Private Cloud based Transformation Projects (PCTP) for Business Intelligence

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ABSTRACT

This article presents the PCTP which can be used as a central part of complex transformation projects. This part uses the author's Polymathic-holistic transformation model and framework, which can be applied in various Applied Problem Domains (APD). These APDs intensively use Business Intelligence (BI), which can make the most important business advantage. The implementation of PCTP based BI Services (PCBIS) is supported the author's Applied Holistic Mathematical Model (AHMM) for Clouds (AHMM4C) and his various research works on Artificial Intelligence (AI), BI, Refinement and unbundling processes, Mathematical Models, Cross-functional/Polymathic transformations projects, and System's architecture. The AHMM4C is based on cross-functional research on an authentic, original, and proprietary mixed research method that is supported by his own version of a search tree or the Heuristics Decision Tree (HDT) that supports AI and BI activities, where the HDT is combined with an internal metaheuristic algorithm. In this article the main focus is on the PCTP's and PCBIS's integrations, PCBIS-based solutions, Data management and analysis, Qualitative and Quantitative analysis, and corresponding transformation methodologies strategies. The proposed AHMM4C based PCTP/PCBIS are virtual platforms that support enterprise wide decision-making processes, which use real-world business cases related to business transformation projects. Such projects need specific Cloud infrastructure and services that are supported by the alignment of various existing Cloud Platform (CP) fields like: Services, Standards, Enterprise architecture paradigm(s), Storage management, Development strategies, AI, and other... In this article the Google CP (GCP) is used as the reference CP, but there is need to define a standardized transformation methodology to support CP based procedures so that the organization can build its In-House Implementation (IHI) of a Private CP (PCP) and tries to: 1) Avoid being locked-in; 2) Bare excessive costs; 3) Protect its AI/BI based models; 4) Implements AI/BI services (simply *Services*); and 5) Have an IHI *Services* concept. The PCTP serves as PCBIS' platform and infrastructure; and in turn the PCBIS uses intelligent (or AI/BI) scenarios. BI scenarios are sets of choreographed *Services* that are used to solve a *Project* problem or a precise requirement to support dynamic business advantages.

INTRODUCTION

The PCTP/PCBIS are based on research resources related to various PCP, CP, AI/BI, Business engineering, Information and Communication Systems (ICS) domains, Compute Services (CS), and Security integration services. This article offers a set of recommendations to support the PCTP/PCBIS where the applied strategy is a generic polymathic driven business concept that uses *Services*, AHMM4C, Enterprise Architecture (EA), and PCBIS' architecture. The PCBIS includes various quantitative and qualitative services that offer different types of decision-making services that can be used to support dynamic businesses. The PCBIS needs different levels of provisioning, that in turn depend on the requested type of APD, the enterprise's maturity and integration capacities in the domains of PCP (and its Application), AI/BI, and Business architectures.

Keywords: Business Intelligence, Artificial Intelligence, Organizational Intelligence, Machine Learning, Cloud systems, Enterprise architecture, Mathematical Models, Business Requirements, Business Services, Business Transformation projects, Performance Indicators, Business (re)engineering and Strategic Vision.

BACKGROUND

The PCTP/PCBIS support business transformations and is a Polymathic-holistic concept that will be analyzed by the Research and Development Project (RDP) for Cloud (RDP4C). The PCTP/PCBIS are business driven and are agnostic to any APD and is founded on the author's framework that interfaces industry standards, like the Architecture Development Method (ADM) for Cloud (ADM4C) [1,2]. The PCTP/PCBIS Manager, BI analyst, Cloud architect or enterprise architect (simply the *Manager*) can integrate PCTP/PCBIS in company's (simply an *Entity)* business architecture's roadmap, where it delivers the path for integrating BI modules using the ADM4C. The RDP4C is based on Literature Review Process for PCTP (LRP4PCTP), a Qualitative Analysis for BI (QLA4BI) methodology and on a Proof of Concept (PoC), used to solve the Research Question (RQ), in which the *Manager*'s role is crucial and his decisions are aided by using the Supporting Decision-Making System (DMS) for Cloud (DMS4C). The PoC uses an insurance case [3] and the following sets of Critical Success Factors (CSF): 1) IHI BI/AI concepts, which are built on the HDT; 2) Unified PCBIS interface mechanisms; 3) A private AHMM4C; 4) Managing PCTP risks; 5) *Entity* resources mapping to PCBIS requirements and Microartefacts; 6) Building internal BI/AI skills; 7) PCTP/PCBIS robustness, security, infrastructure, and requirements technological support; 8) BI/AI implementation and tests capacities; and 9) Monitoring, tracing, and control subsystem(s). A PCP is optimal for the PCTP because it is an internal solution and there is extreme pressure to implement PCBISs in *Entities*, to gain more business sustainability.

*FOCUS OF THE ARTICLE

The PCTP uses EA methods, like The Open Group's Architecture Framework's (TOGAF) and its kernel ADM4C, which supports also PCBIS's integration. Actual CP techniques for PCTPs focus on isolated commercial tools, services, processes, and specific quantitative PCBIS solutions. Minimal modelling technics are needed for PCBIS' to align with other CPs (or PCPs), this is done by using the ADM4C which synchronizes PCBIS [4]. This article also illustrates how PCTPs can support

PCBIS activities and proposes adequate transformation recommendations.

THE RESEARCH AND DEVELOPMENT PROCESS FOR PCTP

The RDP4C RQ is: “Which PCTP/PCBIS characteristics and solution s are needed for a sustainable *Entity’s* business evolution?”. Where the kernel part of the RDP4C is based on PCP, the HDT and CSFs (and business areas). A Critical Success Area (CSA) is a category (or set) of CSFs where in turn a CSF is a set of Key Performance Indicators (KPI), where a KPI maps (or corresponds) to a single PCTP requirement. For a given PCTP or PCBIS requirement, request, or problem; there is a need to identify the optimal sets of CSAs, CSFs and KPIs, for the DMS4C and then maps them to PCBIS requirements, resources, … Therefore, CSFs reflect CSAs that must meet PCTP/PCBIS goals and constraints. Measurements technics that are provided by the Transformation, Research, Architecture, Development framework (*TRADf)*, are used to evaluate performance for each CSA, where CSFs can be internal or external. The CSF-based RDP4C uses the BI/AI/HDT based DMS4C, for RDP4C’s Phase 1 (represented in automated decision-tables), which form the empirical part of the RDP4C, which checks the following CSAs: 1) RDP4C, synthesized in Table 1; 2) PCP and ICS, synthesized in Table 2; 3) DMS4C and Knowledge Management System for Cloud (KMS4C), synthesized in Table 3; and 4) PCTP/PCBIS; and 5) This article’s outcome is synthesized in Table 5. The tables’ decision concept was influenced by the Object Management Group’s (OMG) Decision Model and Notation (DMN) [5]. The PCTP delivers recommendations on how to use the PCBIS by using *TRADf*, which shows how to implement and IHI transformation framework.

An IHI Framework-TRADf and Related Works

The PCTP alignment strategies manage *Entity’s* subsystems, resources and Microartefacts and *TRADf*. The author’s research project’s keywords were introduced in the scholar engine (in Google’s search) and the results clearly show the uniqueness and lead of the author’s methodology, research and works. Due to this fact, the author considers his works in the mentioned fields as successful and useful. A combined Polymathic-systemic approach [6] for the PCTP/PCBIS makes it generic and can be applied to any PCP and *Entity*; and related works are: 1) The Cloud Compute System [7]; 2) The Cloud Holistic Security Integration [8]; 3) The Cloud Business Process Management [9]; and 4) Enterprise Transformation Projects-Cloud Transformation Concept – Artificial Intelligence Services [10]. If all facts are only referenced, it would have impossible to understand this RDP4C which is mainly based on an Empirical Engineering Research Model (EERM) [1].

Empirical Engineering Research Model

The EERM is suited Polymathic-holistic engineering fields, and in this article, it uses the HDT that uses Quantitative Analysis for BI (QNA4BI) and QLA4BI methods, to deliver an empirical mixed method. QNA4BI and QLA4BI methods are compatible and the difference is the scope and depth of the research process. EERM’s validity checks if the RDP4C is acceptable as a contribution to existing scientific (and engineering) knowledge. The goal is to convince the reader(s) that the proposed PCBIS recommendations and the related PoC, are valid and feasible. In engineering, a PoC is a design and software prototype of a testable RQ where one or more CSFs (or independent variables, in theoretical research) are processed to evaluate their influence on the EERM’s

dependent variables. The PoC permits to evaluate with precision the CSFs and if they are related, whether the cause–effect relationship exists between these CSFs and CSAs. The PCBIS uses EA and ICS standards [1].

RDP4C's CSFs

Based on the LRP4PCTP, the most important CSFs are presented in Table 1, which has a high score that is mainly due to the RPD4C maturity and related works. The next CSA to be analyzed is the roles of PCP and ICS environments and the PCTP and hence PCBIS.

Critical Success Factors	KPIs	Weightings
CSF_RDP4C_Standards	Feasible	From 1 to 10. **09 Selected**
CSF_RDP4C_CSF_CSA_Integration	Proven	From 1 to 10. **10 Selected**
CSF_RDP4C_EERM	Proven	From 1 to 10. **10 Selected**
CSF_RDP4C_IHI_Framework	Possible	From 1 to 10. **09 Selected**
CSF_RDP4C_PCTP_MajorRelatedWorks	Proven	From 1 to 10. **10 Selected**

valuation

Table 1. CSFs that have the average of rounded 9.60.

PCP AND ICS' ROLES

ICS Basics

An ICS enable a PCTP to support various services and dynamic PCBIS activities, where the integration of AI/BI modules can be integrated. Therefore, *Entity's* business sustainability depends on the PCBIS, that includes an IHI framework to manage distributed modules and synchronizes all BI activities. The main problem for PCTPs is to unbundle their monolithic legacy ICS and to reuse the transformed modules in the PCBIS. A PCTP is an on-demand services platform; which is distributed over various locations. A PCP includes a group of interconnected ICS nodes, providing services and an entire managed suite of components, which are designed internally. The *Entity's* ICS and sets of applications are managed by the PCP, where the PCBIS is used to serve the DMS4C and *Entity*'s intelligent business capabilities. The PCTP can use EA oriented modelling language like Archimate, to classify applications [7,12,17].

PCP Basic Constructs

The CP, PCP and PCTP use exiting established Cloud services, like GCP services, which can include: 1) Various types of AI disciplines, like Machine Learning (ML) and Deep Learning (DP); 2) Data management services; 3) Integration in CS' components, like Virtual Machines (VM), Compute Engines (CE), …; 4) Use with Cloud Functions (CF); and 5) Infrastructure-as-Code (IaC). The PCBIS includes the following activities and components: 1) EA based Design of optimal BI solutions; 2) Relating with Use Cases (UC)/requirements to AI/BI scenarios; 3) Dynamic deployment using the Development and Operations for BI (DevOps4BI); 6) CSFs' usage; 7) Provisioning, security…; 9) Data flows and pipelines management; and 10) DMS4C and KMS4C. The PCTP is based on CP principle sections, the: 1) Infrastructure as a Service (IaaS); and 2) Platform as a Service (PaaS) [11]. The PCBIS uses Business Processes (BP) and their Models (BPM) that can be used for BI scenarios building or other workflow concepts. The PCBIS needs to integrate BPMs to [13]: 1) Develop and test BI scenarios; 2) Provides an AI/BI implementation

environment; 3) Ensures availability; and 4) Resources' usage. The PCTP/PCBIS use combined models like: PCP modules, PaaS, SaaS, IaaS, Services-based Application Programming Interface (API)… PCBIS uses a Natural Language Processing 4 BI (NLP4BI) to be used for implementing BI scenarios. The PCBIS supports the sharing-interaction of *Project's* resources by using the ADM4C to assist the *Project* team [1]. The unbundling process supports the Digital Transformations (DT) which is mandatory for the PCTP/PCBIS.

The Role of DT

For PCTPs, a DT is a strategic objective and that implies high-adoption rate of digital technologies; but digitization is a complex process, and more than 70% fail. The unbundling process breakdowns *Entity's* silos to enable DT that is PCTP's main construct [14]. DTs are difficult to scope because they depend on the APD and MDTCAS' incorporation capacities.

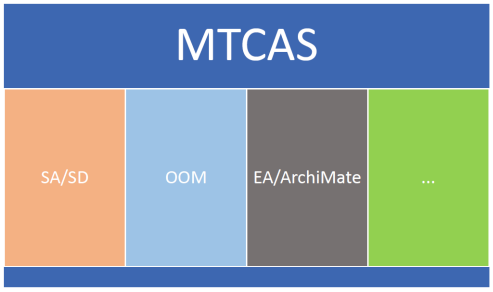

Figure 1. MDTCAS Implementation.

A successful DT supports a PCTP/PCBIS functions, which enhance functional performances. A PCTP defines an MDTCAS, which is a mix of existing methodologies and practices. The MDTCAS includes Object Oriented (OO) Methodology (OOM) and legacy methodologies, like the Structure Analysis and Structured Design (SA/SD). MTCAS interfaces standard methodologies which are based on OOM which have OO features, inherited from three OOM namely Rumbaugh, Booch and Jacobson methodologies, which are the fundaments of the most known ICS standard, the UML. OOM, UC are the basis of the actual EA modelling languages. Like ArchiMate, which has many artefacts, diagram types and views.

The Role of Architecture

Moving to a standardized PCP is the first step to an initial PCBIS architecture and a dynamic pool of BI services and scenarios [1]. EA supports the PCTP/PCBIS by offering: 1) The *Architecture Capability Understanding*; 2) As shown in Figure 2, EA's integration with the PCBIS is done in the business architecture phase [1]; and 3) Tools for *Business Architecture and Modeling*, where PCBIS focuses on designing BI based business requirements and artefacts. EA is needed to transform legacy processes into a dynamic PCTP that is agile and is supportive of the defined PCBIS strategy.

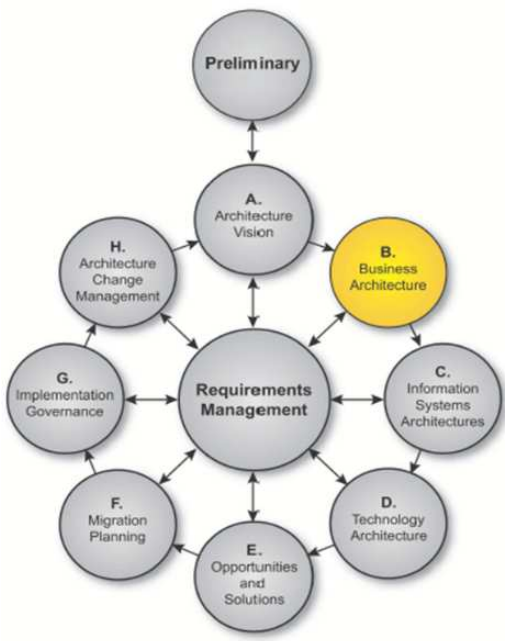

Figure 2. TOGAF's main phases [1].

PCBISs need effective operation's management of BI services. ADM4C's integration with the PCBIS, enables the automation of *Services* and supports cyclic DevOps4BI iterations. The PCBIS uses BI scenarios to support the *Entity's* business intelligence. The ADM4C offers the control and monitoring of BI services by using various types of tests and integration concepts like: 1) Test Driven Developments (TDD) which evaluates the design of a PCBIS requirement; 2) The Acceptance Test Driven Development (ATDD) which supports the collaboration of PCTP team [15]; 3) The Behavior-Driven Development (BDD) concept includes TDD, integration and ATDD tests that serve as a formalism for PCTP team's communication; and 4) AI-Driven Testing (AIDT) which is optimal for the PCBIS [16].

The PCP and ICS CSFs

Based on the LRP4PCTP, the most important CSFs are presented in Table 2, which has sufficient that is due to PCP's feasibility. The next CSA to be analyzed is the roles of DMS4C and KMS4C.

Critical Success Factors	HMM enhances: KPIs	Weightings
CSF_PCP_ICS_Basics	Feasible	From 1 to 10. **09 Selected**
CSF_PCP_ICS_DT	Complex	From 1 to 10. **08 Selected**
CSF_PCP_ICS_Architecture_MDCTAS	Feasible	From 1 to 10. **09 Selected**
CSF_PCP_ICS_PCTP_Support	Complex	From 1 to 10. **08 Selected**

valuation

Table 2. CSFs that have an average of 8.50.

THE DMS4C AND KMS4C

Using the AHMM4C

The AHMM4C that is presented to the reader in a simplified form to be easily understandable on

the cost of a holistic formulation of the architecture vision. The PCTP/PCBIS use the AHMM4C that is formalized as shown in Figure 3. The symbol ∑ indicates the summation of all the relevant named set members, while the indices and the set cardinality have been omitted. The summation should be understood in a broader sense, more like set unions.

Basic Mathematical Model's (BMM) Nomenclature

Iteration	= An integer variable ***"i"*** that denotes a *Project/ADM iteration*	
microRequirement	= (maps to) KPI	(B1)
CSF	= Σ KPI	(B2)
Requirement	= (maps to) CSF = ⋃ microRequirement	(B3)
CSA	= Σ CSF	(B4)
microMapping microArtefact/Req	= microArtefact + (maps to) microRequirement	(B5)
microKnowledgeArtefact	= ⋃ knowledgeItem(s)	(B6)
neuron	= action->data + microKnowledgeArtefact	(B7)
microArtefact / neural network	= ⋃ neurons	(B8)
microArtefactScenario	= ⋃ microartefact	(B9)
AI/Decision Making	= ⋃ microArtefactScenario	(B10)
microEntity	= ⋃ microArtefact	(B11)
Entity or Enterprise	= ⋃ microEntity	(B12)
EnityIntelligence	= ⋃ AI/Decision Making	(B13)
BMM(*Iteration*) as an instance	= EnityIntelligence(*Iteration*)	(B14)

Figure 3. The AHMM4C nomenclature.

The *Project*'s development and mapping processes are a part of the PCTP which uses the DMS4C. The DMS4C, as shown in Figure 8, is based on a light version of the ADM4C.

The Generic AHMM's Formulation

AHMM	= ⋃ ADMs + BMMs	(B15)

AHMM's Application and Instantiation for CTC

Domain	= CTC	(B16)
AHMM4(*Domain*)	= ⋃ ADMs + BMMs(*Domain*)	(B17)

Figure 4. The AHMM for the PCTP domain.

The enterprise AHMM4C is the combination of an EA and transformation methodologies [43,44]. A transformation is the combination of an EA methodology like the TOGAF and the AHMM for a Domain, that can be modelled after the following formula for the PCTP/PCBIS based Transformational Model (PTM) that supports BI/AI activities:

PTM = EA + AHMM4C (B18)

AI and BI Constructs and Viewpoints

BI/AI are crucial and are misunderstood, where AI explores the use of ICS to imitate human-intelligence, like problem-solving, Intelligent Learning Process (ILP)… Even if AI is still in its infancy phase, *Entities* consider AI for basic operations like speech-recognition, basic decision-making… As important. BI refers to the use of ICS to analyze faster business data and to provide *Entities* with meaningful decision-making. AI and BI overlap in various domains, but there are differences; and understanding these differences can support PCBIS' integration. Differences like [18]: 1) The goals of BI are: Streamlines the processes of collecting, reporting and analyzing data; and it supports the improvement of collected data quality to be used in the DMS4C; 2) The goals of AI are: Modeling of human-intelligence to extract behaviors and thought-processes, like the

ILP. BI leaves decision-making to specialists, whereas AI enables PCBIS to make decisions; 3) UC's applications are: BI UCs are fundamental to *Entity's* operations to manage clients and improve business efficiency. AI UCs are used to improve processes automation, cognitive insights, and cognitive engagements, as shown in Figure 5. Cognitive insight are advanced process automation applications which can learn and self-improve; and cognitive engagement humans with interfaces like chatbots; 4) BI/AI are distinct and complementary, where BI help *Entities* manage massive data volumes. By mixing AI/BI (like the HDT based DMS4C), *Entities* synthesize data volumes into PCBIS scenarios. AI supports BI: To produce concise insights from data, clarifies datapoints on a granular level, and Supports humans in understanding decision-making; 5) BI's evolution depends on AI because *Entities* have to combine these disciplines like in the DMS4C.

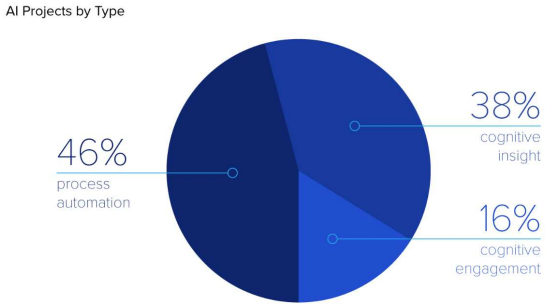

Figure 5. AI types [18].

DMS4C Basics

As shown in Figure 6, the DMS4C offers decision support for various levels of management: 1) Senior managers; 2) Middle management; 3) Operations management; and 4) *Project* management. This is done by using different sets of CSFs and adapting the AHMM4C's *Goal Function* for various management levels [19,20]. The DMC4C and KMS4C support PCBIS' processes that use sets of services. These services are build, deployed, and managed by the ADM4C. The PCBIS is designed to support *Entity's* in streamlining BI/AI workflows, which can interface market products, like GCP's AutoML engine. The PCBIS is designed to support typical BI/AI workflows, as shown in Figure 7, and have defined operation phases: 1) *Prepare* data sets and that includes ingest, clean, feature engineer operations in *BigQuery Datasets*; 2) Uses AutoML (a zero-code platform) for inter-machine training models; 3) *Validate* for the PCBIS environment; and 4) *Deploy* the validated model that was trained using AutoML. All the mentioned operations are managed by an ML Pipeline or ML DevOps4BI (MLOps), and that ensures robust, repeatable, and scalable deployment.

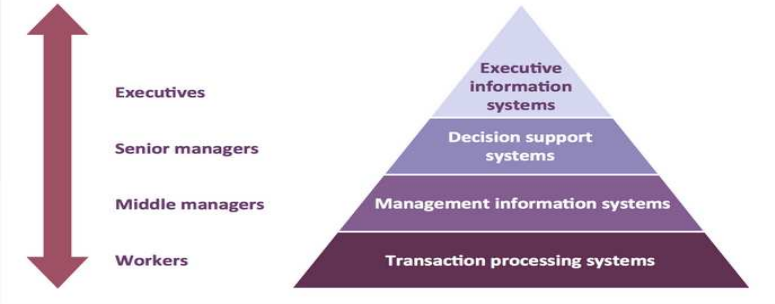

Figure 6. The management pyramid model has different DMC4C levels (Concept, 2014).

The PCBIS offers a set of services to support MLOps, which can be supported by market tools like, *Kubeflow* or *TensorFlow Extended*. Deep Learning (DL) module supports the provisioning of PCBIS applications; and it provides preconfigured modules for PCBIS' and Data Management Capacities (DMC) [21].

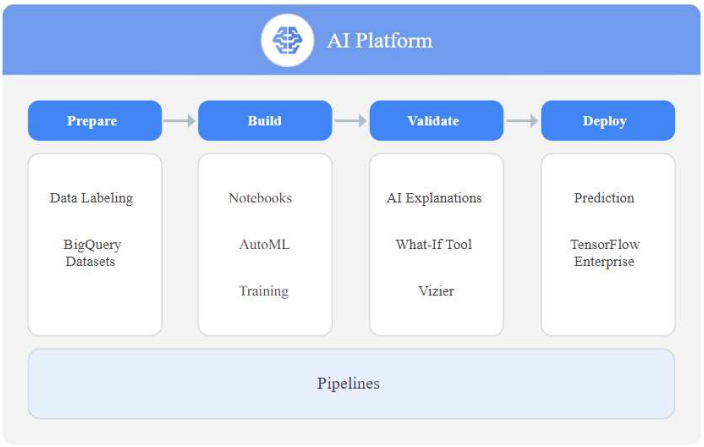

Figure 6. GCP's AI capacity [21].

The DMC

The DMC is based on [22]: 1) Cloud Storage that supports: Media content, Backups, Integrated repository for PCBIS operations, and Supports Cloud SQL; 2) Cloud SQL that supports: Managing Relational DataBases (RDB), Business continuity; RDB provisioning, Capacity management, RDB's observability, Integration with applications, and Facilitates migrations; 3) *BigQuery Datasets* support operations use a collection of tables in GCP's hyper-scale data storage. *BigQuery* is an interface to the *Entity*'s data storage, and BI/AI services; 4) BigTable is a NoSQL wide-column database optimized for heavy reads and writes; and experts wonder if they should use BigQuery or Bigtable; and 5) Support automated BI/AI (like AutoML) operations.

Automating BI/AI Operations

AutoML's main characteristics are [22]: 1) AutoML enables high-quality BI models that can deliver optimal solutions/decisions; 2) Supports refinement activities; and 3) The application of commercial no-code AutoML that offers a set of services to support the deployment of BI/AI models and to generate limited solutions, decisions and predictions. The DMS4C supports complex intelligent sub-systems that include established algorithms like the Operational Research (OR), BI analysis, Modelling, and MLOps [6].

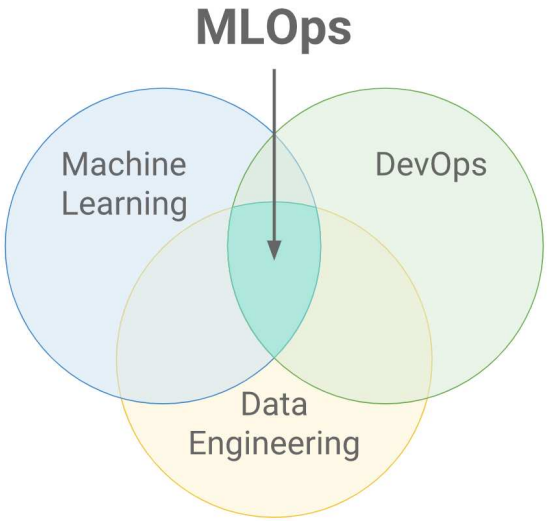

Figure 7. MLOps as an intersection methodology [23].

MLOps' main characteristics [23]: 1) Synchronizes ML, DevOps4BI, and Data engineering, as shown in Figure 7; 2) Deploys and maintains ML models; 3) Combines ML and DevOps4BI; 4) ML models are tested and developed; 5) Includes Data Operations (DataOps) that improves production models; 6) Applies an entire lifecycle; and 7) MLOps is a subset of ModelOps, which focuses on all types of AI models

DMS4C's and KMS4C's CSFs

Based on the LRP4PCTP, the most important CSFs are presented in Table 3, which has sufficient that is due to DMS4C feasibility. The next CSA to be analyzed is the roles of PCTP/PCBIS.

Critical Success Factors	AHMM enhances: KPIs	Weightings
CSF_KMS&DMS4C_AHMM4C	Feasible	From 1 to 10. **09 Selected**
CSF_KMS&DMS4C_AI/BI_Constructs	Feasible	From 1 to 10. **09 Selected**
CSF_KMS&DMS4C_Basics	Complex	From 1 to 10. **08 Selected**
CSF_KMS&DMS4C_DMC	Feasible	From 1 to 10. **09 Selected**
CSF_KMS&DMS4C_Automation	Complex	From 1 to 10. **08 Selected**

valuation

Table 3. CSFs that have an average of 8.60.

PCTP/PCBIS' INTEGRATION

Platforming and Business Capacities

PCP's capabilities are based on by [7,11,22]: 1) ADM4C is used for the creation of capacity building, and applying best practices; 2) Uses standard artefacts, like GCP's services that includes CFs [1]; 3) To access BI orchestration system; 4) Load balancing tasks to support the PCBIS; 5) Use PaaS to support PCTP; 6) Provisioning, provides an interactive interface for managing ICS resources; 7) Manage PCTP states, like using GCP's offers managed databases (*Cloud SQL* and *Cloud Datastore*); 8) Managing dataflows and pipelines, which support services, like, Cloud Bigtable, BigQuery, or Cloud ML; 9) Monitoring and alerting services; 10) Security controls which are pervasive in all its processes, like *Multi-Cloud Logging Strategy*; 11) Cover various APDs; 12)

Enable business advantages and innovative business models which depend on data management capacities [24]; and 12) Support complex BI/AI scenarios (simply *Scenario).*

BI/AI Scenarios

Scenarios are interactions of BI/AI services; and the PCTP aligns of resources, using the "1:1" mapping concept. A PCTP supports a variety of APD actors and handles *Scenario* requests by executing APD processes and services [4]. *Services* provide autonomy, scalability, and an optimal platform for integrating *Scenarios*. *Scenarios* classification concept is used to classify them in central repository. Data *Services* focuse on the encapsulation of the data schemas [25]. Actual AI/BI mechanisms like AutoML are primitive and the author considers that the complex ILP needs action-based approach, like Action Research (AR). The PCBIS use ILP based AR/HDT.

AR/HDT based PCBIS

The author's AR/HDT is a generic ILP-based AI/BI concept that fits various APD problem-solving situations. By extending existing theories and presenting the effects of heuristics under two different contexts: 1) Experiential; and 2) Vicarious. Where heuristics are consequential in explaining variations in ILP and how to manage complexities. AR/HDT can be adaptive and beneficial to the ILP, otherwise complexity and chaos can distort the DMS4C. AR is based on: 1) Reasoning on the acquired status; 2) Tuning the model, CSFs and actions; 3) New iterations launch processes for the collection of data; 4) If the results are satisfying, then conclusions be made, otherwise retry the AR; and 5) It uses mainly qualitative heuristics. The HDT is a combination of a positivist AR based on Grounded Hyper-Heuristic (GHH) algorithms [26,27]. The DMS4C uses the HDT for problem's: 1) Selection; and 2) ILP based solving. The HDT uses: 1) The relationships between sets of CSFs, an algorithm to *rate & weight* the selected CSFs; 2) *Scenarios*; 2) PCTP resources; and 3) PCBIS. Risk management is crucial for *projects* but research on risk propensity of PCTPs has no empirical support even if they are very risky. The HDT is based on the following terms [27,28,29,30]: 1) *Empirical reasoning or induction* is the most serious subject in research sciences, based on induction; 2) CSFs based DMS4C for defining: Capacities, Status; and PCBIS strategy; 3) Data and rules that originate from various sources are verified to be used by the HDT; 4) Based on a generic and Polymathic approach; 5) *Heuristics* have deep roots in philosophy (heureca), mathematics, management sciences and in natural sciences until the present day. It is a *rule of thumb*, and a guide to implement problem solving and the combination of various heuristics defines the hyper-heuristics approach; 6) *Hyper-heuristics* are applied for functions and combinatorial risk assessments in various APDs; 7) The GHH: Is CSF-based, and includes tuning and delivering results by trial-error and develops an Applicative Action Research (AAR); and 8) The AAR is applied in education research which is similar to the ILP. The AAR supports: 1) Actions; 2) State, offers solution(s); and 3) Polymathic research. The HDT based DMS4C manages *Project's* risks through the lens of GHH and this LPI perspective supports heterogeneous *Project* problem types; this form a specific PCBIS construct.

The PCBIS Construct

RDP4C's aim is to convert an *Entity's* legacy system and its components into useful PCBIS constructs, which can be implemented by any *Entity* and to transform *Project's* experiences and

decisions into coherent ILP inputs [27,37]. *Scenarios* are important PCBIS' choreography artefact. Actual AI/BI concepts use mainly simple data-crunching, rule-based algorithms to compete but the proposed adaptive PCBIS offers a more performant model. The PCBIS construct is based on: 1) Default sets of CSAs, CSFs and their links them to PCBIS KPIs. Where CSFs based *Services* help in identifying *Business Transformation Risks and Mitigation Activities*. The *Project* team locates risks related to *Project's* goals and assesses the initial level of risks, by using the AR/HDT. The levels can be: Catastrophic, Critical, Marginal… The *Project* sets the number of ADM4C iterations and assigns a AI/BI based mitigation strategy. TOGAF offers risk management with two levels of risks: 1) *Initial Level of Risk*: Applies categorization prior to determining and implementing mitigating actions; 2) *Residual Level of Risk*: Applies categorization after the implementation of mitigating actions. HDT's root (or initial node) contains the select problem set and related set of CSFs. AR/HDT's goal is to offer an optimal set of solutions. Today there is a gap between standard metrics' evaluation and EA based IHI evaluation methodologies, which offer [31,32]

- *TRADf* manages *Project's* constraints, rules, problem types, and weightings. CSF based PCBIS's processing, delivers set(s) of possible solutions of recommendations [33].
- Offers a mapping concept that links AR/HDT nodes to *Services*, CSFs, resources, requirements, ILP services, actions, and solutions... The AR/HDT uses *Services* to abstract various services technologies [34].
- *Scenarios* support the LPI and AR/HDT; and BI tools can be used for. That includes advanced automated *Scenarios* which enhance PCBIS integration, because it uses smart rules and analytics to enhance the HDT. The HDT is a collection of nodes that contains in each of its node a set of resources.
- The solution node reschedules *Project's* activities to solve occurring problems and optimizes the interaction between *Scenarios*. Solving problems involves the classification of problem types and linking corresponding actions, which deliver a set of solutions [35].
- The HDT contains a collection of tree nodes which contain: 1) Actions that are *services*; 2) Constraints and rules; 3) Requests or problems; and 4) The solutions are *atomic business recommendations, reports…*
- CSFs are used by the HDT, which can be configured, weighted, and tuned. The HDT is launched with an initial set of CSFs, then it processes the selected problem(s) and proposes solutions, as shown in Figure 8 [26,28]. PCBIS is a generic system that can implemented by any *Entity*.
- The PCBIS uses ML models which can find patterns and supports the DMS4C; and persists all ILPs. An ML model can perform by training with qualitative (document cases) or quantitative (large datasets) methods. During the training process, ML optimizes actions to locate patterns or outputs from various sources [36].
- Integrating PCBIS *Scenarios* is a complex task, especially when using standard solutions and that can be a locked-in financial burden.

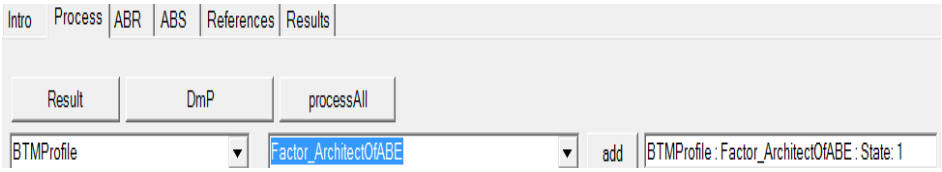

Figure 8. TRADf delivering a possible solution node [28].

Financial Aspects

Using a standard or commercial CP based solutions, like GCP can cause major issues, like: To become locked-in, Can be very expensive, and the high probability that the *Project* fails. Another major issue is that CP providers will control *Entities'* PCTP activities and makes them dependent on their platform; that is why *Entities* must build their own PCP based PCTP/PCBIS, by using their existing legacy system and ICS' resources. The only winners of a commercial CP based ICS, are major CP providers and they are making huge benefits like this year's total CP sales, for: Amazon Web Services (AWS) is $19.74 Billion, GCP is $6.28 Billion, and Microsoft Cloud is $25 Billion… AWS generated a record-breaking $19.74 Billion in revenue gains during 2022 second quarter; and Amazon has spent Billions of USD in installing new data centers worldwide to accommodate the high demand for AWS cloud services [38]. CP related surveys like the *Survey of 100 IT decision-makers in companies with 500 or more employees conducted by NetEnrich* found that 85 percent claimed moderate or extensive production use of CPs and that there are major issues and will make businesses locked-in, in the cases like: 1) CP lacks holistic security (68 percent); 2) ICS related costs are too high (59 percent); 3) Problematic routine maintenance operations (36 percent); 4) Root-cause analysis and post-mortems are unreliable (22 percent); 5) *Entity's* find that skilled PCTP/PCBIS (and related AI/BI) experts are too expensive and are not capable to solve various types of problems; and many other issues related to *Projects* [39].

PCP based BI

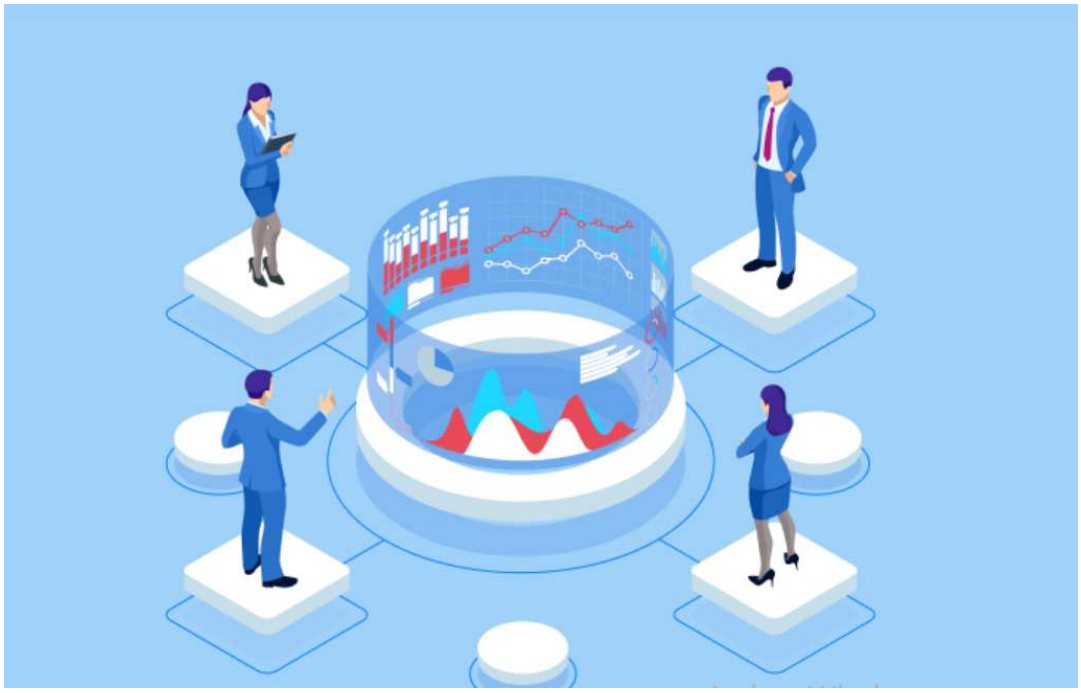

Figure 9. Cloud-based BIs enable business data to become accessible [41].

The basis of CP and PCP have their origins in the 1950s with the evolution of microchips and the monolithic mainframe computer system. APD users were able to use these systems through client (or terminal) frontends and by the help of the critical Central Processing Unit (CPU) they managed ICS resources; afterwards practices related to multitenancy and time-sharing quickly evolved. In the period between the 1960s to the late 1990s, major improvements to time-sharing concepts, server balancing and ICS remote accesses were established to support the dot-com era of the early 2000s. The quick development of ICS4 power and the emergence of the internet during the 1990s, enabled major developments in distributed ICS; and hence CPs and PCPs. Major ICS constructors enabled CPs' ability to deliver distributed ICS power without adding infrastructure and locally installing software/applications. Since the 2000s, the CP industry has exponentially grown, and it is predicted to become a multi-trillions industry. But at the same time destroying these major providers are destroying smaller environments and locking-in various APDs, and that is why an *Entity* must adopt IHI PCP, PCTP, and PCBIS. IHI PCP and BI can be combined to deliver a performant and maintainable PCBIS. PCBIS is used to deliver just-in-time solutions and precise information to the *Managers*, and the PCTP provides an agile concept to access *Services*. The major advantage of Cloud BI or the PCBIS is that they are accessible on multiple PCP/ICS nodes. The PCTP serves as PCBIS' infrastructure and in turn the PCBIS uses *Scenarios. Scenarios* are sets of choreographed *Services* that are used to solve a *Project* problem or a precise requirement. *Services* are based on mainly Cloud BI that are modules that are hosted on a PCP. *Services* provide *Entities* with access to BI-related data-based dashboards, business KPIs and other form of essential business analytics. *Entities* are transforming their ICS or business information system into to PCP enabled business tools which are based on BPM environments, like the Customer Relationship Management (CRM)

system, PCP-based agile file collaboration, dynamic storage, and client-support (or help-desk) software/applications. This major PCTP evolution includes the dynamic integration of: BI modules, *Services*, and agile management. The PCTCP/PCBIS offers the following advantages: 1) Significant advantages over on-premise applications; 2) Ease of use, simple to operate, ease of setting-up, and reduces ICS costs; 3) Are simple to deploy, because they do not require additional PCP installations; 4) Scalability and elasticity, because they can be rapidly scaled to adapt to the increasing number of users; 5) Accessibility to any internet-browser or mobile device. PCTP/PCBIS' potentials are important and *Entities* are implementing IHI PCPs, which are of strategic importance and are beneficial, because they improve business efficiency, increase development cycles and improve unbundled *Services*. PCP based applications are very performant and they offer *Entity's* users feature-depth that was before not available. The PCTP/PCBIS have the potential to cover all APD's analytics and BI strategies, which includes IHI/self-service BI, and to provide APD-users with just-in-time access to business-critical data and solutions [41]. But when implementing a PCTP/PCBIS there is the need not to just implement a Quantitative view but a mixed view like the AR/HDT.

A Quantitative BI

Most of the commercial BI solutions have a pure Quantitative view on DMS4Cs. The actual CP BI tools that included in the CP's data-stack, which uses various (only) Quantitative methods to: Collect, Organize, Move, and Transform (in the sense of simple conversion) data. There are many BI (or common) tools that can be used to manage data; and these tools need to be connected to the *Entity's* data-sources, like databases, data-streams or spreadsheets. These data-sources are then processed with various (Quantitative) methods, algorithms, and statistical models. The used datasets are then made ready to be analyzed by the CP based BI or PCBIS to find insights; with no use or application of ILPs, but by just creating huge volumes of unmanageable data. The resulting insights can then be presented in a data-visualization-environments, like bar-charts or histograms, that can be shared with many users, and offer simplistic decisions to improve business performance, in fields like marketing. There various benefits of classical CP based BIs are used to gain insights into APD's operations and performance statuses; like improving data visibility. Data visibility has to be improved because many *Entities* have been for a long time struggling with siloed-data, where information/data from different data-sources and ICS/systems remains isolated and hard to interface, and hence to be used. By adopting a CP or PCP the goal is to migrate data-sources (and volumes) to these CP platforms, when the unbundling process is successfully finalized, then the PCTP can be continued, because various barriers are removed, which enables a Polymathic-holistic view of the APD/business.

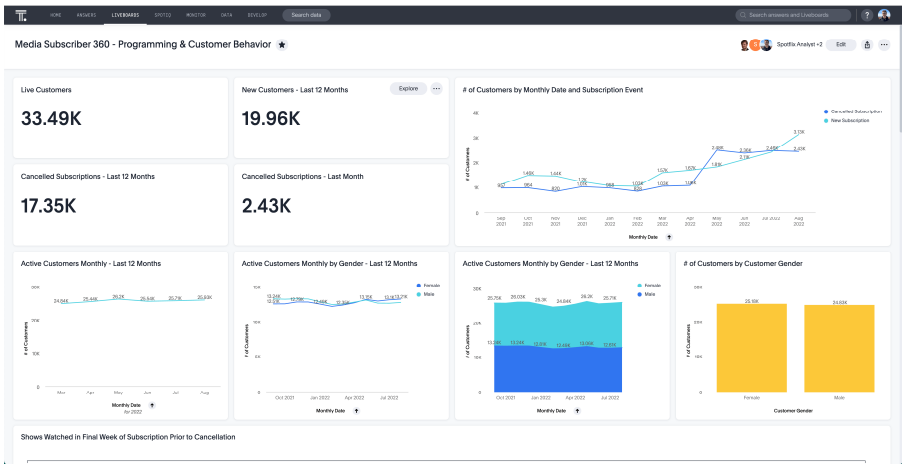

Figure 10. A Live-board showing media subscriber 360 numbers around customers [42].

Effective CP or PCP BI solutions integrate easily and directly with CP or PCP data platforms, and this fact enables *Entities* to interrogate various data-sources in its PCP/ICS landscape. The newly established visibility helps *Entities* to gain a *360-degree* view of their APD activities, as shown in Figure 10 [42]. Maybe the word BI is over-dimensioned for such an activity which is much more a sequence of data-processing and data-presentation activities… So where is exactly the intelligence… but when implementing a PCBIS there is the need not just to implement a Quantitative view but a mixed view like the AR/HDT, which will be presented in the PoC.

PCTP/PCBIS' Integration CSFs

Based on the LRP4PCTP, the most important CSFs are presented in Table 4, which has sufficient that is due to PCP BI's feasibility. The next step is to implement the PoC.

Critical Success Factors	KPIs	Weightings
CSF_PCTP_PCBIS_Platforming_Capacities	Possible	From 1 to 10. **09 Selected**
CSF_PCTP_PCBIS_Scenarios	Complex	From 1 to 10. **08 Selected**
CSF_PCTP_PCBIS_AR/HDT_PCBIS	Possible	From 1 to 10. **09 Selected**
CSF_PCTP_PCBIS_Basic_Constructs	Complex	From 1 to 10. **08 Selected**
CSF_PCTP_PCBIS_Financial_Aspects	Supported	From 1 to 10. **09 Selected**
CSF_PCTP_PCBIS_PCP_BI	Complex	From 1 to 10. **08 Selected**
CSF_PCTP_PCBIS_Quantitative BI	Primitive	From 1 to 10. **08 Selected**

valuation

Table 4. CSFs that have a rounded average of 8.60.

THE POC'S IMPLEMENTATION

This PoC uses an *Entity* that implements *CloudEcoSource* [40], which launches three separate transformation initiatives (or PCTPs); and it uses TOGAF's ADM4C to manage phases. The *CloudEcoSource* is extended to apply and integrate the PCTP/PCBIS. *Entities* must have tested its

Scenarios, *Services*, and PCP/CP functions, which are used in the *CloudEcoSource*. The *CloudEcoSource* needs to implement *Services*-based solutions, and a PCP (or to engage several external *Cloud Service Providers and Partners).* The proposed PCTP includes: The transformation of the heterogeneous legacy ICS, Enabling a distributed platform, Integrating BI, and setting-up *Services/Scenarios* registries. There is also the need to support its critical *Services* based APD/business requests. As mentioned, the *Entity* intends to use the TOGAF standard for EA activities and practices to support the *Project's* implementation phase. The *CloudEcoSource* has three distinct *Project* objectives and an IHI PCP which is based on the following fields: IaaS, PaaS, and SaaS for AI/BI; and these fields are the basis of *CloudEcoSource's* critical business operations. This PoC describes how the extended *CloudEcoSource* case plans to use the *Services*, PCTP/PCBIS, to create and evolve various business APD/models and AI/BI modules. The following features present *CloudEcoSource*'s initiatives [40]: 1) The IaaS initiative, concerns the *Entity*'s infrastructure's modernization, optimization and consolidation; with the expectations on how to transform, manage and regulate dynamic resources consumption in a multi-tenant PCP/ICS infrastructure, with real-world effective management of security and privacy of its tenants, like for example the *Entity*'s clients' requests; 2) The PaaS initiative, is related to the concept of Rapid Application Development (RAD) platform, where the PaaS-focused initiative is used to identify and describe EA based PCTP/PCBIS capabilities of a platform for *CloudEcoSource* BI solutions. Dynamic instances of the PCP(s) could be deployed and operated by a *Project* team, *Entity* or by partners of PCP's Ecosystem; and 3) The SaaS initiative, concerns mainly an enhanced collaboration among multiple external *Scenarios*, *Services*, and PCBIS providers; where the PCBIS assembles AI/BI capabilities for APD/business collaborations that extend the *Entity*'s traditional applications' boundaries, to support business-users (both internal and external users). The PoC's development uses an adapted implementation environment.

The LRP4PCTP's

The LRP4PCTP (or Phase 1) outcome that supports the PoC's background, by the use of an archive of an important set of resources, references and links that are verified and analyzed using a specific *TRADf* interface. After selecting the CSA/CSFs tags, they are linked to various *Scenarios* and *Services*; which is implemented as items, in an Excel file; where all its details are defined; this concludes Phase 1. In this DMS4C related PoC (or Phase 2), the HDT to deliver solutions. The empirical part is based on the AHMM4C's instance and the PCP aBB4I mechanics', which uses the internal initial sets of CSFs' that are used in phases 1 and 2.

From Phase 1 to Phase 2

The *Project's* enumeration of CSAs are: 1) The RDP4C; 2) PCP's and ICS' Integration; 3) The DMS4C's and KMS4C's integration; and 4) The PCTP's and PCBIS' integration;. Where Tables 1 to 4, where presented and evaluated in this article and they are this article's empirical part.

The PoC

The PCBIS 's PoC was implemented using *TRADf* that had been developed using: The GCP and its AI capabilities (and structures), *TRADf's* NLP4BI, Microsoft Visual Studio .NET, C/C++, and JEE. The PoC is based on the PCTP/PCBIS *Services*, AI/BI modules, and CSFs' binding, using a specific

Project requirement and related resources, where the PCBIS was designed using EA and ADM4C (like TOGAF) tools. The PCTP/PCBIS processing model represents the mapping relationships between PCP's requirements, PCP *Services/Scenarios*, and the CSFs. As shown in Figure 11, the PoC sets-up the needed CSs.

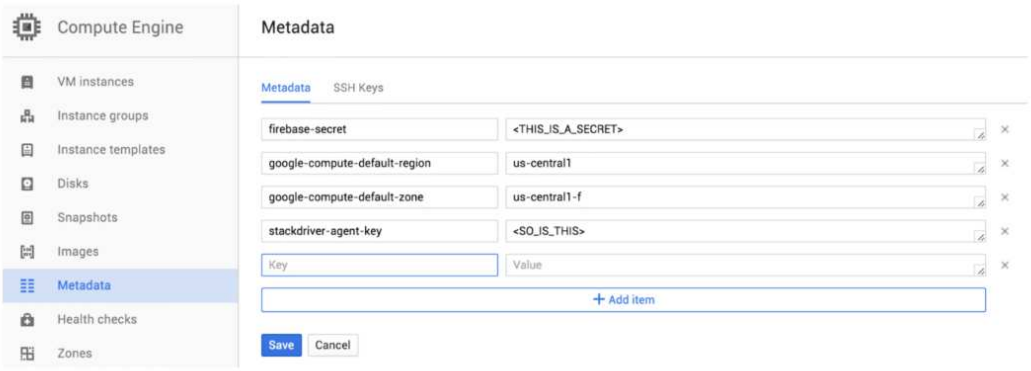

Figure 11. CSs configuration.

The PoC was developed using *TRADf's* frontend and the mapping/linking actions were activated by: 1) Choosing an initial AR/HDT node that contains PCTP/PCBIS requirements; 2) Choosing the *Services* and *Scenarios*; and 3) Choosing to an APD problem to be solved using an NLP4BI-based *Scenarios*. When the setup is achieved, from the frontend the PCTP/PCBIS requirements development initiation interface that is shown in Figure 12, is launched.

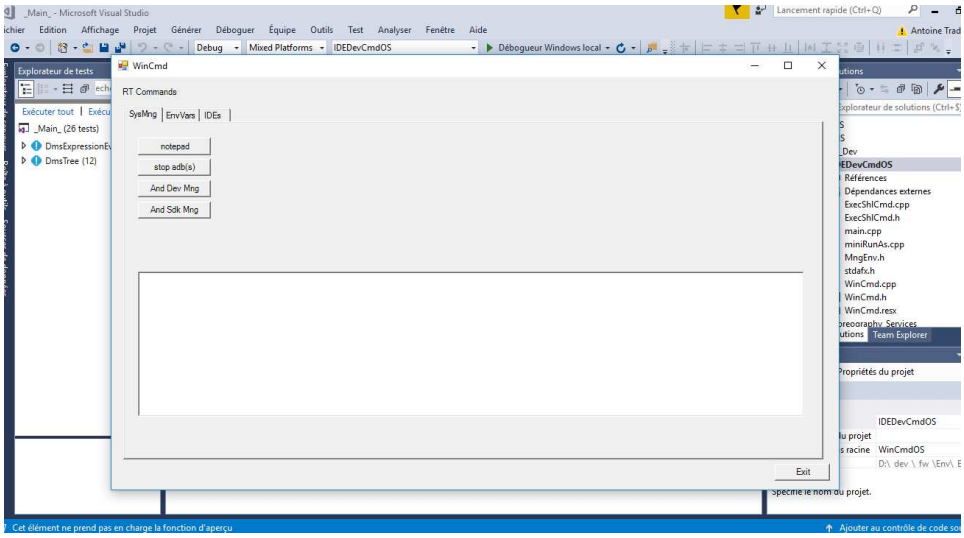

Figure 12. The *TRADf's* setup interface.

The PCTP/PCBIS use the GCP database and *TRADf's* AR/HDT makes calls to *Services* to solve a concrete APD problem. Once the development setup interface is activated, the NLP4BI interface can be launched to implement the needed PCBIS *Services* and *Scenarios*. These NLP4BI *Scenarios* that make up the DMS4C subsystem and the PCBIS's relates set of actions. PCBIS-related CSFs were also selected as demonstrated previously in this article's four tables and the result of the

processing of the DMS4C, as illustrated in Table 5, shows clearly that the PCBIS is not an independent component and in fact it is strongly bonded to the *Project*'s overall risk management approach; but it is a complex undertaking.

CSA Category of CSFs/KPIs	Influences transformation management	Average Result
RDP4C's Integration	Feasible	From 1 to 10. 9.60
PCP and ICS Integration	Complex	From 1 to 10. 8.50
DMS4C and KMS4C Integration	Complex	From 1 to 10. 8.60
PCTP AND PCBIS Integration	Complex	From 1 to 10. 8.60

Evaluate First Phase

Table 5. The PCBIS research's outcome is 8.8.

RDP4C's constraint is that CSAs having an average result below 8.5 will be ignored. As shown in Table 5 (which average is 8.8), this fact keeps the CSAs (marked in green) that helps make this work's conclusion; and no ones in red. It means that such an PCBIS integration is complex but feasible; therefore, the PCBIS based *Project* must be done in prudent multiple transformation sub-projects.

SOLUTION AND RECOMMENDATIONS

This article's resultant technical and managerial recommendations are:

- This article presents the PCTP/PCBIS which can be used for transformation projects.
- *TRADf* uses a Polymathic-holistic transformation model, which can be applied in various APDs.
- The RDP4CT is an EERM and is feasible; and implemented a PoC to check RQ's feasibility.
- The AHMM4C based PCTP/PCBIS supports the DMS4C and KMS4C.
- The *Project* must be separated in multiple processes, where the first one should attempt to unbundle the legacy ICS and propose an IHI PCP. And there is no need for a specific commercial product.
- An *Entity* can build an IHI of a PCP
- The unbundling process generates *Services/Scenarios* that are common to all PCBIS types.
- The PCTP/PCBIS is applicable but very complex and the *Project* must build a global PCBIS.
- EA and the ADM4C are the main methods for PCTP's construction.
- After EA based PCTP/PCBIS is ready the next step is to integrate the AHMM4C based KMS4C/DMS4C.
- Major efforts are applied to integrate existing standards and concepts because the main problem is alignment of silos.

- The PCTP enables the automation of *Services/Scenarios* to support implementation business activities.
- The PCTP/PCBIS are business driven and are agnostic to any APD.
- Table 1, presents a high score that is mainly due to the RPD4C maturity and related works.
- Table 2, presents a sufficient score that is due to PCP's feasibility.
- Table 3, presents a sufficient score that is due to DMS4C feasibility.
- Table 4, presents a sufficient score that is due to PCP BI's feasibility.
- Table 5, shows that PCTP/PCBIS' implementations are complex.

CONCLUSION

The RDP4C is part of a series of publications related to *Projects*, AI, PCTPs and CPs and is based on mixed action model, AR/HDT, and GHH; where CSAs and CSFs are selected and tuned to help *Project's Managers* and architects to diminish the chances for failure when building a PCP based PCTP/PCBIS. In this article, the focus is on PCTP/PCBIS, where its formalism defines a structured inter-relationship of *Services*, *Scenarios*, AI/BI, PCBIS, and other *Entity's* components and resources. The PCBIS needs an important set of CSFs for the *Project's* decision-making capabilities and evolutions. The PoC was based on the CSFs' binding to a set of specific RDP4C resources and AR/HDT's reasoning engine that represents the interaction and relationships between various BI concepts, *Project's* requirements, *Services*, *Scenarios*, and CSFs. The result proves that an PCTP/PCBIS can supports the transformation process, but is complex to implement.

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