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Research on Tourism Enterprise Life Cycle Management Based on Ontology and Description Logic

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Abstract

For the tasks of different participants and requirements of resources information sharing needs of complex product project in the WBS decomposition process, as well as the problems of design, manufacture and the disconnect between tourism management information transfer, the thesis puts forward the formal method to the metadata by using ontology model and description logic. Through the interaction of formal metadata sharing of heterogeneous data through is realized. Taken large OKP enterprise as the object of study, firstly, the data model in material management are domain analyzed; providing effective carrier for the emerge of static data in the work breakdown process of complex product by constructing ontology, the thesis abstracts related concept class to construct domain ontology model. Then, carrying out the formalized description on material management domain ontology model combined with the description logic. Finally, combining typical complex manufacture of Marine product, carrying out the project modeling and decomposition from three levels, the concept, business domains, activity domain, reveal the relationship between task at all levels, suited to the characteristics of the complex product project WBS model is established. The experiment shows that the constructed ontology model can effectively solve the problem of enterprise heterogeneous data sharing. Model has a certain commonality and can be reused for other subject areas, providing an effective way for unambiguous sharing of the enterprise business information.

Keywords: *Ontology, Description Logic, Formalize, Material Management, Work Breakdown, Situation Calculus, Metadata*

1. Introduction

In the construction process of the enterprise data warehouse, because of the knowledge of the builders, experience, different emphasis on description, the enterprise face the heterogeneous data integration problem. Metadata described for the data in the data warehouse, data source and data application rules, it is an important part to build, manage, maintain and use a data warehouse system [1]. Using metadata to heterogeneous data abstraction and generalization is conducive to the integration of information resources and spread[2]. Manufacturing enterprises plays an important role in the economic development of China, researching the manufacturing enterprise management characteristics, analyze the information activities, and building information model, provides theoretical guidance for its informatization construction is of great significance[3]. However, most of the existing research focused on the geographic information system, digital library and medical systems, and other fields, few solutions for manufacturing enterprise business demand. Compared other means of manufacturing with BOM under large OKP batch manufacturing, process route norm table dynamic, complex, as a result, other manufacturing methods can be thought of as a special case of the large OKP batch manufacturing [4-5]. Manufacturing process of complex product project

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involving multiple disciplines, has the time to cover the entire product life cycle, emphasize the characteristic of collaboration in different location[6], need to rely on the work breakdown structure (WBS) and split complex project tasks into relatively simple task step by step, but the decomposition principle of work and the lack of decomposition methods lead to people accustomed to customizate project WBS for a typical complex product for a long time, then, to look for patterns, makes the research on the WBS should be engineered, and difficult to replicate success. Because many management problems emerge in the process of design, manufacture and the disconnect between management information transfer , at the same time, the lack of information description and rugged process flow lead to dependence on dispatching management directly, therefore, the areas of complex product project needs the integration of the WBS urgent which can support multiple perspectives management needs [7].

Many scholars have tried to research two or more than two kinds of decomposition structure for different management information integration requirements, such as OBS combined with CBS, the WBS combined with PBS, OBS [8-9], but often stand in the angle of the task split, not focus too much on integrated management requirements, leading to decomposition results support for subsequent enterprise business process modeling is insufficient, therefore some scholars also began to research how to implement the WBS specific areas and specific business process model (*e.g.*, Petri net) mapping [10-11]; at the same time, only focus on the static split of deliverables and rendering, ignore the link between the deliverables, together with all kinds of WBS compile tools commonly used at present is the main focus is on results rather than on the decomposition method, also lead to not fully reflect the complexity of the complex product project, is difficult to effectively define WBS of complex products project. In the heterogeneous data management applications integration based on metadata and metadata, has quite a few scholars have done related research. NieRu Li Zhengwei [12] the method of data exchange based on ontology mainly solved the problems of data transmission between heterogeneous data sources; Zhang Yu, Jiang Dongxing anf Liu Qixin [13] put forward a kind of integration scheme in decentralized system to integrate heterogeneous data; Xu Boyi Xie Cheng, Cai Hongming [14] proposes a integration method to semantic meaning of metadata using a domain ontology to solve the semantic heterogeneity problem in data warehouse management. Check ZhuHua Zhang Yuanjie, wang lixin [15] using XML technology design three kinds of metadata application mode and content specification, set the metadata database construction method and process, the construction of 1:50000 yuan database update project database. To reflect the integration work breakdown of multi-dimensional management needs in the process of the complex product development projects based on cost, time limit for a project, product structure, resource and so on, relative to the implementation of different organizations, different professional background or participate in the main tasks and resources effective sharing of information between the link between the essential concepts and related field, need to establish a standardized communication mechanism[16]. Express complex products work decomposition principle and the process based on ontology can match this requirement [17]. Therefore, this article carries on ontology modeling to each main body of the process of complex product work breakdown to, and connecting with the typical complex Marine products project using more class of logical situation calculus to express decomposition, reveal the relationship between task at all levels, to establish the WBS decomposition method suited to the characteristics of the complex product project.

(1) this paper connects with enterprise specific business process, For the tasks and resources information’s sharing needs between different participation of the subject in the decomposition process of complex product project WBS, as well as the problem of design, manufacture and the disconnect between management information transfer, put forward the formal method to the metadata using ontology model and description logic, realize sharing of heterogeneous data through formal metadata interaction.

(2) With large OKP enterprise as the object of study, with goods and materials management functions area as an example, analyze data model in material management domain; Based on description logic, concepts and the relationship in the issue field carry out the abstract and build ontology model of material management system is used to represent heterogeneous information and heterogeneous information integration provide effective solutions to the enterprise. Model has a certain commonality and can be reused for other subject areas, provides a effective way for unambiguous sharing of the enterprise business information.

(3) providing effective carrier for the emerge of static data in the work breakdown process of complex product by constructing ontology, abstracts related concept class to construct domain ontology model, carrying out the formalized description on material management domain ontology model combined with the description logic, combining typical complex manufacture of Marine product, carrying out the project modeling and decomposition from three levels, the concept, business domains, activity domain, reveal the relationship between task at all levels, suited to the characteristics of the complex product project WBS model is established.

2. Ontology Construction based on Description Logic

The six group based on the object-oriented thought, using the ontology definition:
Ontolog y= {C, AC, R, AR, H, X} [6]

Table 1. The Symbol Definition Used in Ontology Representation

symbol	Symbol Difinition	Symbol	Symbol Difinition
C	concepts set relating to Ontology	AC	attribute set based on the concepts
CI	Concept set instance	ACI	Property of concepts set's instance
R	related assemblage betwwen concepts	AR	related attribute assemblage
RI	relation instance	ARI	The attribute of relationship instance
H	Hierarchy relation of concept C	X	all kinds of constrians based on attribute

Description logic is a formal tool based on object, is the first order predicate logic which can determine temperament set, it can be used to represent knowledge [7]. In many formal methods of knowledge representation, the main reason for people to pay special attention to description logic is: strict semantic basis; Handling of conceptual knowledge, especially the concept of layered treatment is very effective; Provide effective reasoning mechanism, support service which can determine the reasoning [8]. Next, make a briefly introduce to the concept which has been used in the process of metadata expression based on description logic:

1) the basic logic symbols. Description logic provides the basic logical primitive to represent complex concepts and relationships.

Table 2. Common Logic Symbol Descripting Logic

symbol	Symbol definition	symbol	Symbol definition
$C \wedge D$	Conjunctive concept	$C \vee D$	Disjunctive concept
P^-	inverse relationship	$\neg C$	Take the non- in the concept
$\equiv$	Logical equivalence	$\rightarrow$	Logical implication
$\exists R.C$	Limit existing	$\forall R.C$	Arbitrary restrictions
$\geq n\ R.C$	Minimum number of restrictions	$\leq n\ R.C$	Maximum number of restrictions
Subclass Of	Subclass	Instance Of	Class instance

Wherein, n represents natural Numbers.

1) Atomic and compound class. Classes can be divided into atomic and composite class, class of atoms that are not divided classes, as {C}; Compound class can be connected with the connector by the atomic classes throughing logic, such as: $M \equiv C \wedge D$ said composite class M compounded by atomic class C and D throughing "$\wedge$".

2) The attributes of a class. The attributes of a class represents the characteristics of the class, a class can have multiple attributes. Between the properties of the same class connected with "$\wedge$," belonging to a class, such as <{C},{C.a1$\wedge$C.a2}> said concept class C has attributes a1 and a2,if a concept class C compounded by atomic classes, the composite C atom class are automatically attribute to C.

3) Instance of a class and its properties. Concept class C's I instance is expressed as C (I), the instances of the class can be formulated <{C},{C.a1 $\wedge$ C.a2},{C(I1),C(I2)},{C(I1).a1 $\wedge$ C(I1).a2,C(I2).a1 $\wedge$ C(I2).a2}>,C(I1),C(I2) are concept class C instances of I1 and I2.

4) Relationship and their properties. In the problem domain, the relationship with r lowercase letters, such as {C D$\wedge$r1.a1} said the relationship between concept class for class C and D for r1 with a1 attributes. Relationship is the embodiment of the relationships between objects, represents specific relation, the definition method is the same with the definition of object class instance.

5) The constraints and restrictions of attributes. Constraints including the domain and range of constraints, including domain constraint refers to the scope of the property, only effective to what kind of things; Range constraint refers to the scope of the property, which belongs to the instance of the class or what type of value, *etc*.

3. The Building of Ontology Model in Material Management Domain

A. Building Data Model of Material Management System

The first step in building ontology model in material management domain is to analyze data model of the material management system. Through the analysis of the material management system data model can be clearly identified various behavior main bodies in the activities of material management and the exchange of data, and then the extraction of relevant concepts and abstract. In this paper, using the IDEF1x model to represent the data model of large OKP batch manufacture enterprise material management system, as shown in Figure 1.

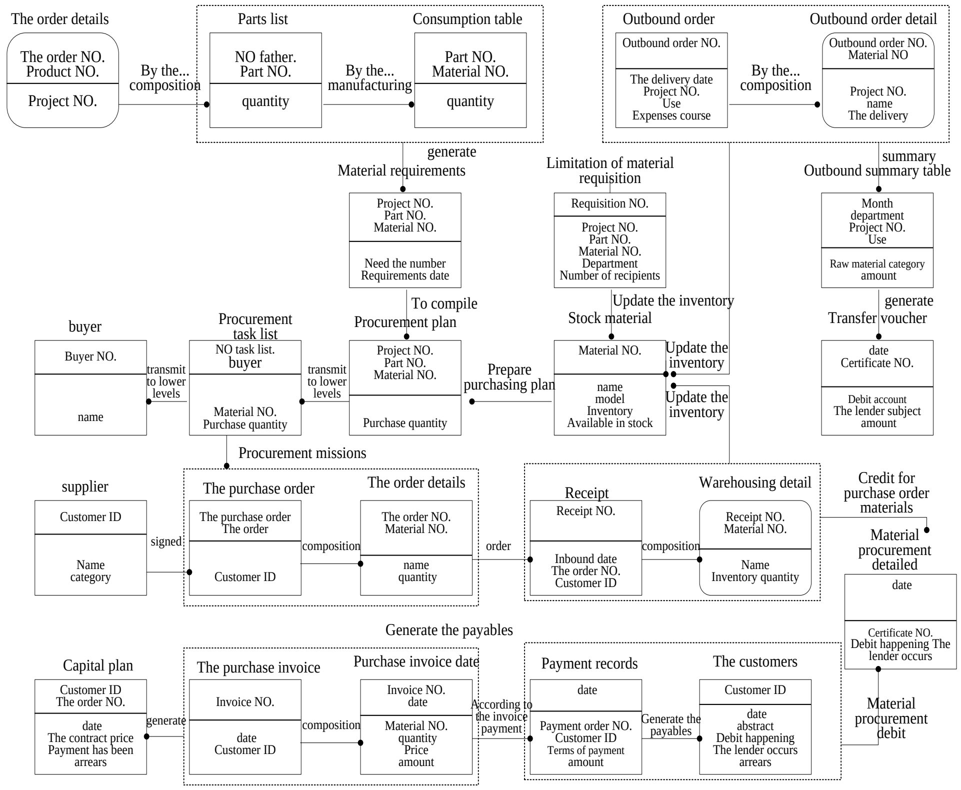


Figure 1. Data Model in Material Management Domain

According to definition of six group [8,9] to create domain ontology of complex product project $Ontology=\{C,\ A^C,\ R,\ A^R,\ H,\ X\}$, including: C represent related concepts of ontology set, in whole or in part or in the field of extension of concept; A^C represent set attributes of C; R represent the collection set of the concept; A^R represent the associated attributes; H represent hierarchy set based on concept C, has the relationship between a father and son; X represent a axiom sets, each justice represent constraints based on the relationship among the concept attributes, the correlation attributes and the objects.

C= {Department organization, schedule, cost, resources, products, activities};

A^C ={ A^C (department), A^C (period), A^C (resources), A^C (products), A^C (cost), A^C (activities)…}

A^C (Department)= {target department number, name, department …}; A^C (period) = {starting time and ending time……}

A^c (department organization)= ｛Target department number, name, department,...｝;

A^c (period)={ starting time and ending time...};

A^c (product)={ Product number, name, type, status,...}

A^c (cost)={ Name, category, fees,...};

A^c (behavior activities)={ Name, start time and end time...}; A^c (resources)={ Resource id, name,...};

$R=(has-resoure$ (department organization, resources), $has-authority$ (department organization, behavior activities), $sub-organization$, $sub-activity$ (behavior activities, behavior activities),

$process$ (department, behavior activities), $use/consume$ (behavior activities, resources), use (behavior activities,cost);

$H = \{$ Organization, time limit for a project resources, and costs) ⊂ (Project status),(product) ⊂ (Project characteristics),(behavior activities) ⊂ (Project running)

$A^R = \{A^R(has-resource), A^R(has-authority), A^R(process),$

$A^R(sub-activity),$

$A^R(sub-actA^R(has-resourceivity), A^R(use/consume),$

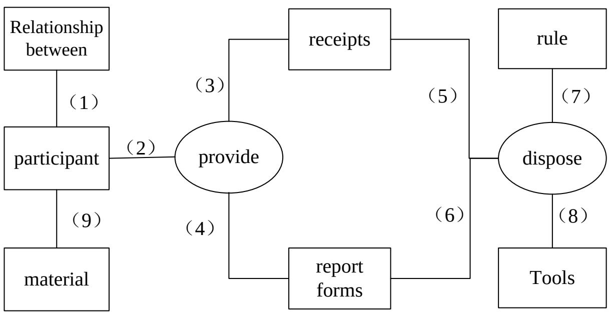
$A^R(send), A^R(map-out),...\}$

$X = \{has-resource$ (Department organization, resource) $\leftarrow accessed-by$ (Resources, the department organization);

($\exists part-of$ (Personnel, resources), responsibilities and activities) $filled-by$ (Responsibility, personnel) $\wedge process$ (Responsibilities, activities) $\Rightarrow doing$ (Staff activities) $\leftarrow actor$ (Activities, personnel);...};

Building domain ontology of complex product project, depicts the static data of the management requirements, and provides the basis for further depict dynamic process from the Angle of logic level through situation calculus.

Through the analysis of material management domain data model, according to its business roles, it can be divided into participants, forms, reports, rules, tools, concepts, and to provide, handle relations between classes. In concept class: participants refers to the activity involved in material management, such as buyer, keeper; Form refers to the document of all the documents in the process of material management, such as receipt, requisition, *etc.*; Report refers to various summary report involved in material management process, such as outbound summary table, customers, *etc.*; Rule is set by the administrative department, the materials department, finance department and other supplies management involved in it, to standardize the behavior of each rules and regulations of participants, such as keeper handbook; Tools include the methods and tools, using for stock inventory and cost accounting activities. In the relationship between class: provide refers to operation all kinds of materials such as form, report provided by the participants; Processing is what happens to all kinds of relationship between each concept class, including documents audit, loading and unloading activities; Material is refers to the participants to the actual material. The abstract concept material management problems is shown in Figure 2.



(1) the relationship between the participants to define (2) to provide a variety of materials
(3) to provide a variety of forms (4) to provide all kinds of reports
(5) document entry, audit report query (6) report query
(7) material management department rules (8) using a variety of computing tools
(9) the actual material operation

Figure 2. Concept Abstract of Material Management Field

B. Domain Ontology Building of Material Management based on Description Logic

Material management system of ontology structure as shown in Figure 3. According to the extracted concept class from the problem domain, combined with the logic primitives of description logic, making the following statement in the material management field such as: concepts classes, class relations, and its attribute and the distribution set of relationship:

1) The concept classes and class relations.

The concept class of participants can be declared as: < {(the applicant), the (review), (planner), (keeper)} >, the applicant, the reviewer, planner, keeper for the subclass of participants. The applicant can derive < {(department), (the buyer), part (acquisition), invoice (blending)} > subclasses, the reviewer can derive < {(department heads), led (workshop), company (led)} > subclass. If A is the workshop leader and is responsible for the audit workshop acquisition application, the concept can be declared as an instance of the class workshop leader<workshop leadership A>.

Form concept class can be declared as: < form {(application), (the contract), (file), (documents)} >, application classes can be derived < {(purchase requisition), (storage application form), (stores requisition), (transfers apps), (turn library apps)} > subclasses, contract classes can be derived subclasses, the purchase order file class can be derived subclasses, the supplier file documents classes can be derived < {(GRN), (single), (requisition)} > subclass.

Rule concept class declaration for: < rules (audit rules), (contract management rules), (archive management rules), (document management rules), (inbound processing rules), (outbound processing rules), (turn library processing rules), blending rules (invoice)} >.

Report concept class can be declared as: < statements {(parameter), (summary report), (the analysis report)} >, parameter classes can be derived < {(inventory parameter), (keeper parameter)} > subclasses, summary report classes can be derived < {(inbound summary table), (outbound summary table)} > subclasses, analysis report classes can be derived < {(inventory analysis table), (capital analysis table} > subclasses.

Tool concept class can be declared as: "{(stock), (inventory analysis tools), (cost accounting tools), and analysis tools (capital)} >.

The handling classes is a relationship between concept. Mainly occurs between the participants in each subclass, the handling classes can be declared as: < processing {(application), (review), (distribution), and (procurement), (sign), (storage), (outbound), (update), (blending), (accounting), (accounting)} >, *etc*. Application classes can be derived < {(purchase requisition), (application for warehousing), (application for acquisition), (application for transfers), (turn library application)} > subclass. Audit classes can be derived < {(purchasing application review), (storage application verification), and (acquisition application verification), (blending audit invoice)} > subclass.

2)The statement of attributes.

Attributes are used to describe certain properties or characteristics of objects. Each class concept or relationship with the corresponding attributes, and the conceptual relationship between classes or every attribute instances of classes must have a value. In addition to the inherited the properties of the base class, subclasses also can derive new properties. Concept class can be declared as another attribute of the class. Due to space limitations, we are only in GRN as an example, its properties can be declared as follows:

< { Receipt. The receipt number GRN ^ Warehouse receipt date ^ Order number GRN ^ Customer number} >

3) The axioms and tools.

The statement of justice concept is different to tool concept class in focused declaration of concept class.

Tool concept class is the material management system according to their own characteristics and methods and tools defined by attributes of business; And justice and tools are used in materials management statement, has been widely adopted and has a certain standard's tools of universal justice and computing.

4) Logical representation between concept class.

Through analysis of the problem in the field of material management, we can abstract the concept of atomic classes. But in practice, it is often not enough to represent all problems only by atomic classes, sometimes need to logical connection between atomic classes to show the concept of more complex. Ontology description of acquisition application verification in material management process, for example, show the concept logic between classes. Known atomic concept class and relation class declared: acquisition part (Material Handler), stores Requisition (Material Requisition the Apply Form), Department heads, Department Leader), acquisition application verification rules (Material Requisition Audit Rule) and offers (Offer), Audit (Material Requisition Audit) such as relationship between classes. Their business relationship is: the acquisition part (the Participant (Applier (Material Handler))) to the Department heads (the Participant (Auditor (Department Leader))) provide (Offer) stores Requisition (Form (the Apply Form (Material Requisition the Apply Form))), Department heads, the Participant (Auditor (Department Leader))) using acquisition application verification rules (Rule (Audit Rule (Material Requisition Audit Rule))) for application for acquisition by (Deal (Audit (Material Requisition Audit))).

Metadata concept of atoms in the class can be summed up as a collection of terms and relationships:{(Material Handler, Material Requisition Apply Form, Department Leader, Material Requisition Audit Rule),(Offer, Material Requisition Audit)}

The relationship between the term can be represented as:

{Participant(Applier(Material Handler)) $A\exists$ Offer Form(Apply Form(Material Requisition Apply Form)),Participant(Auditor(Department Leader)) $B\exists$. Deal(Audit(Material Requisition Audit))$\wedge$ Rule (Audit Rule(Material Requisition Audit Rule))}。

{(Material Handler, Material Requisition the Apply Form, Department Leader, Material Requisition Audit Rule), and (Offer, Material Requisition Audit)}

5) Description between the ontology

One of the most important feature is the reasoning of the ontology. Through the symbolic logic, can represent reasoning between the ontology elements. In material management ontology, concept can be represent the business logic through the relationship between class combined to form a new class. As mentioned above, in the problem field of material management, the inclusion relation class include handling relationship, with limited assessing applications for picking, picking judgment logic functions. Acquisition application audit relationship statement as Do Material Requisition Apply, picking Limit judge relationship statement as Do Material Requisition Limit. Acquisition application Do Material Requisition Apply possess the property of the Boolean type, the statement approved as Is pass, Acquisition Limit judge relationship requires the acquisition application verification with the help of a Rule Class rules, namely Material Requisition Apply Audit Rule Class, picking Limit judge relation can be declared asDo Material Requisition Limit$\wedge$ Material Requisition Apply Audit Rule Class. value(n),value said the value acquisition Limit judge the value of the limitation of the value in parentheses So for acquisition application approval can be declared as Material Requisition Applier$\wedge$ Do Material Requisition Apply. Is Pass$\equiv$ { Do Material Requisition

Limit ^ Material Requisition Apply Audit Rule Class. value(≤N)},if the applicant get acquisition application, it's needs' purchasing Limit will no more than N, N is the rest of the budget Limit for the applicants, the applicant can be individuals or departments can also be a project. Through that, we can transfer the logical relationship between the concept class into logical reasoning formula, can through the logic operation, to complete the logical reasoning in the field of material management problems.

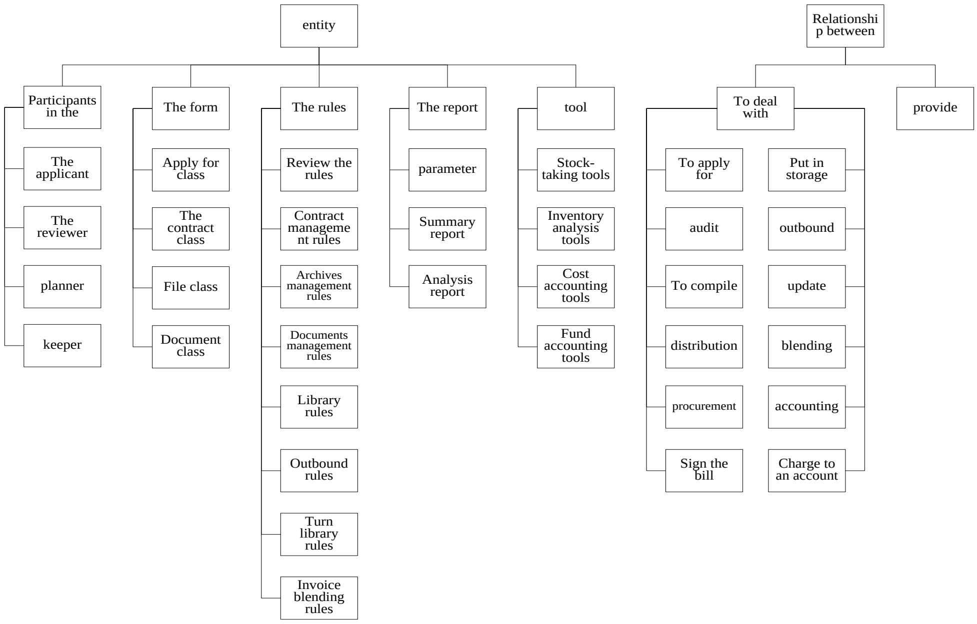


Figure 3. Domain Ontology Architecture of Material Management Field

Large OKP batch manufacture enterprise material management areas including purchasing plan management, purchasing management, inventory management, capital management and statistical analysis, and other functions. Among them, the inventory management including acquisition management, warehouse management, material balance and material transfer library management module, etc. Limited space only use the acquisition application of acquisition management as an example to illustrate the build process of material management domain ontology model and its application in heterogeneous data sharing.

4. Description and Application of Material Management based on Ontology and Description Logic

Material management domain ontology can be divided into three general levels, namely, the concept domain ontology Conc. ontology, domain ontology in business field Proc. ontology, and activities' domain ontology Act. Ontology formed by the bottom of work package set. Ontology relations of three kinds were as follows:

$$Acti\_ontology \subseteq DomMapF(AppMapF(Acti\_ontology, Proc\_ontology),$$

$$Conc\_ontology)Conc\_ontology$$

Wherein, $AppMapF$ represents the mapping function between domain ontology of business and activity layer, $DomMapF$ represents the mapping function among concept layer, business layer, activities and the correlation of concept.

Based on the above principle and the level of the WBS decomposition, determine the process of complex product work decomposition is as follows:

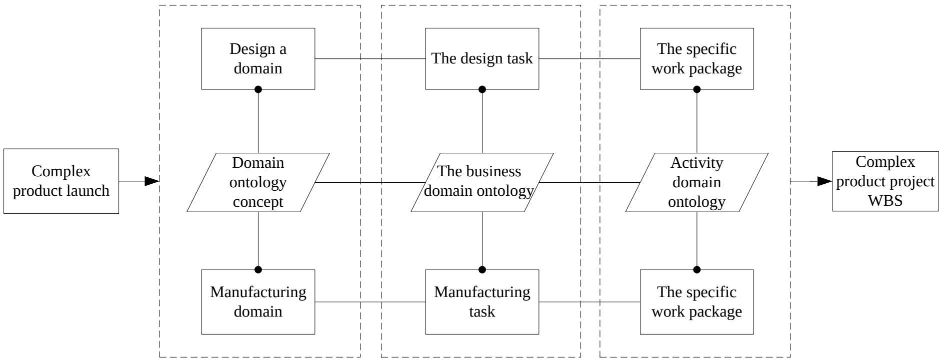


Figure 4. Work Breakdown Process of Material Management Project

A. Work Decomposition of Conceptual Domain

Launch complex product project, project design should be based on customer needs, combined with the external conditions such as manufacturing capability to guide manufacture domain decomposition. For this, we need to build complex product project ontology concept level, ontology support information sharing between the concept layer design fields and manufacturing field.

$Conc\_ontology\{C, A^C, R, A^R, H, X\}$ ={ Design department, resources, products, activities, the design period and cost…; detailed product design, production design, materials, equipment, detailed information, time limit for a project, cost detail…; $has-resource$ (department, resources)…; $has\_resource$ (department, resources)…; $has\_authority$ (Technology, product and process design management) $has\ authority$ (Technology department, the design management of production), $enable$ (Structure decomposition PBS , determine the main structure), $account$ (Structure decomposition $pbsana$, Material requirements table, craft standard)…, $has\_resource$ (Resources, name, quantity, unit…), $has\ authority$ (Type, scope, the period of validity), $enable$ (Enabling conditions, enabling state), $process$ (the time of beginning and ending)…; The design phase, project characteristics, project status…; $has\_resource \leftarrow accessed-by...;$ }

If choose work decomposition of ship as the calculus object, set, $\sigma_0^T = (\exists$ The whole ship) $in-situation$ (The whole ship, order release), first, to know the products we need, second, according to product to conduct decomposition of design domain and manufacturing domain; The situation's calculus process is as follows:

$\sigma_1^T = (\exists$ The whole ship) $in-situation$ (The whole ship, Delivery of the product design)

$= do(A_1, \sigma_0^T) = occours((enables(E_{A_1}, A_1), \sigma_0^T), (enables(E_{B_1}, B_1), \sigma_0^T)$

$= (E\sigma_0, a_{11}, a_{12}, b_1, SA_1, SB_1, E_{SA_1}, E_{SA_2}, E_{SB_1})occours(enables$ (Ship design, technical requirements), $\sigma_0^T) \wedge$

$occours(enables$ (Ship production technology, technical requirements), $\sigma_0^T) \wedge occours(enables(E_{SB_1}, SB_1), \sigma_0^T)$

$= (E\sigma_0, a_{11}, a_{12}, b_1, SA_1, SB_1, E_{SA_1}, E_{SA_2}, E_{SB_1})occours(enables$ (Customer requirements, Total cost of delivery time, etc), $\sigma_0^T)$

$\wedge occours(enables$ (Technical drawings, process line), $\sigma_0^T) \wedge (\exists\sigma_0^T, b_{11}, E_{b_{11}})occours(enables$

(Structure decomposition pbs, Manufacturing capacity requirements) σ_0^T)
$= (E\sigma_0, a_{11}, a_{12}, b_1, SA_1, SB_1, E_{SA_1}, E_{SA_2}, E_{SB_1}) occours(enables$ (Customer requirements, Total cost of delivery time, etc), σ_0^T)
$\wedge occours(enables$ (Technical drawings, process line), $\sigma_0^T) \wedge (\exists \sigma_0^T, b_{11}, E_{b_{11}}) occours(enables(pbs$, Equipment capacity etc.) $\sigma_0^T, T_{i+1})$

Initial scene turn into follow-up scene, performed by the corresponding activities set A_n, $A_n = \{SA_n, SB_n, ...\}$,
$SA_n = \{\exists a_{n1}, ..., a_{mn}, T_1, T_i), a_{n1} \prec ... \prec a_{nn}, SA_n = \{\exists (b_{n1}, ..., b_{nn}; T_{i+1}...T), b_{n1} \prec ... \prec b_{nn}\} E_{A_n}, E_{B_n}$ is for the corresponding constraint set.

σ_2^T = ($\forall$ order products) $in-situation$ (order products, Deliver customer) = $do(A_2, \sigma_0^T) = occours(enables(E_{A_2}, A_2)$,

B. Business Domain Decomposition

Based on ontology of manufacture domain of the established concept layer, implement the work breakdown for the business layer.

$\Pr oc\_ontology = \{C, A^C, R, A^R, H, X\}$

={ Manufacturing department, the technical drawings, intermediate products, manufacturing activities... manufacturing department, manufacturing materials equipment detail,, equipment information details, time constraints, cost detail..., $has-resource$ (The manufacturing department, resources), $has-resource$ (The manufacturing department, equipment), $has\_authority$ (The manufacturing department, Corresponding intermediate products) $has\,authority$ (Technical drawings pbs) $enable$ (Structure decomposition PBS , Intermediate products), $account(pbsand$ Material requirements table, the manufacturing process }…; $has-resource$ (Resources, name, number of units…) $has\_authority$ (Type, the period of validity), $enable$ (Enabling conditions, enabling state), $process$ (The time of beginning and ending)…; The design phase, the project features, project status…; $has-resource \leftarrow accessed-by...;$ }

SET σ_0^t = ($\exists$ Intermediate products) $in-situation$ (Intermediate products, Concept layer structure decomposition), on the basis of work decomposition of concept domain level combining business domain ontology, to conduct the business domain decomposition. Choose warehouse as intermediate product as an example, for example, calculus of manufacturing level decomposition is as follows:

$\sigma_1^t = (\exists$ Warehouse) $in-situation$ (warehouse, the ship)=
$do(A, \sigma_1^t) = occurs(enable(E_A, A)\sigma_0^t)$
$= (\exists \sigma_0^t, a_{21}, a_{22}, b_{21}, SB_2, E_{SA_{21}}, E_{SA_{22}}, E_{SB_2}) occours(enables$ (Warehouse design, technical standards)
$\sigma_0^t \wedge occours(enables$ (warehouse, Technical drawings), $\sigma_0^t \wedge occours(enables(E_{SB_2}, SB_2), \sigma_0^t$
$\wedge occou(rs\ en$ (Manufacturing management, warehouse), σ_0^t)
$= (\exists \sigma_0^t, a_{21}, a_{22}, b_{21}, SB_2, E_{SA_{21}}, E_{SA_{22}}, E_{SB_2}) occours(enables$ (Warehouse design, technical standards, σ_0^t)

$\wedge occours(enables$ (Process line, the design requirements), σ_0^t) $\wedge$ $(\exists \sigma_0^t, a_{21}, a_{22}, b_{21}, SB_2, E_{SA_{21}}, E_{SA_{22}}, E_{SB_2})$

$occours(enables$ (Manufacturing requirements, warehouse), σ_0^t) $\wedge occours(enables$ (Manufacturing process, warehouse), σ_0^t)

$= (\exists \sigma_0^t, a_{21}, a_{22}, b_{21}, SB_2, E_{SA_{21}}, E_{SA_{22}}, E_{SB_2}) occours(enables$ (Warehouse design, technical standards), σ_0^t, t_i

$\wedge occours(enables$ (Process line, the design requirements), σ_0^t, t_i) $\wedge$ $(\exists \sigma_0^t, a_{21}, a_{22}, b_{21}, SB_2, E_{SA_{21}}, E_{SA_{22}}, E_{SB_2})$

$occours(enables$ (Warehouse structure decomposition (bottom section), warehouse), σ_0^t, t_{i+1}) $\wedge occours(enables$ (Warehouse structure, manufacturing tasks (such as graphic processing, Piecewise fitting production tray)), σ_0^t, t_{i+1})

$\sigma_2^t = (\forall$ Intermediate products (such as warehouse) $in - situation$ (Intermediate product snoop-proof department)= $do(A_2, \sigma_1^t) = occours(enables(E_{A_2}, A_2), \sigma_1^t)$

$t = \{t \mid t_0 \le t_i \le t_{i+1} \le t_n\}; T = \{T \mid T_0 \le T_i \le T_{i+1} \le T_n\}; T_i = \sum t_0 + ... t_i$.

C. Activities Domain Decomposition

The result of work decomposition is based on the business level,in the activity field to continue work decomposition, can get different responsibility unit corresponding to the activity level of work units. Just like in the process of ship decomposition, getting each intermediate product's fragmentation by decomposition of business area.

Set σ_0 =($\forall$ Piecewise fitting production tray) $in - situation$ (Piecewise fitting production tray, activities),conduct activity level work decomposition for tray task of piecewise fitting production.

$\sigma_1^{t_{i,j}} = (\exists$ Piecewise fitting production tray) $in - situation$ (Piecewise fitting production tray, At the bottom of the warehouse section)= $do(A_1, \sigma_1^{t_{i,j}})$

$$\exists \sigma_1^{t_{i,j}}, a_{21}, b_{21}, E_{SA_{21}}, E_{SB_{21}}) occours(enables(E_{A_1}, A_1), \sigma_1^{t_{i,j}}, t_{i,i}) \wedge$$

$$=(occours(enables(E_{B_2}, B_2), \sigma_1^{t_{i,j}}, t_{i+1}) \quad)$$

$= (\exists \sigma_1^{t_{i,j}}, a_{21}, E_{21}, t_{i,i}) occours(enables$ Processing process, design standard), $\sigma_1^{t_{i,j}} \wedge (\exists \sigma_1^{t_{i,j}}, b_{21i}, E_{b_{21i}}, t_{i,i+1})$

$occours(enables$ (Activities, processing team), $\sigma_1^{t_{i,j}}$) $\wedge occours(enables$ (Activities, the processing parts number specified)

$\sigma_1^{t_{i,j}}) \wedge occours(enables$ (Activities, other constraints)

Through calculus among the conceptual domain, business domain and the domain decomposition three levels above, complete the entire work decomposition process

D. Material Management Domain Ontology Model in the Application of the Data Sharing

For the material data acquisition application of a domestic ship building co., LTD., we collect and sort date, analysis the data for different enterprise department supplies recipients. First,carrying on formalized description of acquisition application ontology model using description logic, to formal acquisition application of metadata, build relevant acquisition application of formal metadata database. Secondly, to extract the different system, different database tables in the same semantic concept, and statistics of the enterprises within 3 months due to the heterogeneous data acquisition application, Then, RMB will be formalized as middle library database, all heterogeneous data access should through the Central Library, Central Library make the heterogeneous data and the formal metadata correspondence, the data of repeat semantics are unified transmit to end users according to formalized metadata. Finally, statistic abnormal matters of application within three months after using the ontology model, and compares the results of analysis before and after the application domain ontology comparison results as shown in Figure 4.

In this experiment, the data source comes from the enterprise data warehouse for 6 months of data acquisition application. Among them, the warehouse and production department in different systems, each department data acquisition table structure are not the same, and get acquisition application involved more data for analysis and calculation of five departments. Experimental results show that the material domain ontology model based on description logic can effectively reduce the enterprise's abnormal information sharing caused by the heterogeneous data,and through the formal metadata interaction to achieve heterogeneous data sharing.

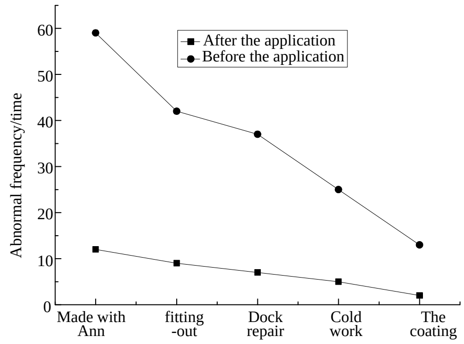


Figure 5. Before and after Contrast of Ontology Model Application Department Data Sharing Anomalies

5. Conclusion

Through the fomal discription of metadata concept terms,terms attribute and the relationships between terms in the field of material management of enterprise above,realize metadata formalization,build enterprise formal metadata database,and then through the formal metadata interaction to achieve heterogeneous data sharing. Building material management domain ontology model has certain universality,the further refinement of the material management field information system platform has certain reference value for design and implementation work. Building material management domain ontology model can be reused for the other main areas of the enterprise, providing an effective way for unambiguous enterprise business information sharing,and increase the utilization level of enterprise information management system.

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