Information Modeling and Process Modeling

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INTRODUCTION

Business process modeling, the activity of recording and representing the processes of an enterprise, is an important part of information modeling, which is the recording and depiction of the persistent and future arrangement of information assets of an organization in a structured or formal manner. Information modeling is often incorrectly understood to be concerned only with data modeling. In reality, information modeling is composed of not only data modeling but also other aspects such as process modeling as well as value- or service-oriented modeling. The resulting information models, covering the strategic, tactical, and operational tier, can ultimately form a single integrated enterprise information model (see Figure 1). The message of this figure is that there must be integration of the strategic, tactical, and operating information models as well as integration into all phases of the business process life cycle. The information models and the record of their content fulfill the purpose of mapping not only the dynamic aspects of the business processes and data flows within an organization, but also the static characteristics of the information space on which the dynamic (time-dependent) aspects build.[1] The purpose of these models is varied; among other things, they provide a record of the information assets of the enterprise, the idea of creating a shared understanding of the business, and thus are important in problem solving and executing change.

Business process modeling tools should be used to depict current business processes ("as-is" modeling) as well as to develop the design of the new business process blueprint[2] ("to-be" modeling). Interlinking the business and application layers and their information meta objects can be organized and their content represented using a range of current information modeling techniques. These models apply concepts already discussed in the Extended Business Process Model and Notation (xBPMN) in Chapter[3], event-driven process chain (EPC), Unified Modeling Language (UML), information engineering (IE), and entity-relationship (ER) modeling, among others. We will then provide evidence via a case study of how these different modeling techniques complement each other through practical examples of their use.

INTENDED AUDIENCE

This topic is interesting to individuals who use only one of these information modeling techniques in their daily work, or professionals seeking to gain insight into how these modeling techniques can be put into practice in a real-world situation.

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FIGURE 1

Process life cycle and enterprise tiers.[4]

The models in the section "The Answer" show how each of the different modeling techniques can in fact complement each other and thus provide a set of integrated enterprise information models that contain all aspects of the business process that has been modeled.

PROCESS LIFE CYCLE

The view of a process life cycle is not new. Several authors[4,5–8] have looked at the problem of defining these cycles and proposed a number of different approaches; for example, Verner proposed a process life cycle containing seven individual stages to an iteration:

Analyze→Design→Build/Develop→Deploy→Operate→Maintain/Continuous Improvement.

However, for our working examples we will use the definition of the process life cycle (see Figure 2) as defined by the LEADing Practice framework[9] because the LEAD standards offer a paradigm shift in the goal of producing a truly open all-encompassing standard (LEAD standards include interfaces to other frameworks, methods, and approaches such as TOGAF, Zachman, FEAF, ITIL, Prince2, COBIT,

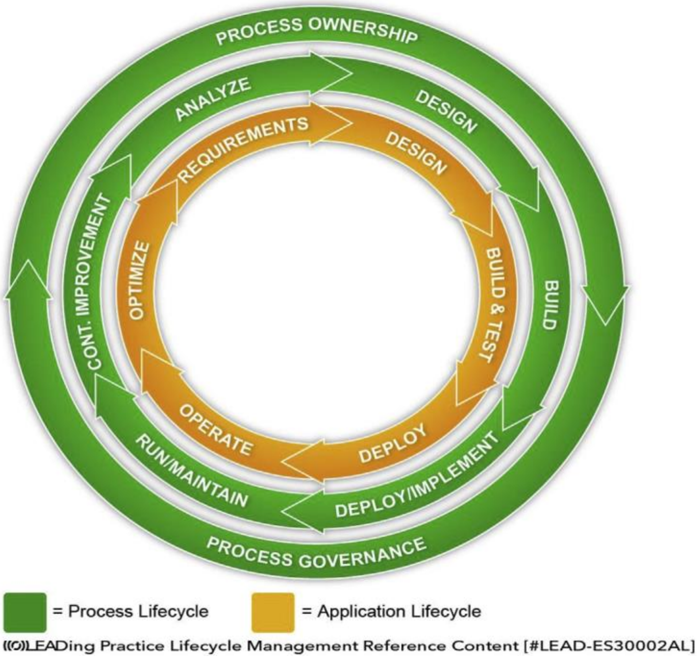

FIGURE 2

Process life cycle with the application life cycle.

and DNEAF).[10] For our working examples, we will use the definition of the process life cycle discussed in the chapter "BPM Life Cycle."

The diagram above (Figure 2) illustrates the cyclical nature of the process and application life cycle.

Analyze (and Discover)

The goal of process analysis is to detect implicit knowledge that exists in the organization about existing or as-is processes and make this knowledge available in an as-is model so as to organize and represent this knowledge.[11] Thus, the analysis phase and documentation are the first steps in providing a complete discovery of existing (as-is) business processes, closely followed by the capture, decomposition,[12] and documentation of all relevant related information objects, properties, and relationships. This procedure is commonly known as business process analysis (BPA).[13]

Above all, the processes, together with the related dynamic and static business structures, should ultimately support and execute the strategic business objectives and critical success factors of the organization. Thus, these strategic aspects are a part of the business direction and therefore value expectations and business requirements that have to be considered in the analysis and organizational design of the associated strategic information objects and their relationships to the processes. The connection between these objects and the processes must be must be both identifiable and verifiable. This connection occurs only through each of the members of the array of integrated and holistic sets of related knowledge, skills, and abilities that, combined, enable the enterprise to act in its environment—the enterprise's competencies. These competencies are important in executing the structured analysis of a process because they provide the context in which to judge the optimization criteria to be used when designing a process, whether centered on value maximization or cost minimization. It is therefore critical to distinguish at an early stage between core competitive, core differentiating, and non-core competencies and thereby the related processes.[14,15] Core competitive competencies and all related processes are essential for an enterprise to compete and core differentiating competencies and all related processes are those that differentiate the business to its customers. In both cases, the processes involved are the tasks that create value, whereas anything that is non-core but that must be done should be done for as little cost as possible.

For a correct and complete analysis of a business process (as-is model), all relevant information objects and their relationships to each other must be identified and documented. This includes consideration of value and business process flow, business competency, service, and data flow. In addition to the dynamic flows, the enclosing static (hierarchical) structures (value, competency, service, process, application, and data) should also be considered. In the case of any of these, the process expert or process engineer must make a thorough decomposition and analysis of the business process. Decomposition is the procedure by which the objects are broken down into their simpler forms. For example, a business process is decomposed into one or more process step(s), whereas a process step is decomposed into one or more process activities(s) and a process activity is decomposed into one or more transaction(s). The result of several successful iterations of the discover/analyze cycle is the completed as-is model.

The manual process of analyzing, decomposing, and documenting business processes from a previous successful run of a process life cycle (assuming process maturity greater than "3" or "standardized") can also be assisted using tools such as SAP Reverse Business Engineering and SAP Solution Manager or ARIS Process Performance Management. However, some tools provide only part of the information required about the processes' state and the relationships between the relevant objects. These tools are even less successful when determining process flows with business rules as well as static structures and hierarchies needed to obtain a full understanding of their design and properties, and lead to incomplete designs that often do not work as needed.

Design

In this phase the new business process flow and business process structures (to-be status) are designed.

Depending on the scope of the project, the design work can involve anything from altering the complete process flow to adding and/or deleting business processes, or just to small changes in basic behavior. A similar range of the scope of change can occur with the information objects and the related dynamic and static structures contained within each of the business processes. This is relevant because the information model must be created throughout the end-to-end process flows. Therefore, output/product of this phase is the successful composition of the new to-be design, captured in a model.[16]

Build

The process build phase is concerned with applying the to-be models defined within the process design phase, including all related dynamic and static structures, to create the operating system (manual or automated).

In a purely manual situation, the build phases are addressed through work design, training, and the preparation of documentation. In an automated environment build, the activity may include programming, configuration, or other work within the software that performs or enables the work. Obviously, in many cases both types of work will be required and must be coordinated to complete the build to achieve the results that are required from the new operations.

Depending on the size and scope of the software-oriented build and the quality of the process models produced in advance, a so-called model-driven design can be used.[4,17] However, more comprehensive process models and methods are required when deploying enterprise and Web/restful services than are the case for implementing or customizing corporate standard software. In the latter case, for example an ERP system, partial automation can also be obtained through such tools as SAP Solution Manager and SAP Business Workflow or BPM systems such as SAP BPM or Software AG webMethods support.

The needs of the business analysts who have produced the specification of the to-be business and the technical application developers who implement the system are not always the same.[18] The challenge and problems associated with producing a successful combined system of work that fully implements the to-be models must therefore lie in collaboration between the members of these two groups. Part of the problem is finding balance between the parts of the work that should be done by machine and those best done by humans, and how best to establish the interface between the two; often the problems are related to matters of precision, which, with BPM and automated business processes, can lead to implementation that does not accurately fulfill the business requirements. When considered in total, the result is the description of a system of work in which human work is efficiently and effectively enabled by the roles and capabilities of the applications. Often attempts at a solution to this problem try to use UML diagrams. However, these are more suited to technical designers and less to business analysts, and they suffer from the fact they do not capture the information needed to provide a complete solution to this problem. In the section on the UML model, we detail a to-be example based on UML class diagrams.

Deploy/Implement

This is the phase where processes based on the to-be models are put into effect to be used by the business. The process models and the information models within them can be a basis for testing and can be used to offer a high level of support during the implementation phase.

Run/Maintain (Monitoring)

This phase is concerned with the successful operation of business processes and their enablers in a production environment. During this phase, efforts must be made to guard the process to ensure its operations remain consistent with the design objectives. Without oversight, the process may be sub-optimized or otherwise modified in ways that needlessly increase cost or reduce value. This is the main task of the process-monitoring phase, which is the final phase and ultimately is the input to the analysis phase in the next iteration of the cycle. Whereas the analysis phase is concerned with determining possible weaknesses of the dynamic and static structures of the business processes and their interrelation, the monitoring phase is concerned solely with one aspect: measurement of process performance indicators (PPIs) together with time, cost, and quality to verify the status of the process. The Gartner group quoted by Verner[19] coined the term “business activity monitoring” to describe the ability to produce real-time performance indicators to assess speed and effectiveness of business operations.

Continuous Improvement

Once the new business processes are operational, ongoing work is necessary to verify whether the intended goals have been met through a continual effort to learn from and improve on the design of the process to achieve its design goals. These efforts can seek evolutionary change or may involve innovative change to the design.

Continuous improvement is a key aspect of BPM whereby feedback from the process and the customer are evaluated against design goals.

PROCESS ATTRIBUTES

Process Flow and Process Resources

A process flow consists of a set of connected process activities organized into a stream, sequence, course, succession, series, or progression, all based on the process input/output states, in which each process input/output defines the process flow that together performs a behavior. These process activities may connect to static resources, including business objects of various types, and to roles.

Process resources such as roles, which are represented as pools or lanes in BPM notation (BPMN) process or collaboration models, have an important role in describing work, in that they signify the allocations of responsibility and thus require consideration in the analysis and design of the work.

For transactional and tacit work, process resources may be either human or automated via software applications.[20] Resource allocation can be useful in showing where one system connects resources to another or where there is an exchange between roles. In our business process model examples, we have identified the following resources:

- Enterprise organization (e.g., sales and distribution, marketing department, warehouse employee, etc.)
- System organizational units of ERP (e.g., client, company code, sales area, etc.)
- Information cubes (e.g., purchase order), dimensions (e.g., time, material, unit)
- Business objects of ERP (e.g., SAP purchase order BUS2012)
- External Web services (Break Even Point)
- Data entities (e.g., customer master file, condition master, customer order)

Data Flow

For the analysis to be sound, data flow needs to be viewed separately from the process flow. A deficiency of BPMN is that it considers just the process flow and does not consider and integrate into a holistic model the separate flows of the business and information objects. Also, BPMN does not recognize that the assignment of business objects or information cubes to process activities may occur and that exposing how, where, and who views static data, information, or data flow is also useful in showing where business data structures are used in the process flow and how they change states.

Process Automation (Application)

Process automation may be supported through a number of means including a specialized BPM engine. To provide a complete solution any tool used to manage processes requires the specification of the process and data flows, together with their association with the above resources.

WHY THE SUBJECT IS IMPORTANT AND THE PROBLEMS AND CHALLENGES IT WILL SOLVE

A major problem for business process professionals is the volatile environment in which they must drive change through the business process improvement life cycle. The volatility of these conditions is highlighted by the fact that "If there is one constant in the market, it is that things are always changing faster and are more dynamic,"[21] thus enforcing the idea that organizations and enterprises are under continuous pressure when optimizing their business processes and thus have to constantly play catch-up with their competitors.

Optimization of business processes most commonly stems from the need to solve three main business problems/strategies:

1. Those that pertain to productivity enhancement
2. Market expansion
3. The creation of new markets[22]

The goal of optimizing business processes can also be one of pure optimization, by reducing time and costs and improving quality within the organization.

The interrelations between these and other strategies or strategic goals are depicted as cause-and-effect chains within balanced scorecards being addressed within the examples of the to be models.

In a report by the Gartner Group,[23] one of the four usage scenarios driving the purchase of BPM Suites was the "Support for a continuous process improvement program," which highlights recognition of the need to optimize business processes. This change is important to enable an enterprise to overlay its application assets with a business-level representation of the end-to-end processes that are then supported by the software assets. This allows the enterprise to see and assess how applications contribute capability and enable the business. The model-driven approach is seen as one of the best ways to enable business and IT professionals to manage and change processes collaboratively to achieve these improvements. Although process-centric models have a critical role in this work, these models must be both complemented by and connected to other applicable information models. Collectively, this approach creates a unified set of models that can provide a complete picture of all phases of the process life cycle. The result is a portfolio of business-oriented models that foster a shared understanding as to how best to pursue business process management objectives.[24]

There has been a significant rate of failure of many BPM projects. The size and cost[25] of these failures expose the correlation between the need for improvement of process and information models and the need for successful completion of the BPM projects. The fact that these models must cross all levels and hierarchies of an organization creates a high level of complexity, with the consequence that many levels of decomposition/composition are required to produce useful and consistent information models,[3] and which therefore can be controlled. Often the reason for failure of the BPM projects lies with the problem that the initial process requirements were not correctly understood, formulated, or communicated throughout the design process.[26] Again, this highlights the need for methods of representation to empower the business process engineer, together with the tools and infrastructure engineers, and other contributors and stakeholders, to achieve greater success.[27]

INFORMATION MODELS WITHIN AS-IS AND TO-BE MODELS

Among the many challenges associated with process modeling, process engineering, and process architecture, questions about how to produce quality as-is and to-be process models are of great concern. The answer to these challenges is not easy because BPM and BPMN do not consider a process in its full context; it is extremely difficult to repeatedly determine the scope, level, and quality standard for processes.

Figure 3 illustrates the architectural layers that are relevant to the analysis, specification, and management of process, e.g., process modeling, as well as relevant to the context of the process architecture. This figure shows the process layer as enabled by the behavior and features of the objects in the application layer, which in turn provides access to the persistent data structure of the data layer. In addition,

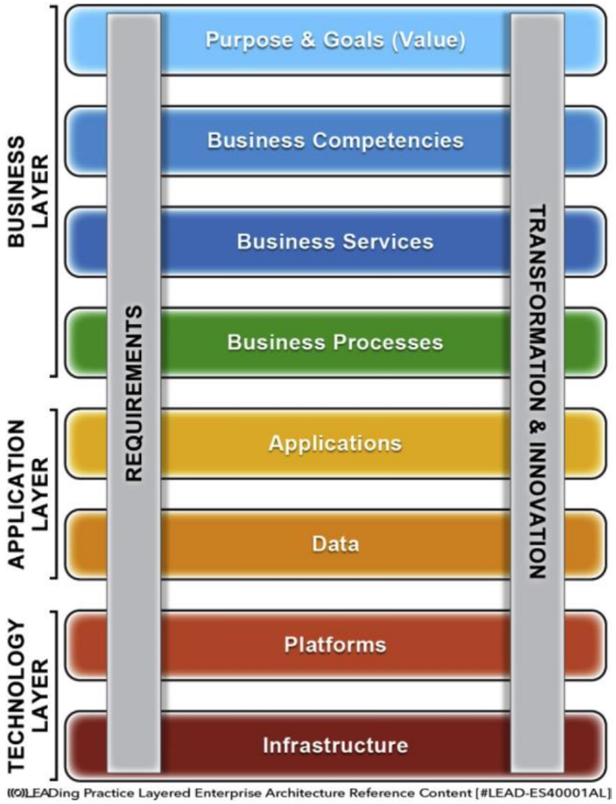

FIGURE 3

Architectural layers.

the figure shows that the need for a process to produce value, and thereby support the enterprise strategy, may only be achieved through the objects within the competency and service layer. It is the services that expose the value of the processes and the competencies that organize, contextualize, and align the processes and services to the enterprise view of value. Enterprise processes and therefore enterprise process models must be designed within and connect to this context and to the relevant objectives that reside in each. By working in this manner, we are exercising the principles behind the objects that ensure that the object of interest, in this case a process, is completely and fully defined. Furthermore, the value in assigning the objects across the layers is that within the layers the various stakeholders who have concerns about the objects view them.

It is important when defining the contextual, conceptual, logical, and physical aspects[28] It relates to a specific way of modeling process aspects of object clustering to define the correct levels of hierarchy. In our example organization, we have assigned four levels, as shown in Figure 4.

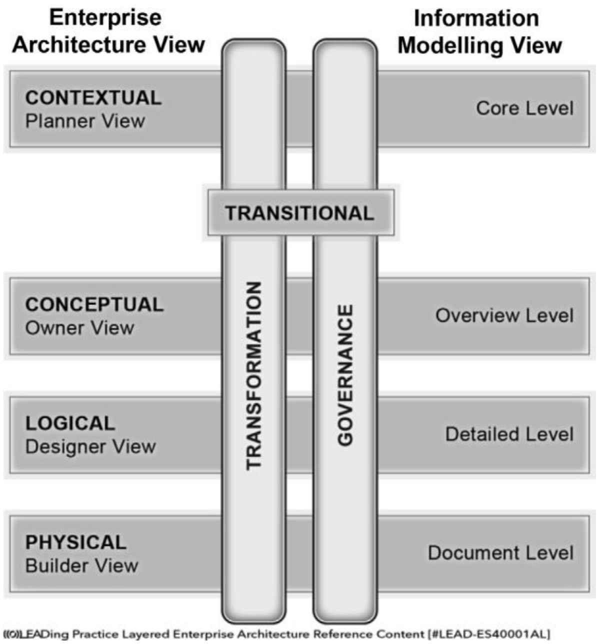

FIGURE 4

Conceptual and logical object clustering hierarchy levels.

The levels and views in Figure 4 should be understood in the following ways[29]:

- Contextual models are the perspective of the planners of the enterprise, and in creating the link between process and information models this is a core level.
- Conceptual models are the perspective of the owners of the enterprise, and in creating the link between process and information models this is the overview level.
- Logical models are the perspective of the designers of the enterprise, and in creating the link between process and information models this is the detailed level.
- Physical models are the perspective of the builders of the enterprise, and in creating the link between process and information models this is document level.

What differentiates the views and levels are not only the details, but in reality the specific models used or developed within them and subsequently different contexts in terms of purpose and goals from the models. The reason this is so important is that the different levels all have different value potential, e.g., purpose and goals, and as a result the different views and levels have their specific transformation potential and governance concept that need to be explored and interlinked throughout the layers (Figure 4). Decomposition and composition happen through the relevant objects across the views and levels and their models, an abstraction that represents and considers the process and information as a whole. As illustrated in

Figure 3, an enterprise should be considered as a whole which subsequently includes the views and models that capture the

- Business layer, such as the resources, roles, value aspects, enterprise capabilities, functions, and services
- Application layer, representing the automated processes and thereby the application components, application modules, tasks, application services, and data components, data objects, data entities, data tables, and data services
- Technology layer, such as the platform components, platform function, platform devices, and platform services, as well as the infrastructure components, infrastructure functions, infrastructure devices, and infrastructure services

In addition to the views and levels discussed, aspects important for both information modeling and process modeling are the subject of tagging and thereby classification and categorization. Processes, information objects, and services can be tagged according to their strategy, tactics, and operational tiers. Figure 5 illustrates an example of the enterprise tiers and relevant process areas.[30]

As illustrated in Figure 5, the enterprise tiers represent tagging possibilities that link the processes, goal and objective view, decision making, and system measurement and reporting view. Therefore, classifying the process links to multiple aspects needed in the information models:

- Strategic aspects: This tier affects the entire direction of the firm. An example is the mission, vision, strategic business objectives (SBOs), and specific business performance indicators (BPIs) and business plans. The strategic tier has the long-term, complex decisions made by executives and senior management and the measurement reporting view is used for the most scorecards.
- Tactical aspects: The aspects at this tier are more medium-term, less complex decisions made mostly by middle managers. They follow from strategic decisions and aim to meet the critical success factors, the way to do this is for governance, evaluation, reports, control and monitoring and the measurement reporting view which is used for most dashboards.
- Operational aspects: At this tier day-to-day decisions are made by operational managers and are simple and routine; the measurement reporting view used is for the most cockpits.

As-Is Modeling

The purpose of as-is modeling is to explore and capture how the processes are performed today. This provides a baseline for describing the business.

Determining the Hierarchy Level

The following section describes a suitable procedure for determining the level within the hierarchy that is applicable to the analytical work being performed, the so-called decomposition or ‘composition level of the information objects.[31]

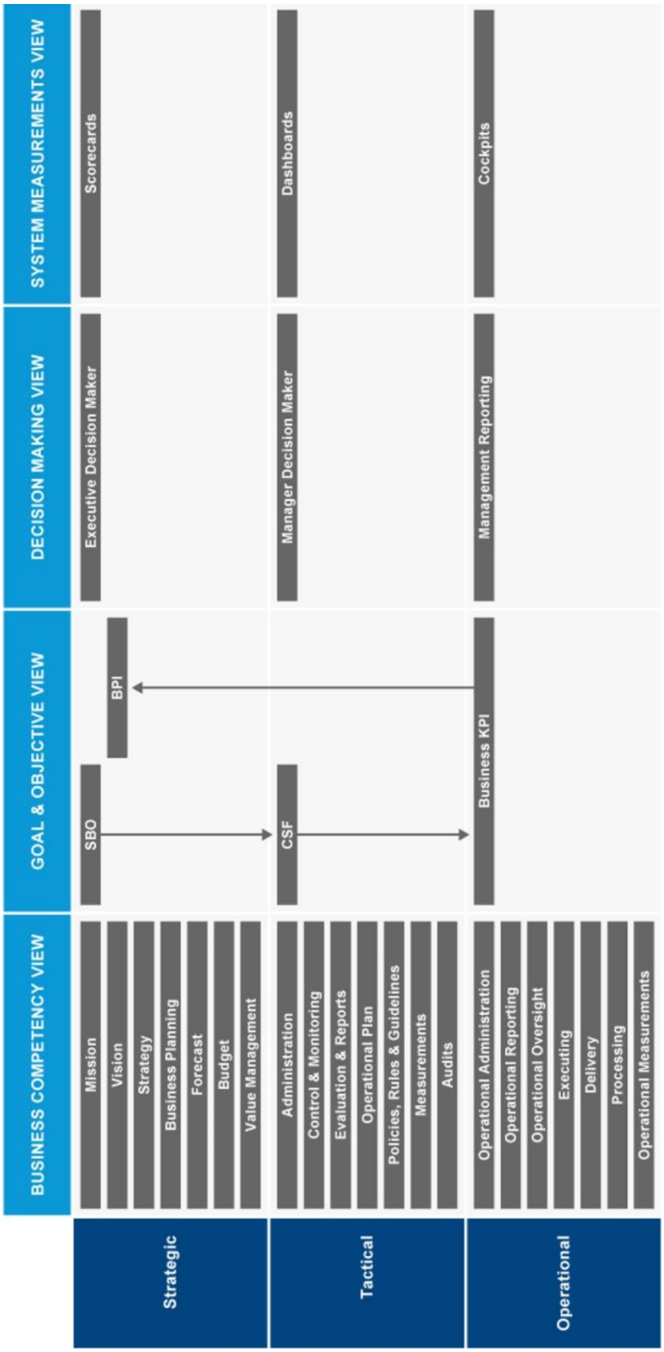

FIGURE 5
Example of enterprise tiers.

Various alternative views exist of the approach to this particular problem. Figure 6 presents the principle variations: the supply chain operations reference model (SCOR)[32] and the American productivity and quality center (APQC).[33] As shown in the figure, each framework attempts to describe and populate the various levels of detail of process with authoritative process inventories. They alternatively provide for four or five levels of process decomposition. On the other hand, the SAP Business Blueprint Solution Manager (in the current version 7.1), which must implement these processes, has support only for three process levels. Unification is therefore not possible without finding another way to approach the problem.

Another related challenge is that when other models are been used, these models must also be consistent with and align with the applicable process model structure. For example, for the models used to describe an enterprise to be unified, it is critical that there be a method to connect horizontally i.e., within the same level, an information object such as resources (Business Competency layer of figure 3) to relate in a logical and coherent way with an information object from the process layer, e.g., a process activity.

A possible solution to this problem is to find and establish horizontal and vertical connections between the objects of interest so as to place the various concepts in layered structures to link the leading process layer structure from "above" to all other applicable layers while simultaneously consolidating/integrating them with their respective data layer from "below". Looking at the intersection of the different frameworks in Figure 6, it makes sense for the processes and all other layers to be set initially to three levels with a default going downward, e.g. Level 1–Business Process, Level 2–Business Step, and Level 3–Process Activity (ref. LEAD column in Figure 6). Process activities access data entities (Data layer) on the same level (horizontal navigation), with the result that finally the data table (data layer) appears (vertical navigation) at Level 4, where the associated key (used to establish and identify relations between tables), foreign keys (establish and enforce a link between

	APQC PCF	LEAD	SAP SolMan	SCOR
Levels of Hierarchy	1. Category	Process Area		
	2. Process Group	Process Group		
	3. Process	1. Business Process	1. Szenario	1. Level 1 2. Level 2
	4. Activity	2. Process Step	2. Process	3. Level 3
	5. Task	3. Process Activity	3. Process Step	4. Level 4
		4. Transaction / PPI		

FIGURE 6

Comparison of the different levels of hierarchy of the process layer.

two tables), and descriptive attributes are found. These attributes are then accessed by transactions (process layer) on Level 4, representing a defined (committed) status of data input and output, creating a spine.

Another important factor that indicates the positioning of transactions at Level 4 is that performance indicators (value layer) must use this level to determine the achievement of strategic business objectives. In all other layers, this performance indicator appears on the same Level 4 e.g. Business Compliance, Service Level Agreements, Process Performance, IT Governance.

Meta Information Objects Within Information and Process Modeling

To answer the question of how to model the business and application layer meta objects, we begin by providing two summaries (Figures 7 and 8). In each case, object mapping is based on the use of four business layers (whereby components are distinguished by their contribution to value,[34] competency,[35] service,[36] and process[37]) and two application layers (which classify the components as to whether they are part of application structure[38] and behavior, or data[39]). These are brought together in a matrix. The layers are classified side by side in six columns to set all objects to a coherent set of categories or layers, and then into a hierarchy of levels (Levels 1–4) to distinguish between their areas of contribution.

Looking further, Level 3 contains the data media or data objects representing data entities and dimensions (application layer). The latter connects directly to Level 2 above, together with the information cubes. From the service group (service layer) on Level 2, individual business services connected to business objects on Level 3 can be refined (Figure 7). These in turn are used with the business objects (application layer) to encapsulate process activities and events (process layer) and the data entities (application layer) on the same level (horizontal).

To complete the picture from a business perspective, the organizational structure of the enterprise (competency layer) must now be included in and distributed across the layers. These can be seen in Levels 1–3. The business areas consist of business groups; business roles are thus assigned to both business areas and business groups (competency layer). When more than three levels of enterprise hierarchies exist, it is useful to divide these into the context of three separate process levels. At Level 3 only business roles are used.

The so-called (by SAP) system organizational unit structure of the ERP application (application layer) should be modeled on the similar-sounding but different internal departmental structure. In contrast to the organizational structure for employees in the enterprise, this structure contains the mapping of external customers and suppliers, services, stock flow, cash inflows/outputs, etc., with a process activity. The system organizational units also constitute a hierarchy of several levels. A process activity on Level 3 of the process layer can access any level in the hierarchy of the system organization. All SAP Solution Manager “compatible” information objects are highlighted blue in figure 7.

Information Meta Objects Mapping									
Layer	Business Layer				Application Layer (ERP, BI, InMemory, Mobile, SOA)				
level of Decomp.	Value	Competency	Service	Process (BPMN)	Application		Data		
1	Vision						Information Object		
	Mission						Information Object		
	Strategy						Information Object		
	Goal						Information Object		
		Business Area	Service Area	Business Process	Application Module		Information Object		
		Organizational unit		Pool	Organizational Unit		Information Object		
2	Strategy						Information Object		
	Goal						Information Object		
		Business Group	Service Group	Process Step/Sub Process	Application Module		Information Object		
		Organizational unit		Lane	Organizational Unit		Information Object		
		Revenue/CostFlow		Revenue/CostFlow			Information Object		
		Information Cube		Lane	Information Cube		Information Object		
				Service Group(Flow)			Information Object		
3	Strategy						Information Object		
	Goal						Information Object		
	Objective						Information Object		
		Business Object	Business Service	Process Activity	Application Function	Business Object	Information Object		
				Screen	Transaction Code		Information Object		
				Lane	System Organizational Unit		Data Entity		
				Events	Business Object		Data Entity		
				Lane	Business Object		Data Entity		
				Lane	Dimension		Data Entity		
				Lane	Data Entity		Data Entity		
				Data Object	Data Object		Data Media		
		Business Roles	Services Roles	Lane	Application Roles		Data Entity		
		Business Rules	Service Rules	Process Rules	Application Rules		Data Rules		
4	Performance Indicator	Business Compliance	Service Level Agreement (SLA)	Process Performance Indicator (PPI)	IT Governance	System Measurements	Fact Table		
							Customizing Data Table	Master Data Table	Transaction DataTable
				Transaction	Application Task		Key	Foreign Key	Describing Attributes

FIGURE 7

Mapping meta objects.

Typical decomposition structures of the meta objects are found when navigating vertically downward; correspondingly, the compositions are found when navigating vertically upward. For example, a business area on Level 1 can be aligned horizontally against a business process or an application module, whereas a business area on Level 1 can be refined into a business group on Level 2. A business process consists of process steps or sub-processes. Information meta objects that have a vertical assignment to an underlying level can be aligned to the lower right side to an additional symbol that branches into one or the more appropriate models of the underlying layer shown within Figure 7. Organizational unit' (competency layer) may appear in the processes at Level 1 as BPMN pools (process layer) or in the lower hierarchy Level 2 as BPMN lanes. All system organizational units are assigned to Level 3. Their keys and foreign keys such as sales organization are assigned to Level 4.

As the engine that informs, influences, and drives all other behavior, vision, mission, strategy, and goal are assigned to the value layer at Level 1. Because they may be constrained by these larger factors, strategy and goal again appear at Levels 2 and 3. The value layer is not going to be implemented but realized, shown as information objects in the matrix of Figure 7. The same applies to the revenue/cost flow as well as the group services on Level 2 of the competency and service layer. Business services, however, are considered on Level 3, as methods of business objects. Their implementation is completed as a process activity (process layer) or application function (application layer). Finally, process activities may appear as collapsed sub-processes in BPMN diagrams at Level 2.

Information cubes (application layer) exist only on Level 2 to support the field of business intelligence. Information cubes consist of dimensions on Level 3 and fact tables on Level 4 of the data layer. On Level 4, the data layer contains master, transaction, and customizing tables as well as their associated keys, foreign keys, and descriptive attributes. The corresponding attributes feed (horizontally), e.g., the PPI of the process layer or the SLA of the service layer.

Business rules culminate in our example in process or application rules; responsibility for the integrity of the data rules (e.g., entity and referential integrity) lies with the database management system. Service rules will not be considered further in our example.

Level 3 of the process layer contains items that are considered resources respectively lanes of processes: system organizational units, business objects, dimensions, data entities, and roles. In xBPMN, data objects represent information objects and are interpreted within our example as data media (document) on Level 3 representing data entities at Level 3 or a data table on Level 4.

The information meta objects in fact have many more relationships than previously mentioned within this hierarchy; all relationships are shown in the following models in Figure 8, in which exactly one layer and one level are identified. The respective models represent more than one layer or more than one Level (e.g., hierarchical models) and therefore its information meta objects from Figure 7 can appear multiple times.

Information Models Mapping						
Layer	Business Layer				Application Layer	
Level of Hierarchy	Value	Competency	Service	Process	Application	Data
1	Balanced Scorecard	Organizational Chart (Business)	Function Tree	BPMN Process Diagram (Business)	Value Added Chain Diagram	
	Objective Diagram				Function Allocation Diagram (level O) Function Allocation Diagram	
2	Balanced Scorecard	Organizational Chart (Business)	Function Tree	BPMN Process Diagram(Business)	Value Added Chain Diagram	
	Objective Diagram				Function Allocation Diagram	
				E-Business Scenario Diagram		Data Warehouse Structure Diagram (Information Cube)
3	Balanced Scorecard	Organizational Chart (Business)	Function Tree	BPMN Collaboration Diagram (Business Rules)	eEPC BPMN Process Diagram (Application)	BPMN Process Diagram (Data) Organizational Chart (Application)
	Objective Diagram	Business Vocabulary	UML Cass Diagram		Function Allocation Diagram	ERM Information Engineering
		Accounting Model				Document Flow
	KPI Allocation Diagram					Data Warehouse Structure Diagram (Dimension)
4	KPI Allocation Diagram	KPI Allocation Diagram	KPI Allocation Diagram	KPI Allocation Diagram	KPI Allocation Diagram	Data Warehouse Structure Diagram (Fact Table)
					Screen Diagram (Mobile)	Attribute Allocation Diagram

FIGURE 8

Mapping information models.

The balanced scorecard (value layer) for the organization should not only exist on Level 1 but should also be included (cascaded) to Level 2 as departmental balanced scorecards and therefore exist for each individual department (Business Group). On Level 3 we can find an employee balanced scorecard. In addition to the external customer/supplier relationship at Level 1, the related cause-and-effect chains on Level 2 should also depict the internal relationship among all departments (Business Groups). The objective diagram on Level 1 shows an objective hierarchy for each of the four perspectives of the balanced scorecard of the enterprise (Level 1) and its departments (Level 2), whereas Level 2 connects the strategic objectives (goals) of the departments of the balanced scorecard to the corresponding process steps. Via key performance indicator (KPI) allocation diagrams on Levels 3 and 4, the goals are connected to objectives that are later connected to their KPIs.

The organizational structure (competency layer) includes three levels; the corresponding department hierarchy can be mapped into a single organizational chart or broken down into hierarchies over these three levels. The individual departments are identified for reasons of simplification in our example as cost centers. Using the standard accounting model, the individual transactions will be booked according to the rules of accounting on Level 3. The KPI allocation diagram on Level 4 is used to measure business compliance.

Value-added chain diagrams describe Levels 1 and 2 of the application layer (Figure 8). Level 2 can also be represented by either an xBPMN process diagram or an e-business scenario diagram (process layer). On Level 3 both EPC and xBPMN process diagrams are used in the application layer. The connection to the business objects is represented through an UML class diagram (service layer). The KPI allocation diagrams on Level 4 cover the measurement of the service level agreements and process performance indicators (process layer).

The lowest level of the application and data layer (Level 4) covers the screen diagram and the attribute allocation diagram. The requirement and importance of fully integrating mobile workplaces into an organization's business processes is paramount in today's mobile society.[40] The key, foreign key, and attributes that describe the transactions of a screen and documents, and system organizational units are mapped to the attribute allocation diagram. The KPI allocation diagrams map the values of KPI (IT Governance) that have been identified with the fact table.

On Level 3 the data layer contains a document flow diagram, an ERM, and an information engineering model. The data warehouse information cubes are represented as star schema on Level 2, as dimensions on Level 3, and as fact tables on Level 4 of the data layer. One BPMN process diagram (data) specifies and collects the assignments of the data entities (data layer) and one BPMN process diagram(application) the system organizational units (application layer) of the function allocation diagrams, showing the process models in different complementary views for demo company Global Bike inc. (GBI).[41]

EXAMPLE AS-IS MODEL (SALES AND DISTRIBUTION)

Business Process Model and Notation Model

Business process model and notation (BPMN) is a standard for graphical representation of business processes that provides a means for specifying business processes.[42] The objective of BPMN is to support business process management for both technical users and business users.

During the categorization of information models, the information meta objects have an important part in the analytic process, depending on whether the objects are types (like "employee") or instances of types (like "Sales Person 1"). The enterprise information model can be used to depict many different types of organization: for example, for a specific branch of an organization or an entire enterprise (consisting of several organizations), or for only one specific organization. The enterprise information model usually also depicts the actors (subjects) within the organization, including the entire organizational chart (usually with employee name, position, department, etc.), which can be defined either by so-called type or instance level, or sometimes mixed together. In comparison, the enterprise objects (customer, supplier, material, etc.) and services (quotation provision, sales order provision, etc.) are generally assigned only as types to a model. Eventually, during the execution phase of a single business process, only instances of all objects remain. Figure 9 shows an example of a fragment of BPMN diagram in which both types (e.g. "create sales order") and instances of types (e.g. "Sales Person 2") are used.

The BPMN collaboration diagram in Figure 9 records the as-is status of a typical sales and distribution process at Level 3 (process activity). What are expressed and can be seen are the process and the data flows of the data objects and actors involved within the operating organization. The upper black box includes activities of external customers and the exchanged documents (data objects). Both pools are located at the hierarchy Level 1, the departmental three (only "Marketing" is visible in Figure 9) lanes of the GBI on Level 2, and the seven (only three of them are visible in Figure 9) role lanes at Level 3. This allows the process to be assigned on Level 3 and thus go through many hands. The occurrence of various intermediate events wait until the process terminates; until then, numerous data objects flow back and forth between the various process activities.

The data objects flow at Level 3 can be defined by the logical/physical procedures of the organization, which require the fulfillment of certain conditions or an allocation of certain resources. The document flow in Figure 10 shows how individual documents from left to right reference each other; thus, in our example, customer payment, customer invoice, and outbound delivery are all based on a sales order. Documents such as goods issue' or customer payment are required to maintain certain business compliance such as the HGB (Handelsgesetzbuch, the German commercial law) or USGAP (United States General Accounting Principles).

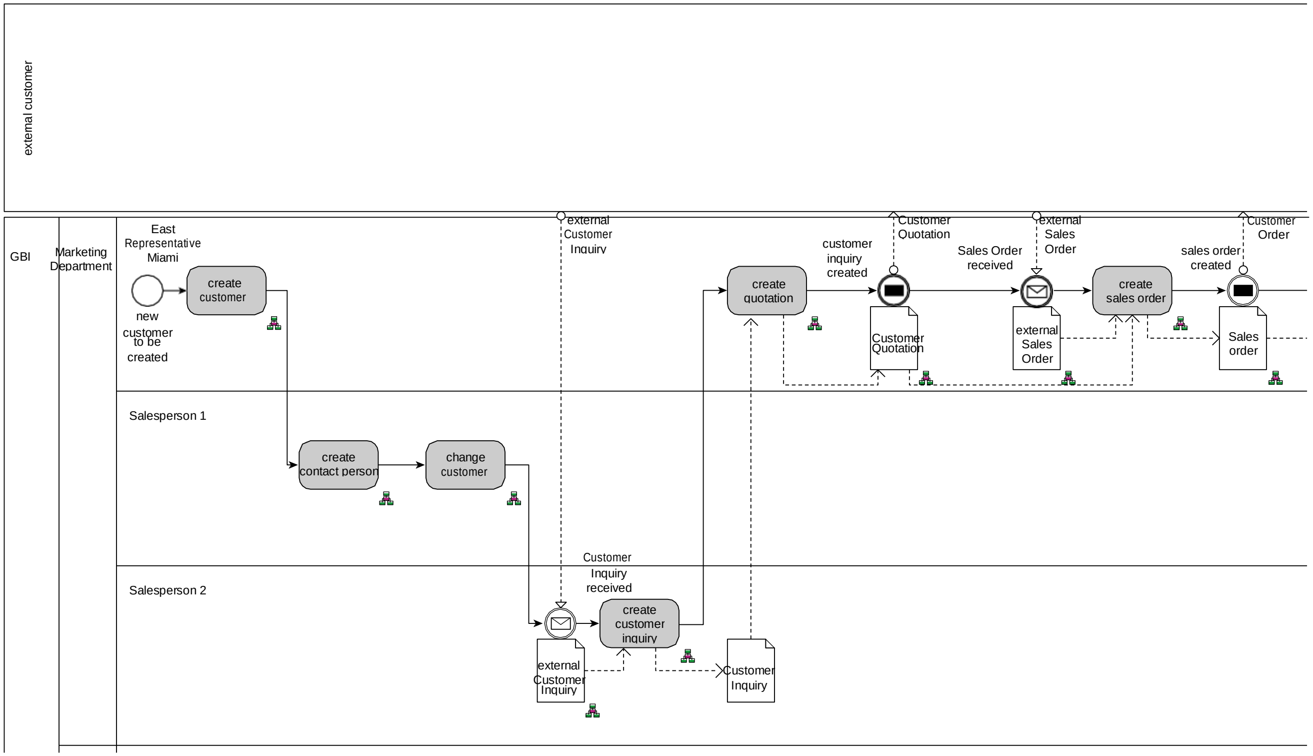

FIGURE 9

Business process model and notation collaboration diagram with process and information flow and organizational lanes (Level 3).

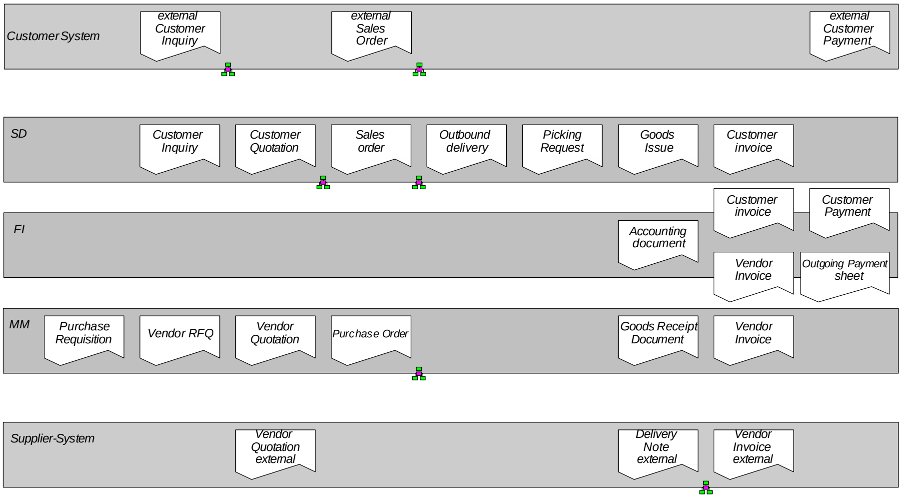

FIGURE 10

SAP document flow (Level 3).

The accounting sales model presented in Figure 11 represents the set of documents from the document with the double book entry activity necessary to execute a complete customer payment. Once the ware leaves the company, there is an effect on the balance, inasmuch as the value of the ware is missing. At the same moment, an account accrues to the customer who requested the material. A goods issue records the decreasing of material in the inventory and discharges the real account in finance. The debtor bill creates an account for the debtor. Then, in-payment bill balances the debtor bill and money gets transferred to the bank account.

Event-driven Process Chain Model

Event-driven Process Chain (EPC) diagrams are another approach to expressing business process work flows.

As shown in Figure 10, for the flows to be truly unified, three different functional areas (data objects systems within SAP) must be integrated: the customer system, sales and distribution (SD), and financial (FI) system; the external sales order should ultimately be stored as a sales order in the SD system. Because the two systems are not physically connected, until this occurs there will be a data discrepancy/media disruption between the two data objects. This is evident on the EPC in Figure 12, which depicts the processing through time from top to bottom. What the model shows is that the data (data object "sales order") of the incoming document "external sales order" must be entered manually by East Representative Miami in the screen mask VA01 Order create. This is shown

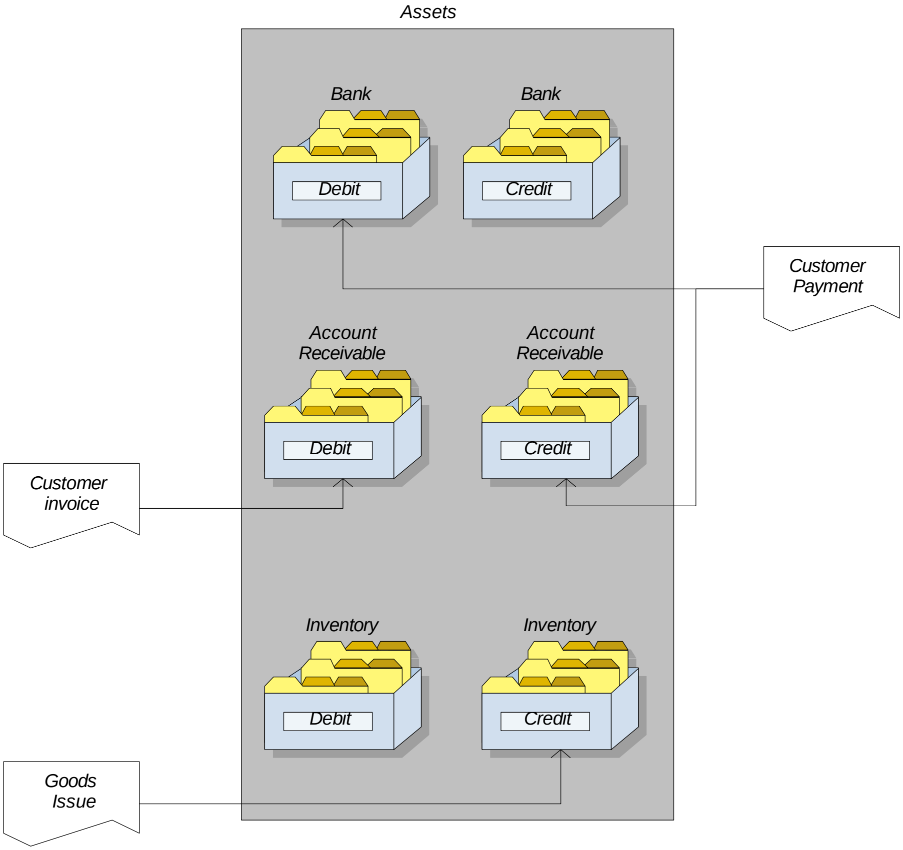

FIGURE 11

Accounting model sales/financial impact (Level 3).

on a more detailed level in Figure 13, where purchase order number is recognized as a foreign key attribute for the hierarchies on Level 4 of the model, thus providing the exact reference to the existing purchase order number of the customer.

The enterprise information models also include its customers and suppliers, such that all attributes on Level 4 refer to a unified data model (a portion of which is presented in Figure 14) on Level 3.

The focus of the BPMN process model in Figure 15 is on a portion of the persistent integration (data read/write) of the recorded sales process with the appropriate master (e.g., customer, material, and condition) and transaction data (e.g., sales order, goods issue, etc.) on Level 3 at the GBI (Level 1) in marketing (Level 2). The data are implemented and nested in Level 3 over overlapping

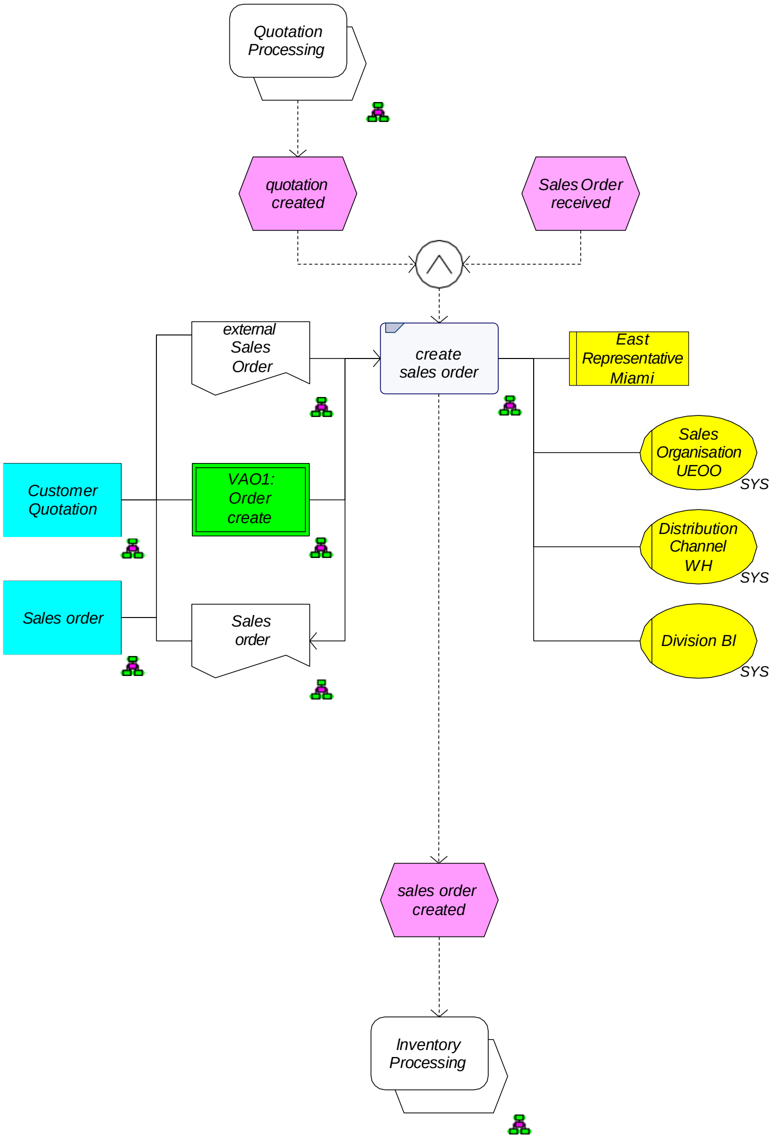

FIGURE 12

Event-driven Process Chain “create customer order” with documents, data entities, SAP screens, position and SAP system organizational units (Level 3).

lanes and are not included in this figure. Figure 15 shows that when a new customer is identified, a business process is performed to assign first the customer master data that are in turn associated with the condition master. The condition master overlaps in the upper part with the material master (not visible in the

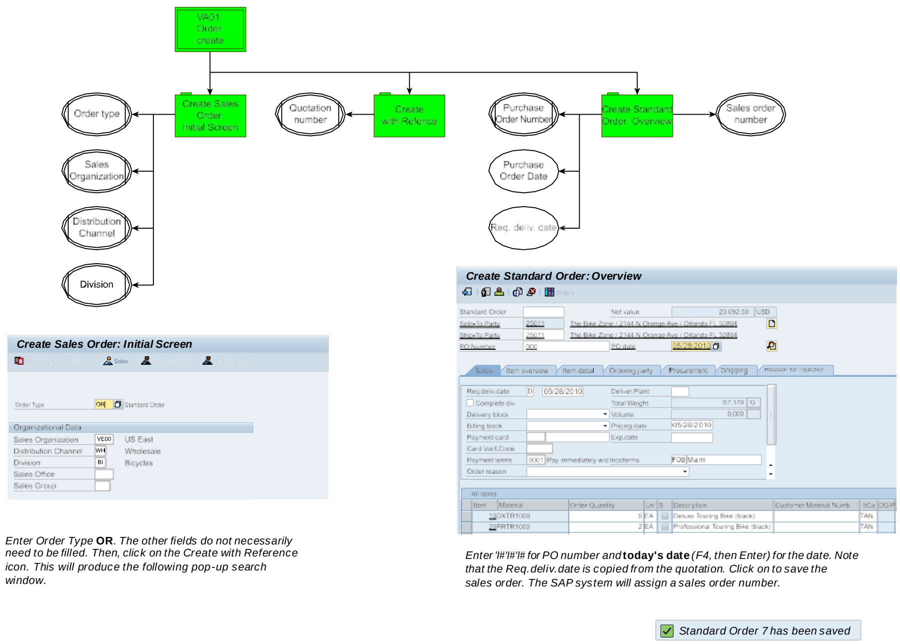

FIGURE 13

SAP screen diagram "VA01 order create" (Level 4).

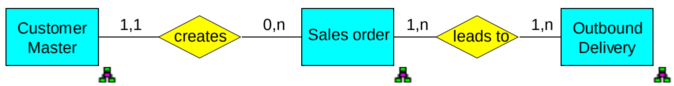

FIGURE 14

Fragment of entity–relationship (ER) model customer order (Level 3).

figure); therefore, creation of the first transaction data such as customer inquiry also means that material or a combination of materials, customers, and condition master (see overlap) data is generated. Many other transaction data are based on this combination.

Entity–Relationship (ER) Model

The ER model is a method for describing the persistent data or information aspects of a business domain using properties of the data.

The fragment of the ERM associated with the example (Figure 14) shows the dependencies between the customer master data and different transaction data. A sales order leads to at least a (partial) delivery one or more outbound deliveries

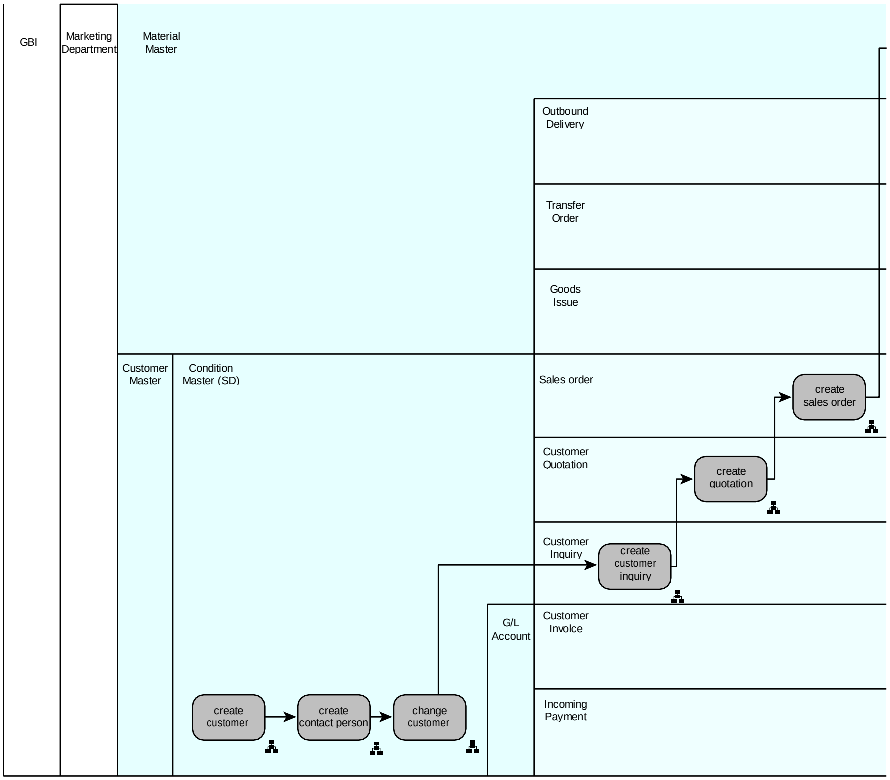

FIGURE 15

Business process management notation process diagram with process flow and data lanes (Level 3).

are created from a single sales order, whereas a (collective) delivery is associated with at least one sales order. The corresponding key or foreign key and descriptive attributes (Level 4) are not visible in this view; however, the input/output attributes (Figure 13) are shown via a 1:1 relationship, with the exception of system organization objects that are defined by customizing data entities.

The BPMN of Figure 16 shows the same process on Level 3 at the GBI (Level 1) in marketing (Level 2), this time as a function of the instances of the organizational units hierarchy of the involved system—which can exist at Level 3—similar to the BPMN collaboration diagram in Figure 15. The system organizational units are shown in Figure 16 as nested but not overlapping lanes (not visible in the example figure), which are all on the same Level 3. The system organizational units covering four extra levels are exposed within their own hierarchy in Figure 16. On the first two levels of this separate hierarchy, the company code

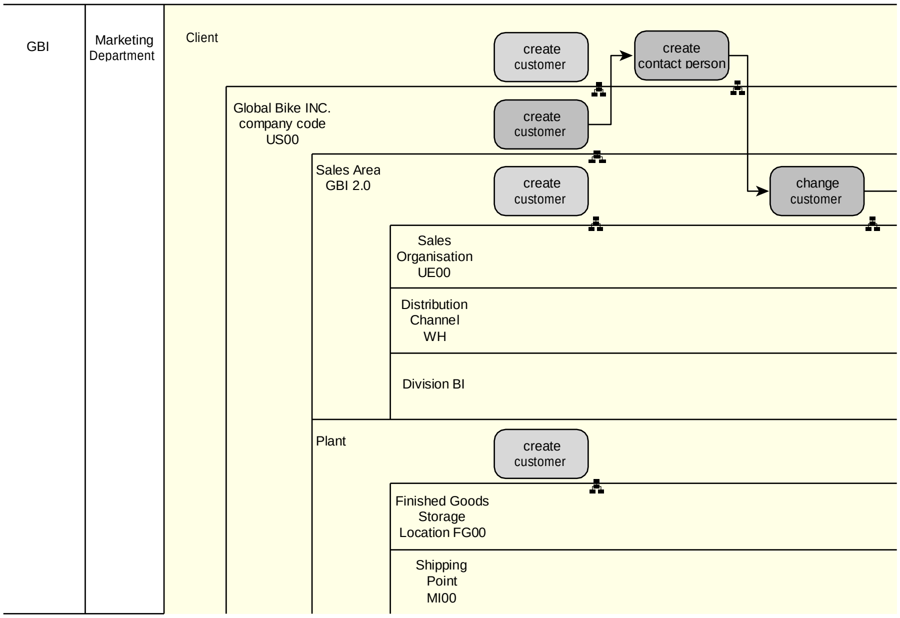

FIGURE 16

Business process management notation process diagram with process flow and system organizational unit lanes (Level 3).

US00 is assigned to the client GBI and consists of the Sales Area GBI 2.0 plus the Plant MI00, etc. A customer can be created as a "general customer (Client)", as a "sales area customer", as a "company code customer "or can be assigned to a delivery plant (plant MI 1000).

To-Be Modeling

Models can be used to describe or capture the current behavior and structure of the business. They can also be used to express possible future ways of doing business, which can then be developed. These to-be models allow decision makers to develop a shared understanding regarding how to do business and to consider design trade-offs, just as one would do with a more tangible product such as a house, a car, a toaster, or an item of clothing.

EXAMPLE OF TO-BE (BPMN) MODEL (MATERIALS MANAGEMENT)

Process automation typically focuses on the to-be status, in this case for materials management. The BPMN collaboration diagram for the purchasing process

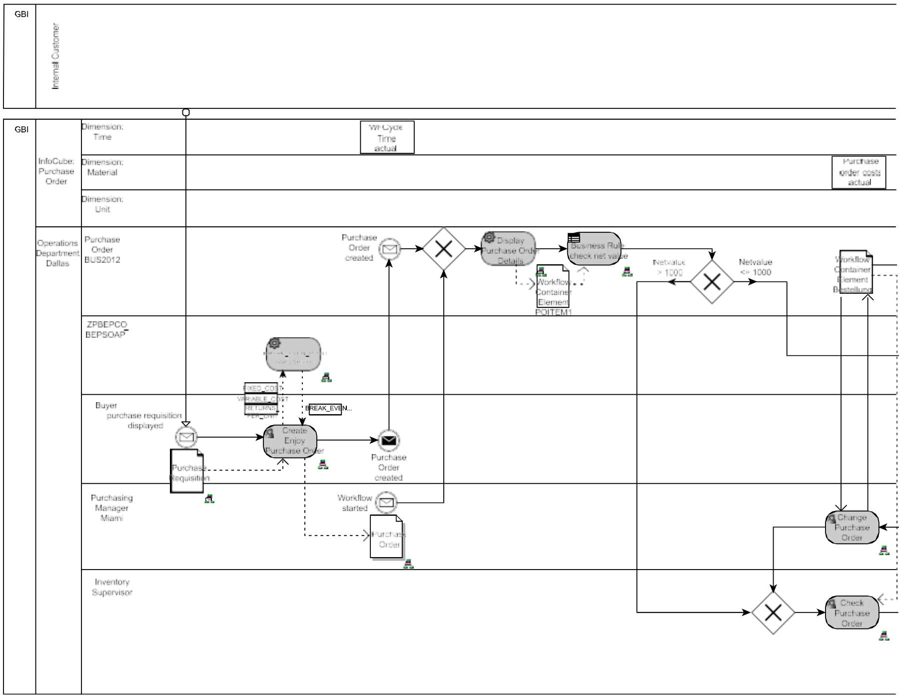

FIGURE 17

Business process management notation collaboration diagram "Purchasing Process" with process and information flow (Level 3).

in Figure 17 includes three pools, above the internal customers (black box, i.e., it not possible to see inside), below the external supplier (which is all expressed as a black box), and in the middle of the purchasing process at Level 3. The left frame for the middle and upper pool depicts the organization GBI at Level 1, which can be found next to the internal customer and the Operations Department Dallas as a lane on Level 2. These use the info cube "Purchase Order" with the three dimensions of time, material, and unit, which are also designated with lanes on Level 3. The buyer, purchasing manager Miami, and inventory supervisor use the SAP Business Object 2012 (Business Order) and the Web service Break Even Point (BEP) (both on Level 3). After displaying a purchase requisition the process is started, e.g., from a mobile work place (terminal), by the buyer. Once the break-even point has been calculated automatically, the buyer generates a purchase order. The consequence of this process is that at a predefined time, an event is automatically generated that starts a business rule, which ultimately forwards a decision to increase the inventory limits to the inventory supervisor. Alternatively, the Purchasing Manager Miami can start the workflow manually. Upon completion of the workflow, both the workflow order cycle time and the number of traversed workflows measured can then be found as PPI on Level 4. The data object flows are displayed, as well as the business documentation together with such values as purchase requisition and purchase order (see SAP Document Flow in Figure 10) technical data object flows such as the so-called workflow container flow.

Unified Modeling Language Model

The UML class diagram (Figure 18) shows a section of the business object BUS 2012 on Level 3. It displays the component together with its attributes and methods: the automated receive activity “Display Purchase Order Details ()”, the user task “Change Purchase Order ()”, the “Create Enjoy Purchase Order()”, and the send task “Display Object ()” used by three different roles and therefore shown in three separate lanes in Figure 17. The attributes of the UML class diagrams are integrated on Level 4 with keys, foreign keys, and attributes.

Note. The UML class diagram needs to be expanded for use in Web and enterprise services.

Star Scheme

The use of the so-called star scheme or star schema is a design strategy to improve access to data for the purpose of generating complex reports. The data structure separates business process data into facts that hold the measurable quantitative data about a business, and dimensions that are foreign keys related to the fact data. This information is held in what is often referred to as a data warehouse or data mart; data are held for the purpose of reporting or analytics, so-called online analytic processing, as opposed to online transaction processing, in which data are optimized for transaction processing.

In the following example, and building on the case example, the information cube Purchase Order presented in Figure 19 is located on Level 2. It contains the three dimensions “Time”,“Material” and “Unit” reffering figure 17.

Information Engineering

Information engineering (IE) is an architectural method for planning, analyzing, designing, and implementing persistent data structures in an enterprise. Its aim is to enable an enterprise to improve the management of its resources, including capital, people, and information systems, to support the achievement of its business vision.

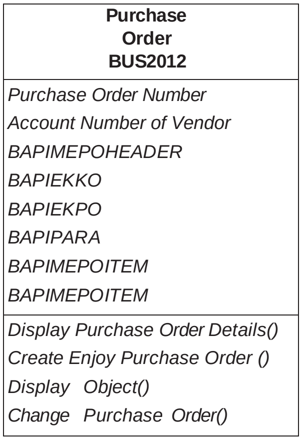

FIGURE 18

UML class diagram for SAP business object BUS 2012 (Level 3).

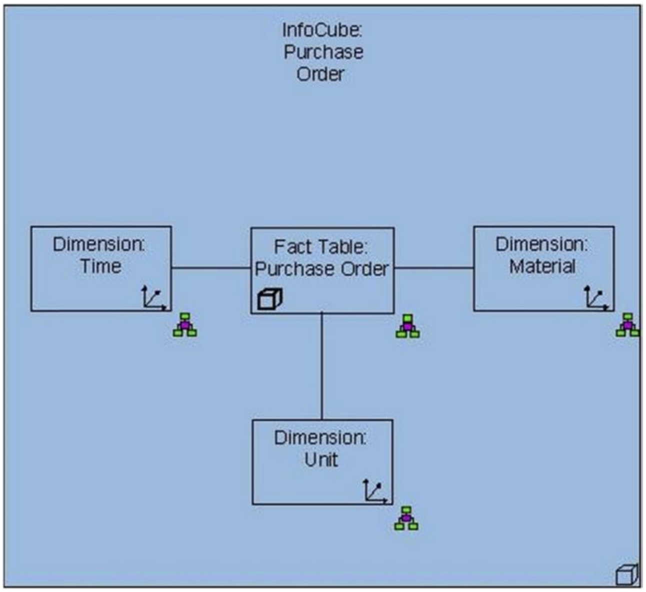

FIGURE 19

Information cube Purchase Order (Level 2).

The IE model (Figure 20) at Level 3 shows how it is possible using an in-memory database at Level 4 to accelerate access to the relevant information cube: for example, sales and distribution data. The customer and product (material master) attributes views, as well as the data foundation, include data entities used by extract–transfer–load of the

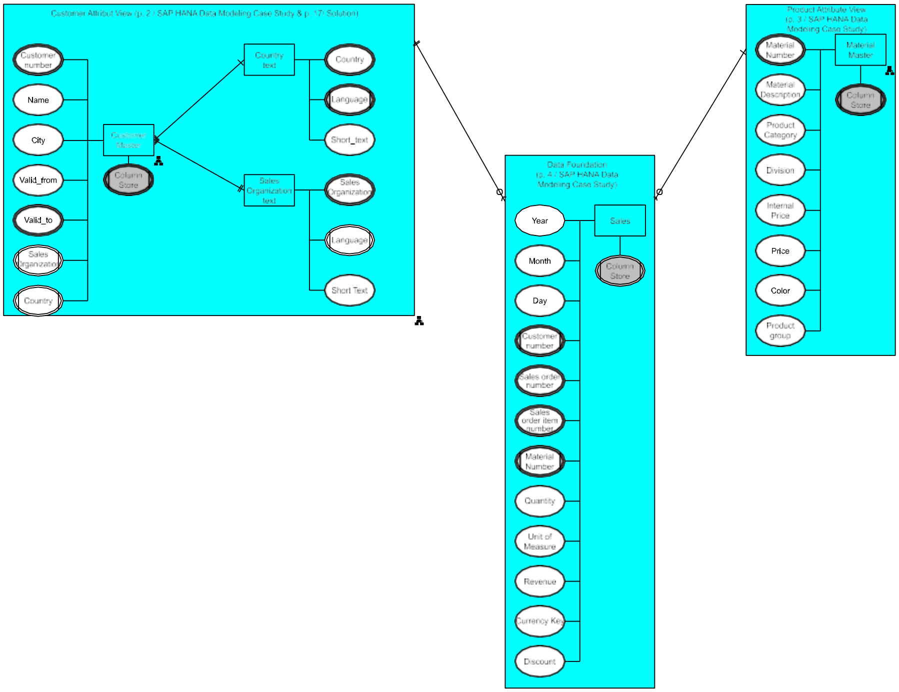

FIGURE 20

SAP High-Performance Analytic Appliance (HANA) data model analytical view (Level 3).

master and transaction data, such as material master or sales from the data warehouse, which are stored subsequently and used via column store in the in-memory database.

Current practice has evolved so that data are now stored separately in two different systems, and evolving strategy is looking toward the future and has everything implemented in one system, whereby the multiple views are combined with one primary key for the customer or material.

The details of how such a fact table (Figure 19) can be organized and its related components are shown in Figure 21. The four PPI pairs—each of as-is (actual) and to-be (plan) status—correspond to the objectives of the four perspectives of a balanced scorecard, e.g., Figure 22.

The objective diagram on Level 2 (Figure 23) shows the breakdown of the strategic objective "improve purchase order process" for the Check Purchase Order process step on the three process dimensions: quality management target, time target, and ABC target (not relevant here). These dimensions are not to be confused with the dimensions of the information cube. Arranging the strategic objective leads into a hierarchy for a KPI allocation diagram (value layer of Figure 8) on Level 3 (not shown for reasons of space), which then leads by another hierarchy to Level 4 and subsequent horizontal navigation to the data layer (Figure 8) branches in the fact table shown (Figure 21).

Level 2 depicts the process step Check Purchase Order, which can also be navigated horizontally into the e-business scenario map (Figure 24). This is shown with

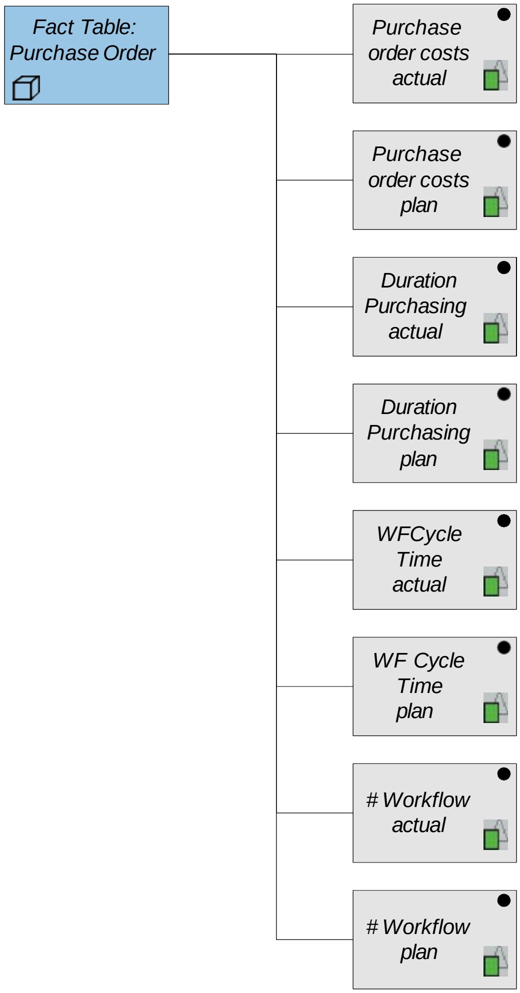

FIGURE 21

Fact table Purchase Order with PPIs (Level 4).

(internal) customers to the right, together with the (internal) suppliers to the left. The process flow extends from top to bottom. Also evident in this diagram is the revenue/cost and business service group flow and the document flow, which are actually a deeper level, at Level 3. This historically grown property is characteristic of the e-business scenario diagram during the document flow from right to left, e.g., from the purchasing department to the external supplier as a purchase order, or from left to right, e.g., from the supplier to the FI department as an external vendor invoice. The net cash flow may show only the (internal) customers toward the (internal) suppliers. In this case, they roughly correspond to the costs of the three pictured internal departments and the difference of the incoming moving/standard price minus the

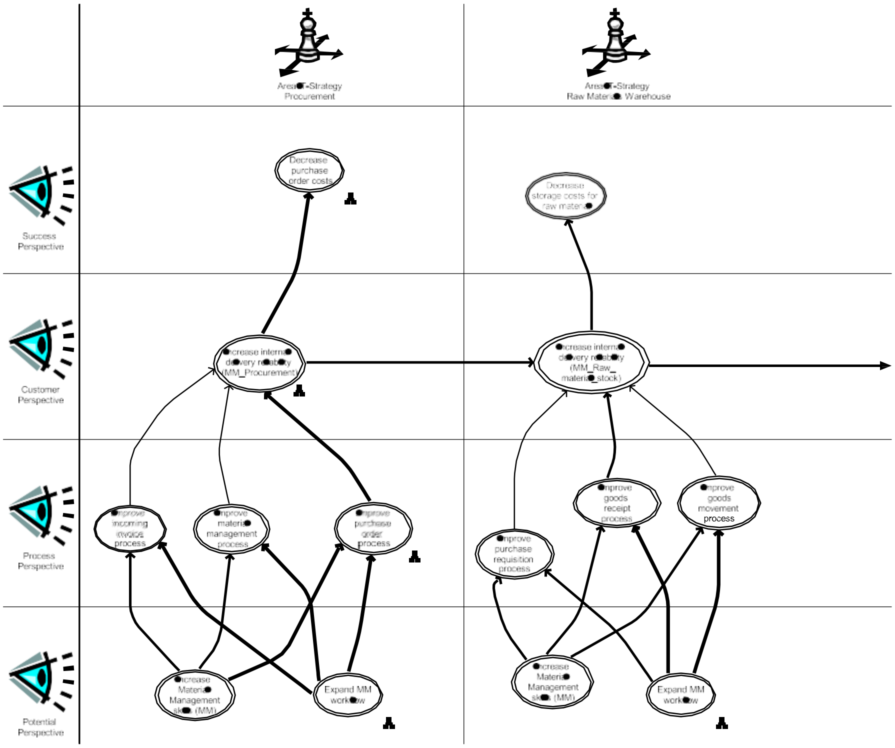

FIGURE 22

Department balanced scorecard cause-and-effect chain procurement (Level 2).

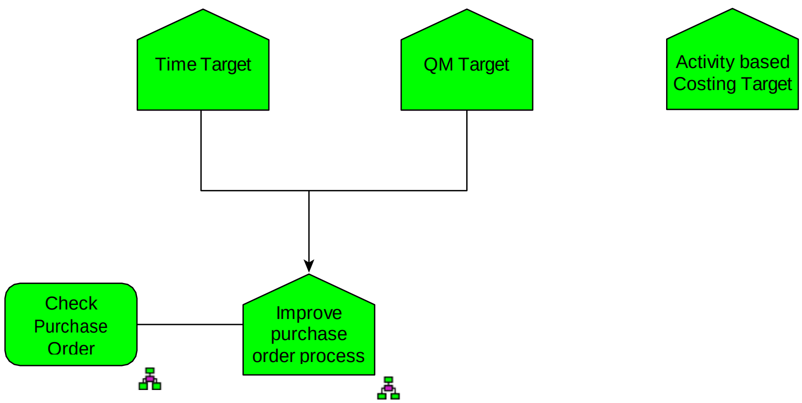

FIGURE 23

Objective diagram of process perspective of purchase department (Level 2).

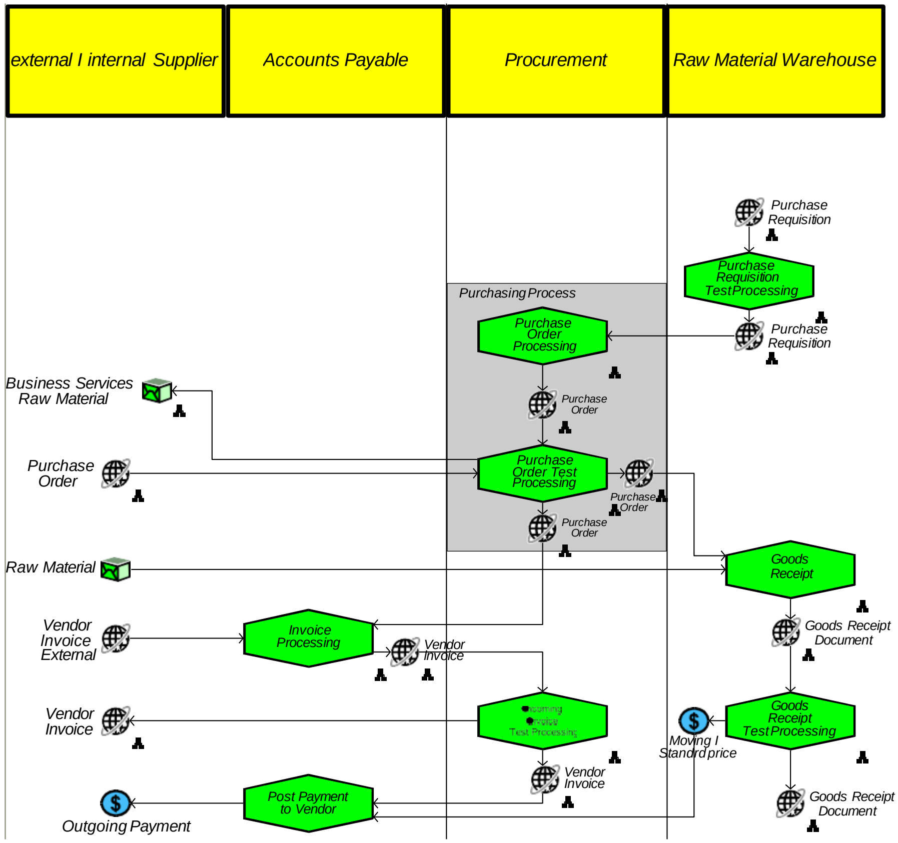

FIGURE 24

e-Business scenario diagram fragment (Level 2).

actually flowing externally outgoing payments. The services that are to be provided in return business services, e.g., to the purchasing department and another internal supplier such as an IT department run counter to the net financial flow. The BPMN shown in the Figure 17 collaboration diagram Purchasing Process (gray shaded) includes both the process Create Purchasing Order referring to RFQ and Check Purchase Order.

Balanced Scorecard Cause-and-Effect Chain

Alternatively, it is possible to navigate horizontally from the objective diagram in Figure 23 via the process objective "Improve Purchase Order Process" into the corresponding department balanced scorecard cause-and-effect chain (Figure 22). In the example considered, the two areas of procurement and raw material warehouse are be managed as cost centers. Furthermore, a procure-to-stock scenario is assumed. The strategy is based on an expansion of the existing IT resources (materials management (MM) skills and workflow system), which is also reflected in the Potential Perspective of the diagram. The internal customer of procurement (department) is, according to Figure 24, the raw material warehouse and internal customer objective of the purchasing' department, therefore, for example, an increase in the internal delivery reliability as a consequence of its internal customers, so the range of raw material warehouse is all a part of the flow. Ideally, a cost savings to the department occurs and supports the goals of the business in question and its customers, represented by a connecting line from the left to the right cause–effect chain. Another horizontal line connecting to the right emphasizes this point, where the warehouse must support the goals of its internal customer (e.g., production or sales and distribution receiving "finished goods"). Over a two-step hierarchical jump of the strategic objective, the model user vertically navigates to Level 4, where by horizontal navigation, he ultimately gets to the fact table (Figure 21) and can assign one KPI couple (actual/plan) to each of the four perspectives of the balanced scorecard.

In Figure 22 we assumed the internal customer of the finished goods warehouse department, seen as an internal supplier, could possibly be the sales and distribution department as mentioned above. We also found in Figure 24 that for every department, internal suppliers exist. If we have a closer look at the sales and distribution department balanced scorecard in Figure 25, we can see another internal supplier of the sales and distribution department: the human capital management department. Its supplier is the internal/external job market. The characteristics of the internal/external job market finally are its objectives on the potential perspective: increase general education and increase national culture. The cultural aspects might have an important role in the success of BPM in the future.[43]

LESSON LEARNED

As we have highlighted, business process modeling is a key element when aligning business processes with the requirements of an organization. With the right methodology and appropriate artifacts, it is possible to provide a clear, complete, accurate, and actionable framework for information and process modeling.

WHAT WORKED

Business process management notation process models must be complemented by and extended with information models aspects for several reasons:

1. Information modeling aspects within the process are important in any ERP implementation projects, primarily to streamline the execution of the business process and to support all report requirements
2. Reporting requirements can stem from different information aspects in an end-to-end process flow
3. Integration of more information objects of the business world (i.e., mission, vision, strategy, objectives/requirements engineering)
4. Integration of three enterprise tiers (strategic, operational, and tactical)

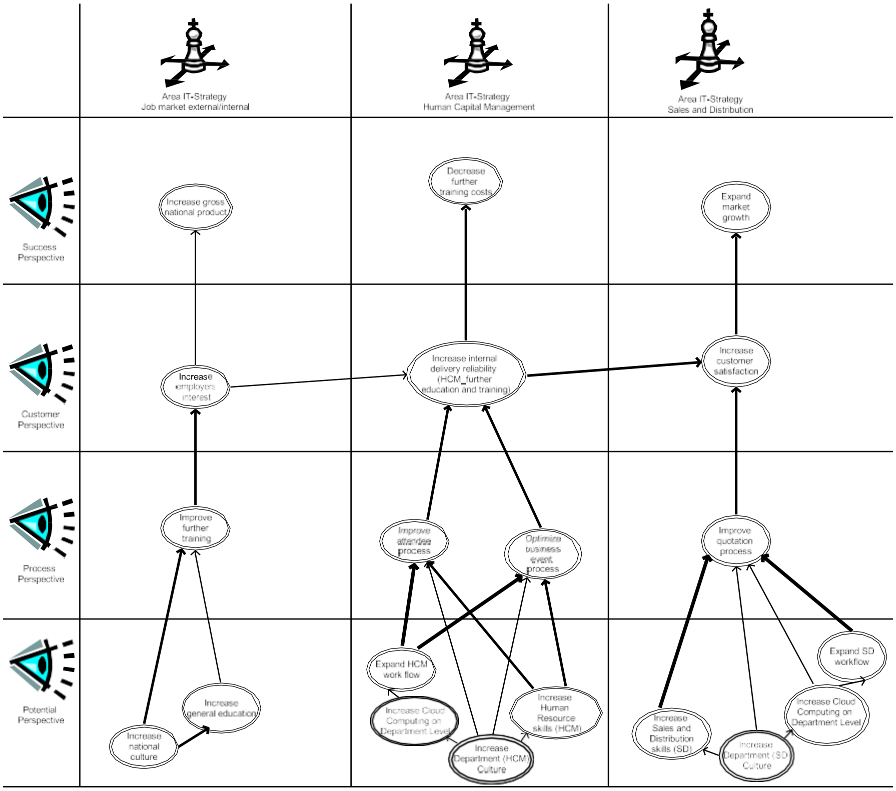

FIGURE 25

Department balanced scorecard cause-and-effect chain Human Capital Management (Level 2).

5. Performance management in an organization can be:
    a. Strategically related—measuring performance against a strategic plan
    b. Tactically related—enabling oversight, governance, evaluation, and audits
    c. Operationally related—measuring operational related activities
6. The information system will also need to be able to respond to strategic, tactical, and operational requirements, and operational requirements simultaneously
7. Different levels of abstraction (from overview to detailed level of composition/decomposition)
8. Identification and cascading of internal customer/supplier relationships (i.e., procurement/warehouse/employee)
9. Integration of dynamic (time dependent) and static information models (i.e., organizational chart, ERM)
10. Identification of more BPMN resources (i.e., system organizational units, business objects, or information cubes)

11. Integration of business compliance (HGB, USGAP)
12. Integration of types and instances (such as process activities versus business department names)
13. Integration of old but content-rich information model types (EPC) with new but content-poor (BPMN) ones
14. The integrated end-to-end flow should take business, application, and technology layered requirements into consideration, thus aligning end-to-end flow process automation potential with requirements across the layers
15. Different views/layers (i.e., business and application)
16. System integration should address all of these stakeholder requirements to ensure that the correct information is available to all areas when business processes execute and afterward.
17. All related objects, in terms of business objects, information objects, and data objects, should be derived automatically in the process.
18. The purpose of the designed and integrated end-to-end flow is to maximize the level of automation by which associated business, information, and data objects in the flow through the information system are derived when a business process is executed
19. Rules are applied within the process as well as information models as traditional rule sets, rule scripts, and flow rule sets
20. Transformation potential is identified in the various process and information models. Exploiting the full innovation as well as transformation potential of the opportunities must consider both process and information models

This extension can only happen within a well-elaborated enterprise information model architecture using four or more levels of composition/decomposition, which can be found in APQC, SCOR, and other frameworks. The challenge is to transfer these levels to layers other than processes, e.g., value, competency, or application. Once this has been defined, horizontal (to get a different view) and vertical navigation (to get a more/less detailed view) between different information model and object types within one single integrated enterprise information model are possible.

This integrated enterprise information model supports the entire process life cycle from Analyze to continous improvement.

WHAT DID NOT WORK

Pure BPMN collaboration or BPMN process diagrams are not sufficient to provide all of the information needed for a successful business process implementation. The integrated enterprise information model does not yet support complete model-driven implementation. With existing BPM tools fewer than 50% of the information models (e.g., with ARIS Netweaver for SAP, SAP Solution Manager,[44] SAP Business Workflow, iGrafx, or SAP BPM) can be implemented. The reason for this deficiency is that existing tools focus on specific tiers, views, levels, model types, or information objects, and have missing or limited interfaces between the different conceptual spaces in which they reside, considering only narrow aspects of the total problem, such as focusing on automation or on transformational work, without fully capturing other forms of work.

CONCLUSIONS

Findings and Summary

In this chapter, we have elaborated on the need to interlink the process models with information model aspects and have shown how it would be done. To increase the level of understanding we have provided a comparison of the different hierarchies for the process layer. We have demonstrated how it is possible to align the different levels against each other for a number of different frameworks: APQC PCF, LEAD/GBI, SAP Solution Manager, and SCOR (Figure 6).

Through our analysis we identified the problem of determining when using multiple information models whether it is possible to map the layers from one information model to another, e.g., LEAD to SAP solution manager, and retain a consistent process model structure. As a solution, we proposed the idea of making horizontal (layers) or vertical (levels) connections of the leading process layer structure from "above" to all the other layers, with simultaneous consolidation/integration with the data layer from "below".

The result of this solution is the matrix (Figure 7) showing how we can map business and application layer meta objects over four business layers and two application layers, whereby the layers are classified side-by-side in six columns. This allows us to detail the relationship of meta information objects to each other in different layers (horizontal integration) on different levels (vertical integration). Moreover, the meta information objects are associated with each of one or more of the specific layers (1–6) and one or more of the specific hierarchy levels (Levels 1–4), thus allowing for horizontal or vertical navigation in the matrix for each of the information meta objects.

In reality, the information meta objects have many more relationships than are detailed within the meta object mapping (Figure 7); thus, we have also provided a map of the information models (Figure 8) in which exactly one layer and one level are identified. The resulting models represent more than one layer or more than one level (e.g., hierarchical models), and therefore the information meta objects from Figure 7 can appear multiple times.

We have then taken our mapping matrices and, using a case study as detailed in Section "Process life cycle", provided validation of how they can be effective in producing business and application information models. The case study and examples detailed identify how it is possible, using our matrices and methods identified by the LEADing Practice together with a range of different modeling techniques (BSC, BPMN,[45] EPC, UML, and ER modelling), to produce useful as-is and to-be process models.

The business and application information models that we have provided detail the following:

- Integration of document flows (Figure 10) required for compliance and adherence to regulations
- Integration of user interfaces (Figure 13)
- Integration of system organizational units (second organization) (Figure 12)

- Integration of keys, foreign keys (media break), and describing attributes
- Integration of BI (three tiers), information cubes (Figure 19), dimensions, and fact tables (Figure 21)
- In-memory (SAP HANA) analytical view (Figure 20)
- Integration of enterprise services and Web services (Figure 24)
- Enterprise and department balanced scorecard cause-and-effect chains (Figure 22, 25)

These process models identify how using meta object (Figure 7) and information models (Figure 8), matrices, and the initial ideas of the LEADing Practice have improved the quality of the process models by providing extended information modeling. Thus, we have been able to identify:

- Visible connection of strategic objectives and business processes
- Internal customer supplier relationship interfaces to other departments (flow of money, services)
- Integration of three process dimensions (quality, time, and costs)
- Integration of process and data flow

Our models demonstrate how is possible to integrate six layers (20 model types and 38 information objects) (Figures 7 and 8) and provide information models that also show how composition/decomposition can provide relevant information over four levels of six layers showing both vertical and horizontal integration/navigation. To date, the authors are not aware of another solution using such a step-by-step repeatable description that enables one to build the information models into the process landscape with a high level of detail in as-is and to-be process models.

Finally, our matrix and working examples use the definition of the process life cycle and frameworks as described in the BPM Life Cycle Chapter. It can also be found as enterprise standards[46] that are flexible, agile, and highly customizable. A further benefit in using the LEADing Practice standards is that they interlink to other frameworks, methods, and approaches such as TOGAF, Zachman, FEAF, ITIL, Prince2, COBIT, DNEAF, and many others,[47] and thus provide a powerful integrated BPM framework and enterprise architecture framework.[48]

End Notes

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