


The Business Transformation Framework and Enterprise Architecture Framework for Managers in Business Innovation: An Applied Holistic Mathematical Model

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ABSTRACT

This journal article proposes a cross-business domain applied holistic mathematical model (AHMM) that is the result of a lifetime long research on business transformations, applied mathematics, software modelling, business engineering, financial analysis, and global enterprise architecture. This ultimate research is based on an authentic and proprietary mixed research method that is supported by an underlining mainly qualitative holistic reasoning model module. The proposed AHMM formalism attempts to mimic some functions of the human brain, which uses empirical processes that are mainly based on the beam-search, like heuristic decision-making process. The AHMM can be used to implement a decision-making system or an expert system that can integrate in the enterprise's business, information and communication technology environments. The AHMM uses a behaviour driven development environment or a natural language environment that can be easily adopted by the project's development teams. The AHMM offers a high level implementation environment that can be used by any team member without any prior computer sciences qualification. The AHMM can be used also to model enterprise architecture (EA) blueprints, business transformation projects, or knowledge management systems; it is supported by many real-life cases of various business domains. The uniqueness of this research is that the AHMM promotes a holistic unbundling process, the alignment of various EA standards and transformation strategies to support business transformation projects.

KEYWORDS

Business Applied Mathematics, Engineering, Business Transformation Manager, Business Transformation Project, Decision-Making Systems, Enterprise Architecture, Holisms, Knowledge Management Systems, Neural Networks, Risk Management

INTRODUCTION

Actual archaic Business Transformation Projects (BTP) are managed as separate black-boxes that are isolated silos where their internal and external components create a messy hairball that is called the enterprise's Information and Communication System (ICS) (Desmond, 2013). As already mentioned, the AHMM is based on many real-life cases and uses a model that can be used in a large variety of application fields, like: 1) business transformation projects; 2) business engineering projects; 3) critical success factors management; and 4) EA development procedures. This article recommends that the ICS's Decision Making System (DMS) uses the AHMM instance to solve problems by offering

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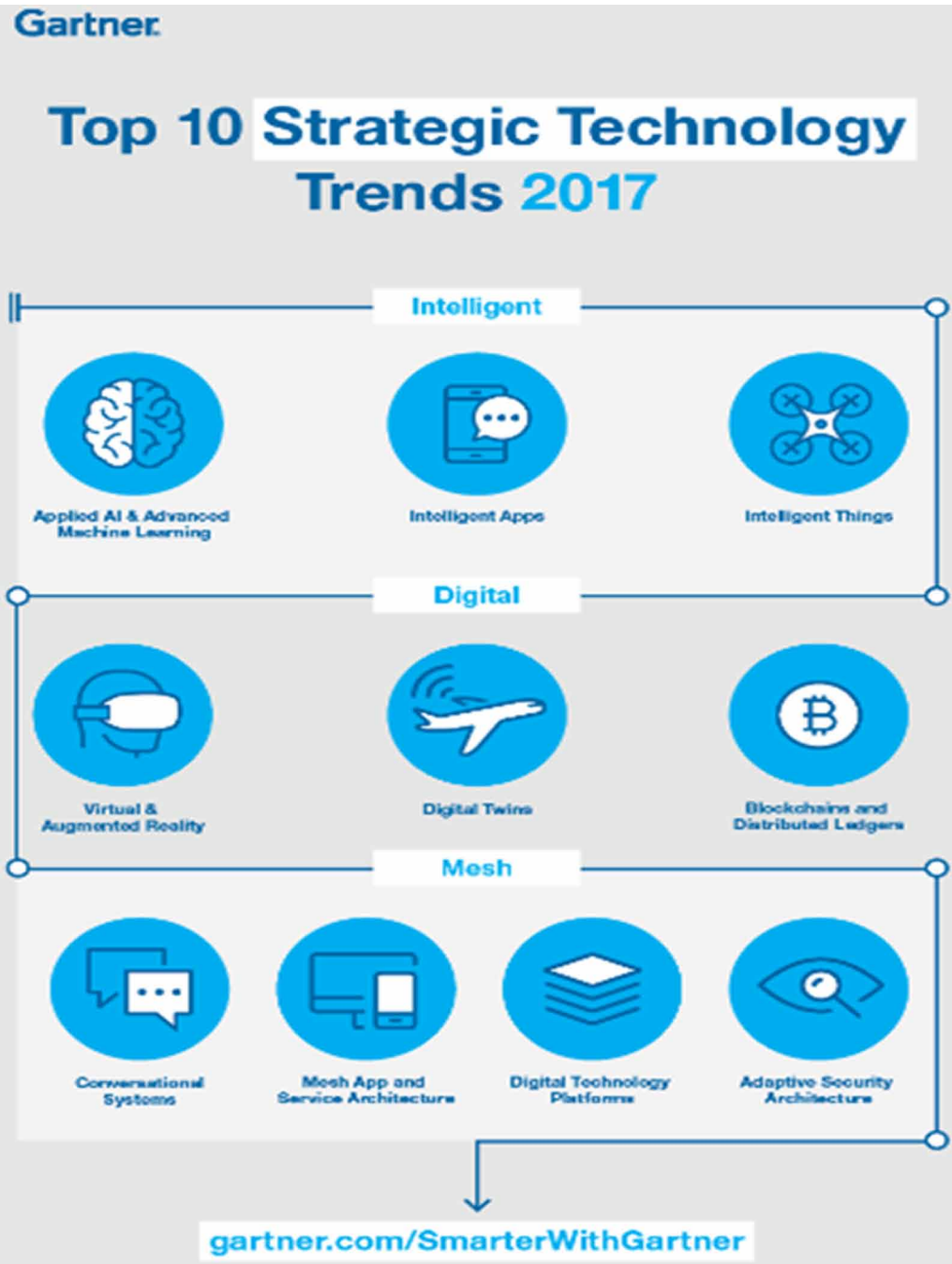
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a set of possible solutions in the form of architecture, managerial and technical recommendations or blueprints, for any type of business problem; by using a central qualitative method based on a beam search (heuristic tree) that uses quantitative methods at its nodes. The proposed AHMM's implementation is very complex and needs a profound understanding of many fields. The DMS' actions produce solutions, which have the form of technical and managerial recommendations, can be applied by the business environment's architects, business managers, business analysts and project engineers to enforce the implementation of the transformation processes. A DMS is a multi-objective, multi-project, multi-factor (CSF) and BTP problem in the context of a complex implementation phase. The DMS attempts simultaneously to maximize the success rate (Felfel, Ayadi & Masmoudi, 2017). Such processes should surpass the business environment's currently used usual DMs. The AHMM is a model first modelling environment that is supported by an applicable framework (IBM, 2001; Trad & Kalpić, 2018a; Trad & Kalpić, 2018b). This article's background combines Knowledge Management (KM), innovative decision making systems approach, enterprise architecture, heuristics/mathematical models, information technology management, business transformation initiatives and business engineering fields (Goikoetxea, 2004; Tidd & Bessant, 2009). As shown in Figure 1, where the major strategic technology trend is artificial intelligence based systems; so the authors conclude that building an innovative AHMM model (Cearley, Walker & Burke, 2016; Thomas, 2015; Ho, Xu & Dey, 2010). The AHMM model enables the implementation of a generic and cross-functional reasoning engine that is mainly based on: 1) factors classification and management mechanism; 2) an adapted qualitative heuristics tree (beam search) research method; and 3) a set of quantitative modules that can be triggered from the tree's nodes. The AHMM manages sets of factors which can be applied to BTP or to any other type of project. This article's authors based their research model mainly on intelligent neural networks which can execute specific calls to quantitative modules and is supported by information technology driven development models, where both disciplines, applied mathematics and information technology models are complementary, due to the use of many existing industry standards, like for example the Architecture Development Method (ADM) (The Open Group, 2011a; Tidd & Bessant, 2009). The AHMM holistic concept is mainly business driven and is agnostic to a specific business environment's internals. As shown in Figure 1, it has been decided by the authors that this genuine research framework should be founded on DMS microartefacts that in turn are based on existing standards (Johnson & Onwuegbuzie, 2004).

Actually, there are many mathematical models and EA methodologies that can be used to implement BTP (Gartner, 2016), but all of them lack a systemic holistic approach. The Business Transformation Manager (BTM) or an enterprise architect can integrate an AHMM based DMS in the architecture roadmap of a BTP to support its complex and risky transformation implementation, probable ventures and future maintenance (Zaiane & Ben Moussa, 2018; Trad & Kalpić, 2017b; Trad & Kalpić, 2017c; Trad & Kalpić, 2018a; Trad & Kalpić, 2018b; Thomas, 2015; Tidd, 2006). The AHMM model aim is to deliver a generic skeleton for a DMS that is capable to deliver just-in-time solutions in the form of applicable actions or recommendations for solving BTP or EA problems. To achieve this goal, the research methodology is based on: 1) a multi-domain literature review; 2) a qualitative methodology; 3) a quantitative methodology; and 4) an engineering oriented proof of concept (or a controlled experiment); which is the optimal methodology applied in information technology, applied mathematics and other types of engineering projects (Easterbrook, Singer, Storey & Damian, 2008).

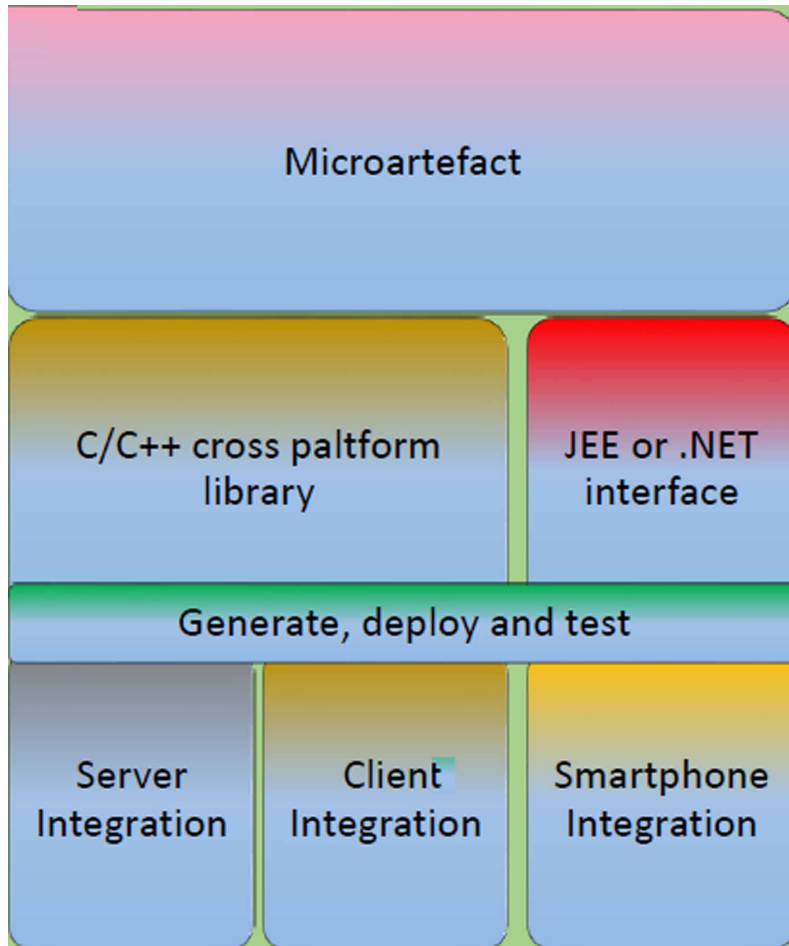
For a successful integration of the AHMM in BTPs, the BTM's profile and role are crucial and his or her (for simplicity, in further text – his) decisions are supported by the selection and implementation of CSF that are essential for the BTP development process. A holistic system approach is the optimal choice to integrate an AHMM based DMS in the BTP (Simonin, Bertin, Traon, Jezequel & Crespi 2010; Daellenbach & McNickle, 2005; Trad & Kalpić, 2017d). The AHMM based DMS interacts with business users by means of a graphical user interface in order to manage the CSFs and launch the reasoning process, as shown in Figure 2.

Figure 1. Technology Trends (Cearley, Walker & Burke, 2016)



BTPs lack holistic and synchronized implementation approach (Thomas, 2015; Cearley, Walker & Burke, 2016). As shown in Figure 3, an adapted development and iterative process of operations can be adapted to support synchronized implementation approach; where the evolution of ICS based on the integration of Internet of Things (IoT) and cloud computing technologies needs holistic robust

Figure 2. The research framework's concept (Trad & Kalpić, 2017d)



management approaches that support *Projects'* resources/assets to be protected and, hence, improve profitability (D'Emilia, Galar, 2018).

The AHMM classifies CSFs in Critical Success Areas (CSA) groups as shown in Figure 4. In BTPs, there is pressure to offer robust systems. The mentioned pressure is the main cause that a BTP can fail or is simply cancelled (Kornilova, 2017).

THE RESEARCH PROCESS

The Research Cluster

The research cluster is a set of similar research fields, in parallel with a unique research question and goal (Cambridge University Press, 2018). The main topic of this global research is related to BTPs and their enterprise architecture implementation disciplines. The ultimate research question is: "Which business transformation manager characteristics and which type of support should be assured in the implementation phase of a business transformation project?"

Figure 3. The agilization process (Kornilova, 2017)

AMM

mcRequirement	= KPI	(1)
CSF	= \sum KPI	(2)
CSA	= \sum CSF	(3)
Requirement	= \sum mcRequirement	(4)
(e)neuron	= action + mcIntelligenceArtefact	(5)
mcArtefact	= \sum (e)neurons	(6)
mcEnterprise	= \sum mcArtefact	(7)
(e)Enterprise	= \sum mcEnterprise	(8)
mcArtefactScenario	= \sum mcArtefactDecisionMaking	(9)
IntelligenceComponent	= \sum mcArtefactScenario	(10)
OrganisationalIntelligence	= \sum IntelligenceComponent	(11)
AMM	= ADM + OrganisationalIntelligence	(12)

The Research's Uniqueness

The uniqueness of this research is that the AHMM promotes a holistic unbundling process, the alignment of various EA standards and business strategies to support BTPs (Farhoomand, 2004). The uniqueness of this research project is based on its holistic approach that:

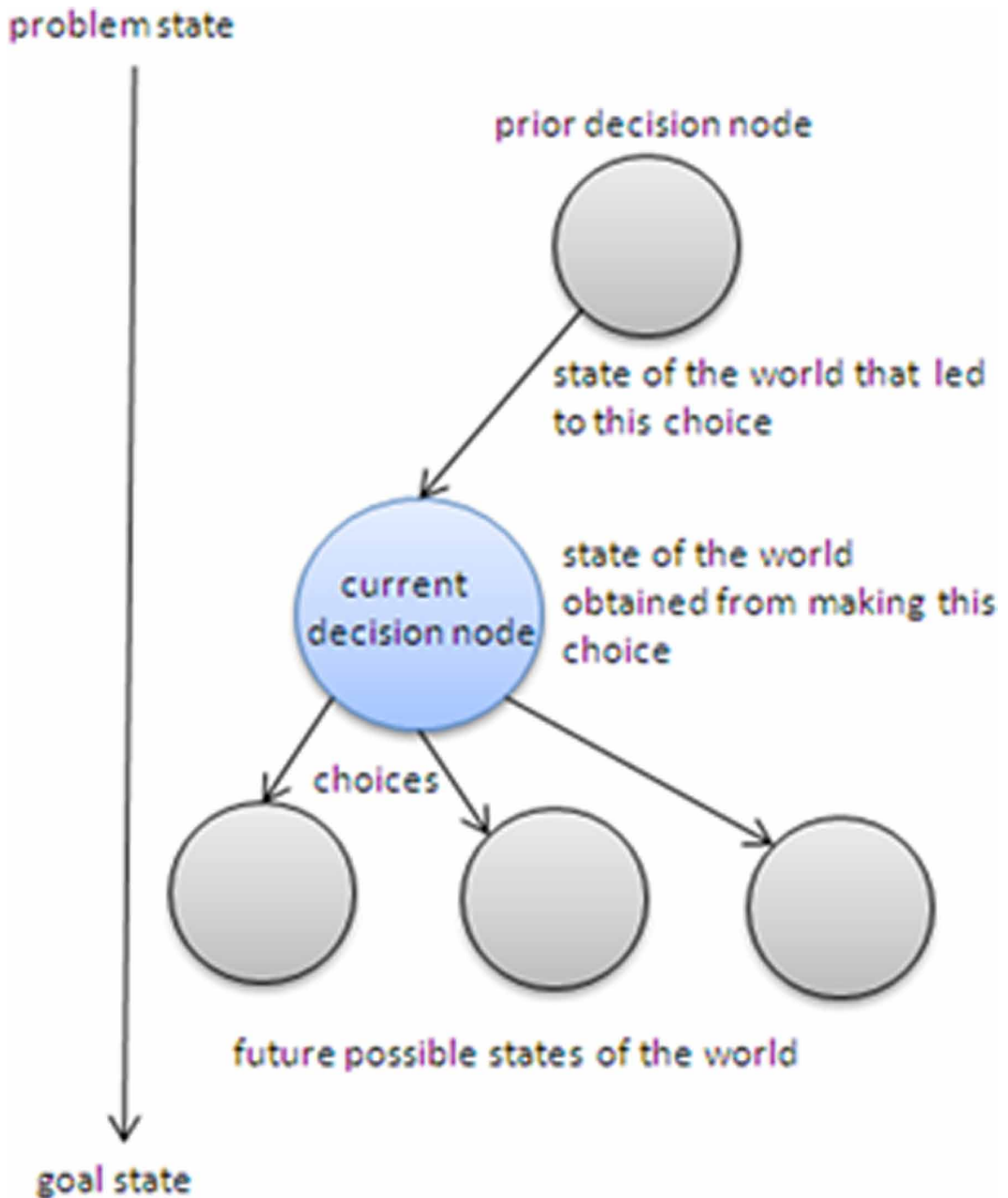
- Combines: 1) BTP; 2) AHMM; 3) software modelling and architecture; 4) business engineering; 5) financial analysis; 6) BTM; and 6) global enterprise architecture. And offers a methodology and Framework.
- Using a scholar search engine (like Google's) combining the previous topics, clearly shows the uniqueness and the lead of the authors' works.

This research question and its analysis are genuine and intended to close the immense gap in this field.

The Research Gap

Today an important gap exists in BTP research areas (Cambridge University Press, 2018) and this research is a pioneering work in the field. It tries to link the Mathematical Model (MM) to all levels of the EA and to the underlying resources (Agievich, 2014). This is achieved by using a central qualitative engine, which is based on beam-search heuristics (Kim & Kim, 1999; Della Croce & T'kindt, 2002). BTPs or ventures, are very risky and have a very high failure rate and one of the concrete reasons is that these BTPs lack a cross-functional and holistic coordination; especially if the BTP understands merges or new important ventures (Zaiane & Ben Moussa, 2018). That is why the authors would like to contribute to enhance the success rate of BTPs (Tidd & Bessant, 2018).

Figure 4. Structure of critical success descriptors (Trad, 2018a)



To close or at least narrow the gap in the mentioned research field, the authors propose a holistic approach that unifies the following:

- An applied mathematical model that maps to all the project's components.
- A concrete manageable holistic AHMM project overview.
- The integration of a AHMM based DMS as the kernel of the BTP.

- The CSA and CSF management.
- Implementation strategy for the development of microartefacts.
- The BTP's risk and audit management.

The Research Framework

AHMM based DMS uses CSFs, which are managed by this research's framework. The AHMM based framework supports a complex formalism that combines EA, DMS and various standards with a mathematical model (Goikoetxea, 2004; Johnson & Onwuegbuzie, 2004), as shown in Figure 5. Unfortunately, most of the existing formalisms are archaic, and silo-built. Examples of such archaic sets of facts are: 1) the set that influences microartefacts' management, like the governance of Service Oriented Architecture (SOA) modules (IBM, 2014); that are based on Internet and e-business e-service configuration/tuning, mechanics and quality (Kim & Lennon, 2017); 2) the set that influences the implementation of complex software management systems (Newman, 2015); 3) the set that influences the DMS (Busenitz, 2014); and 4) the set that influences the implementation of a KMS. A global AHMM concept is optimal for BTPs (Daellenbach & McNickle, 2005) where it supports the integration of a holistic EA for a BTP. The AHMM is a part of the Decision making module (Dm) and the Architecture module (Am), that in turn are parts of the framework. In this article, the authors propose a set of AHMM managerial and technical recommendations on how to use a framework in a BTP (Trad 2018a; Trad 2018b; Trad 2018c; Trad 2018d).

The AHMM supports standards, like The Open Group's Architecture Framework's (TOGAF) ADM, where each BTP microartefact circulates through its phases; these microartefacts are a set of e-services that need to be choreographed, configured/tuned to insure scenario qualities (Kim & Lennon, 2017). In this research, TOGAF is used, but other architecture frameworks can also be used. These microartefacts contain their private sets of CSFs that can be applied to (Peterson, 2011): a) select the initial CSFs; b) weight and rate the CSFs, a multicriteria based estimation (Azadfallah, 2018); c) estimate the BTP's status using the DMS; and to eventually take a decision on BTP's continuation; d) control and monitor the needed DMS mechanisms; e) specialize the AHMM based DMS skills; and f) support the DMS automation processes. The actual research article and the resultant experiment are also a part of the Selection management, Architecture-modelling, Control-monitoring, Decision-making, Training management, Project management, Finance management, Geopolitical management, Knowledge management and Implementation management Framework (SmAmCmDmTmPmFmGmKmlmF, for simplification reasons, in further text the term *Environment* will be used). The *Environment* is not a black-box product to be applied as-is, it is rather a transformation strategy that offers recommendations and vision on how to implement a BTP.

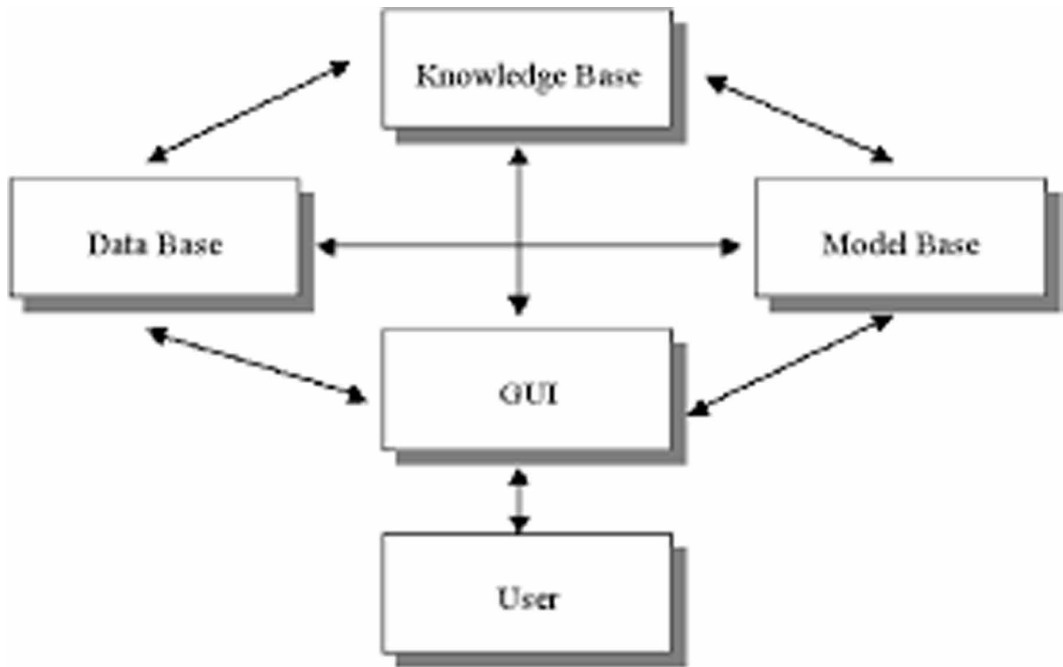
This article can be considered as a non-conventional and pioneering one, in the field of holistic BTPs and EA projects. This article's research question is: "Can an applied holistic mathematical model be used to implement business transformation projects and enterprise architecture projects?". It was formulated after an extensive literature review.

The Research's Literature Review

As already mentioned, this research cluster that is focused on BTPs and EA; and owns an extensive literature library that contains major publications related to the research topics. For this research article, the literature review process has focused on the following subjects:

- Modelling EA with a mathematical model.
- Modelling BTPs with a mathematical model.
- Modelling an enterprise with a mathematical model.
- The role of CSFs in a mathematical model.
- Integrating qualitative and quantitative methods.

Figure 5. The components of a business and information system

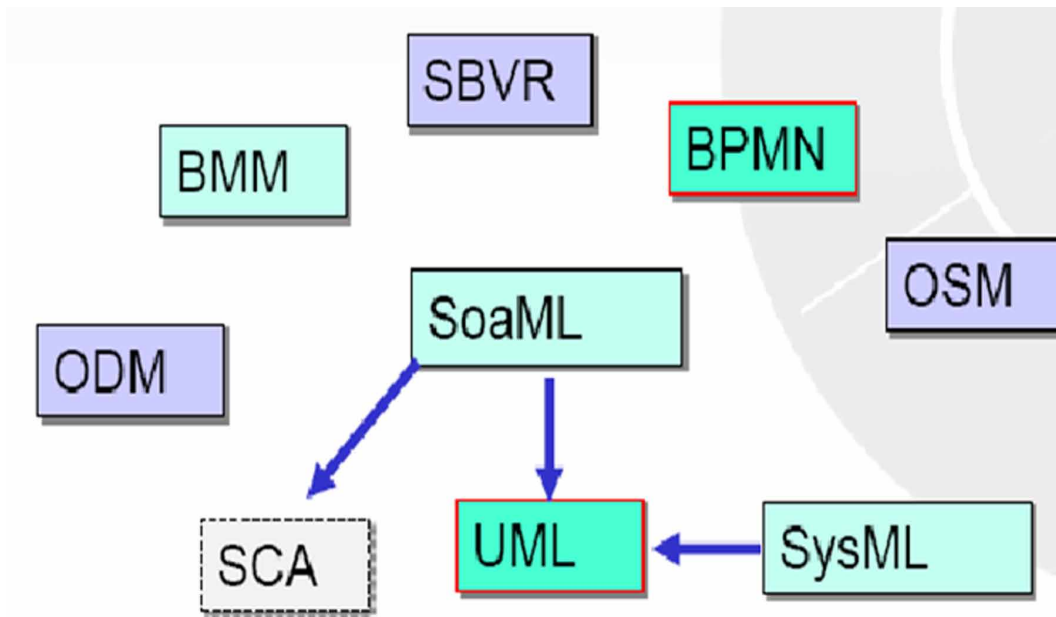


The outcome is that very little scholar or even general literature and research resources exist on the selected subject. The authors consider their work as a pioneering one; the most relevant works found are:

- Models that provide abstractions of a real world physical system (Hinkelmann, 2016).
- Modeling is a descriptive design process which validates principles (Sankaralingam, Ferris, Nowatzki, Estan, Wood & Vaish, 2013).
- Model driven architecture: is defined by the Object Management Group, as shown in Figure 6; where IoT holistic implementation approaches, to maintain BTP resources (D'Emilia, Galar, 2018; Hinkelmann, 2016).
- The gap between the adoption and its usage is still huge today (Syynimaa, 2015).
- A decision making system (Norusis, 1993; Dogan, Çalgici, Arditi & Gunaydin, 2015).
- A mathematical model, the AMM4BT approach (Giachetti, 2012; Kim & Kim, 1999).
- An applied mathematical model is the description of a business system using mathematical concepts and language (Sankaralingam, Ferris, Nowatzki, Estan, Wood & Vaish, 2013).
- Multi-criteria or a multi-factor model for decision making needs a mixed method based on qualitative and quantitative criteria (Zandia & Tavana, 2011; Kim & Kim, 1999).

As already mentioned, this article uses a unique mixed methods research that can be considered as a natural complement to traditional qualitative and quantitative research, in order to deliver an authentic empirical validation model of the CSFs (Easterbrook, Singer, Storey & Damian, 2008).

Figure 6. Relation of an architecture model with a modelling language for microartefacts (Hinkelmann 2016)



Review's and Check of the Critical Success Factors

The BTPs starts with the initial phase called the feasibility phase to check if the whole undertaking makes sense. Based on the AHMM literature review and related evaluation processes, the most important extracted CSFs that are used and evaluated using the following rules:

- References should be credible and are estimated by the authors; the notions of official ranking are less important and ignored, due to ego-concentration of lobbying of closed circles of influence; we often find there same institutions and individuals. By references it is meant the origins found in various types of literature and other CSF related resources, while the credibility of these references is estimated by Key Performance Indicators (KPI) that are related to requirements, which are empirically weighted as follows: 1) the authors' academic and professional experiences that adds to 20% of the whole estimation value; 2) statistical checkers like Gartner, Forester and others make 20% of the whole estimation value; 3) various company's and specialists surveying that is 20% of the whole estimation value; 4) CSF related code/application sources' prototyping that is 20% of the whole estimation value; and 5) simulation in the PoC and frequency build the final 20% of the whole estimation value.
- BTPs like mergers are the result of organisational changes in companies to act as a single enterprise with consolidated resources and business interests; and its success is measured by the CSFs,, hence the literature references presented in the previous point.
- Applied modelling language should be limited in order to make the BTP manageable and not too complex. Whether it is usable, can be estimated from literature review or from own working experience or reliable references like Gartner.
- The ADM is considered to be mature and it has been in use for more than ten years and it has been reported as successful; the interest in using TOGAF is very high and its ADM kernel is about 90% (Alm & Wissotzki, 2015; Kotusev, 2018). Unfortunately, that does not mean that

Projects are successful and in fact their success rate is very low; serious publications present less than 10% success rate (Mintzberg, 1994).

- The ADM is appropriate for any project's local conditions and manages the *Environment's* iterations.
- If the aggregations of all the BTP's CSA/CSF tables are positive and exceed the defined minimum, the BTP continues to its PoC or can be used for problem solving.

The main reason for failures is because methodologies are not used in a holistic manner to achieve organizational alignment, centralized DMS and KMS (Syynimaa, 2015). This work is based on empirical engineering models.

Empirical Engineering Research Model

This research article is based on an empirical engineering research approach because of the following facts (Johnson & Onwuegbuzie, 2004; Easterbrook, Singer, Storey & Damian, 2008):

- It uses an authentic mixed method (where mixed research is a simplistic synonym) that can be considered as a natural complement to conventional qualitative and quantitative research methodologies.
- Today we have five classes of research methods that are the most relevant to applied mathematics in engineering fields.
- Engineering and applied mathematics researchers are very poor at making theories and related research explicit.
- Positivism argues that the project's knowledge must be founded on logical reasoning from a well-defined set of observable facts that are presented as CSFs.
- This research considers that qualitative research is a huge set of quantitative analysis schemas.
- This research uses Action Research (AR) which helps the researchers to solve a real BTP problem and also stores the gained knowledge and experience of solving the problem; this is known as the knowledge item (Berger & Rose, 2015).
- Empirical validity checks if the research work is acceptable as a contribution to existing scientific knowledge.
- A controlled experiment or a PoC is a software prototype of a testable hypothesis where one or more CSFs (or independent variables) are processed to evaluate their influence on the model's dependent variables.

This research article is an empirical research and it includes a proof of concept and uses action research (Easterbrook, Singer, Storey & Damian, 2008). The proposed AHMM based DMS is a business-driven model which is based on three areas of research that represent separate sets of CSFs:

- The mathematical model with its artefacts.
- The mathematical model's integration in the information and communication technology system.
- The holistic management of the decision making system, using a mathematical model.

A MATHEMATICAL MODEL'S MAIN ARTEFACTS

The BTP has a major precondition and that is, that the traditional business environment has to undergo a total and successful unbundling process, before the transformation activities start. The unbundling insures that the ICS microartefacts are ready to be used; this is the most delicate and complex undertaking in BTPs and the main cause of their failure. For illustration, here we present some typical examples for ICS microartefacts:

- Microartefacts are e-services based that tend to improve the BTP's quality CSF (Kim & Lennon, 2017).
- SOA unbundling procedures.
- Microartefacts development cycles.
- Reengineering of classical software systems.
- ...

This research offers a mathematical model, the AHMM that is an abstract model containing a Mathematical Language (ML) that can be used to describe and implement the behaviour of any business system and its ICS (Goikoetxea, 2004). The AHMM that is based on related research by many authors and development works, can be used in natural sciences, social sciences and engineering fields; where managers, engineers, computer scientists, and economists can use AHMM to solve project problems and model its kernel architecture.

Authors' Related Works

The authors' have researched the presented topics for a long time, resulting in more than 90 articles, considering the possibility of applying an MM in BTPs. Before forming and finalizing a complete applied mathematical model, finally named the AHMM, the authors would like to invoke their previous most important works related to this article:

- The "Selection and Training Framework" (STF) for Manager's in Business Innovation Transformation Projects" - The mathematical model (Trad & Kalpić, 2014a).
- The Selection, Control, Decision making and Training Framework for Managers in Business Innovation and Transformation Projects-Decision making model (Trad & Kalpić, 2015a).
- The Selection, Control, Decision making and Training Framework for Managers in Business Innovation and Transformation Projects-Managerial Recommendations for enterprise architecture (Trad & Kalpić, 2015b).
- The (e)Business Transformation Framework for (e)commerce Architecture-Modelling Projects (Trad & Kalpić, 2016a).
- A Transformation Framework Proposal for Managers in Business Innovation and Business Transformation Projects- A heuristics decision module's background (Trad & Kalpić, 2016b).
- A Transformation Framework Proposal for Managers in Business Innovation and Business Transformation Projects-A heuristics decision module's design concept (Trad & Kalpić, 2016c).
- Business Transformation Projects-An EA Applied Mathematical Model / The Basics (Trad & Kalpić, 2017b).
- Business Transformation Projects-An EA Applied Mathematical Model / Proof of Concept (Trad & Kalpić, 2017c).
- The Business Transformation and EA Framework / The London Inter Bank Offered Rate Crisis - The Model (Trad & Kalpić, 2017e).
- An IGI book of 22 chapters that is entitled "An applied mathematical model for business transformation" that is mainly based on this articles approach; and will detail all its aspects.

These works promoted the need to develop a holistic model that tackles the various business and technical domains in a coordinated process; and above all, to prove that such a model can be the fundament and skeleton of a holistic EA of a BTP.

A Holistic Approach

There are many different views on how to manage a transformation process, there is a need for a holistic approach to manage possible risks and to avoid a practically certain failure. Traditionally,

risk concepts and possible failures were associated with a single origin or factor. Failure may be defined as a violation of an internal risk factor of the business system that can be due to various types of problems. The possibility of failure can be represented in various types of problems that can occur. A set of important, mainly permanent, constraints exist that can make BTPs very fragile. These constraints depend on the level of enterprise's global status and on the way BTP development planning is managed. To understand better the notions of holism and related mathematical models, the history of evolution of sciences and mathematics is important, in order to show that this evolution is very old and interrelated.

History, Technology and Evolution of Mathematical Sciences

Evolution, Internet of Things, globalization, progress and hyper-engineering is not a set of dislocated isles of inventions and discoveries, in fact they are interconnected because of the following simplistically presented facts (Kinnunen, Ylä-Kujala, Marttonen-Arola, Kärri & Baglee, 2018):

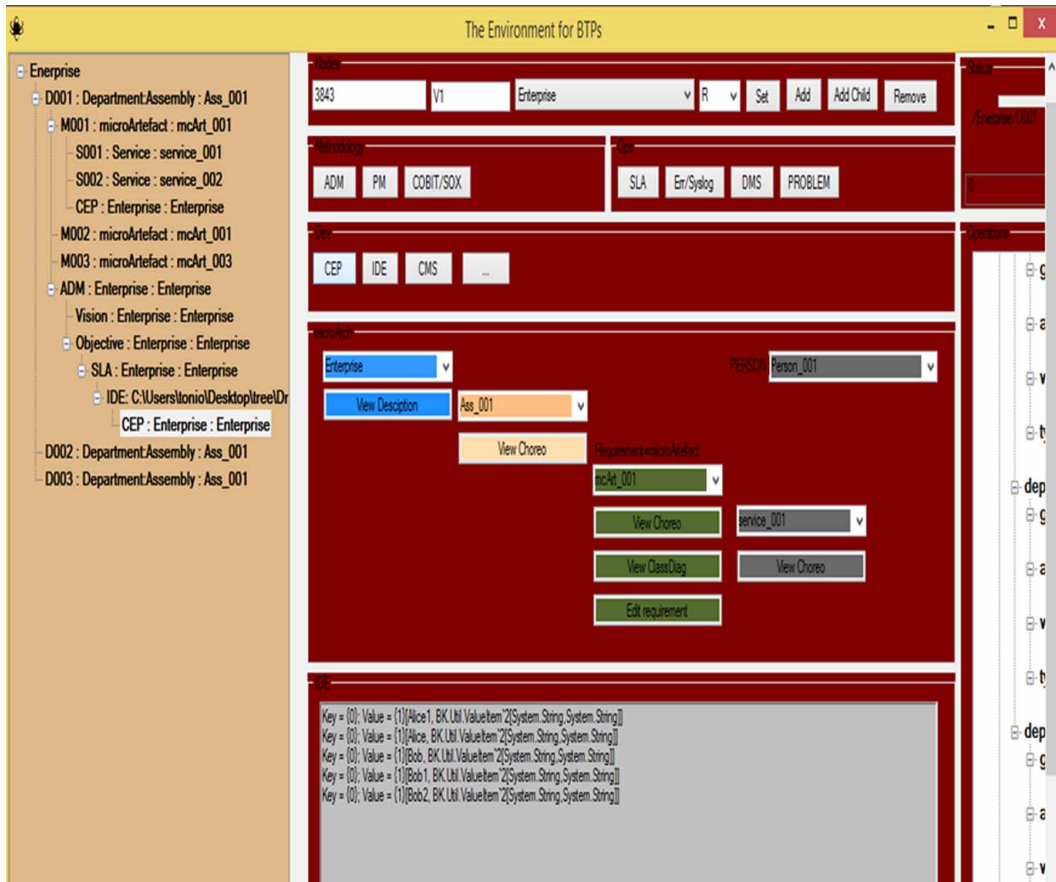
- The generalisation of the alphabet gave the possibility to pose the problem. The Greeks inherited their alphabet from the Semite Phoenicians, shown in Figure 7. The Phoenician alphabet was spread across the Mediterranean to the rest of the then known world. It was later assimilated and modified by the Greeks and by most of the world cultures to change the way of communication (Allan, 2015).
- The Semite Phoenicians introduced counting systems (numerical characters), geometry and arithmetic. The Greeks were heavily indebted to the Phoenicians for their knowledge of applied mathematics, especially arithmetic (the art of calculation). The most known for such a propagation were Pythagoras and Thales who were Phoenicians, according to Herodotus (Hetzron, 1997; Ball, 2010).
- Evolution of various mathematical fields like heuristics geometry, algebra... (Martin, 1981).
- The development of algorithmics, like operational research, heuristics,...
- The standardisation of modelling, like business process modelling that has roots in mathematical models; rationalization of processes which in turn have roots in Petri nets (Lohmann, 2007; Salimifard & Wright, 2001; Gravemeijer, Lehrer, van Oers & Verschaffel, 2002).
- The evolution of internet technologies, ICS modelling towards the Unified Modelling Language (UML) that can be expressed as a mathematical model and contains diagrams like the communication diagram that can be created from the business process model (Breu, Hinkel, Hofmann, Klein, Paech, Rumpe & Thurner, 1997; Salimifard & Wright, 2001).
- The establishment of EA standards, that in turn have roots in UML.
- The AHMM that inherits most of the previous evolutions and proposes a holistic approach to various domains.

This implies that there is a need for a holistic perspective for the BTP that can base its architecture and design on an underlying mathematical model that is founded CSAs and CSFs (Goikoetxea, 2004; Cardona, 2004).

A Mathematical Model's Basics

Polderman and Willems (Polderman & Willems, 1998) argue that mathematical model is a subset of real world's possibilities and that mathematical model is a description of reality; in this research case, the reality is a BTP. Once a mathematical model is established, it can offer a certain subset of possible solutions or explanations. The mathematical model acts as an exclusion law which admits and records accepted solutions. The subset of accepted solutions is called the behaviour of the mathematical model. Such an approach defines the basis of a dynamical system as subset of time-evolution that can be traced with a set of timestamps. A mathematical model as an exclusion law, offers the explanation

Figure 7. The Phoenician alphabet (Allan, 2015)



and origin of events that can take or have taken place; and it can estimate whether they are factual or fictive, simply feasible or infeasible. Business and economic processes functions can explain that certain resources like materials, capital, and human labour can be planned to deliver a product or a service. Thus, it can be stated that a mathematical model offers a subset of the real world solutions, those solutions' instances that the model admits can be assumed as feasible ones. A mathematical model can contain different interrelated formulas or equations; in our modern times, even diagrams. The behaviour, and not the behavioural equations, can be considered as the central basics for the specification of a mathematical model like AHMM. In the AHMM the reality is the business context that understands: 1) enterprise architecture; 2) business transformations; 3) business and software engineering; 4) algorithmics; and 5) finance and audit. Whereas for the time variable, it is split in two categories: 1) greenfield, that occurs when the BTP starts or for a BTP major iteration, time is considered to be zero and a qualitative evaluation is executed for a go or no go recommendation(s); and 2) in a BTP iteration, a time variable is set to evaluate a precise objective factor using a quantitative approach (Polderman & Willems, 1998). Kepler claimed using a mathematical model that planetary orbits non-obeying his three laws were impossible to take place (Britannica, 2018). This implies that there is a need for holistic perspective for the BTP and its underlying mathematical model structure to prove if it can succeed (Cardona, 2004).

A Mathematical Model's Structure

The mathematical model's structure is used to resolve various types of interdependencies that can be used because of existence of a huge set of BTP resources. These BTP's resources interdependencies can result in many silo subprojects that endanger the outcome of a BTP. The use of a holistic methodology in the form of mathematical model structure can insure a successful outcome, or in the worst case, try to predict it. A mathematical model's structure represents the mapping relations between BTP's resources, like modules, microartefacts and resources that are not mutually exclusive. A mathematical model's structure facilitates a dynamic implementation to generate feasible BTP objectives and an execution plan. A mathematical model's structure supports a decision making strategy that offers solutions to various BTP problems. A BTP plan is generated by the DMS's beam-search heuristics engine to realize enterprise transformation processes, using critical success areas and factors (Giachetti, 2012; Kim & Kim, 1999; Della Croce & T'kindt, 2002).

Critical Success Areas, Factors and Decision Making

The AHMM is based on CSA which are categories of sets of CSF where in turn, each CSF is a set of selected Key Performance Indicators (KPI), where: 1) each CSA corresponds to a BTP domain, like for example, finance; 2) each CSF corresponds to a set of project requirements, like for example, accounting balance sheet finalization; and 3) each KPI corresponds to a single transformation or architecture project requirement (Farhoomand, 2004); where the CSF/KPI elements interact with the ADM cycles, as shown in Figure 8.

For each BTP problem type, a DMS qualified user can define the initial set of CSFs. CSFs are important for the mapping between the project requirements, microartefacts, organisational items to the AHMM structure (Nilda Tri & Yusof, 2009; Peterson, 2011). CSFs can express for example the BTP's performance requirements' control that must be met and is defined in the EA's strategic goals and AHMM's limit constraints. The AHMM's qualitative heuristic algorithms and punctual qualitative analysis can be used to evaluate for example the performances in each CSA, where CSFs can be internal or external; like: 1) the BTP's gap analysis is an internal CSF; and 2) client's purchase predictions is an external one as shown in Figure 9.

Once the BTP's initial set of CSFs have been selected, then the BTP's members can use the AHMM based DMS to query for possible solutions. The DMS relates CSFs that maps to a BTP requirement to a unit of work (Trad & Kalpić, 2017b; Trad & Kalpić, 2017c).

The Model's Unit of Work

A holistic alignment and classification of all the BTP's resources must be done, so that the unbundling process can start. A holistic alignment needs also to define the AHMM Unit of Work (UoW) or a basic microartefact. Using the "1:1" mapping concept, the microartefact is represented with a class diagram and can be represented also by an extensible Mark-up Language (XML) model; like in the SOA unbundling and naming conventions. Such a mapping concept is based on an automated naming convention that can link all the BTP's resources. The mapping concept supports the interoperability between all the BTP's modules and enables the use of ML microartefacts that include the needed knowledge and intelligence support (Mehra, Grundy & Hosking, 2005; Scherer & Schapke, 2011).

Mathematical Microartefacts

A mathematical microartefact is any BTP microartefact that is a part of the AHMM and which interacts with a multitude of BTP microartefacts in a coordinated manner. A ML microartefact uses the ADM to assist the BTP's implementation process (The Open Group, 2011a). The AHMM includes various types of mechanisms that use heuristics scenarios to make the BTP's integration more flexible and to avoid the classical and ridiculous archaic decision making systems and offer a holistic collaborative decision system (Trad & Kalpić, 2017a; Nakakawa, van Bommel & Proper, 2010). The AHMM

Figure 8. The factors' management environment

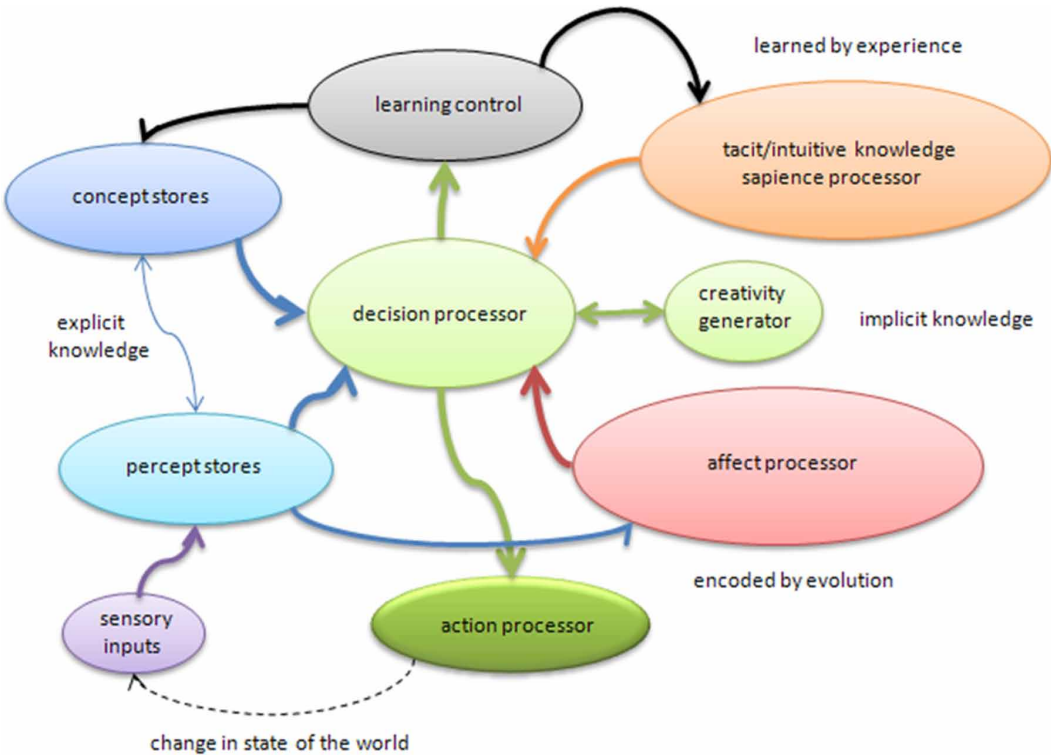
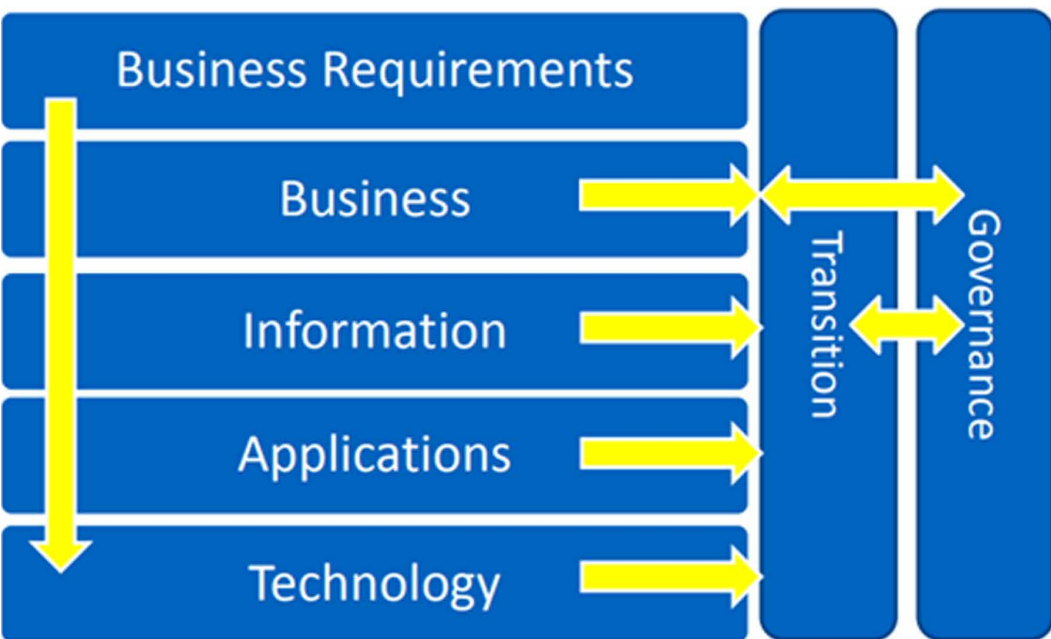
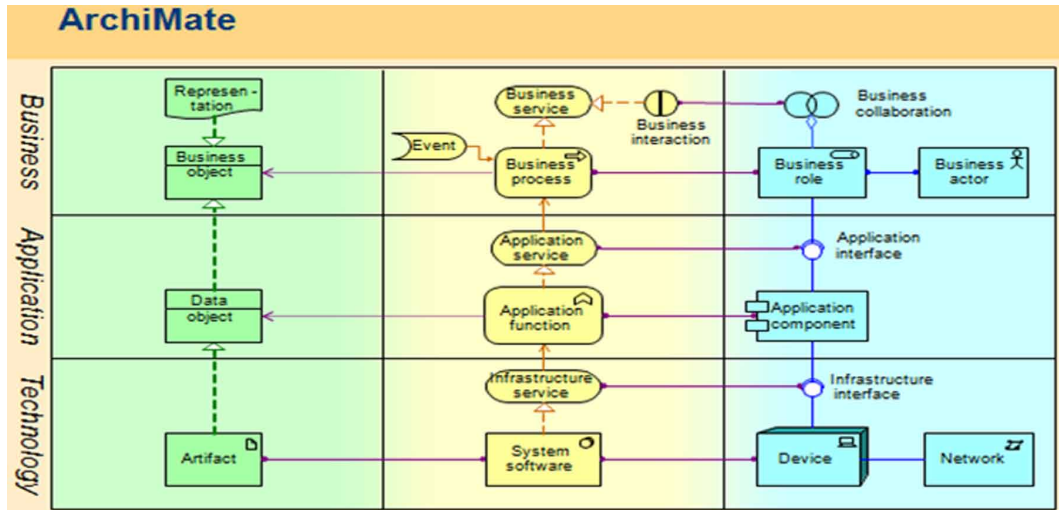


Figure 9. The factors' integration and heuristics (Trad & Kalpić, 2017b; Trad & Kalpić, 2017c)



supports the BTP by offering microartefacts to handle various types of decision scenarios. In Figure 10, the authors present the optimal microartefact construct, where the biggest part of microartefacts are written in portable and optimized C/C++.

Figure 10. The microartefact development components and layers



A set of ML or generic microartefacts can be a library or any other software component written in any programming language. The usage of microartefacts provides some of the mechanisms needed to make AHMM offer a pluggable component in the distributed architecture model (Kraisig, Rosélia, Welter, Haug, Cargnin, Roos-Frantz, Sawicki & Frantz, 2016).

The Microartefacts' Distributed Architecture Model

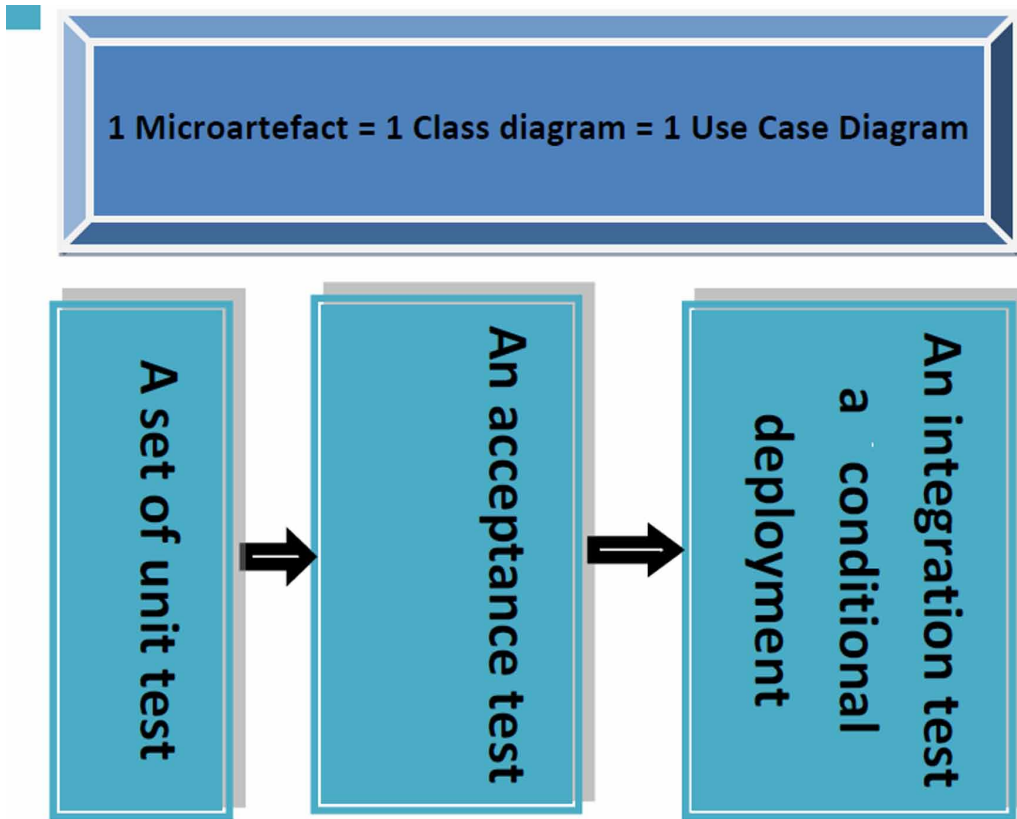
The previously developed Applied Mathematical Model (AMM) is an architectural instance that can be applied to a BTP's subproject. The BTP's decision making processes are based on the AMM formalism. The AMM has a defined nomenclature to facilitate its integration in an architecture model. The AHMM is the company's holistic MM and is a set of multiple coordinated AMMs that correspond to various just in time processing schemes which use the same BTP's central pool of CSAs and CSFs. The AHMM that is presented in Figure 11, to the reader in a simplified form, to be easily understood on the cost of a holistic formulation of the architecture's vision. The DMS uses an AHMM's instance to solve a BTP problem.

The proposed architecture and the management of mathematical models enables the possibility to define EA as an AMM; using CSFs weightings and ratings, based on multicriteria (Azadfallah, 2018).

The symbol \sum indicates summation of all the relevant named set members, while the indices and the set cardinality have been omitted. The proposed MM should be understood in a broader sense, more like set unions. As shown in Figure 11:

- The abbreviation "mc" stands for micro.
- The symbol \sum indicates summation of weightings/ratings, denoting the relative importance of the set members selected as relevant. Weightings as integers range in ascending importance from 1 to 10.
- The symbol \cup indicates sets union.

Figure 11. The applied mathematical model's nomenclature (Trad & Kalpić, 2017a)



- The proposed AHMM4BT enables the possibility to define BTP/EAPs as a model; using CSFs weightings and ratings.
- The selected corresponding weightings to: $CSF \in \{ 1 \dots 10 \}$; are integer values.
- The selected corresponding ratings to: $CSF \in \{ 0.00\% \dots 100.00\% \}$ are floating point percentage values.

The Applied Mathematical Model's Structure

A holistic AHMM's has a composite structure that can be viewed as follows:

- The static view has a similar static structure like the relational model's structure that includes sets of CSAs/CSFs that map to tables and the ability to create them and apply actions on these tables; in the case of AHMM they are microartefacts and not tables (Lockwood, 1999).
- In the behavioural view, these actions are designed using a set of mathematics nomenclature, the implementation of the AHMM is in the internal scripting language, used also to tune the CSFs (Lazar, Motogna & Parv, 2010).
- The skeleton of the *Environment* uses microartefacts' scenarios to support just-in-time *Project* requests.

Enterprise Architect as an Applied Mathematical Model

A generic EA model and its ADM are the kernel of this research and they are the basics of its *Environment*. The authors want to propose a mathematical model to represent the BTP's global architecture and solve its problems. The literature review has shown that existing research resources on EA, as a mathematical model, are practically inexistent. This pioneering research work is cross-functional and links all the BTP's microartefacts to BTPs and EA (Agievich, 2014); where the main reasoning component is a qualitative engine that is based on heuristics.

Heuristics and Action Research

The BTP's AHMM is based on a set of synchronized AMMs, where each AMM can launch a qualitative beam-search based heuristic processing (Kim & Kim, 1999; Della Croce & T'kindt, 2002). The AHMM processes tree scans its nodes, extracts and correlates them in both states and time to detect heuristic patterns to support problem solving (Gardner, 1999). These patterns are used to tune sets of weightings and ratings for possible actions' execution that in this research are called ML microartefacts;, based on multicriteria and iterative tuning (Azadfallah, 2018).

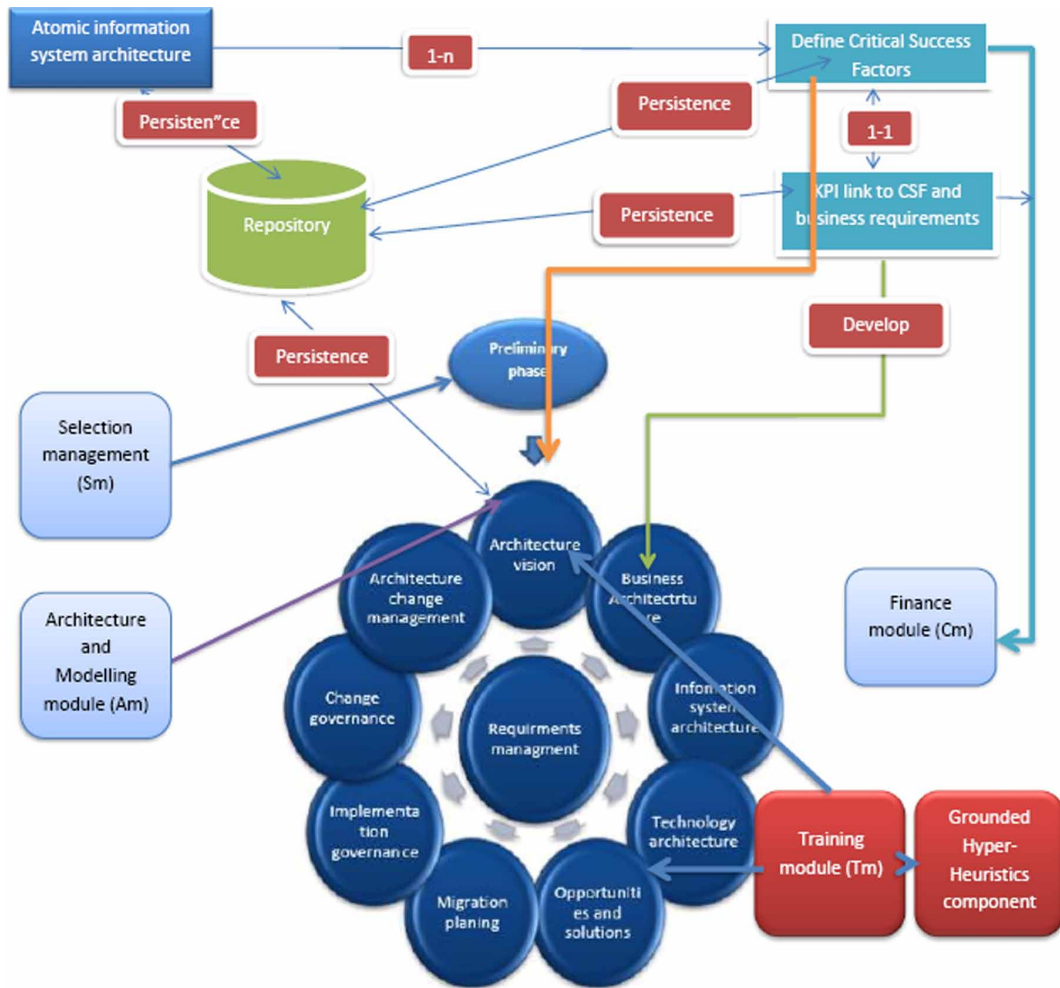
. Weightings and ratings concept support the AHMM to find and select the optimal solution for a given BTP problem. Actions research can be considered as a set of continuous beam-search heuristics processing phases and is similar to design and architecture processes, like the ADM (Järvinen, 2007). Fast changing BTP client requests may provoke an important set of problems that can be hard to solve and makes the BTP actions useless and complex to implement. The AHMM is responsible for the qualitative heuristic process for BTP's problem solving and synchronizes a set of AMMs which have also separate heuristics processes and are supported by a dynamic tree algorithm, as shown in Figure 12 (Nijboer, Morin, Carmien, Koene, Leon & Hoffman, 2009) that manages tree nodes and their correlation with memorized patterns that are combinations of data states and heuristic goal functions. The AMM capacities are measured by analysing the *Environment's* AMM tree.

The AMM's concept is based on a holistic systemic approach to use all the *Environment's* components, being this chapter's main focus (Daellenbach & McNickle, 2005). Major research and advisory firms like Gartner, confirm that intelligence services will leverage business information systems' components from various enterprise activities and there are some simplistic attempts to deliver mathematical models for certain features of the information system (Kalimoldayev, Abdildayeva, Mamyrbayev & Akhmetzhanov, 2016). Gartner confirms also that services are the dominating business enablers for Fortune 500 companies who need business intelligence support (Thomas, 2015; Clark, Fletcher, Hanson, Irani, Waterhouse & Thelin, 2013). The AMM's heuristics algorithm uses the microartefact as a UoW that is technically managed by TOGAF's ADM (The Open Group, 2011b); and is a detailed method and framework for the development of the AMM by using the choreography capacities. The AMM's building blocks are based on ML microartefacts that use a light version of the ADM (Trad & Kalpić, 2015c). This research proposal's approach is based on the simplification of the architecture as a holistic mathematical model, whereas TOGAF is too confused, complex and archaic. Nevertheless, TOGAF's ADM is a maturation of many previous models, like the Model Driven Architecture (MDA) and can be recommended to integrate a holistic DMS; which are witnessing a hyper-evolution(Kinnunen, Ylä-Kujala, Marttonen-Arola, Kärri & Baglee, 2018). Action-research based heuristics enables reflective practice that is the basis of a holistic approach to develop EAs where its kernel and skeleton are a dynamic DMS (Leitch & Day, 2006). Such a DMS is based on both qualitative and quantitative methods.

Qualitative, Quantitative and the Notion of Time

As already mentioned, the AHMM and its underlining set of AMMs is mainly a qualitative beam-search heuristic tree (Della Croce & T'kindt, 2002). In each of the tree's node a precise call to a quantitative

Figure 12. The applied heuristics tree algorithm (Nijboer, Morin, Carmien, Koene, Leon & Hoffman, 2009)



function can be executed, by precision or objectivity the authors refer to input data, constraint and above all a timestamp. These form the basis of an applied transformation mathematical model.

The Applied Transformation Mathematical Model

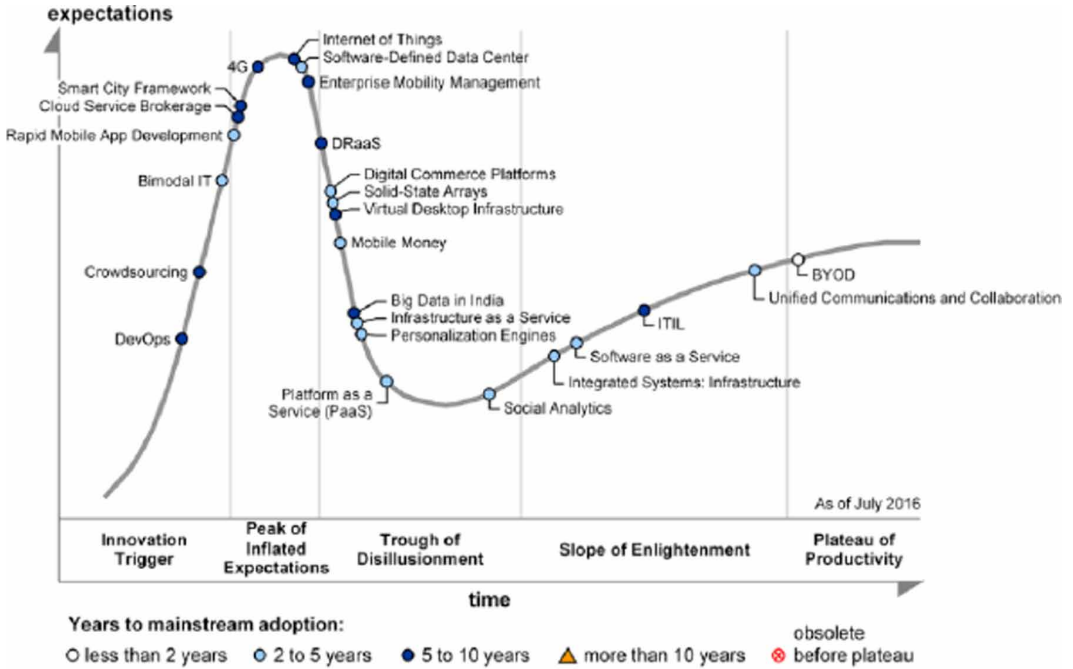
A holistic DMS is a part of the *Environment* that uses services to support just-in-time decision-making. The DMS components and interfaces, as shown in Figure 13, are based on a light version of the ADM.

The transformation is the combination of an enterprise architecture methodology like TOGAF and the AHMM that can be modelled after the following formula for the Transformation Mathematical Model (TMM) that abstracts the BTP:

(AHMM):

$$AMM = Weighing_1 * AMM_Qualitative + Weighing_2 * AMM_Quantitative \quad (1)$$

Figure 13. The decision making system's just in time execution and its components



$$AHMM = \sum AMM \text{ for an enterprise architecture's instance} \quad (2)$$

(TMM):

$$TMM = \sum AHMM \text{ instances} \quad (3)$$

The objective function of the TMM's formula can be optimized by using constraints and with extra variables that need to be tuned using the AHMM. The variable for maximization or minimization can be, for example, the BTP success, costs or other (Dantzig, 1949; Sankaralingam, Ferris, Nowatzki, Estan, Wood & Vaish, 2013). For this PoC the success will be the main and only constraint and success is quantified as a binary 0 or 1. Where the objective function definition will be:

$$\text{Minimize risk TMM} \quad (4)$$

The AHMM is based on a concurrent and synchronized *Environment*, which uses concurrent threads that can make various AMMs run in parallel and manage information through the use of the AHMM's mathematical choreography/language. The TMM is the combination of an EA, BTP methodologies and a holistic mathematical model that integrates the enterprise organisational concept, information and communication technologies that have to be formalized using a functional development environment.

Functional Development Environment

The *Environment's* internal functional development tool and its mathematical language can be used for various application domains and in general for hard systems' thinking. The authors recommend the use of an interpretable scripting for building a DMS (Moore, 2014; North, 2010). The AHMM

Table 1. The critical success factors that have an average of 8.15

Critical Success Factors	KPIs	Weightings
CSF_MM_HolismEvolution	DifficultButImplementable ▾	From 1 to 10. 6 Selected
CSF_MM_Structure	Applicable ▾	From 1 to 10. 10 Selected
CSF_MM_CSA	Applicable ▾	From 1 to 10. 10 Selected
CSF_MM_Microartefacts	Applicable ▾	From 1 to 10. 10 Selected
CSF_MM_Architecture	DifficultButImplementable ▾	From 1 to 10. 7 Selected
CSF_MM_TransformationalModel	DifficultButImplementable ▾	From 1 to 10. 7 Selected
CSF_MM_FunctionalLanguage	Applicable ▾	From 1 to 10. 10 Selected

based DMS is business-driven and is founded on a genuine research framework that in turn is based on a ML to manage heuristics, enterprise architecture and information and communication artefacts (The Open Group, 2011a; Simonin, Bertin, Traon, Jezequel & Crespi, 2010). The complexity lies in how to integrate the AHMM and its programming ML in the enterprise's existing information and communication technology system.

The Mathematical Model's Critical Success Factors

Based on the literature review process, the most important mathematical model's CSFs that are used are evaluated to the following:

As shown in Table 1, the result's aim is to prove or justify that it is complex but possible to implement a mathematical model in the information system. The next CSA to be analysed is the holistic management of the DMS.

THE MATHEMATICAL MODEL'S INTEGRATION IN THE INFORMATION AND COMMUNICATION TECHNOLOGY SYSTEM

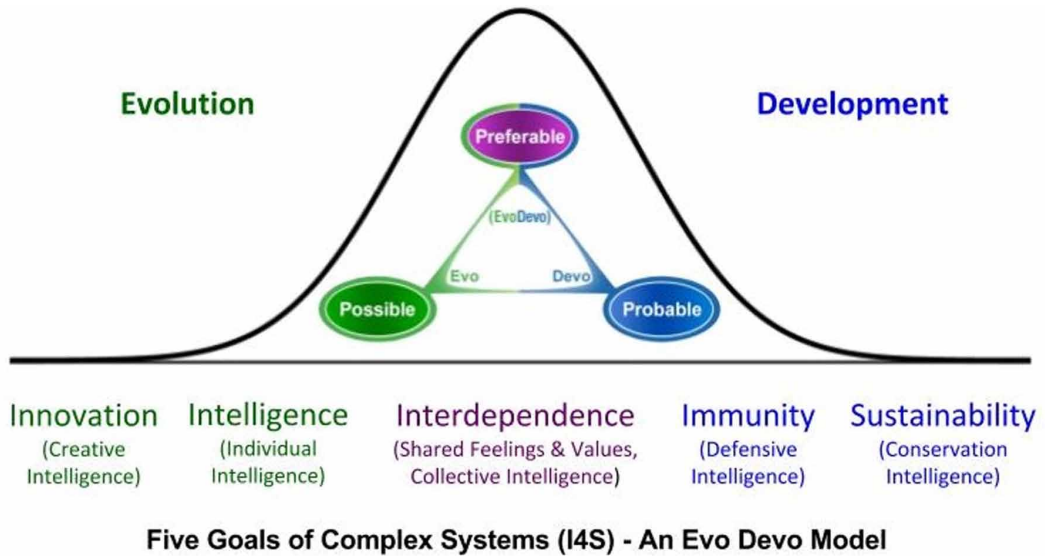
Today many technology standards exist, as shown in Figure 14, and their related tooling and development environments are supposed to support the iterative unbundling process of a traditional business and its information technology environments, through the execution of an agile process (Tidd & Bessant, 2009).

Development, Operations, Choreography and Maintenance

Actual architecture, modelling, development, operations, integration and transformation tools/environments are skeletons that should enclose various automated ML microartefacts building capabilities, needed in a holistic and unified implementation strategy for a BTP. The *Environment* offers a high level interpreted ML environment, which includes the AHMM formalism that can be used to enable fast business transformation development, operations, integration and testing iterations and to support its implementation processes. Such a development environment must respect and adapt existing software implementation standards, as shown in Figure 14, and its main characteristics are (Kraisig, Rosélia, Welter, Haugg, Cargnin, Roos-Frantz, Sawicki & Frantz, 2016):

- It uses the company's development environment(s) and does not alter any aspect of its global engineering.
- It offers mechanisms for the microartefacts' version management, deployment and testing.

Figure 14. The existing design and implementation software standards



The AHMM formalism is based on existing proven standard architectures that are based on service oriented architecture to support AHMM design process and choreography.

The Design First Approach

Defining a ML microartefact granularity and responsibility for a BTP are a very complex undertaking in the holistic implementation of the BTP. The design first approach supports the *Environment's* AHMM microartefacts design (Neumann, 2002). As shown in Figure 15, the AHMM based DMS offers an graphical user interface to manage the automated and auto-generated build and deploy formalism.

The AHMM formalism expresses a holistic structural concept or schema for the BTP's DMS's capabilities.

A Holistic Microartefacts Delivery Model

ML microartefacts' manipulation and its contained intelligence is in fact, a set of micro-actions that manage various business activities. The AHMM structure is used to generate ML microartefact instances and receives and evaluates change requests. The AHMM includes an ML to manage interaction with other BTP's microartefacts, as shown in Figure 16. The AHMM's concept is based on a holistic systemic approach to use all the *Environment's* ML microartefacts using an agile implementation process (Daellenbach & McNickle, 2005).

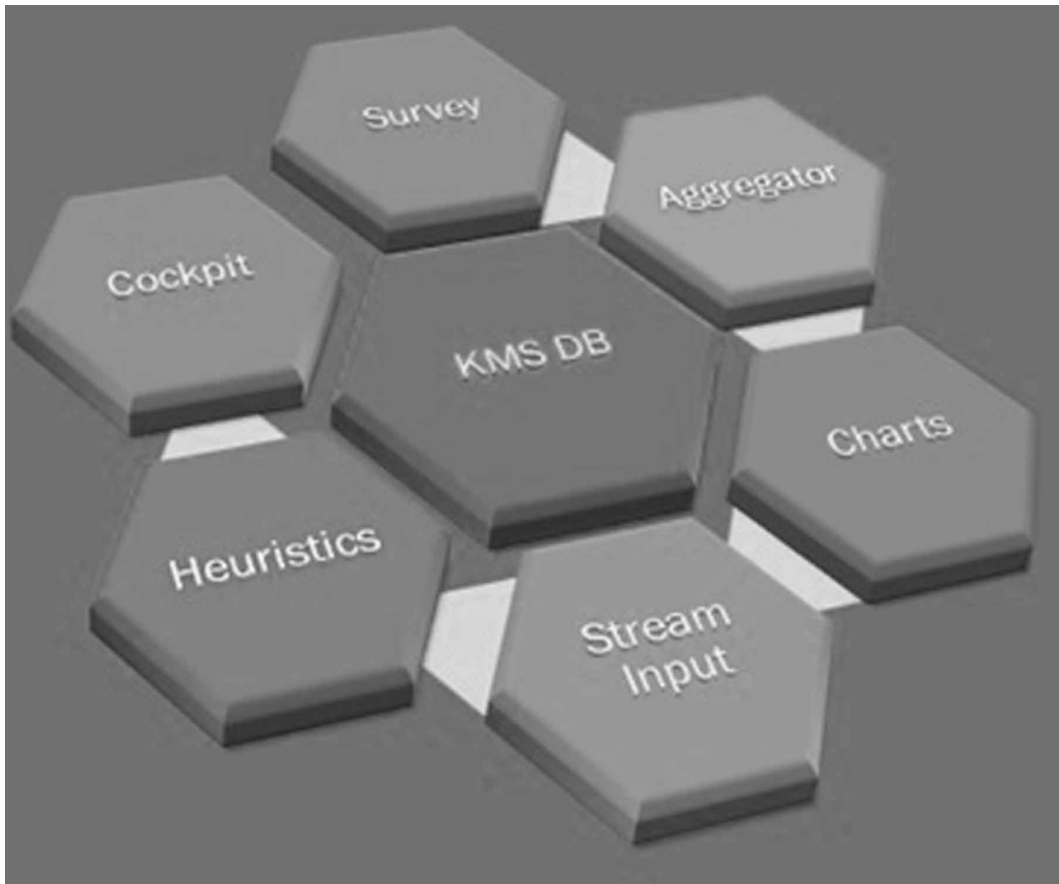
An Agile Implementation Process

In order to unbundle an existing enterprise environment and glue its legacy of newly innovated microartefacts, an adapted AHMM formalism is needed as shown in Figure 17. Using a mixed bottom-up approach.

Integration with Existing Rapid Application Development

AHMM needs a real world, technically agnostic, development tool like the enterprise's Rapid Application Development (RAD) environments; where RAD tools have been the ICS's obsession since the right beginning of programming techniques (Kraisig, Rosélia, Welter, Haugg, Cargnin,

Figure 15. The graphical user interface for development and operation client interface



Roos-Frantz, Sawicki & Frantz, 2016). RAD tools and gadgets complicate the adoption of a holistic n-tier architecture.

A Holistic n-tier Architecture

The integration of AHMM based DMS in the ICS, is the backbone of the future n-tiered decoupled business system. An adaptable, tuneable and cross-functional AHMM formalism is important for the future of any business or information system and a holistic integration strategy has to be defined using a standardized methodology like TOGAF and its Archimate modelling environment (Vicente, Gama & Mira da Silva, 2013), as shown in Figure 18.

Robustness is a major CSF for an electronic or distributed system that in general are very complex to manage; EA methodologies can improve the robustness of a distributed (or e-) business system by transforming their design, development, integration and maintenance processes and (e)transactions; nevertheless, EA standard methodologies must be supported by an additional automated mechanism like the AHMM formalism that fits in the architecture development methodologies like the ADM (Tripathy & Mishra, 2017; Greefhorst, 2009).

Figure 16. The neural network tree processing component

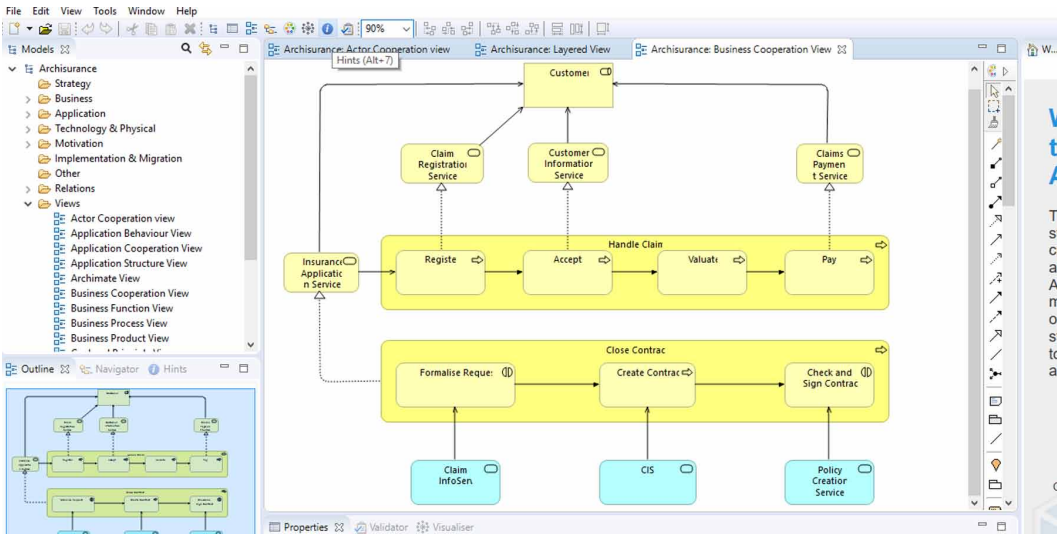


Figure 17. The information system's components

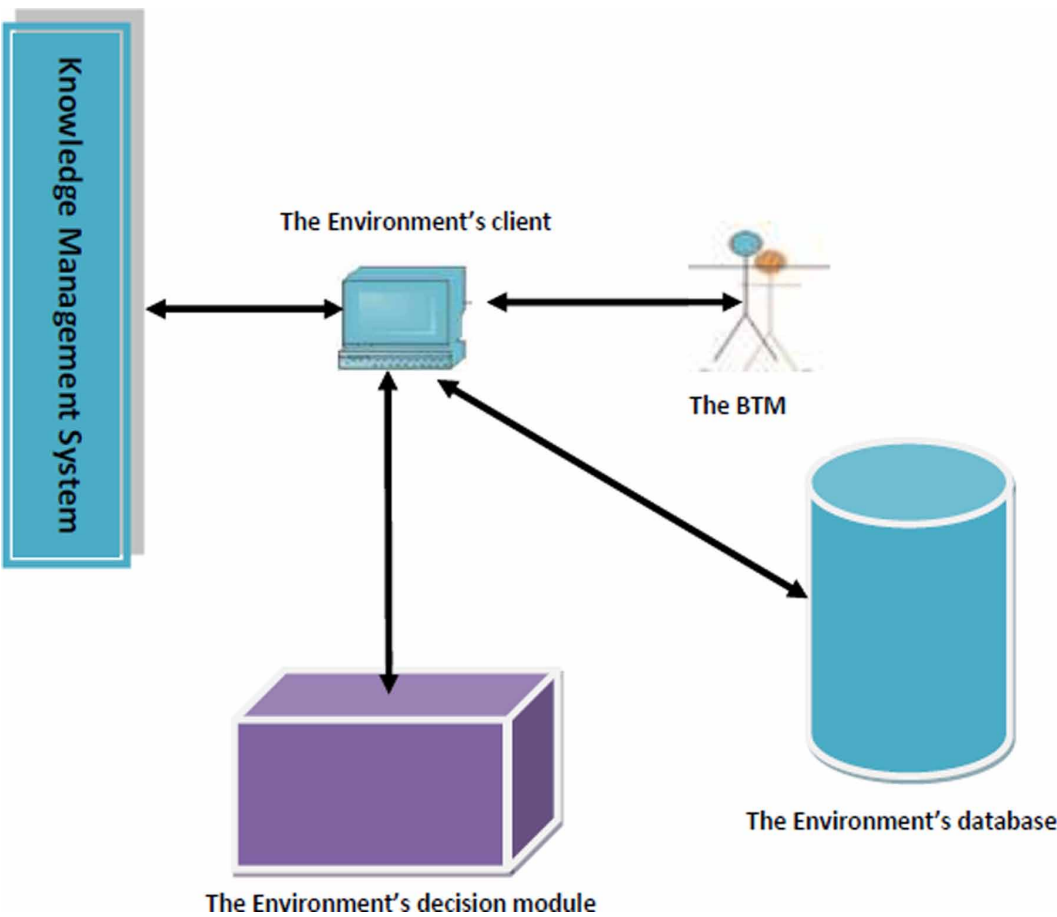
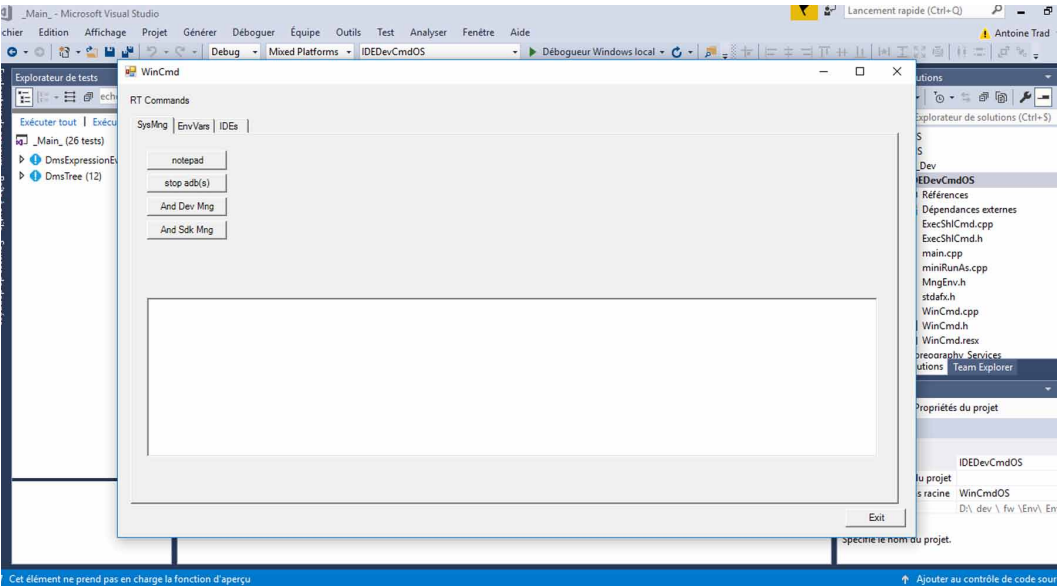


Figure 18. Archimate modelling environment (Greefhorst, 2009; Vicente, Gama & Mira da Silva, 2013)



Architecture Development Method's Integration

The AHMM integration with the ADM, enables the automation and the auto-generation of the project's ML and other generic microartefacts. These microartefacts management scripts, circulate throughout all the ADM phases and in various iterations. (Vicente, Gama & Mira da Silva, 2013).

Holistic Tests, Performance, Integration and Monitoring Environment

The major problem that causes a BTP to be stopped or to fail, is the performance problem that in general in business enterprises is translated and justified by the human behavioural aspects; that is the major reason for the emergence of the saviour's new mirage, Microservices and astonishingly again with the same mammoth approach ...

Figure 20 shows that actual immature development and operations for decision making systems is still in an infancy age and enterprises are losing a lot of energy on putting BTPs together. RAD and hyper comfort natural implementation environments are still confronted with serious project issues. These problems show that RAD tool are still immature for large enterprise intelligent applications and hence BTPs (Gartner, 2016), as shown in Figure 21.

The Mathematical Model's Integration in the Information and Communication Technology's Critical Success Factors

Based on the literature review process, the most important information and communication technology's CSFs that are used are evaluated to the following:

As shown in Table 2, the result tries to prove or justify that it is complex but possible to implement a mathematical model in the information and communication system. The next CSA to be analysed is the holistic management of the DMS.

Figure 19. The Environment's global tests environment

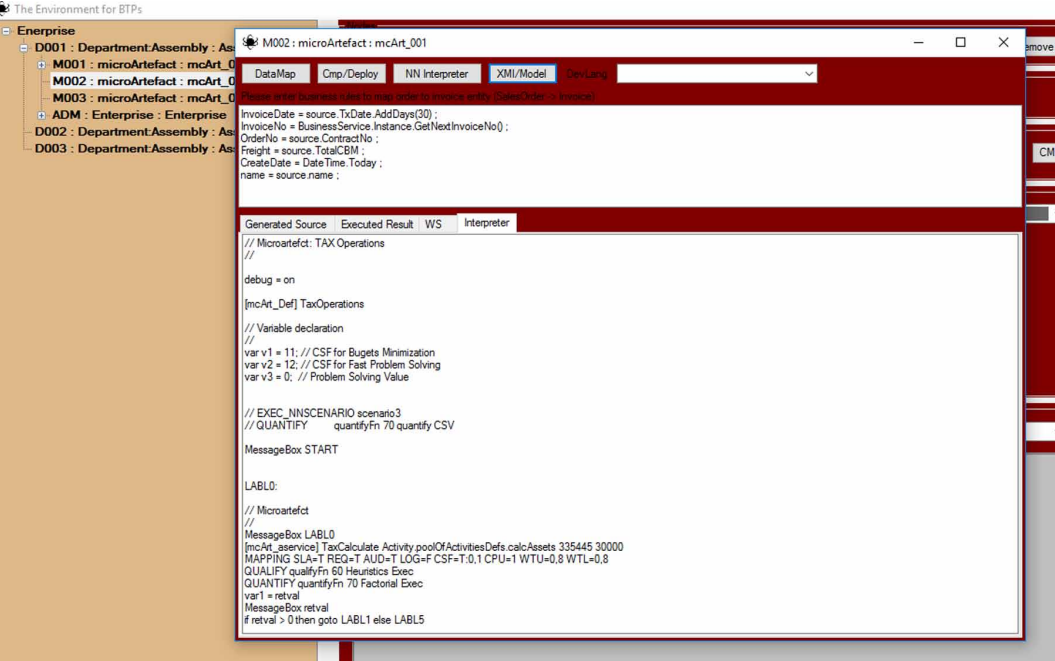


Figure 20. The decision making maturity evolution (Gartner, 2016)

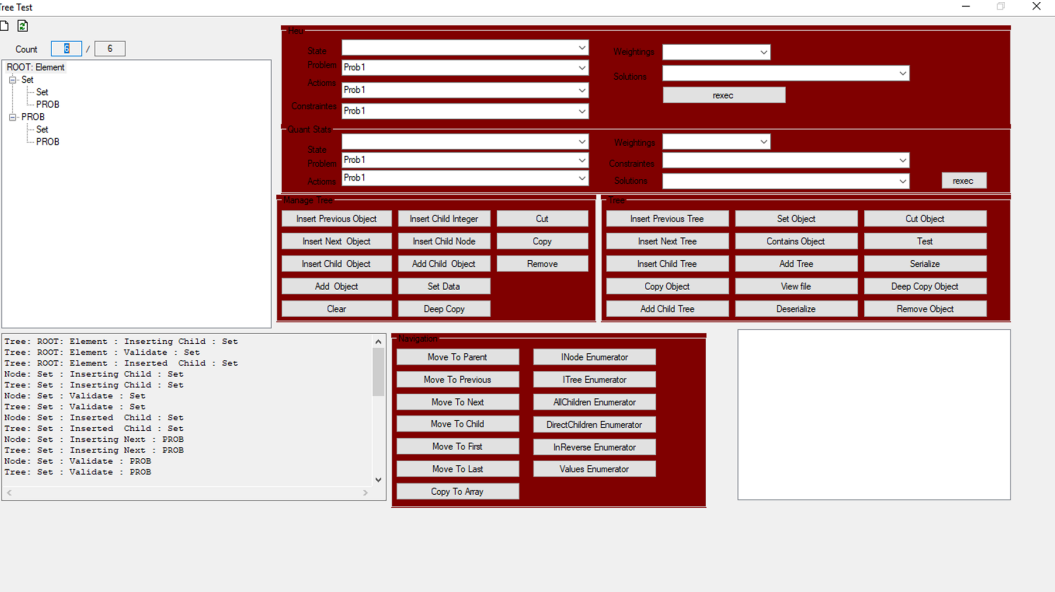


Figure 21. The modelling language environment structure

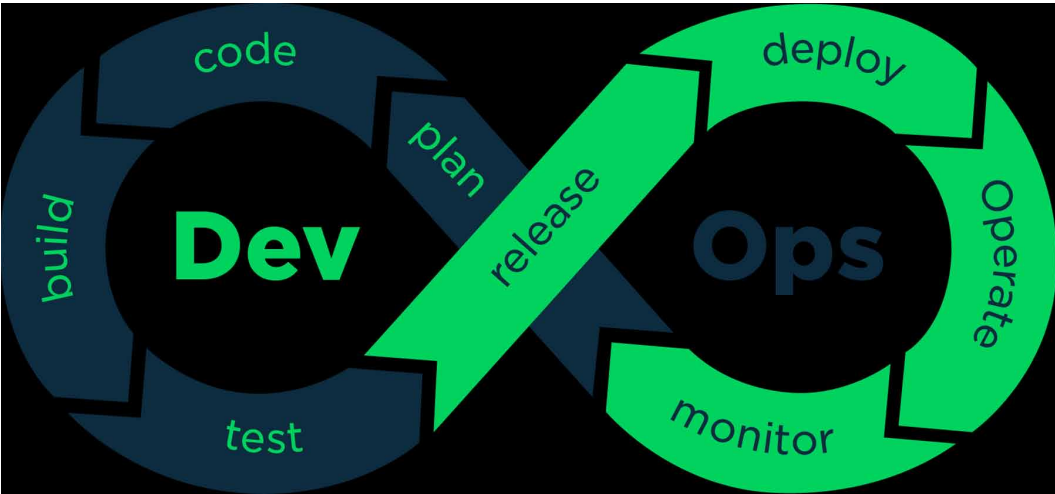


Table 2. The critical success factors that have an average of 7.15.

Critical Success Factors	KPIs	Weightings
CSF_ICS_DevOps	<input type="text" value="Immature"/>	From 1 to 10. 2 Selected
CSF_ICS_DesignFirst	<input type="text" value="TooComplex"/>	From 1 to 10. 6 Selected
CSF_ICS_RAD	<input type="text" value="Ready"/>	From 1 to 10. 9 Selected
CSF_ICS_NTierArch	<input type="text" value="Applicable"/>	From 1 to 10. 9 Selected
CSF_ICS_ADM	<input type="text" value="Applicable"/>	From 1 to 10. 9 Selected
CSF_ICS_SysAdmin	<input type="text" value="TooComplex"/>	From 1 to 10. 6 Selected
CSF_ICS_Tests	<input type="text" value="Applicable"/>	From 1 to 10. 9 Selected

HOLISTIC MANAGEMENT OF THE DECISION MAKING SYSTEM

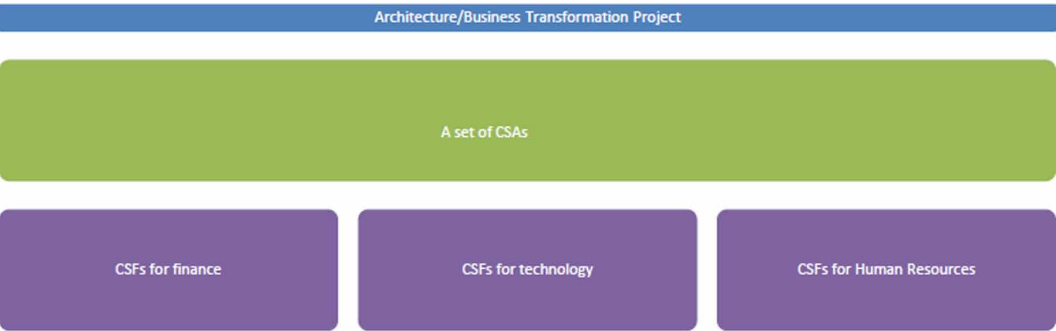
Complex Systems

Complex systems management can be adapted to the BTP's problems and requests by using AHMM based DMS (Daellenbach & McNickle, 2005). The BTP requests are processed by using the *Environment's* AHMM, as shown in Figure 22 that in turn are based on the selected critical success areas and factors that can be used as a Knowledge Management System (KMS) which has a very complex system evolution nature.

Knowledge Management System

This research's *Environment's* relates and assembles the BTP's microartefacts and resources; it links them also to the KMS and automates the autonomic ML microartefacts' instances management in all of the ADM's phases (The Open Group, 2011a). The AHMM system has to identify the initial set of CSFs to be used in the KMS and DMS, as shown in Figure 23.

Figure 22. Complex system's nature and approach (Foresight Guide, 2017)



The Decision Making Process

The AHMM based DMS is managed by the *Environment*, where any BTP user can configure the types of ML microartefacts and CSFs to be used; these ML microartefacts are orchestrated by the AHMM choreography engine. The AHMM based DMS' actions map to the various ISs mechanisms to deliver actions. The AHMM formalism is implemented in all of the BTP's processes and the implementation of microartefacts to deliver a DMS; such a set of actions can be modelled and managed by the AHMM that is implemented with an experiment or a proof of concept (The Open Group, 2011a; Trad & Kalpić, 2017a; Trad & Kalpić, 2017b; Trad & Kalpić, 2017c).

The Decision Making System's Critical Success Factors

Based on the literature review process, the most important decision making system's CSFs that are used are evaluated to the following:

Figure 23. The knowledge management system

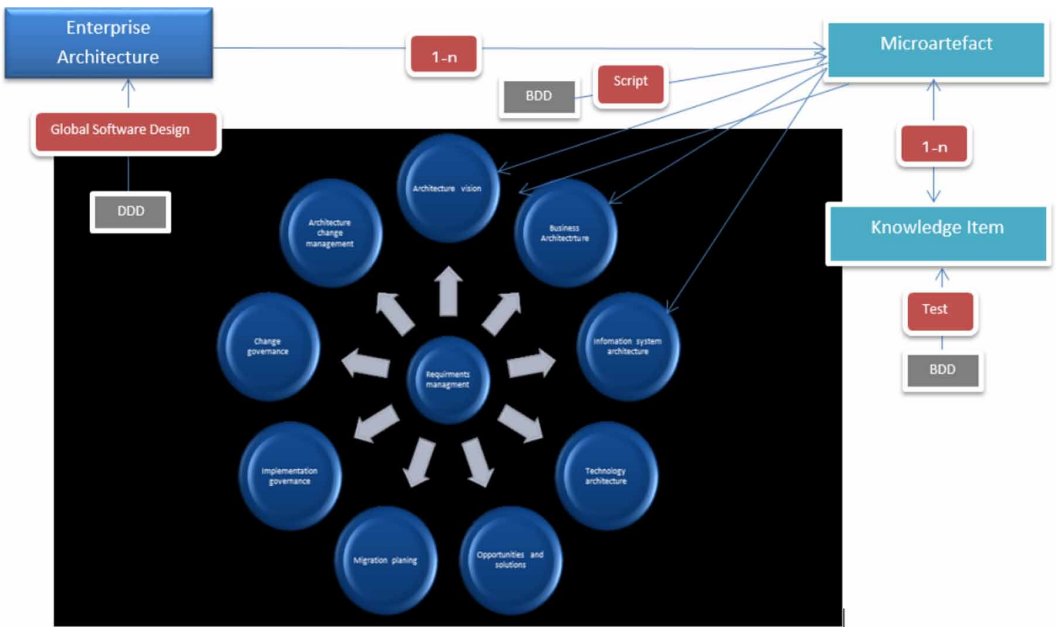


Table 3. The critical success factors that have an average of 9.7

Critical Success Factors	AHMM enhances: KPIs	Weightings
CSF_DMS_ComplexSystems	Support	From 1 to 10. 9 Selected
CSF_DMS_KMS	Enables	From 1 to 10. 10 Selected
CSF_DMS_DMP	Intgerates	From 1 to 10. 10 Selected

As shown in Table 3, the result tries to prove or justify that it is complex but possible to implement a decision making system in the information system. The next CSA to be analysed is the holistic management of the DMS.

THE RESEARCH'S IMPLEMENTATION

The Business Case

This PoC's implementation uses the default demo application named Handle Claim Process case study that comes with the Archi tool, as the experiment's business case. The demo application is an insurance claims management system that has a CRM System, a mainframe, claim files service, customer file service. The demo application manages, registers, accepts, valuates and invoices claims activities. The demo application uses the Archi Archimate modelling tool for the proof of concept, as shown in Figure 24 (Beauvoir & Sarrodie, 2018).

The Proof of Concept

The AHMM research experiment or Proof of Concept (PoC) was implemented using the research's cluster known as the *Environment* that had been developed by the authors, using the Microsoft Visual Studio .NET, C/C++ and Java. The PoC is based on the AHMM based DMS and an internal set of CSFs' that are presented in Tables 1 to 3. These CSFs have bindings to specific research resources, where the AHMM formalism was designed using an ML microartefacts, object oriented and enterprise architecture methodologies and tools. The AHMM based DMS processing model represents the relationships between this research's requirements, project ML generic and microartefacts (or building blocks), unique identifiers and the three defined CSAs.

The proof of concept was achieved using the development environment and the research framework's, *Environment* client's interface that is shown in Figure 25. From the *Environment* client's interface the ML development setup and editing interface can be launched, as shown in Figure 26.

Once the development setup interface is activated the NLP interface can be launched to implement the needed microartefact scripts to process the defined three CSAs. These scripts make up the kernel knowledge system and the AHMM set of actions that are processed in the background. The AHMM uses a knowledge database that automatically generates decision making actions which make calls to DMS, that manages the edited mathematical language script and flow, as shown in Figure 27.

This research's instance of the AHMM and its related CSFs were selected as demonstrated previously, as shown in Figure 28.

In this article's three tables and the result of the processing of the DMS, as illustrated in Table 4, shows clearly that the AHMM is not an independent component and in fact it is strongly bonded to the BTP's overall risk architecture, hence has to have a holistic approach.

The four tables in this article and the result of the processing of the first initial phase, as illustrated in Table 4, show clearly that the AHMM can be used in *Projects*. AHMM is a central component and is bonded to all the *Project's* overall architecture, hence there is a need for a holistic approach.

Figure 24. Archi Archimate modelling tool, as shown in Figure 24 (Beauvoir & Sarrodie, 2018)

A	A	⌘	⌘	⌘
B	B	⌘	⌘	⌘
C	Γ	⌘	⌘	⌘
D	Δ	⌘	⌘	⌘
E	E	⌘	⌘	⌘
F	F	Υ	⌘	⌘
G	Z	I	⌘	⌘
H	H	⌘	⌘	⌘
	Θ	⌘	⌘	⌘
I	I	⌘	⌘	⌘
J				
K	K	⌘	⌘	⌘
L	Λ	⌘	⌘	⌘
M	M	⌘	⌘	⌘
N	N	⌘	⌘	⌘
	Ξ	⌘	⌘	⌘
O	O	⌘	⌘	⌘
P	Π	⌘	⌘	⌘
	⌘	⌘	⌘	⌘
Q	⌘	⌘	⌘	⌘
R	P	⌘	⌘	⌘
S	Σ	⌘	⌘	⌘
T	T	⌘	⌘	⌘
U				⌘
V	Υ			⌘
W	Φ			⌘
X	X			⌘
Y	Ψ			⌘
Z	Ω			⌘

The *Environment* and hence the AHMM’s main constraint is that CSAs for simple research components, having an average result below 8.5 will be ignored. In the case of the AHMM’s holistic implementation an average result below 6.5 will be ignored. As shown in Table 4, this fact keeps the CSAs (marked in green) that helps to make this work’s conclusion; and drops the ones in red.

Figure 25. The Environment's client interaction

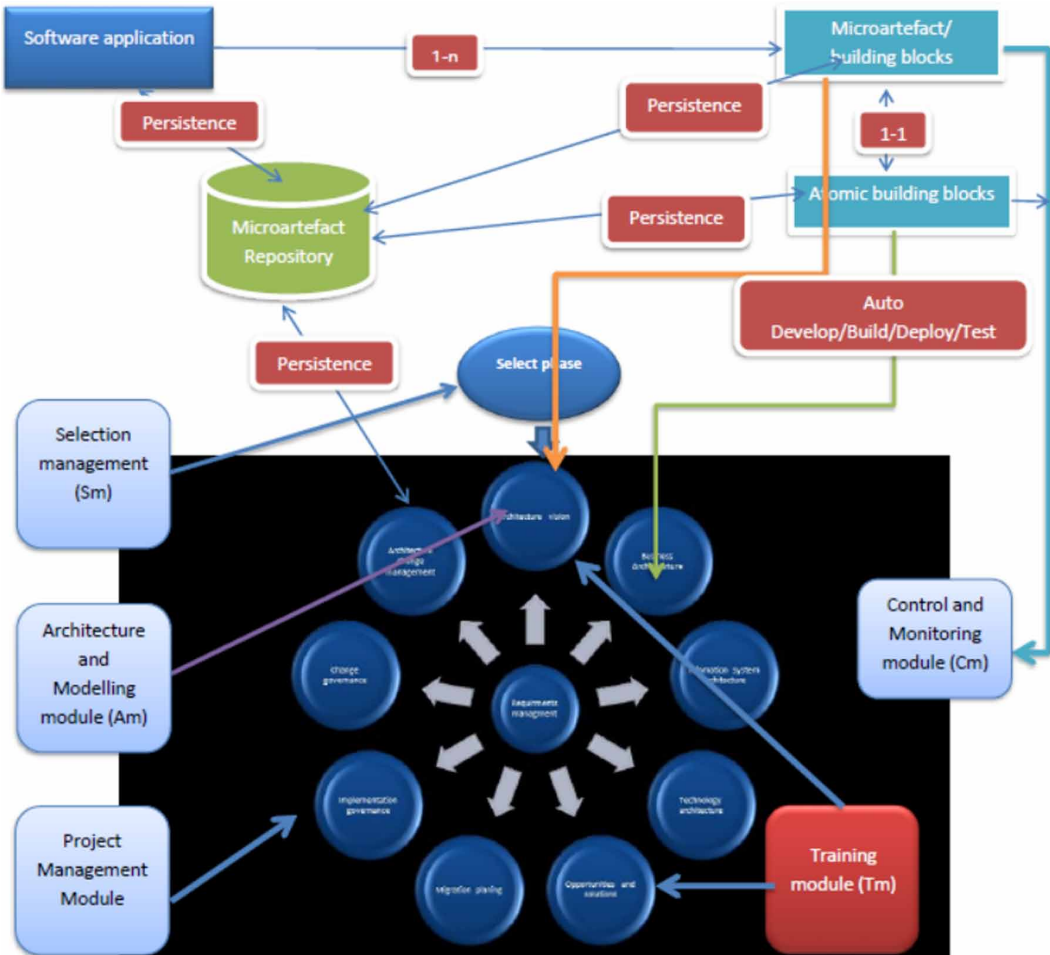


Figure 26. The Environment's development setup interface

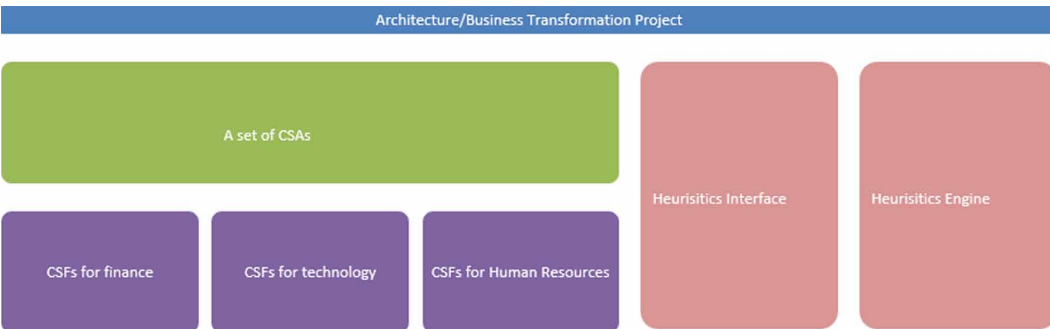
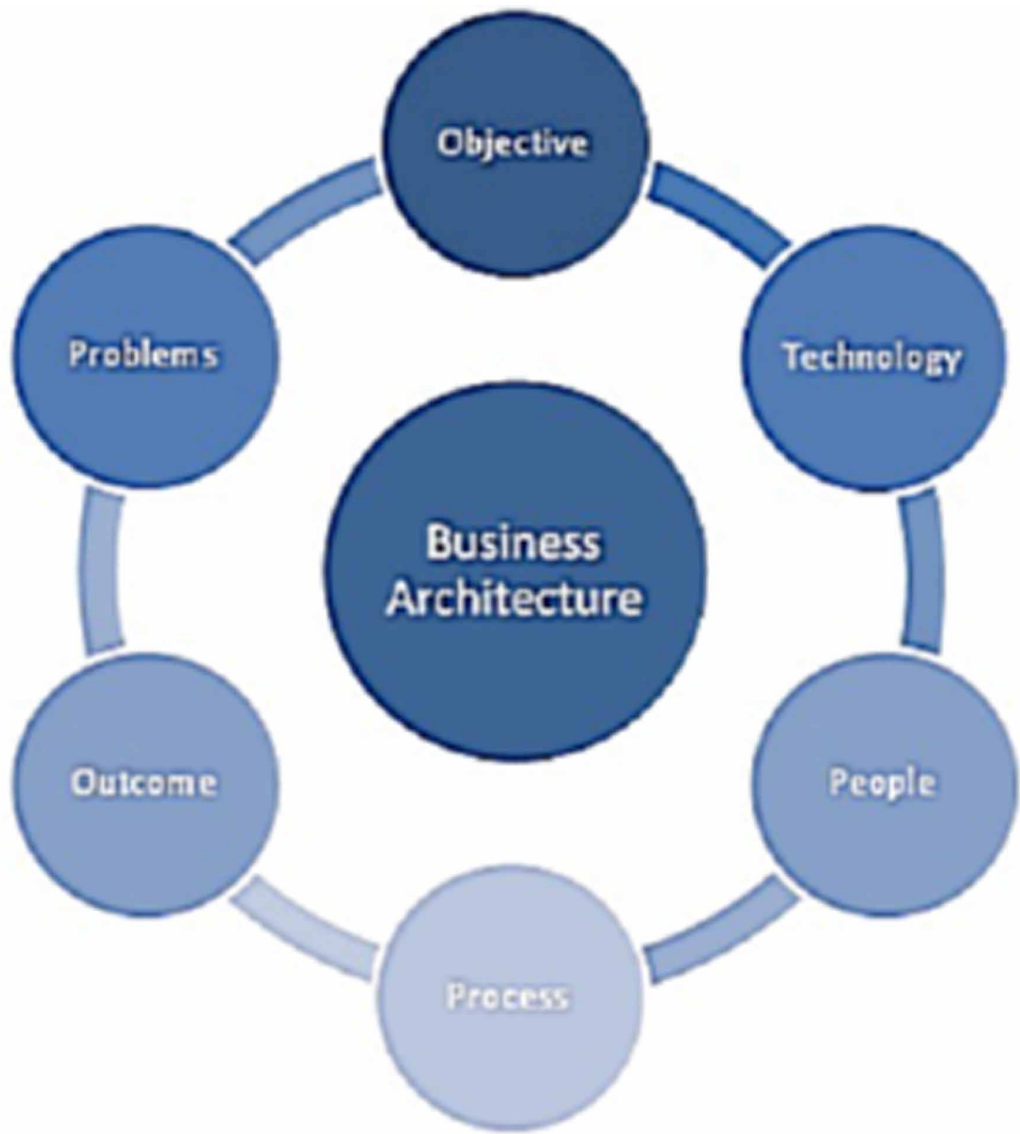


Figure 27. The edited mathematical language script and flow



It means that such an AHMM formalism global integration will surely face difficulties and that the AHMM based transformation must be done in multiple transformation sub-projects, where the first one should try to transform the base enterprise systems, the information system and the decision making paradigm.

SOLUTION AND RECOMMENDATIONS

Because of high scores, Table 4 shows that AHMM implementation is not a very risky and that a positive domain is the architecture and knowledge management; this research work and its PoC have fully achieved the defined objectives. The resultant technical and managerial recommendations are:

Figure 28. The heuristics tree configuration

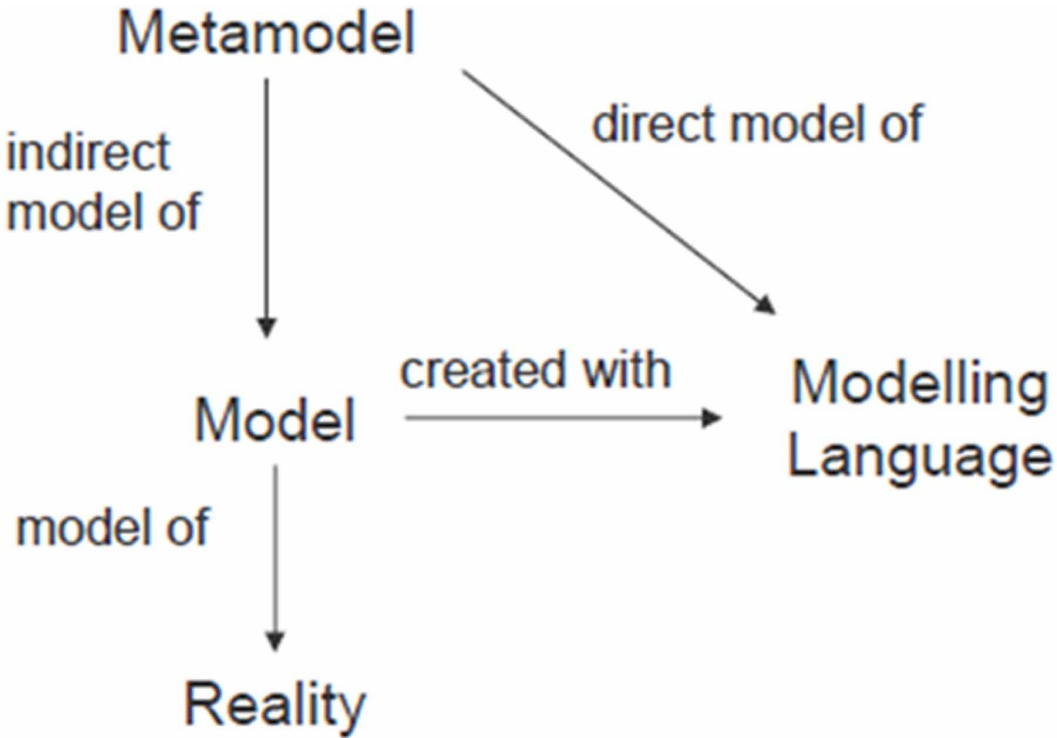


Table 4. The decision making management research's outcome

CSA Category of CSFs/KPIs	Influences IDDevOps management	Average Result
The Information and communication technology system	Built on silos/difficult to transform ▾	From 1 to 10, 7.15
The mathematical model integration	Applicable ▾	From 1 to 10, 8.15
The DMS	Implementable ▾	From 1 to 10, 9.70

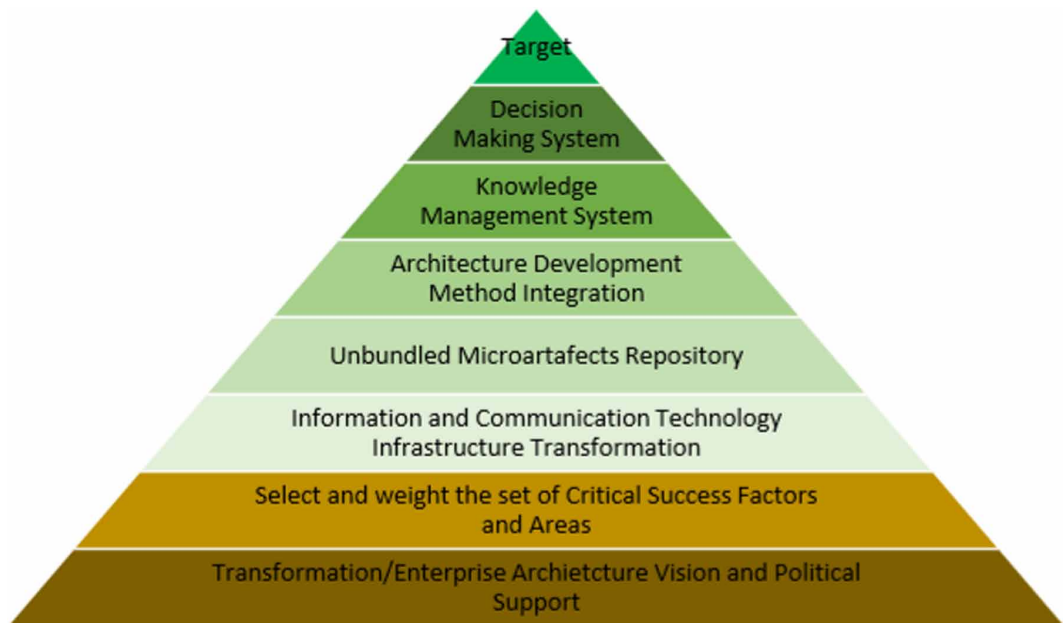
- EA methodologies improve the robustness of a distributed (or e-)business system by a BTP and (e)transactions support (Tripathy & Mishra, 2017; Greefhorst, 2009).
- Unbundle the enterprise system to deliver the needed microartefacts library.
- Build an information system based on the AHMM-like concept.
- On top implement a DMS.

The AHMM uses and tunes types of CSAs and CSFs to be processed in the BTP; the selected CSFS are orchestrated by the AHMM's choreography engine that is the base of the DMS, as shown in Figure 29. The AHMM4BT instance is in all of the *Project*'s processes; such a set of CSF mapped

actions; like the ones presented in this chapter's experiment or a proof of concept (The Open Group, 2011a; Trad & Kalpić, 2017a; Trad & Kalpić, 2017b; Trad & Kalpić, 2017c).

As shown in Figure 30, the AHMM is a part and is the skeleton of the *Environment* that uses microartefacts' scenarios to support just-in-time DMS requests. An instance of the AHMM is created at the BTP's initialization phase and takes care of the logical interaction of various elements. As mentioned and shown in Figure 30, if the aggregations of all the BTP's CSA/CSF tables exceeds the defined minimum, the BTP continues to its PoC or can be used for problem solving using the heuristic algorithm with punctual calls to quantitative methods. The BTP's initialization phase generates the needed CSFs and hence creates the types of problems and actions to be solved.

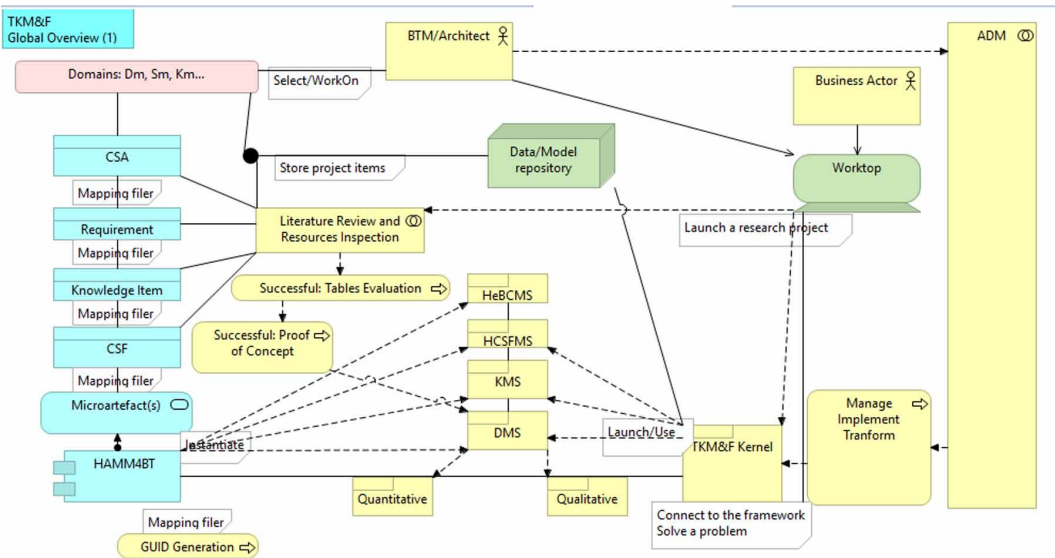
Figure 29. The proposed methodology and framework pyramid



FUTURE RESEARCH DIRECTIONS

The *Environment* future research efforts will focus on the holistic integration of the article's mentioned various fields to increase success of transformational initiatives in a cross-functional environment. During the literature and resources review process the authors were negatively intrigued by the superficial and exclusively cost-oriented (or business outcome oriented) approach that is adopted by traditional businesses managers to manage *Projects*. The role of business schools raise the failure rate and should be replaced by engineering schools for forging of flexible profiles. This research topic appears to be undiscovered and under-estimated, because many intangible values are ignored. The probable reason for such a de facto situation is the classical approach that is based on too much scoping of the research question and simplifying the research method to the level of marketing-like quantitative descriptive statistics taught in many business schools; which undermines the possibility of solving more complex problems and development of sophisticated decision systems. The future research and development process will continue to tune the *TKM&F* and will work more specifically on the decision module's evolution.

Figure 30. The framework's components and its mathematical model



CONCLUSION

This research phase is part of a series of publications related to BTPs, decision making systems and enterprise architectures. This research is based on mixed action research model; where critical success factors and areas are offered to help BTP architects to diminish the chances of failure when building development and operation systems. In this article, the focus is on the AHMM's formalism that defines a structured inter-relationship of microartefacts decision making fields. AHMM decision making engineering concepts are an important factor for the business information system's evolution. The most important managerial recommendation that was generated by the previous research phases was that the business transformation manager must be an architect of adaptive business systems.

The PoC that proven this research work's objectives, was based on the CSFs' binding to a specific research resources and the internal reasoning model that represents the relationships between this research's concepts, requirements, microartefacts and CSFs. The final result clearly implies that a decision making engineering attempt for transformation is dangerously prone to failure. To avoid such a costly scenario, the authors recommend performing the BTP operations through multiple independent sub-projects, where the priority is to transform the information system, structure a mathematical model, decision making system and global architecture.

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In a work as large as this research project, technical, typographical, grammatical, or other kinds of errors are bound to be present. Ultimately, all mistakes are the authors' responsibility.

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