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Modelling Ontology of Craft Convection as Small and Medium Enterprises

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Abstract

Knowledge elicitation is a process to obtain and transfer knowledge (that is, for example, accumulated inside the minds of experts in a certain domain) from humans to abstract and effective representations, to organize, model, and ultimately, communicate it in such form that is easier to understand and utilized through formal representation. Knowledge elicitation uses ontology approach so that knowledge representation can be presented in knowledge management system. This knowledge will be utilized mainly in Craft Convection Small Medium Enterprises (SMEs). Ontology as an instrument to represent knowledge has been studied and applied in various fields such as information science, knowledge engineering, artificial intelligence, or digital library. In the field of ontology and design, ontology can be applied in knowledge sharing. Using methontology approach, ontology modeling and implementation are developed to identify patterns and concepts of knowledge related to Craft Convection SMEs.

Keywords: *Knowledge Elicitation, Ontology, Methontology, Craft Convection SMEs*

Introduction

In Indonesia, according to the Law No. 20 of 2008 on Micro, Small and Medium Enterprises (SMEs), SMEs are enterprises that exhibit following criteria: (a) possessing net worth in excess of Rp50 million to Rp500 million excluding land and business establishment assets; and (b) generating a sales turnover of Rp300 million up to Rp2.5 billion/year. Meanwhile, Medium Enterprises are enterprises that exhibit following characteristics: (a) possessing net worth in excess of Rp500 million to Rp10 billion excluding land and business establishment assets; and (b) generating a sales turnover of Rp2.5 billion up to Rp50 billion/year.

In general, common problems faced by SMEs consist of two factors, namely internal and external factors. Internal factors include access to markets and marketing activities, access to banking capital, governance and management, human resource quality. External factors include volatile business climate, limited facilities and infrastructure, high cost economy, the impact of regional autonomy, the presence of free trade, limited access to information. Furthermore, SMEs also face a major problem such as low competitiveness. This may very well be due to, among others, lack of research in the SME field and human resource factor, including motivation, education and experience that hinder SME performance [1].

Another major problem revolves around the utilization of knowledge among SMEs, in other words, how SMEs manage their knowledge to achieve business success [2]. Even though WWW (the World Wide Web) brings so many possibilities, competitive edges can be maximized by leveraging internal knowledge and documents [3]. As if those were not enough, the loss of knowledge due to high

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turnover rate also has a detrimental effect on businesses [4]. High turnover rate is caused by low wage and restricted career path. When employees leave a business, the relevant knowledge is lost with them (if it has not yet been taken, preserved and/or shared).

In addition, the challenge in recruiting skilled labors by small enterprises further emphasizes the need for effective knowledge management in general. On one hand, there is no guarantee that skilled employees are willing to share their knowledge, or even know how to transfer their knowledge effectively with their peers, in their groups and between different groups in their organization [5]. On the other hand, problems may also arise from the receiver of knowledge, in regards to their capacity to process shared knowledge [6]. Knowledge acquisition process is also influenced by factors related to an organization such as organizational structure, business process and cultures that enable, drive, motivate, and preserve the transfer of knowledge related to an activity [7]. Therefore, governing knowledge management process is also a major challenge to small enterprises. In the implementation of knowledge base, the absence of a process that initiates knowledge base system in company units poses a problem to micro, small and medium enterprises. In general, Knowledge Management is the ability of organizations to create new knowledge, disseminate it through organizations and attach it to products, services and systems. Knowledge itself consists of tacit and explicit knowledge [8]. Both are needed to maximize competitive edges [9].

Knowledge elicitation is a process to obtain and transfer knowledge (that is, for example, accumulated inside the minds of experts in a certain domain) from humans to abstract and effective representations, to organize, model, and ultimately, communicate it in such form that is easier to understand and utilized through formal representation [10]. This knowledge elicitation process can be linked to knowledge conversion process in SECI model proposed Ref [11], and is a preliminary process in a knowledge technique cycle. Nonaka and Takeuchi use tacit and explicit knowledge concepts. Tacit knowledge is personal, context-specific knowledge, and therefore difficult to formalize and communicate. While explicit knowledge is codified, referring to knowledge that can be transmitted in formal and systematic language. In the context of knowledge representation technique, activities that are centered on humans and collaborative techniques will play a significant role in designing the abstraction of natural language into a concept and relation in knowledge extraction. There are many knowledge representation extraction techniques such as rules, frames, scripts, semantic network and ontology. Efficient Semantic Web requires knowledge to be presented in a well-defined form in order to be understood by humans and computers. The result shows that ontology supports represent semantic knowledge to build a system based on robust knowledge.

Ontology as an instrument for knowledge representation has been studied and applied in various fields such as information science, knowledge engineering, artificial intelligence, or digital library [12]. It is still relevant to fundamentally consider in the field of ontology engineering and design that ontology can be applied in knowledge sharing. The ontology modelling technique is still frequently used for modelling knowledge representation in an unambiguous manner [13] so that knowledge can easily be comprehended, shared, and utilized by user computationally [14].

Characteristics of knowledge extraction include heterogeneous, distributed, document variations and non-structured document and data types. This problem necessitates a management of knowledge formalization process for automation process of information data that keeps expanding in terms of quality and quantity in optimizable problems and solutions. Based on their turnover and asset capabilities, SMEs are divided into micro, small and medium scales. Based on their life cycle, they are divided into startup, growing and mature [15]. In West Java, SMEs are developed by paying attention to regional potentials such as fisheries, agriculture, plantations, animal husbandries as well as local cultures with creativity and capital such as culinary art, cosmetic and convection, especially handicrafts or Crafts. This study will focus on how to elicit knowledge using ontology approach so that the extraction of knowledge representation can be presented in knowledge management system. The result of ontology knowledge representation will later be utilized as the foundation for developing knowledge-based ontology system.

One research method that is widely used in developing an ontology is Methontology [16]. Methontology is a structured model to develop an ontology based on experience accrued in ontology development [16]. Methontology include a set of activities, techniques, and deliverables generated after the execution of every activity using a preferred technique. Methontology proposes idea expressions as a set of intermediate representations (IR) and generates an ontology using translators. IR bridges the discrepancy between how people think about a domain and the language used to compile an ontology. Methontology possesses detailed conceptualization and is capable of reengineer an ontology. The framework of methontology enables the development of ontology at knowledge level. The framework includes three elements, namely identification of ontology development process, ontology life cycle, and methodology of Methontology [16].

This methodology has an advantage in regards to descriptions of every activity that must be performed in detail. In addition, another advantage is that the ontology developed can be reused for further system development. Therefore, this study aims to develop an ontology model that represents knowledge domain revolving around small medium enterprises (SMEs), especially SMEs in Craft Convection field, using methontology method.

Literature Review

Literature review includes knowledge overview, knowledge representation and ontology modelling, and subchapters such as ontology modelling technique and knowledge representation.

A. Knowledge, knowledge types, and knowledge elicitation

1. Knowledge

   Knowledge has been defined in various ways from various perspective, ranging from practical to conceptual, even philosophical ones. Based on the definition from various literatures, in general, knowledge is a consequence and derivative of information processing. Information itself is a result of data processing and data is a collection of unprocessed numbers, words, and images.

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Knowledge is the high-value of information that is ready to be applied in decisions and actions [17]. Knowledge is one's characteristics that can influence their habit potential. Knowledge is defined as a true and justified belief. Knowledge is not a picture or representation of reality; it is more of a map of actions allowed in the real world. Knowledge encompasses concepts, semantic relationships, and actions or operations that have been proven to be feasible to achieve objectives. Knowledge is a set of patterns that are structurally connected. The contents of knowledge have been proven to be feasible achieve objectives [18]. Knowledge is dynamic, meaning that it is shaped in social interactions between individuals and organizations; context-specific, meaning that it is dependent on given period and place; humanistic, meaning it is related to human actions and represented in individual belief and commitment [11]. Knowledge is a full use of information and data, combined with the potentials of one's abilities, competencies, ideas, intuitions, commitments, and motivation. Knowledge is something that is believed to be and considered valuable based on the accumulation of information that is processed meaningfully through communication experience, or conclusions [17]. Knowledge is information that combined with experience, context interpretation, and reflection.

Based on the definition above, in general, knowledge can be defined as a consequence and derivative of information processing. General depiction of data processing to produce knowledge is shown in Fig. 1.

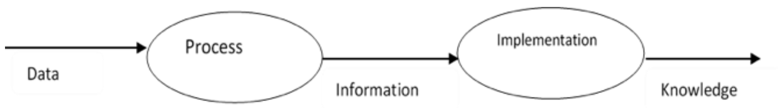

Fig. 1. Flow of Changes of Data-Information-Knowledge

2. Knowledge types, classification, and assets

Knowledge can be classified into many ways owing to various point of views, contexts, scopes when understanding knowledge. The following framework is based on two differences namely epistemological and ontological differences. According to Freeze, R. and Kulkarni (2007, in [10]), there are five assets of knowledge in knowledge management, namely: (1) Data which is facts that are summarized in simple value or images, (2) Experience which is ways, skills, or abilities that come from observation, from event facts and experience, and from events in human life, (3) Learning lessons, which are a collection of knowledge obtained through analysis and thought process on experience, projects, processes, or situations in an organization, (4) Knowledge documents which are knowledge that is explicitly compiled such as reports, documented procedures, statistical analysis, and process maps, and lastly, and (5) Proceedings and politics which are a knowledge asset that represents organizational knowledge needed to run the organization in efficient and coherent manners.

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3. Knowledge elicitation

Knowledge elicitation is a process to obtain and transfer knowledge (that is, for example, accumulated inside the minds of experts in a certain domain) from humans to abstract and effective representations, to organize, model, and ultimately, communicate it in such form that is easier to understand and utilized through formal representation [10]. This knowledge elicitation process can be linked to knowledge conversion process in SECI model proposed by Ref [11].

Every elicitation technique is based on knowledge dimensions (tacit/explicit) that can be acquired by implementing a technique, based on its capability to describe processes/activities, based on its capabilities to clarify and classify concepts, based on the types of knowledge source acquisition (direct source indicated with D or indirect source indicated with I), based on its implementation (for knowledge elicitation or requirement elicitation), and based on the types of knowledge conversion proposed by Ref [11]. This guide is designed based on the types of interaction with experts in their domain.

B. Ontology as knowledge modelling technique

Ontology Engineering is a series of activities concerning with ontology development process, life cycle, method and methodology to develop an ontology, and a set of supporting tools and languages [19]. In the past decade, increased attention has been paid to ontology and Ontology Engineering.

1. Ontology

Etymologically, ontology derives from two Greek words: ontos (őntoc), meaning "being", and logos (lógoc), meaning "discourse". Thus, it can be said that ontology is a study of existence, from all entities—abstract and concrete—that shape the world. In addition, the term ontology has different meaning in different contexts. In philosophy, it is a branch of metaphysics and a study of being. Consequently, there is no universal definition of ontology. However, in computer science an ontology is commonly defined as explicit specification of conceptualization. This definition then is further refined by Ref [20] saying that ontology is an explicit and formal specification of shared conceptualization.

Based on this definition, ontology in computer science encompasses structuration process of knowledge in a certain domain. This is used as a form of representation for knowledge about the real world or only certain parts of the real world. It can be seen as a kind of data model representing a certain domain. In addition, it is used for rationales about entities in the domain and the relationship between them. The main concepts of the definition given about are conceptualization, explicit, formal, and share specification. A conceptualization maps a phenomenon (real world) given to abstract representation of concepts, relationships, axioms, and its relevant limitations. The term "explicit" refers to explicit definition of concept type and shared relationship with axioms and limitations. The term "formal" implies that ontology must be readable by machines and thus, defined using mathematical notation or formal notation. In

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accordance with the definition, ontology structure in explicit specification of conceptualization on a specific domain can be formulated as in equation 1 and 2.

O is defined as ontology structure with following formulation:

O = {C, R, Ao}……………………… (Equation 1)

Where:

- C is a set of elements named concept
- $R \subseteq C \times C$ is a set of relations between concepts and contains inherent hierarchical structure that exists between concepts in C (hierarchical taxonomy), and
- Ao is a set of axioms in O.

General vocabularies regarding conceptualization of O (ontology structure) is determined by appropriate lexicon (language) L that is defined as follows:

If L becomes the lexicon for ontology structure O:

L = {LC, LR, F, G}…………………(Equation 2)

Where:

- LC is a set of elements called concept lexical entry;
- LR is a set of elements called relation lexical entry;
- $F \subseteq LC \times C$ is a set of references for concepts, each connects concepts to lexical entries; and
- $G \subseteq LR \times R$ is a set of references for relations, each connects relations to lexical entries.

2. Ontology development technique

Ontology development process is more of a "craft" activities rather than engineering activities. Each development team follows self-determined principles, whether it is in criteria, phases or objectives in the process of ontology development. The absence of consensus and agreement in instructions and methods of ontology development often complicates the achievement of the objectives of ontology in the term 'reuse'.

Below we try to look at some ontology development methodologies, and compare them with IEEE standard 1074-1995 for software engineering. The objective of this comparison is to see how mature the ontology development methodologies, and to look for potentials to develop a standard/generic methodology for developing ontology. Ontology development methodologies will refer to following methodologies:

- Uschold methodology
- Grüninger & Fox X methodology
- Kactus methodology
- Methontology methodology
- Sensus methodology
- On-To-Knowledge (OTK) methodology

Each methodology will be elaborated in brief in the following section, and compared with IEEE standard at the end of the section. Uschold Methodology has four main phases: (1) defining the objective and the scope of ontology; (2) constructing ontology with ontology capture step which is collecting knowledge, ontology coding which is building a concept model and integrating existing ontology (reuse); (3) evaluation with verification and validation; (4) instructions of each phase and documentation.

Grüninger & Fox X Methodology is based on experience when building ontology in TOVE project. The important thing in the development of logical model of this ontology is that it is not constructed directly. The first is the motivation with scenario in the application. Description and formalization based on first-order calculus. Composition and decomposition of mechanization will help the integration of ontology.

Kactus Methodology by Bernaras has general stages as follows: (1) specification of the application; (2) initial design based on top-level ontology category; (3) refinement and ontology restructuration.

Methontology is a structured model to developed an ontology based on experience accrued in ontology development [16]. Methontology include a set of activities, techniques, and deliverables generated after the execution of every activity using a preferred technique. Methontology proposes idea expressions as a set of intermediate representations (IR) and generates an ontology using translators. IR bridges the discrepancy between how people think about a domain and the language used to compile an ontology. Methontology possesses detailed conceptualization and is capable of reengineer an ontology. The framework of methontology enables the development of ontology at knowledge level. The framework includes three elements, namely identification of ontology development process, ontology life cycle, and methodology of Methontology [16].

Sensus Methodology carries out its steps by (1) identifying important terms (seed); (2) linking terminology to Sensus manually; (3) inputting nodes into the path to root; (4) adding subtree with heuristic rules. If many of the nodes in a subtree are relevant, then other nodes in the subtree are relevant. On-To-Knowledge Methodology (OTK) has stages and processes of feedback. Stages in OTK are feasibility study, ontology kickoff, refinement, evaluation and evolution maintenance. IEEE Standard 1074-1995 for software engineering encompasses following stages:

- Process model in software life cycle.
- Management project processes (planning, control and quality management).
- Processes oriented in development broken down into:
- Pre-development process (environment and feasibility study)
- Development process (requirements, design, implementation)
- Post-development process (installation, operation, support, maintenance, continuity)
- 4. Integrated process (evaluation, documentation, configuration and training).

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Each methodology will be compared to IEEE standard by looking at the management process, pre-development process, development in requirement field, design and implementation, post-development and integration process. Summary of the observation results can be seen in Table 1. In the table, we can also see the maturity of ontology methodology by looking at the life cycle factor, compatibility with IEEE standard, technique recommendation, ontology and application as well as details of methodologies can be seen in Table 2.

The different methodologies described will be able to provide a description for prospective ontology developers to consider which methodology will be used or make a combination of existing methodologies. This is highly likely due to ontology advancement in computer field, especially for information interoperability and integration, are still relatively. The comparison for technique details has not been performed yet. This paper only addresses methodology concept stage in ontology development. Because even in concept stage, the number of approaches is already plentiful, let alone in technical stage, the difference will even greater. It can be seen in the language used to create an ontology, tools used in planning stage, coding and evaluation.

Table 1. Comparing methodologies of ontology development against IEEE standard

Development Methodologies of Ontologies	Process Management	Development Oriented Process					Integral Processing
		Pre-Develop	Development			Post Develop	
			Requirement	Design	Implementation		
Uschold Methodology	X	X	V	X	V	X	O
Grüninger & Fox X Methodology	X	X	V	V	V	X	O
Kactus Methodology	X	X	V	V	V	X	X
Methontology Methodology	O	X	V	V	V	O	O
Sensus Methodology	X	X	V	X	V	X	X
On-To-Knowledge (OTK) Methodology	V	V	V	V	V	O	O

Description: V = available, O = partially available, X = unavailable

Table 2. The maturity of ontology development methodologies

Development Methodologies of Ontologies	Process Recommended Life Cycle	Compliance with IEEE Std	Recommended Techniques	Ontologies and application	Details of the Methodology
Uschold Methodology	X	O	X	O	O
Grüninger & Fox X Methodology	O	O	X	O	O
Kactus Methodology	X	O	X	O	O
Methontology Methodology	V	O	O	V	V

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Sensus Methodology	X	O	X	V	O
On-To-Knowledge (OTK) Methodology	V	V	O	V	O

Considering what is outlined above, and considering that ontology development is highly dependent on domain, application, and ontology type, can a standard and real methodology for ontology development be developed? Ontology development methodologies are the result of experience accrued in ontology development, thus, obtaining a proper and generic methodology is one painfully long process. Studies must strive to reduce the time and efforts needed to create a generic methodology for ontology development. The long process of standard development can also be seen in software engineering process which took a relatively long 20 years in average.

Methodology

Based on Table 1 and Table 2, methontology method has sufficient process completeness to develop an ontology [21], which is why it is used in this study. This methodology consists of tasks to construct an ontology in detail as shown in Fig. 2. Methontology has several ontology development stages. The stages of ontology development for Craft Convection SMEs following the steps as in Fig. 2.

- Build glossary of terms
  Initial stage that serves to identify all terms needed in the development of an ontology.
- Build concept taxonomies
  In this stage, all concepts to be build are classified thoroughly based on the previous stage.
- Build ad hoc binary relation
  Relations of a concept to be build are determined in this stage. In this stage, all related classes will be identified.
- Build concept dictionary
  In this stage, a concept dictionary describing classes and their attributes such as data properties and object properties will be build.
- Describe ad hoc binary relation
  This stage aims to describe ad hoc relation in detail based on the concept to be build. Each ad hoc relation must have a specific name, a concept target and if any, an inverse of the relation.
- Describe instance attributes
  This stage serves to describe in detail every instance attribute that emerges in an ontology.
- Describe class attribute

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This task describes in detail all class attribute that describes the class. For example, value types, measurement unit and attribute name.

- Describe formal axioms

  This stage lays out formal axioms to check the limitations of each class.
- Describe rules

  In this stage, rules governing logics of an ontology designed in the ontology of neurological disease are established.
- Describe instances

  This last stage describes information of each instance possessed by the ontology being built.

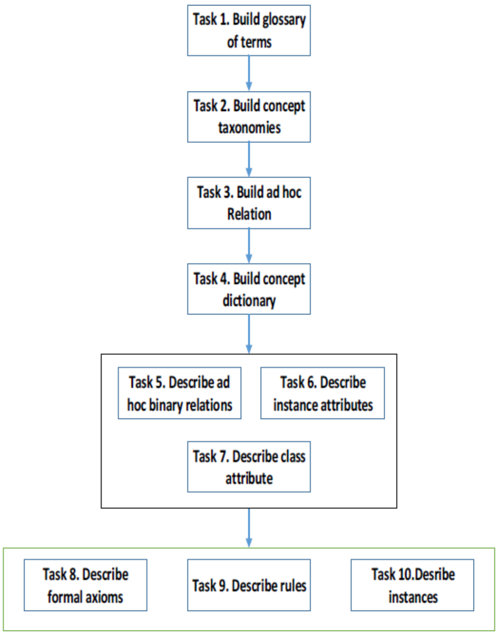

Fig. 2. Methontology methodology [22]

Results and Discussion

The development of Craft Convection SME ontology based on the existing tasks in methontology will only be carried out until stage 5, namely the ad hoc binary relation description stage, while the subsequent stages will be presented in further research. Each stage has an output that describes the components in ontology. This section explain ontology modeling for Craft Convection SMEs using methontology, in which the first five stages are explained: build glossary of terms, build concept taxonomies, build ad hoc binary relations, build concept dictionaries, and describe ad hoc binary relations.

A. Build glossary of terms

This stage is the initial stage of this method, where a literature study is conducted on SMEs and the results of identification of Craft Convection components will be converted into Craft Convection ontology components. In essence, all the components that will later be made are described in several terms so that the form is standard. Glossary of terms includes relevant terms in the domain discussed, namely: concepts, instances, attributes, relations between concepts, etc.). For sub concepts that are part of a more general concept (related to relation is a) not presented in the Table 3.

Table 3. The glossary of terms of the craft convection SMEs ontology

Name	Synonim	Acronyms	Description	Type
Convection Craft Small Medium Enterprice	---	CC SMEs	Companies that have a turnover of between 300 million to 2.5 billion.	Concept
Material	---	---	Materials used for crafts	Concept
Product Type	Product Kind	---	The type of craft made	Concept
Learning method	---	---	How to learn carried out by SME employees	Concept
Value	---	---	SMEs have certain values that are upheld by their employees	Concept
Process	---	---	SMEs have a production process to produce products	Concept
Treatment	---	---	The things that SMEs must do in order to develop	Concept
Event	Fair	---	UKM participated in the exhibition to introduce their products	Concept
Stages	---	---	Stages by SMEs to develop	Concept
Problem causes	---	---	UKM has various causes of problems	Concept
Problem diagnoses	---	---	SMEs experience certain problems	Concept
Is a	---	---	A concept is a part or sub-concept of a larger concept	Relation
Has material	---	---	The relationship between SMEs and materials	Relation
Has type	---	---	The relationship between SMEs and types of products	Relation
Learn by	---	---	The relationship between UKM and learning	Relation
Has value	---	---	The relationship between SMEs and company values	Relation
Has process	---	---	The relationship between SMEs and the production process	Relation
Treated by	---	---	The relationship between UKM and treatment	Relation
Has event	---	---	Relationship between UKM and event	Relation
Has stages	---	---	Relationship between UKM and stages	Relation
Has cause	---	---	The relationship between SMEs and the cause of the problem	Relation
Diagnoses by	---	---	The relationship between SMEs and the problems that occur	Relation

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B. Build concept taxonomies

At this stage a classification for all concepts or classes in the Convection Craft SMEs ontology has been identified in the previous stage, so that a taxonomic concept is obtained as shown below Fig. 3.

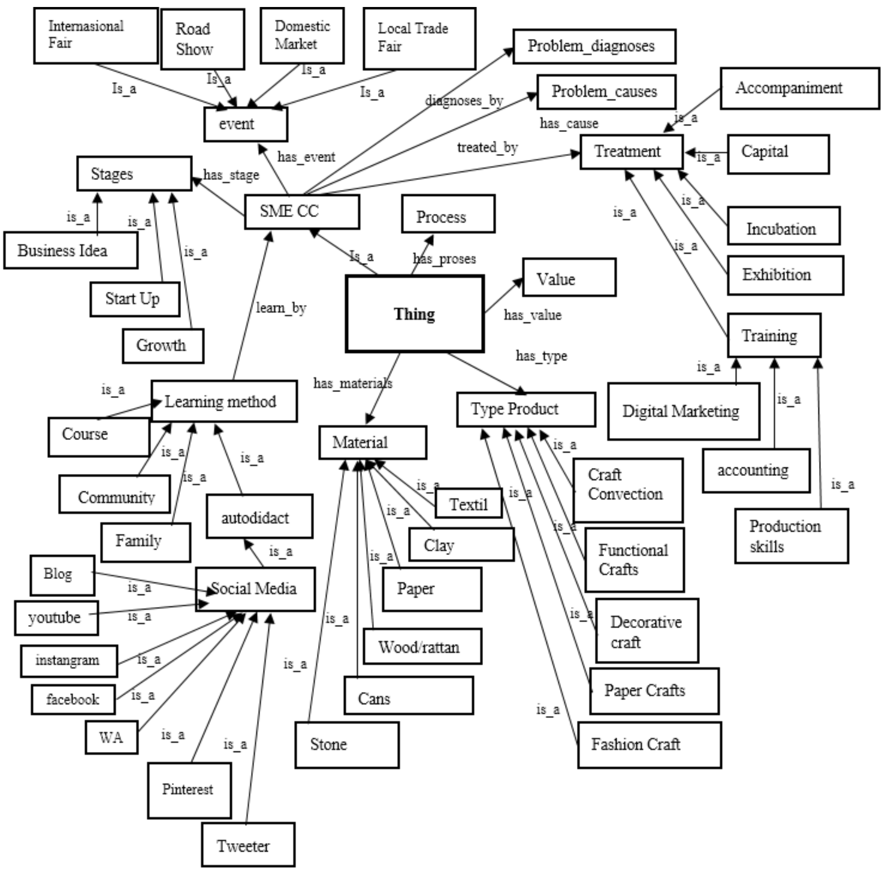

Fig. 3. The concept taxonomies of craft convection SMEs ontology

C. Build ad hoc binary relation

This is the stage of identifying relationships between concepts or on the Craft Convection SMEs ontology so that it maps the interrelationships that will ultimately form the desired map of knowledge as presented in Fig. 4.

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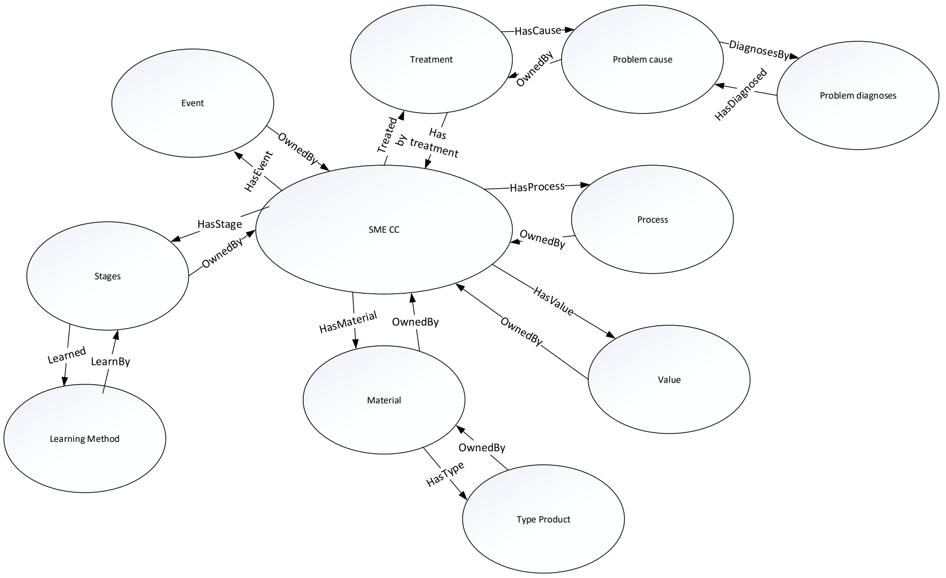

Fig. 4. Ad hoc binary relation diagram convection craft SMEs ontology

D. Build concept dictionary

At this stage all instances of the attribute or constituent components are identified from each existing concept, so that each concept will be fully described in the form of information or knowledge as presented in Table 4.

Table 4. The concept dictionary of SME craft convection ontology

Name	Instances	Class Attributes	Instance Attribute	Relations
Small Medium Enterprice Convection Craft	---	Name, dateofstanding	---	Has Type, has materials, learn by, has stage, has event, diagnoses by, has cause, treated by, has process, has value
Material	Textile,Clay, Paper, wood/rattan, cans, stone	---	Id, description	Is a
Product Type	Craft Convection, Functional Craft, Decorative Craft, Paper Craft, Fashion Craft	---	Id, description	Is a
Learning method	Course, Community, Family, Autodidact	---	Id, description	Is a
Value	---	Number, description	---	---
Process	---	Number, description	---	---
Treatment	Accompaniment, capital, incubation,exhibition, training	---	Id, description	Is a
Event	International Fair, Road Show, Domestic Market, Local Trade Fair	---	Id, description	Is a

Stages	Business idea, start up, growth	---	Id, description	Is a
Problem causes	---	Number, description	---	Diagnoses by
Problem diagnoses	---	Number, description	---	Has cause

E. Describe ad hoc binary relation

At this stage a merger between relations and attributes that have been generated in the previous stage is carried out, so that all components of the KC ontology will be incorporated as presented in Table 5.

Table 5. The ad hoc binary relation table of the craft convection SMEs ontology

Relation name	Source concept	Source cardinality(Max)	Target Concept	Inverse relation
Has materials	SME CC	1	Material	Owned by
Has values	SME CC	1	Value	Owned by
Has process	SME CC	1	Process	Owned by
Has treatment	SME CC	1	Treatment	Treated by
Has event	SME CC	1	Event	Owned by
Has stages	SME CC	1	Stages	Owned by
Has type	Material	N	Type product	Ownde by
Learned	Stages	N	Learning methods	Learning by
Has cause	Treatment	N	Problem cause	Owned by
Diagnoses by	Problem cause	N	Problem diagnoses	Has diagnosed

Conclusions

Small medium enterprises (SMEs), especially Craft Convection enterprises, harbour potentials to be utilized in knowledge management. However, a large part of knowledge related to SMEs, especially craft convection, have not yet been codified. To improve this utilization, clear, explicit representation of original knowledge for knowledge management is needed, and ontology emerges as proper basic representation. In addition, ontology requires explicit and fully-documented conceptual models to formalize ontology. In this study, a conceptual model of Craft Convection SMEs has been developed using methontology approach up to ad hoc binary relation description stage. Further studies will focus on subsequent stages until describe instance.

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