for the given requirements.
- Is the result of the evolution of statistics, DA, and the massive use of BD.
  Big-Data

BD's main features are (OMNI-SCI, 2021; SAS, 2021):

- BD manages larger masses of both structured and unstructured data, using existing ICS's resources.
- Uses the three V's: 1) Volume, collect data from a variety of sources; 2) Velocity that needs extreme speed, requests just-in-time processing; and 3) Variety of types of formats, from structured, numeric data…
- DA, DS, BD, and others depend on PAIPs' quality and integration capabilities.

PAIP's Integration Capabilities

PAIP's strategy is based on principles that data (IBM, 2015a; Veneberg, 2014; Clancy, 2019; Moore, 2014):

- Can be easily managed and are accurate; and collections use data models and corresponding patterns.
- Is available to analysts, and BPs are automated.
- Costs are optimized, and standards are adopted for common data models and patterns.
- Offers traceability and monitoring patterns.
- Provides a PEMM to support operational and historic data.
- Needs a Functional Integrated Development Environment (FIDE) to describe needed patterns.
- NLP-based FIDE that is agnostic to any APD, and is an interpretable scripting environment
- Improves efficiency and is an alternative to traditional approaches.

Patterns for AI- Subsystems

PAIP enables design adaptability by promoting a modular AI-subsystem that can be dynamically reconfigured and improves problem-solving performance. And it is highly effective for Entities that require tailored pattern-based solutions. The idea of patterns originated from building architecture and has been adopted by ICS practitioners, like GoF. Patterns can abstract AI experts' knowledge and enable design decisions. There are existing pattern sets for AI-Subsystems, as shown in Figure 5.

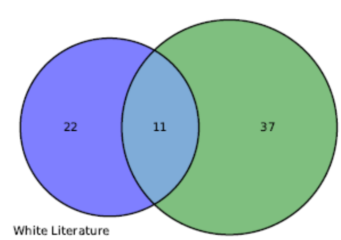

Figure 5. Various categories of patterns (Heiland, Hauser, & Bogner, 2023).

Among these unique ones, there are many new patterns, and some are traditional ones that have been adapted. Pattern categories include: 1) Architecture (25 patterns); 2) Deployment (16); 3) Implementation (9); 4) Security (9); 5) Process (8); 6) Testing (5); and Topology (3). These categories emerged as a mixture of existing categorizations, refined with adaptations based on our understanding of the holistic data-sets, like:

- High-level ones like the Strategy Pattern, Deploy Canary Model, and Batch Serving (Heiland, Hauser, & Bogner, 2023).
- Domain-specific like (Koc, 2024) that work with Large Language Models (LLM), like: Layered Caching Strategy Leading To Fine-Tuning…
- And the next CSA to be analyzed is PAIP's advanced domains.
  Paip Advanced Domains, Topics, And Patterns

A Qualitative Approach

The PAIP uses an AI-enhanced qualitative approach that supports (Stevens, 2020):

- LPs' interactions, training, and model development. It is used by moderators.
- Manages, analyses, and responds to large volumes of unstructured text data.
- Virtual moderator activities by conducting text-based interviews through a chat interface.
- Remote video observation, interviews, and focus groups.
- Consumers' video to help generate consensus around a topic.

Optimal Development and Operations Processes and Integrating Business Intelligence

PAIPD needs an Intelligent Strategic Development and Operations (iSDevOps) that is supported by an alignment of various standards and development strategies that bias the standard development and operations (DevOps) procedures (Trad, 2021f). Intelligence-driven EA and Enterprise Asset Management (EAM) that use neural networks and HDT. Heuristics are applied in Project problems and define sets of actions to deliver solutions (Trad, & Kalpic, 2018b). Such an approach can use the Private Cloud-based Transformation Projects (PCTP) for business intelligence to support HDT, AI, and BI activities, where Neural Networks (NN) and HDT are combined with an internal metaheuristic algorithm. PCTP offers a virtual platform that supports PAIPD and Knowledge and Intelligence-Driven Development (KIDD) (Trad, 2023b; Trad, & Kalpic, 2017a, 2017b, 2021b). But that needs specific skills.

The Roles of Education, Profile, and Skills

The PAIP supports a Behavior-Driven Development (BDD) environment that can be easily adopted by any Entity. An AI-specific development environment, like FIDE, can be used by any team member without any prior ICS/computer science skills/qualifications. For a successful Project, the team's and manager's profiles are crucial, where their activities and decisions are supported by the IHIPTF and its modules. A holistic systemic approach is the optimal (Trad, 2021b), but the manager needs specific PAIP skills like (Ghulati, 2024):

- EA and ICS's system design to integrate AI modules.
- Estimate training data needed and how to integrate it.
- Define the latency of the model/pattern required in inference.
- How to prototype models/patterns.
- ….

  This chapter is a part of a new cluster labelled Patterns to Transform (P2T).

The PQLC

The PQLC interfaces with existing standard formats like: Project Management XML (PMXML) used by the project management body of knowledge (PMBOK); Architecture XML (ArchiXML)... These AI XML formats support M, DL, and other formats, which need a specific environment. AI XML formats (Aravilli, 2017):

- The Predictive Model Markup Language (PMML) is an XML-based language that provides a way for applications to define statistical and data mining models...
- The Portable Format for Analytics (PFA) is an open standard model interchange format...
- Apache SystemML provides an optimal workplace for machine learning using big data. Declarative large-scale ML…

- Artificial Intelligence Markup Language (AIML) is an XML dialect for creating natural language software agents.

These formats support the IHIPTF and PAIPD, which depend on PQLC and not on simplistic statistical methods, which may appear complex for the reader. But PQLC is needed (Trad, 2024a):
- Heuristics-based reasoning emerged as an Intelligence domain in the middle of the 20th century, and in 1950, Alan Turing developed a fundamental test for machine logic, which is known as the Turing Test (Schmelzer, 2021).
- Uses mainly AR that is optimal for LPs, because its empirical approach enriches reflective practice and local practical inquiry.
- Manages Return On Experiences (ROE). ROEs are enriched by solutions for encountered problems.
- Because the rate of failures in such Projects is about 95%.
- Intelligence includes a cognitive process and attempts to replicate human intelligence and behavior, and also tries to apply heuristics/HDT by using an IHI NLP.
- The PQLC is the foundation of AI domains like OR, ML, DL, and others.
- Can interface with Artificial Neural Networks (ANN) that promote iterative LPs, which can be 1) Supervised; 2) Semi-supervised; or 3) Unsupervised. And the next CSA is the APDs.
  POSSIBLE APDs

Military Applications

The Role of AI for Military Strategies (RAI4MS), supports the Entity to predict and prepare for conflicts. To build the RAI4MS against AI-enabled threats, the Entity needs to transform its capacities into potential security barriers. Foreign interference demands transformation steps to ensure resilience and to confront disinformation and rumours. The PAIP leverages AI-enabled Cyberdefence modules to protect against Cyberattacks, and today, biosecurity has the top priority. The actual phase of warfare will transform the world, where an option is to design Projects and implement PAIPs. Adversaries are determined to use AI capabilities (Trad, 2022b). If RAI4MS is not given priority, adversaries will take advantage and might attack, and the PAIP should be IHI.

General Purposes Applications

General-purpose applications can be (Tableau, 2024):
- Facial recognition is steadily on the rise.
- Email automation and spam filtering by finding patterns in emails.
- Social media optimizations that use AI to enhance their functionalities…
- Mobile voice-to-text and predictive text by applying LP and predictive text deals with language.
- Predictive analytics is an area of advanced analytics that uses data to make predictions.
- Interfaces to business and industrial applications.
  Business and Industrial Applications
  Business applications can be (Datasentics, 2024; Tableau, 2024; CallMiner, 2019):
- PAIPs are fundamental in many industries, like digital marketing, complex quality control, general task automation, and business intelligence.
- Ensuring on-shelf availability is prone to human errors. All the reasons mentioned above have led to the development of the Shelf Inspector application.
- Matching resumes to job descriptions to optimize time, to share them, and find the right employers.
- Text extraction and classification that improves high-quality input data.
- Intelligent Data Models to abstract data-volumes for AI-subdomains and offer data-driven solutions. Where a PAIPD offers fast model development.
- Add value to business by solving complex business problems that are rich in data, such as interpreting health applications, like medical images, to diagnose cancer earlier.
  Health Applications

AI-based health applications can (CallMiner, 2019; Tableau, 2024):

- Support healthcare advancements to enable the transition to e-medical records …
- Offer LP/NLP, cognitive computing solutions for processing health data.
- Support complex clinical DMS to reduce routine, time-consuming, resource-intensive tasks.
- Assists clinicians in going through a patient's entire medical history and provides recommendations.

Engineering Applications

Automating repetitive Entities' tasks by using PAIPs can streamline critical BPs or workflows. And thus improve productivity for common, business, and ICS parts like software and data-modelling operations. Engineering applications include the following activities (Moses, 2023):

- Automatically generating Blocks, AI-scenarios, and quality checks…
- Automatically debugging and rectifying minor errors, or predicting possible problems.
- Generate large volumes of synthetic data that mirror real-world information for test activities.
- Automatically generate documentation.
- Update and transform legacy software components.

And with this CSA, RDP 1st phase ends, and the next section presents the PoC.

The Proof Of Concept

The main Factors were deduced from the selected ACSs, which are used in the Project to evaluate its status and they are managed by the FMS/PRWC. One basic ACS is the insurance management system (ArchiSurance) that wants to transform its legacy system, which has a claim files-services manager and a customer file-services manager; and is used to finalize the unbundling process. The ACS explains how to manage, register, accept, evaluate, and invoice claims-related activities (Jonkers, Band, & Quartel, 2012). For this PoC, a Polymathic approach is used to restructure Factors, Blocks, and patterns.

Evaluating RDP's CSA_DTs-The 1st Phase

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 6. The CTWRE's values

The PAIPD interfaces the DMS, FMS, and Factors, which are presented and evaluated in Table 1, using the CSA_DT's Tables Weighting and Rating Enumerator (CTWRE) that is shown in Figure 6. The PAIPD-required skills have mappings to Project's resources, and the PRWC defines relationships between the Project and requirements. Table 1 shows Phase 1's final results and deduces that the PAIPD and Projects have "Important Risks". The AHMM4AI's main constraint to integrate the PAIPD is that CSAs having an average result below 8.0 will be ignored. The conclusion with the result of 8.50 implies that PAIPD integration will fail. And as Phase 1 was terminated, the PoC continues to IHIPTF's setup for concrete problem solving.

CSA Category of CSFs/KPIs	Transformation Capability	Average Result	Table
The RDP's Integration	Usable-Mature	From 1 to 10. 9.20	1
Standard Topics	Transformable-Possible-Complex	From 1 to 10. 8.20	2
Data Management	VeryComplex	From 1 to 10. 8.50	3
EA models for AI	Transformable-Possible-Mature	From 1 to 10. 8.25	4
PAIPD's Basic Domains	Heterogenous-Complex	From 1 to 10. 8.25	5
PAIPD's Advanced Domains	Heterogenous-Complex	From 1 to 10. 8.25	6
Possible APDs	Heterogenous-Complex	From 1 to 10. 8.20	7

Evaluate First Phase

Table 1. The PRWC RDP's outcome is (rounded) 8.50.

Phase 2-Solving a Concrete Problem

The PoC configures Factors, then they are mapped to Project resources and artefacts. The FMS contains the relationships that link the Project's requirements, Blocks, FIDE/NLP scripts, and Global Unique IDentifiers (GUID). FIDE/NLP scripts contain the defined sets of actions to be processed, and AHMM4AI supports PAIPD's. For the PoC, a Problem is selected from a list of Problems (or PRB) to be solved.

PRBs Solving for a concrete HDT Node:

Intelligence solves PRBs, where Factors are a defined set of actions that are processed in a selected/concrete HDT node. For this aim, the action CSF_IHIPTF_PAIPS_Integration_Procedure (from the Intelligence CSA) was executed and offers sets of solutions (SOL).

SOL Nodes activities:

- NLP scripts are called by the IHIPTF's modules, like the PAIPD.
- These scripts are processed in the background to deliver IHIPTF's module value(s).
- These values are translated into PAIPD actions, conclusions, and recommendations.

Phase 3-AI-Subdomain Implementation

Cloud-based ICSs offer AI support like the Google Cloud Platform (GCP) that includes ML services, Vertex AI, which offers end-to-end support for ML workflows and has many ML services, FIDE/tools… But it is limited. The GCP also offers tools like: Command interface gcloud, Storage manager gsutil, and scripts for setting up the prerequisites or constraints; these tools support (Pangu, 2021; Trad, 2023c):

- GCP's AI/ML uses a statistical approach that can improve accuracy.
- Problem selection setup that has a predefined set of actions.
- Using JupyterLab (a Python environment) to develop and set up needed processes.
- The solution was used for data preparation, which is an important task in ML processing.
- TensorFlow processes datasets that are uploaded to GCP's Storage (GCS).
- Training a Model Locally (TML) was used before Vertex AI.
- Launch the training job on Vertex AI, using a prebuilt container.
- Using TML with GCP Vertex AI supports: A distributed training strategy…
- Final model's construction program trains the model on Vertex AI.
- All the operations used PAIPs as interfaces.

Conclusion And Recommendations

This RDP offers a set of recommendations on how to implement a PAIPs for Projects, for any APD. In turn, the IHIPTF uses modules like FMS, PRWC, GAPA, and Factors to assert Project's feasibility, and because of the low score of 8.50 (Table 1) the Project contains "Important Risks", and recommendations are:

- This RDP uses a qualitative approach for AI.
- The RDP proved the existence of an important PAIPD knowledge gap and XHFRs.
- The AHMM4AI supports the PAIPD.
- The HDT supports IHIPTF's module reasoning.
- Cross-functional/Polymathic AI skills are needed.
- The IHIPTF uses and interfaces with existing frameworks, standards, and methodologies.
- The PAIPDs offer the needed sets of AI patterns.
- The PoC checked PAIPD's feasibility.

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