Chapter 4

Experimental Results

In the previous chapter, the knowledge management model to increase value of the teak furniture product was explained in details. It applied the concept of knowledge creation to elevate existing knowledge. The knowledge engineering methodology was also utilized for the elicitation and development of the knowledge pack. This was especially in the externalization and combination of the knowledge creation. This chapter then presents the results and analysis of the proposed knowledge management model. Section 4.1 provides the analysis of the research problem considered in this thesis and support the first research objective. Please note here that this research considers the value of the teak furniture product from the price and production time. Section 4.2 then provides the results of the proposed knowledge management model and support the second research objective. These include changes in the knowledge pack after each cycle and changes in the production process accordingly. Finally, Section 4.3 provides analysis on the price and production time of the teak furniture products.

4.1 Results and Analysis of the Teak Furniture Product from the Value's Perspective

As Teak furniture was export-oriented, adding value to the Teak wood furniture and economic handicrafts should be done in a way that consumers could experience the real difference. Apart from functionality, certain features had to be created by emphasizing the uniqueness and artistic style (niche market). This view was consistent with the data obtained from the interviews that handicraft export was expected to be growing at a rate of 4 percent in congruent with the overall export market that was also expanding. Mrs. Pimpa Chansilp, director of the SUPPORT Arts and Crafts International (Public Organization) or SACICT revealed in the innovative arts festival or an ICF International 2014, held from March 27th to 30th at BITEC, that the overall export of Thai handicraft products was likely to recover and grow at 4% a year,

compared with as the growth rate of 0.14% in the previous year as resulted from the stagnant economy in the U.S and Europe. The recovery sign could be seen in February that export markets of ASEAN, Japan, and Europe gains the momentum at the rate of 2.4%. Domestic market, which generated over 50,000 million Baht last year, which exceeded international markets over 2-3 times, was also expected to grow constantly. The growth could be contributed by foreign tourists, condominium market, and hotels nationwide, which are growing impressively. SACICT considered more supports for Thai community handicrafts so that they could be developed with added values through arts, modern design, and functionality.

Teak furniture could be divided into 3 main types according to the methods of installation. These include built-in furniture or fixed furniture, movable furniture and loose furniture, and knock down furniture. Built-in furniture or fixed furniture refers to furniture that was been designed and installed for a particular area, which was difficult to move or re-install. The advantage of this type of furniture was that the furniture had strength as it was installed directly to the building or structure. The design emphasizes on elegance, uniqueness that could be adapted to the different areas without limitations. This type of furniture was usually designed with a great height that reaches the ceiling for maximum usage and preventing the accumulation of dust (ideal for dusty countries). However, the major disadvantage of this furniture was the inability to move and the shapes cannot be easily changed. If there was a change of ownership, the furniture will had to be entirely removed or demolished and become unusable. Moreover, the price of the furniture was very expensive as it requires skilled labor to install the furniture specifically. Often times, customers had to deal with the occurring dust in the working atmosphere and the painting smell, which was harmful for health.

Movable furniture or loose furniture refers to furniture completely manufactured in the factory, which was exhibited for customers to choose from the actual samples in furniture shops. This type of furniture had the advantages that the customers could choose a model, functionality, and could even try the furniture, where sometimes the movable furniture could be relocated and needed. The moreover, the whole manufacturing process was completed at the factory and the customers do not had to be bothered by dust, smell of paintings. However, since Moveable furniture was produced in a large quantity, the uniqueness of design was missing and the price was rather low.

Movable Furniture or Loose Furniture was suitable for export because of the ease of transportation and installation as well as lower prices. This type of furniture should be improved in terms of the functionality and aesthetics to enhance the value.

Knock down furniture combines the advantages of the two types of furniture mentioned above. The furniture could be installed at the needed location needed while almost the entire production process had nearly been completed. The furniture could be installed or assembled by a small number of skilled technicians. One of the advantages of Knock down furniture was that it takes a short time to install, reduce the problems of dust and painting smell. However, this type of furniture often requires the designs and the preparation of machinery for production could be complicated. Knock down furniture often requires mass production to minimize the average costs in the design and preparation for production. The manufacturers of this type of furniture general select Particle Board or Chip Board as raw materials as the quality control could be easily done. Due to the quality of raw materials, Knock down furniture was not as lasting as furniture made from real wood or plywood. In addition, the designs of Knock down furniture are still limited as the manufacturing process was rather complicated and required the expensive machinery. The outer appearances of this type of furniture are quite similar to one another and that leads to competition in terms of pricing. As a consequence, the manufacturers finally had to reduce the quality of the products and that causes Knock down furniture to be the cheapest type.

Current prices of teak furniture are not significantly different from the prices of other types of furniture. Targeting at the same markets is, therefore, not recommended, especially when the objective was to create added value for Teak furniture. This research proposes that the producers of Teak furniture look for a different market such as the manufacturing of Teak furniture in colonial style for decorating in colonial architecture.

Since the colonial architecture was originated in the period of European colonialism, in which the colonial architecture was spread and became known worldwide. Its history and uniqueness had the start from Greek-Roman civilization, combined with the European architecture and local cultures. The promotion of colonial architecture could simple since there was no need to introduce the products. (Drucker, 1999).

Teak trees had been grown commercially that reach the proper age for use had been cut down to be used as raw materials for Teak furniture production. A critical problem occurs nowadays was that the value of Teak was not significantly different from the values of other types of woods despite that Teak furniture possesses finer qualities than other types of wood furniture. Value should be added to Teak furniture using the principles of mixed marketing. The distribution should focus more on the export and target the new market, which was the colonial architecture. Teak furniture could be manufactured based on the colonial style which had strength in terms of functionality and aesthetics, which could be chosen for decorating in colonial architecture.

Teak wood of Thailand had fine qualities suitable for furniture manufacturing. With high value, Teak was illegally cut down. In 1989, the government canceled Teak logging concessions resulted in a shortage of wood materials. Teak wood was imported from abroad for the purpose of furniture manufacturing. Later, the government promoted private sector to operate commercial forestation. In the past, the maturity of Teak trees was set for 50-60 years.

Nowadays, with the innovative technologies in cultivation and maintenance, the cycle was reduced to 20-25 years only. As a result, there was no shortage in the supply of raw materials in the furniture industry as experienced in the past. According to the statistics, the exports of Teak furniture are facing lower value, compared with the exports of all wood furniture, therefore, it was necessary to add value to the Teak furniture targeting new markets to generate higher value for Teak furniture industry as well as the export.(District Administration Phrae, 2013).

According to the analyzed problems with the Teak industry of Thailand, the philosophy of creative economy presumes to be a potential solution. The elements in the supply-chain that maximizes the value will be extracted. The focus was on loose furniture, i.e. the furniture with low value. The analysis of the value-adding means was carried out according to the concept of creative economy and shown in Table 1.5, which was shown that the Teak carving could maximize the added value to the Teak industry because the Teak carving was a branch of Thai handicrafts, which was considered to be the creative industry recognized worldwide UNCTAD and was in the economic development plan of Thailand.

Therefore, the researcher proposes that the certain values are added to the Teak wood furniture. According to the principles of the mixed marketing, distribution channel should focus more on exporting. The focus should be on new markets and that was the colonial architecture. The production of Teak furniture should then focus on the functions coupled with beauty so that the products could be decorated in colonial architecture. There was a need to establish a body of knowledge related to the production (knowledge worker), in which involves two main groups. The first group was Teak wood furniture manufacturers focusing on machinery that was capable of producing at a great quantity. The production takes less time, focuses on functions, and does not stress on beauty. The second group was carving workers of Teak wood furniture, who focus on skills and are thus capable of producing in a small quantity. They require more time as they expect beauty in their works. In this research, the new body of knowledge was offered to the 2 groups by capturing the existing knowledge of both groups and then by matching with the existing knowledge with new knowledge.

4.2 Results of Proposed Knowledge Management Model which could assist in value adding to Teak Furniture Industry

4.2.1 Development of the Proposed Knowledge Management Model

As mentioned in the previous section, the focus of the knowledge worker in the factory (interview population 1) was the functionality of the teak furniture products by emphasizing solely on the production process to gain the maximum volumes. The carvers, on the other hand, focus on the aesthetics of the teak furniture products by emphasizing on the craftsmanship skills. This had resulted in little knowledge management practices in the factory. Currently, only the corrective actions in the factory could be perceived as the existing knowledge management practices where mistakes were recorded in the reporting documents. However, this existing knowledge management practices only serve as the references, but still not utilized to improve the production process.

Hence, in this research, the new knowledge management model were developed and proposed. The concept of knowledge creation was applied as a way to elevate existing knowledge. This change in knowledge was expected to result in better

production process in the factory, and better quality of the teak furniture products with higher values. The proposed knowledge management model was illustrated in Figure 4.1

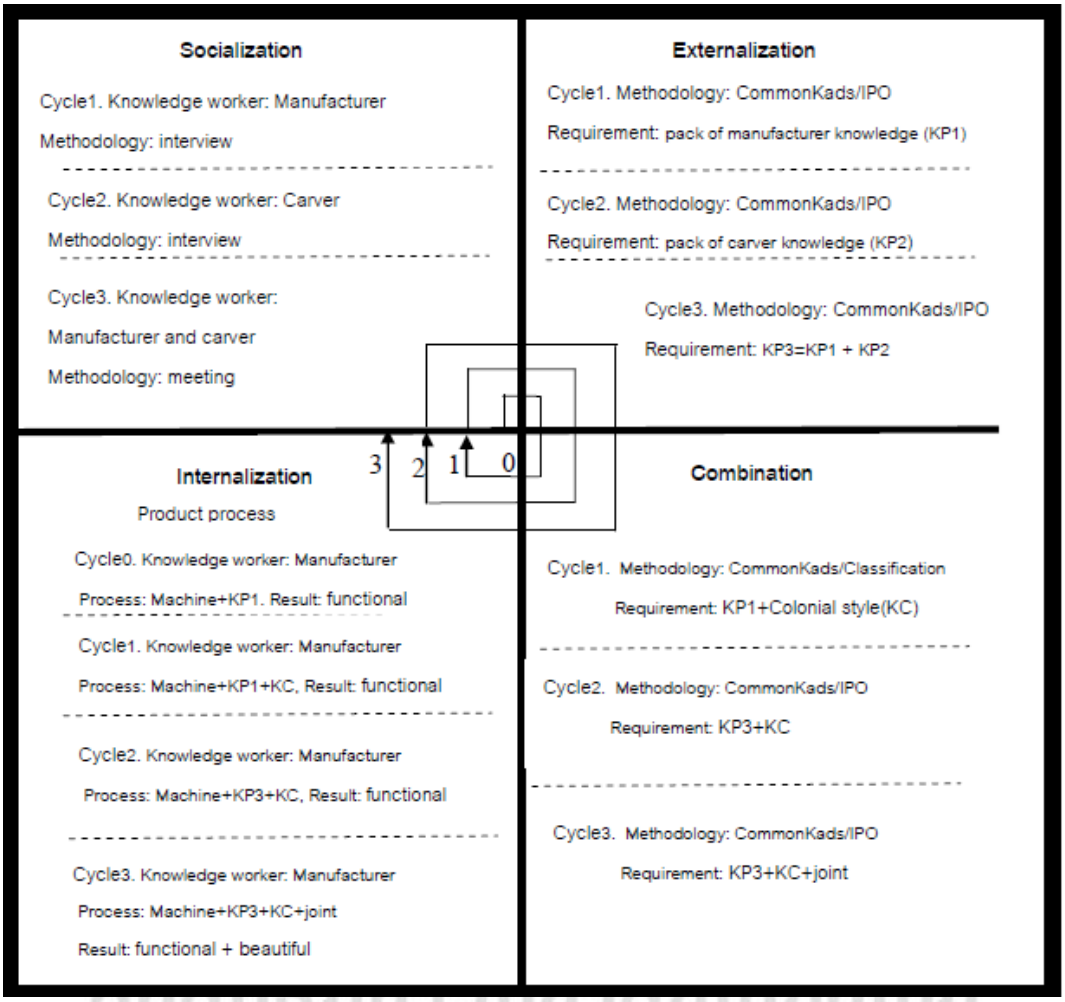

Figure 4.1 Proposed Knowledge Management Model

Figure 4.1shown the proposed knowledge management model for the value adding of the teak furniture products. It was believed that better knowledge results in better production process and higher value of the teak furniture product. The knowledge creation applied comprises of 4 phases. The first phase was the socialization where knowledge workers were gathered for the knowledge exchange. The second phase was the externalization where experiences exchanged in the socialization were captured and elicited in the forms of knowledge pack according to the knowledge engineering methodology. The third phase was the combination where the current

knowledge pack from the externalization was combined with new information to form new (better) knowledge pack. The final phase of the knowledge creation was the internalization where new developed knowledge pack after combination was adopted and tested. Please note that in the internalization, this was where the production process was modified according to the changes in the knowledge created. Moreover, this research applied 3 cycles of knowledge creation. The detailed explanations of each phase and cycle as well as the tools used in each phase were given in the following subsections.

4.2.1.1 The first cycle of knowledge creation

4.2.1.1.1 Socialization

In this research, the socialization was organized in the form of knowledge exchange meeting. The human experts on manufacturing were invited and included in this socialization of tacit to tacit meeting. Two manufacturing experts were presented in this meeting. This was based on the proposed idea in this research to develop new knowledge for value added by functionality (manufacturing). The Manufacturer experts were invited to attend the meetings to exchange their knowledge. The first meeting was the discussion from the Manufacturer experts divided into 2 sessions. The first session was lasted 4 hours, where the participants were asked questions, explained details, and exchanged their opinions. The second session was lasted 2 hours, where the participants were reviewed, verified, and concluded data obtained from the first session. After that the exchanges of knowledge were constantly conducted via telephones.

4.2.1.1.2 Externalization

In the externalization, the experiences exchanged in the socialization were then captured and explicit in the form of knowledge pack according to the knowledge engineering methodology. This explicit knowledge could then be combined with others systematically. To prove that knowledge engineering that could be used to capture, analyze, and synthesize knowledge from groups of Teak furniture manufacturing workers, which could maximized the functionality or utilization of furniture. The emphasis was the use of machinery to add more values to Teak furniture.

The details of the interviews with the experts in Teak chair manufacturing for utilization could be seen in sub-section 4.2.3.1(2).

Knowledge engineering could be used for manufacturing by capturing, analysis and synthesis. The CommonKADS was a tool in the knowledge engineering that was used for the knowledge analysis and synthesis. CommonKADS model captures the knowledge in the categories of Task, Inference, and Domain. For Task, the captured knowledge involves the goals of the task. For Inference and Domain, the captured knowledge would be synthesized. The knowledge engineering could give the framework for knowledge capturing, which could be divided into three levels consisting of Task, Inference and Domain as shown in Figure 4.2

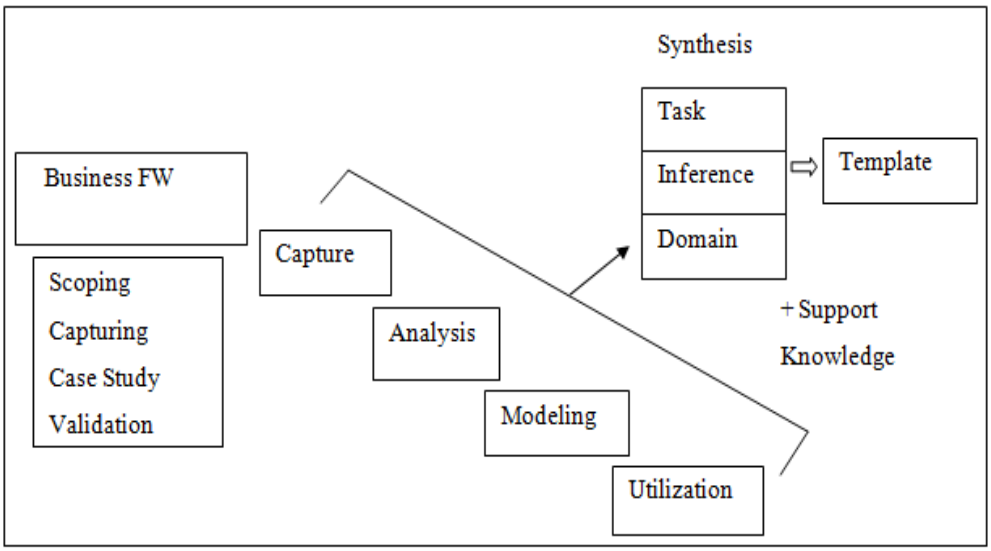

Figure 4.2 The CommonKADS Model

Figure 4.2 shown the CommonKADS, which was a tool in the knowledge engineering that was used for the knowledge analysis and synthesis, which could be described by following processes.

- Knowledge capture was used for specialist knowledge capturing, which was consisted of four steps.
  - Scoping: Interviews to determine the scope of knowledge capture, adding value to Teak through carving handicraft and manufacturing.

- Capturing: Interview to capture the knowledge, adding the value to Teak through carving handicrafts and manufacturing.
- Case study: Case study interviews, adding the value to Teak through carving handicrafts and manufacturing.
- Validation: Interview to review understanding, adding the value to Teak through carving handicrafts**.**

- Knowledge analysis
  - Recording and Transcription from Interview or Protocol Analysis
  - Use Annotation to create Ontology and Knowledge Mapping
- Knowledge Modeling for knowledge analysis and knowledge synthesis. Task Knowledge was the goal and sub goal that lead to obtain Task completion.
  - Inference Knowledge was the knowledge in the reasoning process that leads to obtain sub goal such as requirement, output, solving problem and others.
  - Domain Knowledge was the knowledge in the reasoning process that was the conceptual knowledge or conceptualization, especially for solving problem or making being successful.
- Knowledge Utilization was the easy knowledge access, for examples IT, web board and information board etc.

The CommonKADS was used for the knowledge analysis and synthesis. The representation of the synthesized knowledge would be applied for the purpose of knowledge transfer and learning. In this thesis, for the development of the knowledge packs on the manufacturing, the CommonKADS tools called the Input/Process/Output (IPO template) was selected and applied for the capturing, analysis and modeling of the relevant experiences. The Input/Process/Output structure was given in Figure 4.3

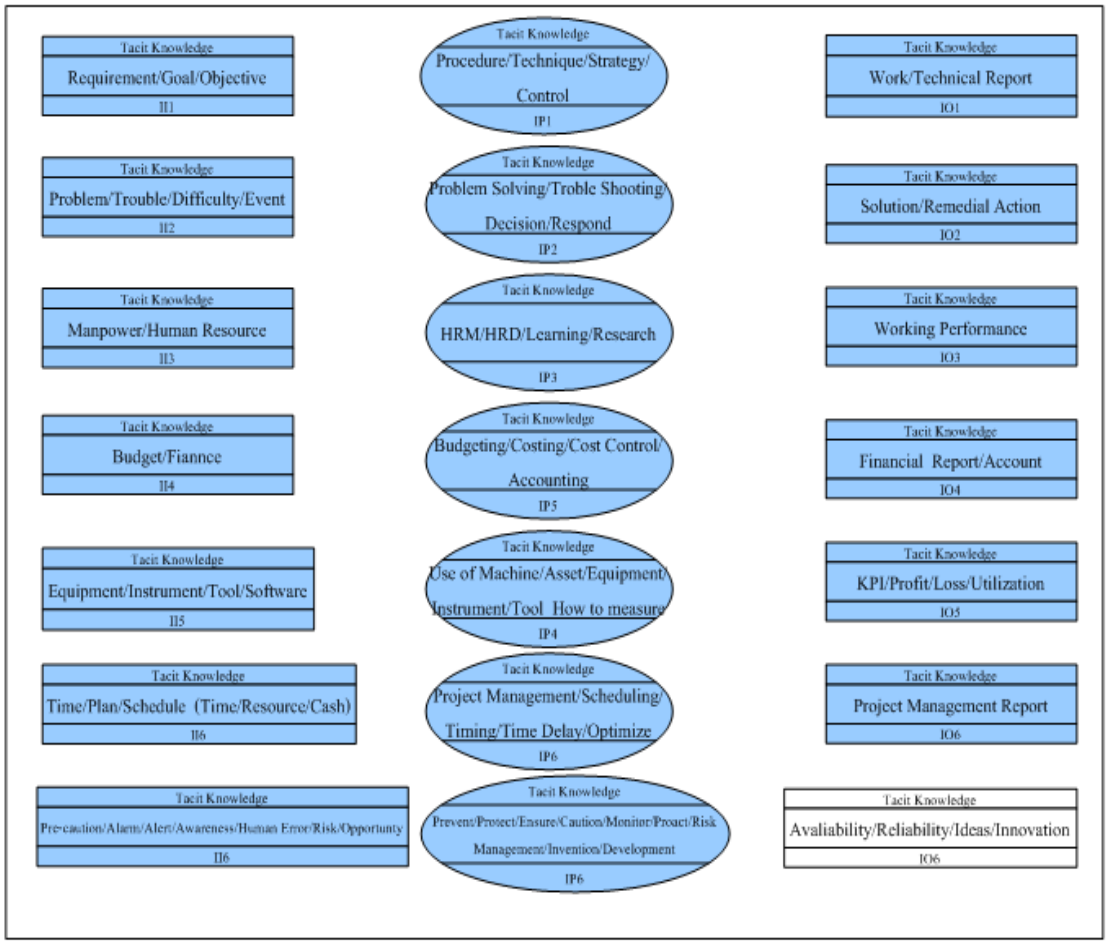

Figure 4.3 The IPO template

Figure 4.3 shown the IPO template applied and used in this thesis for the development of the knowledge packs on the carving and manufacturing of the teak furniture. To capture, analyze and model the relevant knowledge/experiences, the IPO template divides the relevant knowledge/experiences into 3 subsets. These subsets include the input inference, the process inference and the output inference. This was based on the believe that on the fundamental level the human experts should approach the problems and reasoning the tacit knowledge from 3 different perspectives as follows:

- Input inference: this represents the set of inferences the human experts must think or reason prior to the task. These include inference ("what to think") on requirements, problems, manpower, finance, equipments, plans and precaution.
- Process inference: this represents the set of inferences the human experts must think or reason during the task. This usually implies the steps,

activities, tools and techniques involved. In this research, these were procedure, problem solving techniques, learning of the manpower, budgeting and costing, the asset planning, project management, and risk management.

- Output inference: this represents the set of inferences the human expert must think or reason after the task. This set of knowledge was important in the sense for the human experts to be sure that the task was completed effectively. These include technical report, remedial actions, working performances, financial report, KPI and the project management reports.

As mentioned previously, this set of inferences was then used to capture the knowledge on carving and manufacturing from experts and repositories. Then, this experiences and knowledge was then analyzed and modeled according to the inference structure shown in Figure 4.3 The results of this analytical tool on the carving and manufacturing could be seen in sub-section 4.2.3.1(2) and sub-section 4.2.3.2(2) respectively.

In the Figure 4.3 illustrated IPO Template, which could be applied as a framework to design questionnaires that used for collecting data collection of the experts in Teak furniture manufacturing**.**

(1) Scoping Meeting Agenda for the First Cycle of Knowledge Creation

Agenda 1. Inform the interviewees of the project objectives and knowledge capture

Agenda 2. Inform the interviewees of the expected objectives

Agenda 3. Each interviewee was asked to share their inputs on how to manufacture Teak chairs for utilization (Critical Tasks).

Agenda 4. Interviews were individually conducted to find out specific contents (Critical Tasks).

Agenda 5. Inform the schedule of the interviews

Agenda 6. Discuss the case studies that would be used in Case Study Meeting.

Other agendas

Inquire the names of the interviewees and related people, documents, information system, and references.

Who

Document

Information

(2) Knowledge Capture Meeting Agenda for the First Cycle of Knowledge Creation

Agenda 1. Inform the interviewees of the project objectives and knowledge capture

Agenda 2. Inform the interviewees of the expected objectives

Agenda 3. Each interviewee was asked to share their inputs on how to manufacture Teak chairs for utilization (Critical Tasks) 15 minutes each.

Agenda 4. Interviews were conducted to find out critical aspects, necessary concepts obtained from experiences, and other principles related to Teak chair manufacturing for utilization.

Agenda 5. Interviews were conducted to find out other technical knowledge obtained from experiences for making decision (Support Tacit Knowledge)

Other agendas

Inquire the names of the interviewees and related people, documents, information system, and references.

Who, Document, Information

(3) Case Study Meeting Agenda for the First Cycle of Knowledge Creation

Agenda 1. Inform the interviewees of the project objectives and the background of knowledge capture

Agenda 2. Inform the interviewees of the objectives of the meeting

Agenda 3. Experts were requested to explain the case studies, approximately 15 minutes each case.

Agenda 4. Review the procedures

Other agendas

Inquire the names of the interviewees and related people, documents, information system, and references.

Who, Document, Information

(4) Validation Meeting Agenda for the First Cycle of Knowledge Creation

Agenda 1. Inform the interviewees of the project objectives and the background of knowledge capture

Agenda 2. Inform the interviewees of the meeting

Agenda 3. The experts were requested to review the knowledge, essential aspects, necessary concepts obtained from experiences, and other principles related to Teak chair production one more time.

Agenda 4. Review the case studies

Other agendas

Inquire the names of the interviewees and related people, documents, information system, and references.

Who, Document, Information

4.2.1.1.3 Combination

The knowledge management was described as a tool for capturing, analysis and synthesis. There were variety of colonial architectures, where sometime was difficult to explain. In order to systemize and being principle, it was necessary to introduce the knowledge engineering for capturing, analysis and synthesis, which could be useful for other researches. Figure 4.4 shown knowledge engineering diagram.

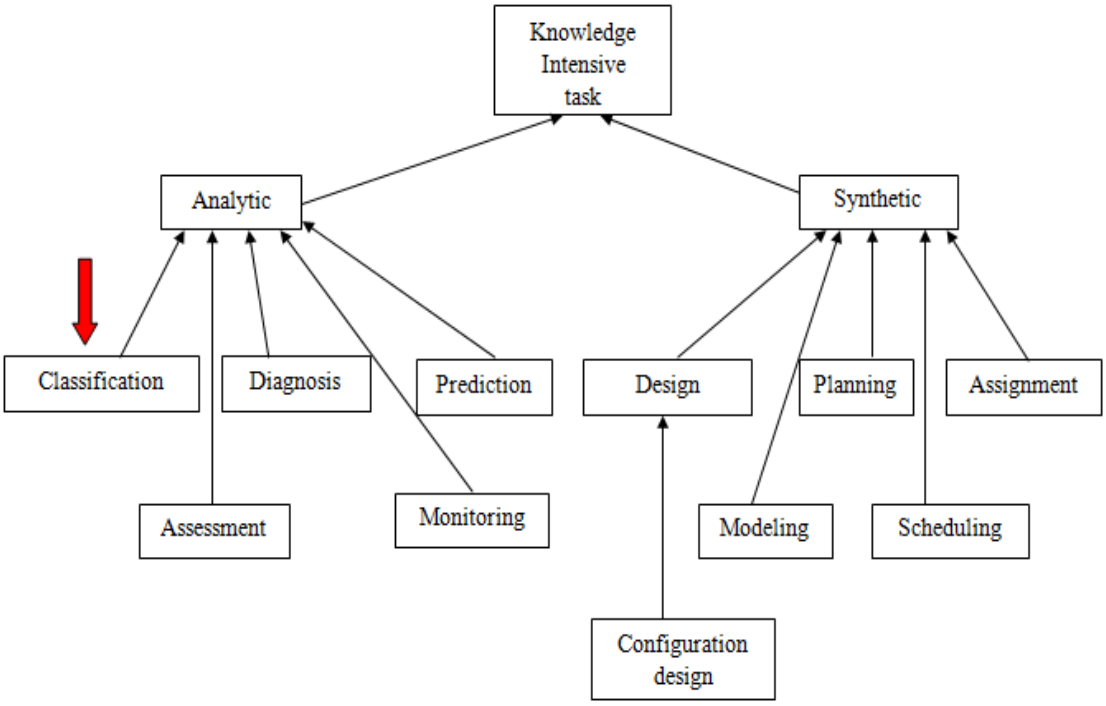

Figure 4.4 Hierarchy of knowledge-intensive task types based on the type of problem being solved

From Figure 4.4, Classification model was one of the simplest analytic tasks for many existed methods. Other analytic tasks could sometimes be reduced to a classification problem, especially for diagnosis. Classification model could capture knowledge in the task categories of Task, Inference, and Domain. For Task, the captured knowledge involves the goals of task. For Inference and Domain, the captured knowledge would be synthesized (Schreiber, 2000). Inferences structure for the classification method was shown in Figure 4.5

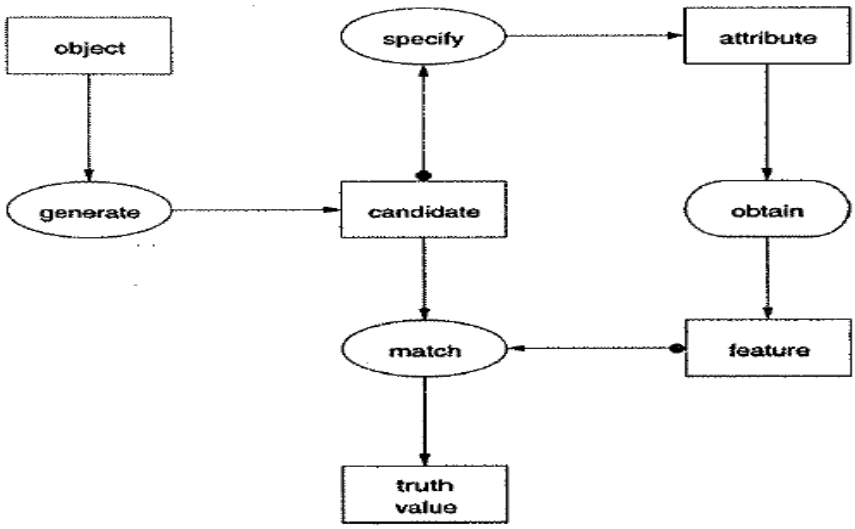

Figure 4.5 Inferences structure for the classification method

Figure 4.5 illustrates the classification template which was one of the knowledge template provided by the CommonKADS methodology. Please note here that the classification template contains the predefined inferences relevant to the reasoning of the knowledge workers in the classification activities. Not only this template provides the set of possible inferences, but it also provides the reasoning sequence of the classification activities.

This was for example in Figure 4.5 the input was the object of which the class needs to be established. The object was required to find the class or category, for example, the Colonial style chair. The Attribute was a characteristic that could either be observed or inferred, e.g., chair arms. The feature and attribute –value pair that holds for a certain object, for example, "chair arms that had the slight upward curve", where the output was the class and found.

Hence, in this framework proposed in this thesis, a group of inferences in Figure 4.5 was selected to form the analytical tool to capture, analyze and model the knowledge on the colonial style. These inferences selected include and could be explained as follows:

- Object (generate, candidate): this means the object focused for the classification and its related attributes which differentiate it from others. In this research, "chair" was selected as an object

for the classification, especially under the context of the colonial style.

- Specify/Attribute: this means the possible attributes of the selected object mentioned above which differentiates its from other object classes.
- Obtain/Feature: this means the all the possible features contained in each attribute determined.

As mentioned previously, this set of inferences was then used to capture the knowledge on colonial style from experts and repositories. Then, this experiences and knowledge was then analyzed and modeled according to the inference structure shown in Figure 4.5. The results of this analytical tool on the colonial style could be seen in sub-section 4.2.3.1 (3)

New knowledge would be selected and combine from the existed knowledge of the manufacturing from the first step of socialization phase (KP1) and from style knowledge. In the thesis, it was focused in colonial style which was about value adding in beauty (KC). This was the combination of Inference and Domain concept of manufacturing (KP1) and colonial style (KC). The inference was merged the relative or closed knowledge and added the domain or inference for new domain knowledge.

4.2.1.1.4 Internalization

The newly developed knowledge pack from the combination was tested by the knowledge workers. The current production process was modified according to the changes in the knowledge pack. Hence, comparison of production process before and after when combining KP1 and KC could be made and the results were given in sub-section 4.2.3.1(4)

4.2.1.2 The second cycle of knowledge creation

4.2.1.2.1 Socialization

In this research, the socialization was organized in the form of knowledge exchange meeting. The human experts on carving **was** invited and included in this socialization of tacit to tacit meeting. 5 carving experts were presented in this meeting. This was based on the proposed idea in this research to develop new

knowledge for value added by aesthetic (carving). The carving experts were invited to attend the meetings to exchange their knowledge. The first meeting was the discussion from the carving experts divided into 2 sessions. The first session was lasted 4 hours, where the participants were asked questions, explained details, and exchanged their opinions. The second session was lasted 2 hours, where the participants were reviewed, verified, and concluded data obtained from the first session. After that the exchanges of knowledge were constantly conducted via telephones.

4.2.1.2.2 Externalization

In the externalization, the experiences exchanged in the socialization were then captured and explicit in the form of knowledge pack according to the knowledge engineering methodology. This explicit knowledge could then be combined with others systematically. To prove that knowledge engineering could be used to capture, analyze, and synthesize knowledge of groups of Teak furniture carvers, which could be used to add more aesthetics to furniture and more value to the furniture simultaneously. Details of the Interviews with Experts of Teak Carving could be seen in sub-section 4.2.3.2(2).

Knowledge engineering could be used for carving by capturing, analysis and synthesis. The CommonKADS was a tool in the knowledge engineering that was used for the knowledge analysis and synthesis. CommonKADS model captures the knowledge in the categories of Task, Inference, and Domain. For Task, the captured knowledge involves the goals of the task. For Inference and Domain, the captured knowledge would be synthesized. The knowledge engineering could give the framework for knowledge capturing, which could be divided into three levels consisting of Task, Inference and Domain as shown in Figure 4.2 The CommonKADS was used for the knowledge analysis and synthesis. The representation of the synthesized knowledge would be applied for the purpose of knowledge transfer and learning. In this thesis, for the development of the knowledge packs on the carving, the CommonKADS tools called the Input/Process/Output (IPO template) was selected and applied for the capturing, analysis and modeling of the relevant experiences. The Input/Process/Output structure was given in Figure 4.3.

In the Figure 4.3 illustrated IPO Template, which could be applied as a framework to design questionnaires used for collecting data collection for carving experts.

(1) Scoping Meeting Agenda for the Second Cycle of Knowledge Creation

Agenda 1. Inform the interviewees of the project objectives and knowledge capture

Agenda 2. Inform the interviewees of the expected objectives

Agenda 3. Each interviewee was asked to share their inputs on how to add the value to Teak through carving (Critical Tasks).

Agenda 4. Interviews were individually conducted to find out specific contents (Critical Tasks).

Agenda 5. Inform the schedule of the interviews

Agenda 6. Discuss the case studies that would be used in Case Study Meeting.

Other agendas

Inquire the names of the interviewees and related people, documents, information system, and references.

Who

Document

Information

(2) Knowledge Capture Meeting for the Second Cycle of Knowledge Creation

Agenda 1. Inform the interviewees of the project objectives and the back ground of knowledge capture

Agenda 2. Inform the interviewees of the expected objectives

Agenda 3. Each expert was asked to share their inputs on how to add the value to Teak through carving (Critical Tasks) for 15 minutes.

Agenda 4. Interviews were conducted to find out specific contents and necessary concepts obtained through

experiences and principles related to Teak carving with each interviewee.

Agenda 5. Summarize other technical skills obtained from experiences that could support the decision-making process (Support Tacit Knowledge).

Other agendas

Inquire the names of the interviewees and related people, documents, information system, and references.

Who, Document, Information

(3) Case Study Meeting Agenda for the Second Cycle of Knowledge Creation

Agenda 1. Inform the interviewees of the project objectives and the back ground of knowledge capture

Agenda 2. Inform the interviewees of the objectives of the meeting

Agenda 3. Experts were requested to explain the case studies, approximately 15 minutes each case.

Agenda 4. Review the procedures

Other agendas

Inquire the names of the interviewees and related people, documents, information system, and references.

Who, Document, Information

(4) Validation Meeting Agenda for the Second Cycle of Knowledge Creation

Agenda 1. Inform the interviewees of the project objectives and the back ground of knowledge capture

Agenda 2. Inform the interviewees of the expected objectives

Agenda 3. The experts were requested to review the knowledge, essential aspects, necessary concepts obtained from experiences, and other principles related to Teak carving one more time.

Agenda 4. Review the case studies

Other agendas

Inquire the names of the interviewees and related people, documents, information system, and references.

Who, Document, Information

4.2.1.2.3 Combination

The new knowledge was selected and combined with the existing manufacturing at the first socialization phase step (KP1) and style knowledge which colonial style focus. In this Thesis, it was focused in colonial style which was added value of beauty (KC) and carver in the second socialization phase step (KP2). This was the combination of Inference, manufacturing domain concept manufacturing (KP1), colonial style (KC) and the carver knowledge of the second socialization phase step (KP2) together. The inference was integrated between the relative knowledge and added the new domain or new inference for newer domain.

4.2.1.2.4 Internalization

The newly developed knowledge pack from the combination was tested by the knowledge workers. The current production process was modified according to the changes in the knowledge pack. Hence, comparison of production process before and after when combining (KP1+KC) and KP2 could be made and the results were given in sub-section 4.2.3.2(4)

4.2.1.3 The third cycle of knowledge creation

4.2.1.3.1 Socialization

In this research, the socialization in the form of knowledge exchange meeting was organized. The human experts on carving and manufacturing were invited and included in this socialization of tacit to tacit meeting. 3 carving experts and 17 manufacturing experts (designers, product development, factory process) were presented in this meeting. This was based on the proposed idea in this research to develop new knowledge for value added by integrating functionality (manufacturing) with aesthetic (carving).

4.2.1.3.2 Externalization

The conversion of tacit knowledge into explicit knowledge. The experiences acquired from each step of the manufacturing of furniture as art objects used in everyday life could be transmuted into the Externalization, which was a written record, still pictures, and motion pictures.

In this research, the CommonKADS methodology was applied and used to translate the group tacit knowledge into explicit knowledge. The tacit knowledge was conversed and explicit into simple knowledge structure of task, inference, and domain concepts.

4.2.1.3.3 Combination

The new knowledge was selected and combined with KP3+KC and joint This was the combination of Inference, manufacturing domain concept KP3+KC and joint together. The inference was integrated between the relative knowledge and added the new domain or new inference for newer domain.

4.2.1.3.4 Internalization

The newly developed knowledge pack from the combination was tested by the knowledge workers. The current production process was modified according to the changes in the knowledge pack. Hence, comparison of production process before and after when combining (KP1+KC+KP2) before the combination of joint could be made and the results were given in sub-section 4.2.3.3(4)

4.2.2 Framework and Tools for Results Analysis

4.2.2.1 Relationship of Knowledge Creation Process, Production Process and Changes in the Value of Teak Furniture

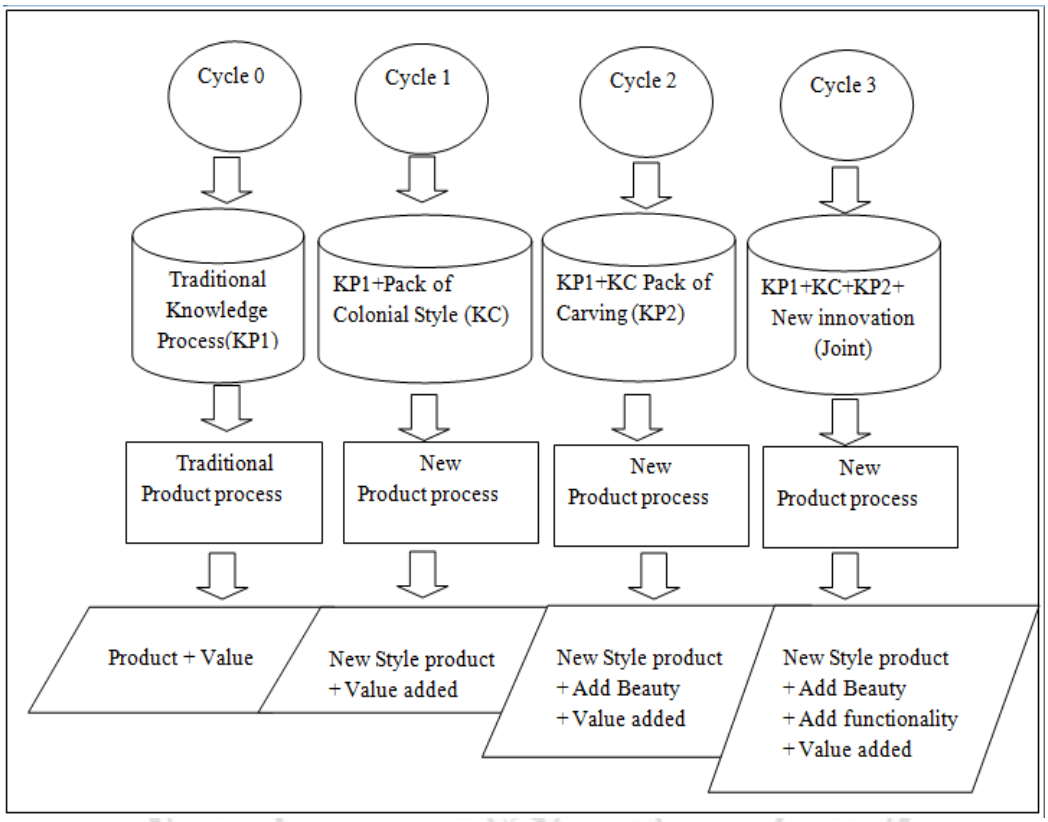

Figure 4.6 Diagram shown Relationship of Knowledge Creation Process, Production Process and Changes in the Value of Teak Furniture

Figure 4.6 shown the relationship between the knowledge creation process, the production process and the changes in the value of the teak furniture product. After each cycle of knowledge creation, changes in the knowledge pack could be measured by considering the inference and domain concepts contained in the knowledge pack. As mentioned earlier, the production process was modified accordingly in the internalization, and could be compared after each cycle. The method to evaluate the value of the teak furniture product was explained in the following subsections.

4.2.2.2 Value added analysis by the comparison between furniture and house sale prices

Value added analysis of furniture was conducted based on the understanding of the ratio of house sale prices and furniture value. This research collected secondary data from commercial housing companies, which were classified according to functional space, house value based on functional space, furniture value,

and types of furniture. Secondary data was obtained from (i) commercial housing companies and (ii) furniture manufacturing companies

4.2.2.3 Value added analysis by style and carving

This value analysis was based on the perspective of walk in customer, who made decisions whether or not they would spend more for better appearances of products. This was used to verify the relationship between price and appearance. The data was collected from 50 samples of furniture purchasers.

4.2.2.4 Value added analysis by product sourcing by purchasers

To analyzed the relationship between house value, furniture value, and types of furniture based on the secondary data. Value added analysis was verified by primary data. Interviews were conducted with the responsible people in the furniture sourcing to be used in the commercial houses. The samples were managers of commercial housing projects and company executives where they were responsible for making decisions in terms of cost and budget of each project. The samples chosen were 50 in total. Comparison of furniture preferences and house value Inexpensive houses usually selected the inexpensive furniture. Expensive houses normally avoided selling cheap furniture. On the contrary, they usually selected the expensive furniture.

4.2.2.5 Time production comparison between before and after knowledge sharing

This value added analysis was conducted with 2 groups of knowledge workers to find out the results from using new knowledge obtained through SECI measured from time production.

4.2.3 Results of Proposed Knowledge Management Model

Once the knowledge models of colonial style, wood crafting technique, Teak furniture manufacturing technique, had been constructed explicitly and systematically, the knowledge management theory, especially SECI model, was applied for the development of new knowledge for value added in Thai Teak furniture industry. The selected groups of knowledge workers are the experts in wood crafting and the experts in Teak furniture manufacturing. The results of the SECI are given as follows:

4.2.3.1 The first cycle of knowledge creation

(1) Socialization (S) was applied by creating a bulletin board system for the collect of knowledge the experts of Knowledge workers from the Teak chair manufacturing. Meetings are held once a month for the period of 6 months.

Figure 4.7 Illustration of Manufacturing Knowledge meeting and interview

From Figure 4.7, the manufacturing knowledge meeting and interview for self knowledge exchange and working corporation using the IPO template. Environment was an air conditioned room with recording equipment. Presenting and representing the manufacturing process. This interview had scoping meeting agenda for the interview.

(2) Externalization (E) was the process of collecting all relevant documents and of creating storing system of studies related to Teak chair manufacturing. Data base, in which experts are allowed to add or edit the information, was also created. Analysis and knowledge model development of Teak Manufacturing.

In this subsection, the knowledge model of Teak manufacturing technique was presented. The knowledge engineering methodology, especially the Input/Process/Output framework, was utilized to capture, analyze, and synthesize the experiences from the experts in Teak furniture manufacturing. The interviews were conducted by following the agenda and hidden agenda of the scoping, knowledge capture, case study, and validation meetings explained. Note here that, 2 human experts with experiences more than 20 years in manufacturing are selected. These selected human experts are key managers in 2 different manufacturing factories who understand and design all the manufacturing processes within their own factories. The knowledge transcript of the Teak manufacturing technique could be summarized as follows:

Table 4.1 The knowledge transcript of the Teak manufacturing technique

Inference Input	**Inference Process**	**Inference Output**
• II1 What are the strategies to manufacture Teak chairs for utilization? - Complete the works in a short time - Parts are manufactured in a high quantity. - Focus on the use of machinery	• IP1 Are there any manuals / standards for Teak chair manufacturing for utilization? - Designs or patterns sent from the designers	• IO1 Are there any reports of Teak chair manufacturing for utilization? - Yes, the report of analysis was seen from the carved products.
• II2 What are the difficulties in producing Teak chairs for utilization? - Machines are expensive. - Lack of beauty - The design was not unique or outstanding. - Lack of artistic identity	• IP2What are the solutions to the difficulties in Teak chair manufacturing for utilization? - Focus more on the aesthetic elements - Emphasize the artistic patterns or designs	• IO2 Solutions of problems of Teak chair manufacturing for utilization are considered acceptable. - If carvers cannot follow the pattern of the specimens, the imagination could be used to fix the problem.

Table 4.1 The knowledge transcript of the Teak manufacturing technique (Continues)

Inference Input	Inference Process	Inference Output
• II3 What are good qualities of personnel? - Knowledgeable and fluent in each step of the production	• IP3 How to effectively develop Teak chair manufacturing for utilization? - Focus more on the aesthetic elements - Focus on functionality/utilization - Easy to repair	• IO3 How to measure good Teak chair manufacturing for utilization? - Beauty - Creativity - Sales
• II4 What was the budget for Teak chair manufacturing for utilization? - Over a million Baht	• IP4 How to find funding / spend money for Teak chair manufacturing for utilization? - Different sources of funding	• IO4 Are there any reports on money spent on Teak chair manufacturing for utilization? -Revenue-Expense document
• II5 What are the tools required for Teak chair manufacturing for utilization? - Lathe - Cutter - Drilling	• IP5 How to use tools to manufacture Teak chairs for utilization? - Tools must be used correctly with the types of tasks required.	• IO5: Are there any reports on the use of tools for Teak chair manufacturing for utilization? - Tools Manual.

Table 4.1 The knowledge transcript of the Teak manufacturing technique (Continues)

Inference Input	Inference Process	Inference Output
• II6 What are the planning / instructions for Teak chair manufacturing for utilization? - Design - Implement BOM parts required for the assembling and raw materials to be used - Cut pieces by the patterns of BOM - Lathe wooden parts - Drill - Assemble - Decorate - Packing	• IP6 How to manage the planning / instructions for Teak chair manufacturing for utilization? - Expertise in design	• IO6: How to conduct reports on the planning or instructions for Teak chair manufacturing for utilization? - Prepare reports on the manufacturing in each step.
• II7 What are the precautions / limitations in Teak chair manufacturing for utilization? - Each cutting process should produce a high volume of wood required. - The leftover wood should be minimal. - Focus more on aesthetic elements	• IP7What are the solutions to problems of Teak chair manufacturing for utilization? - Carving techniques should be used to enhance the aesthetic elements. - Manufacture chairs as art objects used in everyday life	• IO7: Innovation - Knowledge management for Teak chair manufacturers

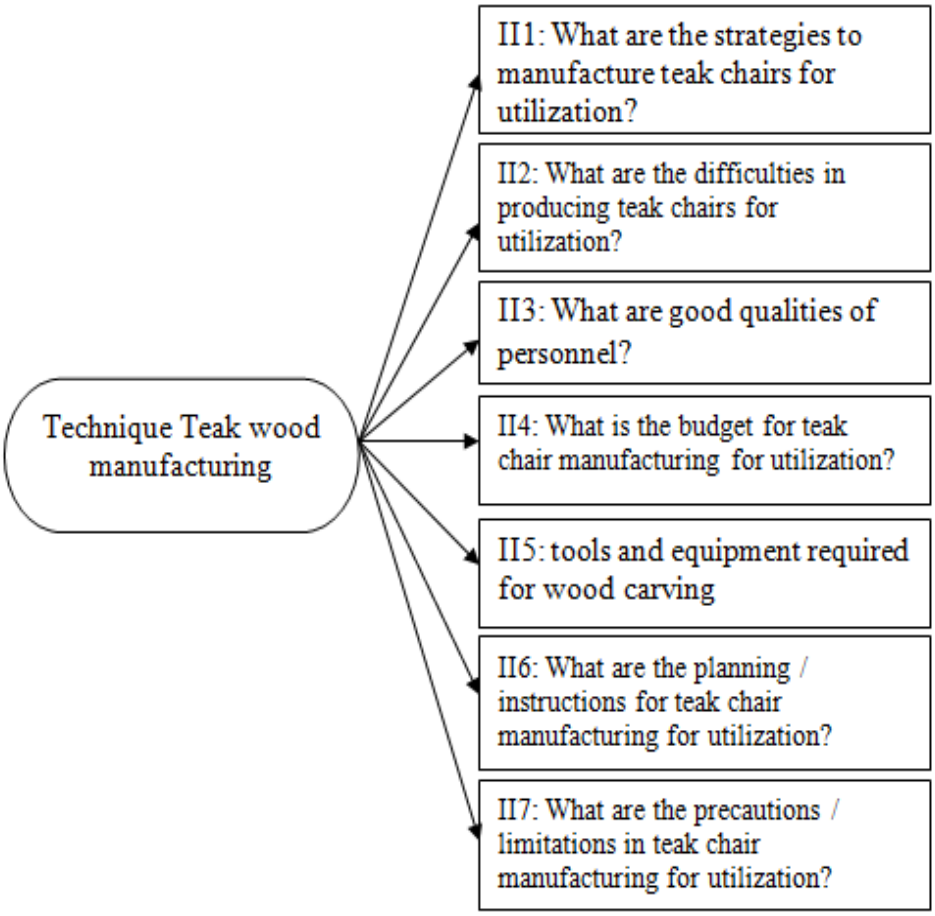

Figure 4.8 Task and Inference of input technique wood manufacturing.

Figure 4.8 illustrates the Task and Inference related to technique Teak wood manufacturing shown that requirement, complications, manpower, budget, tools, plan and precautions.

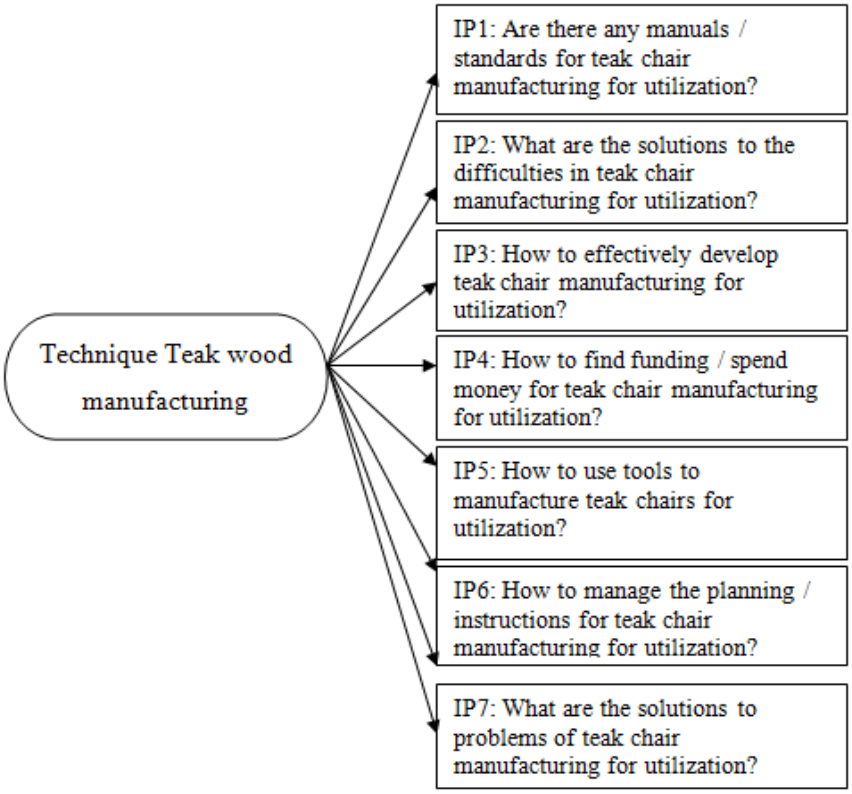

Figure 4.9 Task and Inference of process technique wood manufacturing

Figure 4.9 illustrates Task and Inference related to technique Teak wood technique wood manufacturing shown that technique, problem solution, learning, budgeting, tools, scheduling and prevent.

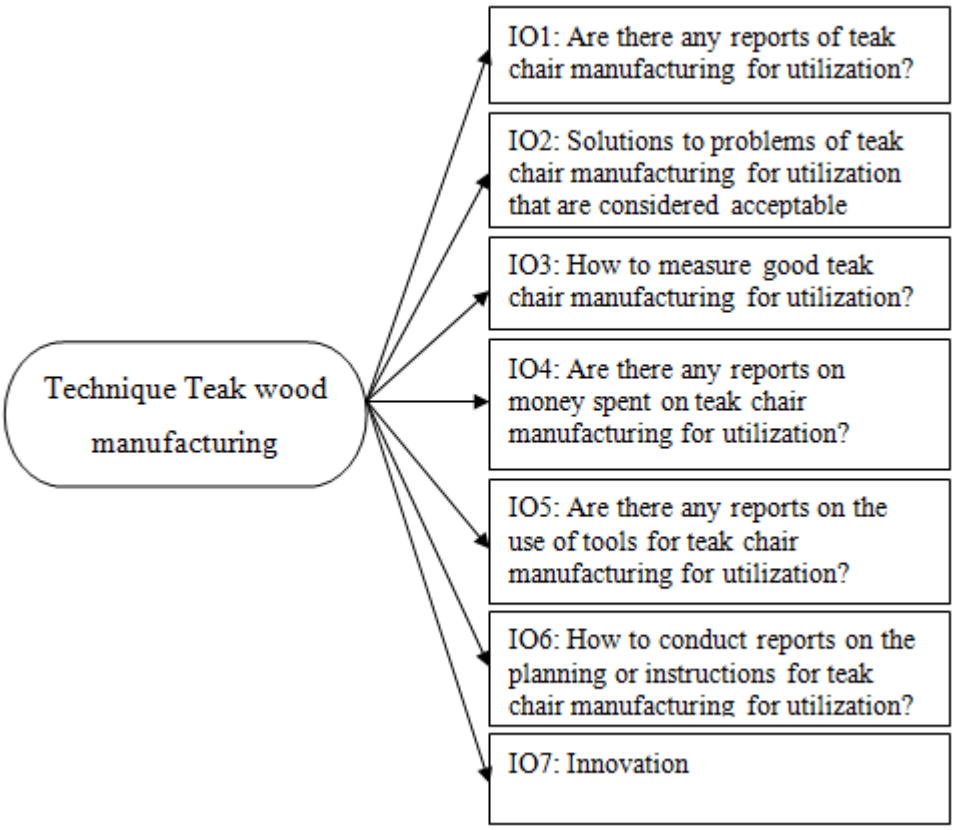

Figure 4.10 Task and Inference of output technique Teak wood manufacturing

Figure 4.10 illustrates Task and Inference related to technique Teak wood manufacturing shown that report, solution, working performance, financial report, KPI, project management report and innovation.

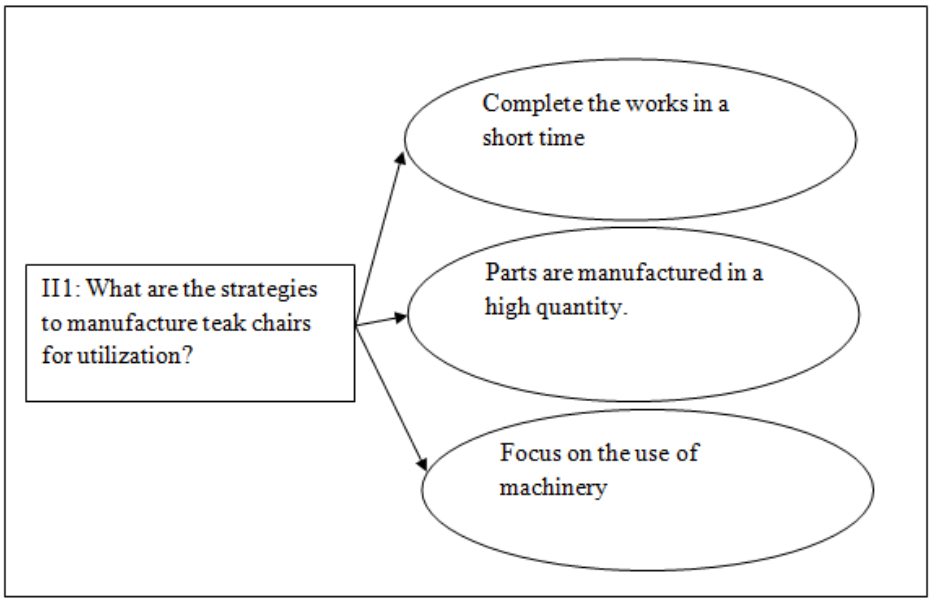

Figure 4.11 Inference and Domain concept of the requirement to manufacture Teak chairs for utilization

Figure 4.11 illustrates the inference and domain concept related to be the requirement to manufacture Teak chairs for utilization shown that complete the works in a short time. Parts are manufactured in a high quantity. Focus on the use of machinery.

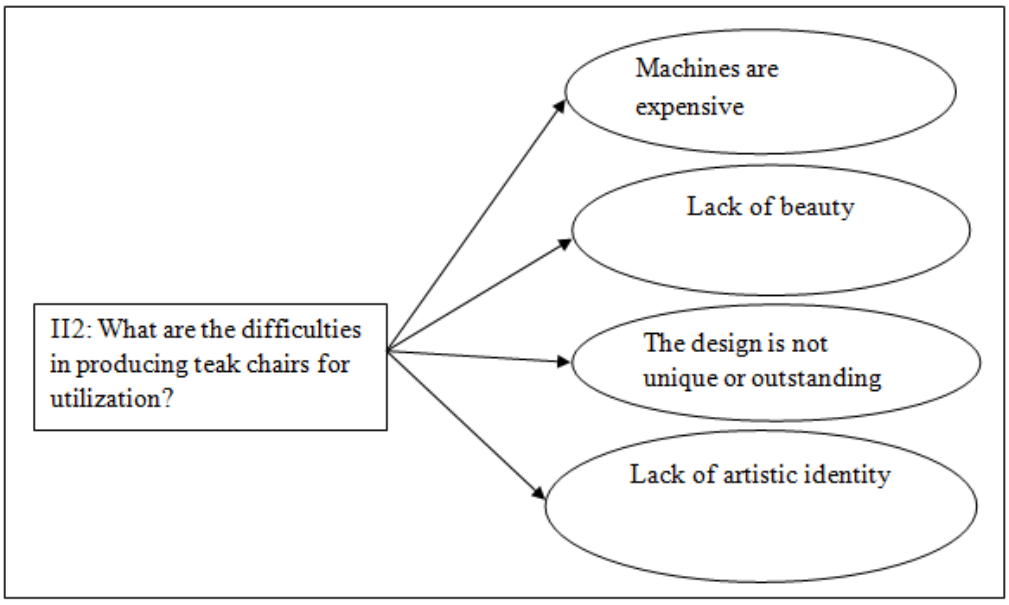

Figure 4.12 Inference and Domain concept of the difficulties in producing Teak chairs for utilization

Figure 4.12 illustrates the inference and domain concept related to be the difficulties in producing Teak chairs for utilization shown that Machines are expensive. The products are lack of beauty. The design was not unique or outstanding. The products are lack of artistic identity.

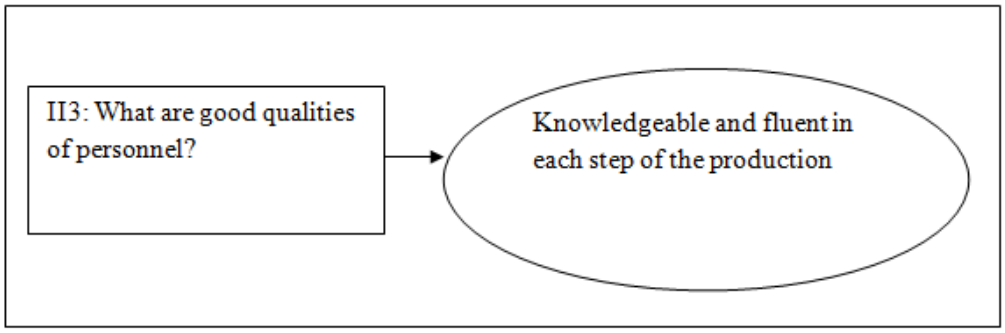

Figure 4.13 Inference and Domain concept of good qualities of personnel

Figure 4.13 illustrates the inference and domain concept related to be good qualities of personnel shown that Knowledgeable and fluent in each step of the production.

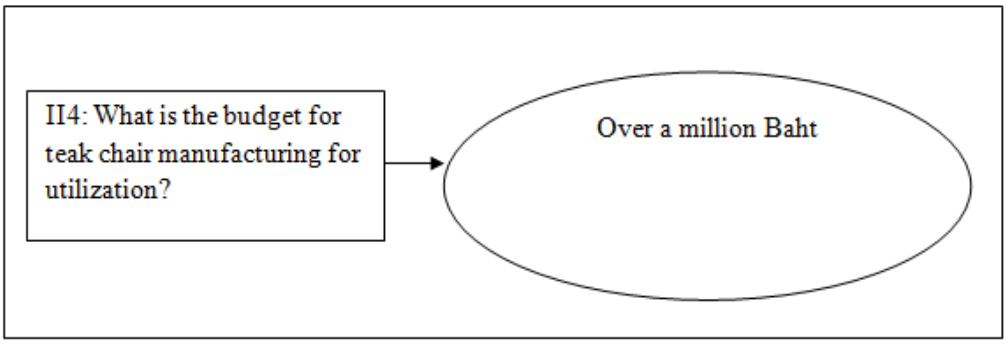

Figure 4.14 Inference and Domain concept of the budget for Teak chair manufacturing for utilization

Figure 4.14 illustrates the inference and domain concept related to be the budget for Teak chair manufacturing for utilization shown that over a million Baht.

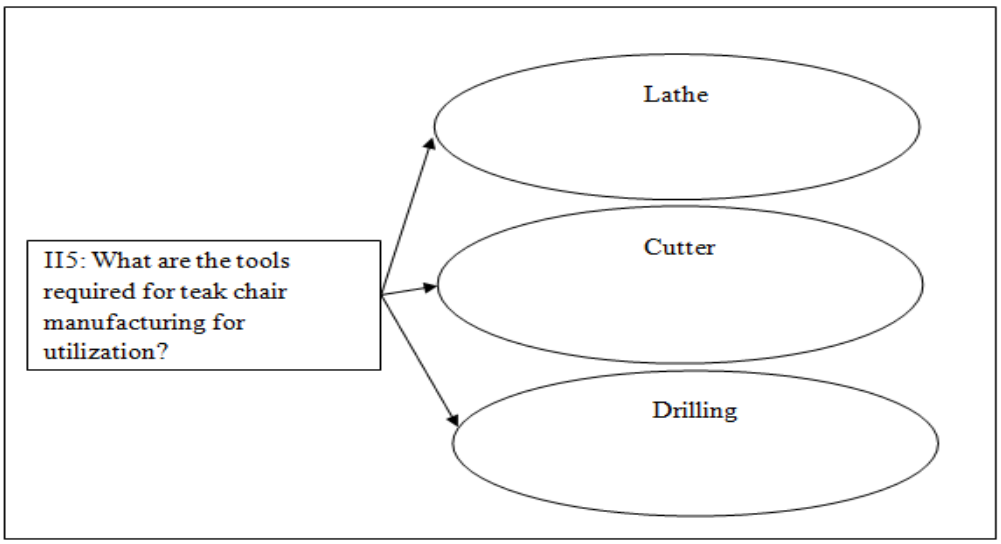

Figure 4.15 Inference and Domain concept of the tools required for Teak chair manufacturing for utilization

Figure 4.15 illustrates the inference and domain concept related to be the tools required for Teak chair manufacturing for utilization shown that Lathe, Cutter And Drilling.

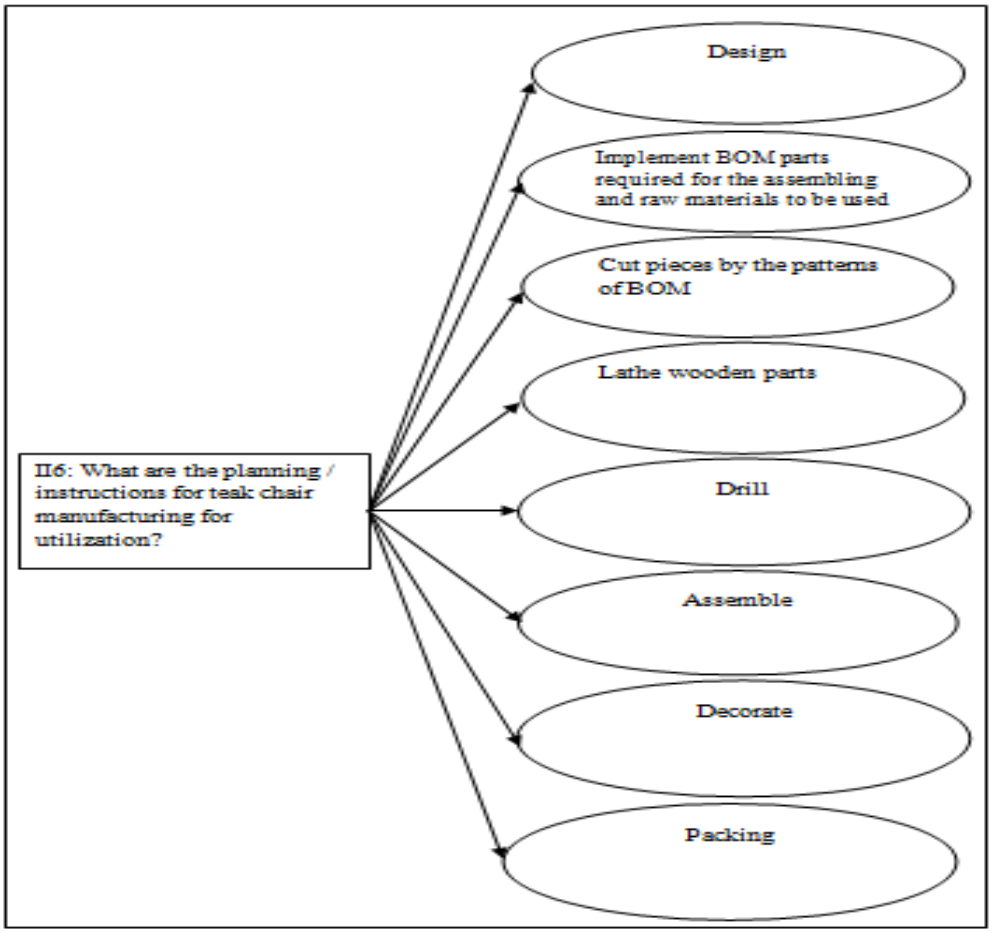

Figure 4.16 Inference and Domain concept of the tools required for Teak chair manufacturing for utilization

Figure 4.16 illustrates the inference and domain concept related to be the planning and instructions for Teak chair manufacturing for utilization shown that Design, Implement BOM parts required for the assembling and raw materials to be used. Cut pieces by the patterns of BOM, Lathe wooden parts, Drill, Assemble, Decorate and Packing.

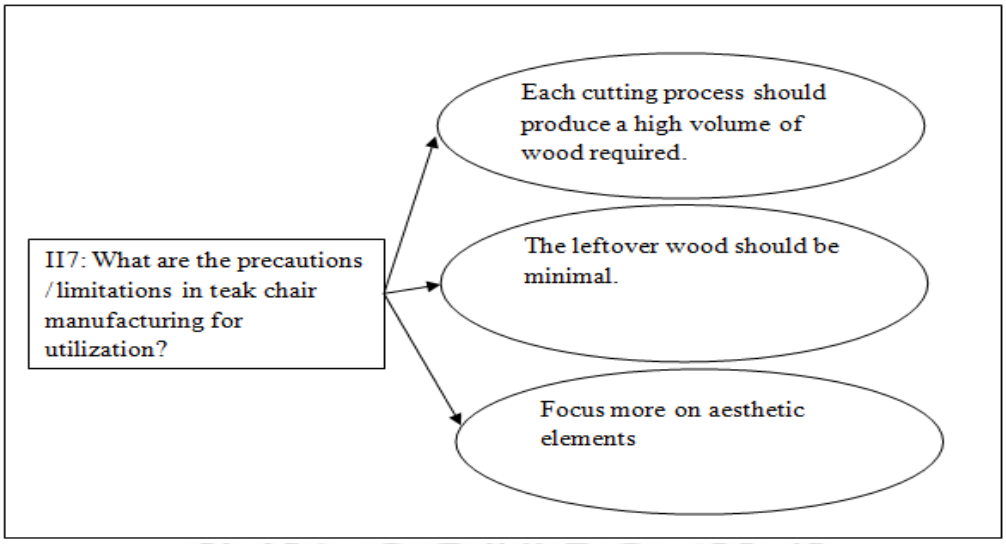

Figure 4.17 Inference and Domain concept of the precautions and limitations in Teak chair manufacturing for utilization

Figure 4.17 Illustrates the inference and domain concept related to be the precautions and limitations in Teak chair manufacturing for utilization shown that each cutting process should produce a high volume of wood required. The leftover wood should be minimal. Focus more on aesthetic elements.

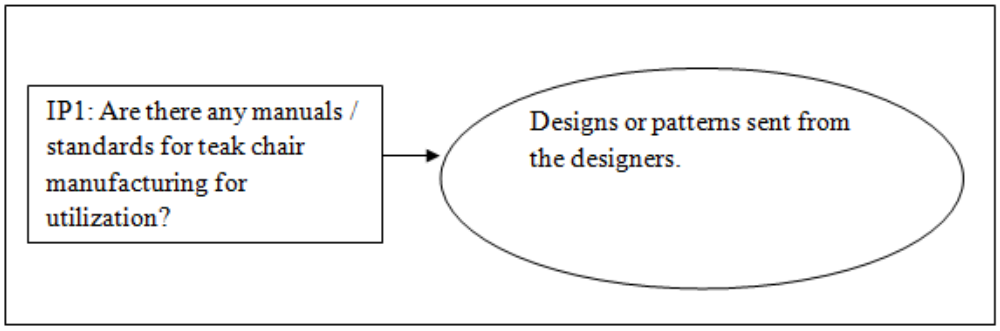

Figure 4.18 Inference and Domain concept of any manuals and standards for Teak chair manufacturing for utilization

Figure 4.18 illustrates the inference and domain concept related to be any manuals and standards for Teak chair manufacturing for utilization shown that designs or patterns sent from the designers.

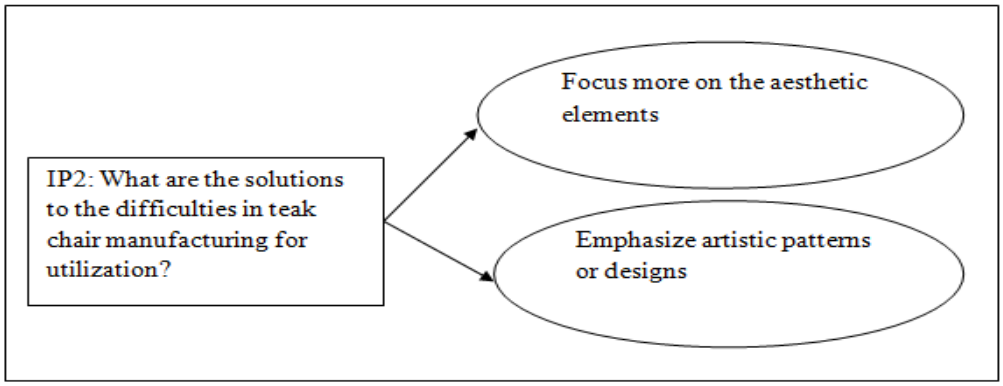

Figure 4.19 Inference and Domain concept of the solutions to the difficulties in Teak chair manufacturing for utilization

Figure 4.19 illustrates the inference and domain concept related to be the solutions to the difficulties in Teak chair manufacturing for utilization shown that focus more on the aesthetic elements, emphasize artistic patterns or designs.

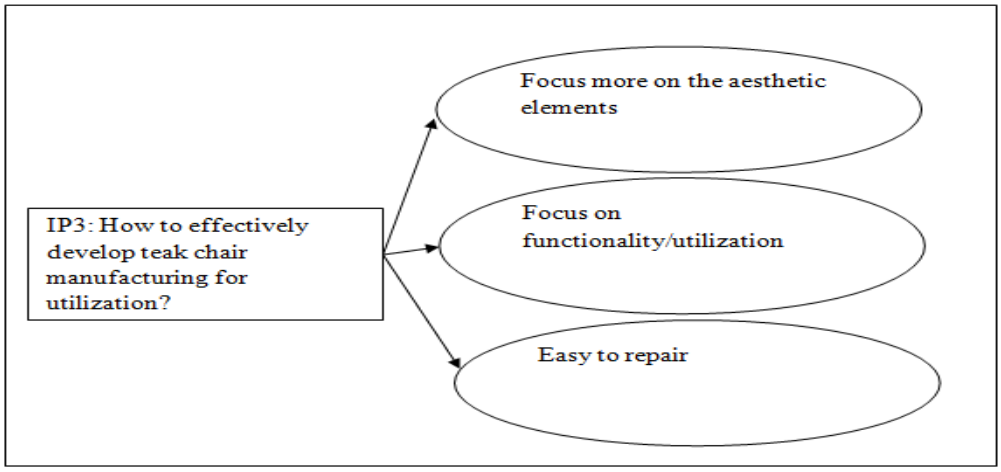

Figure 4.20 Inference and Domain concept of effectively develop Teak chair manufacturing for utilization

Figure 4.20 illustrates the inference and domain concept related to effectively develop Teak chair manufacturing for utilization shown that knowledge Focus more on the aesthetic elements, Focus on functionality or utilization, Easy to repair.

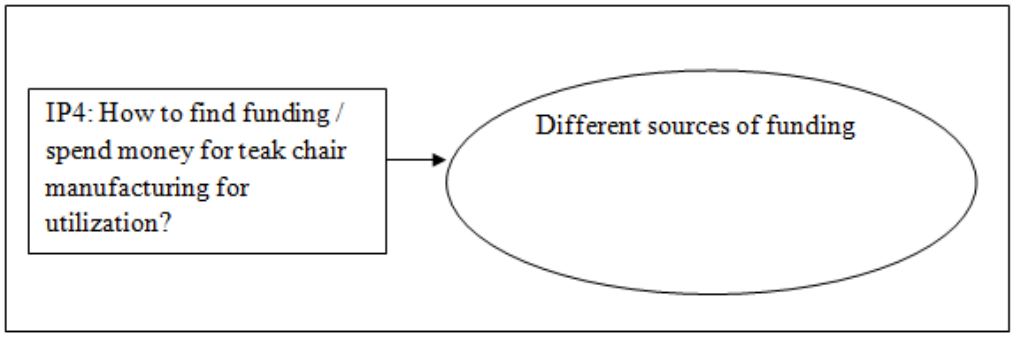

Figure 4.21 Inference and Domain concept of find funding and spend money for Teak chair manufacturing for utilization

Figure 4.21 illustrates the inference and domain concept related to find funding and spend money for Teak chair manufacturing for utilization shown the different sources of funding.

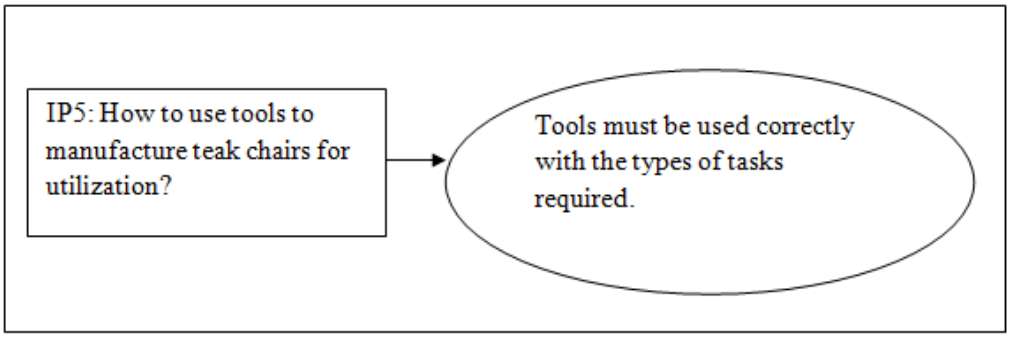

Figure 4.22 Inference and Domain concept of use tools to manufacture Teak chairs for utilization

Figure 4.22 illustrates the inference and domain concept related to use tools to manufacture Teak chairs for utilization shown that Tools must be used correctly with the types of tasks required.

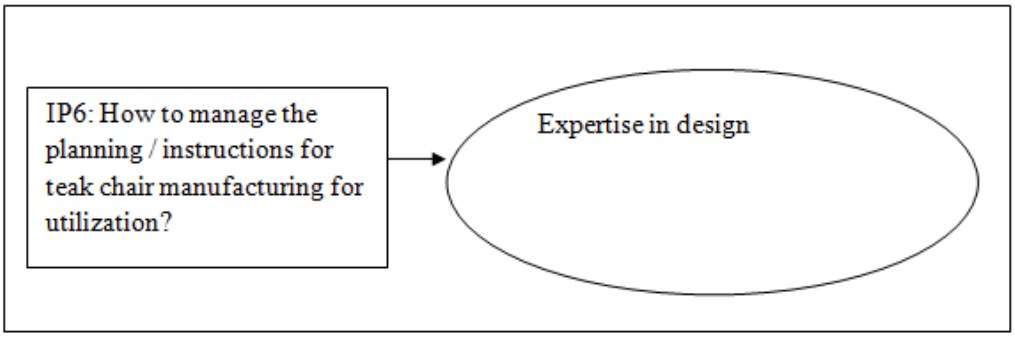

Figure 4.23 Inference and Domain concept of use tools to manufacture Teak chairs for utilization

Figure 4.23 illustrates the inference and domain concept related to manage the planning and instructions for Teak chair manufacturing for utilization shown that Expertise in design.

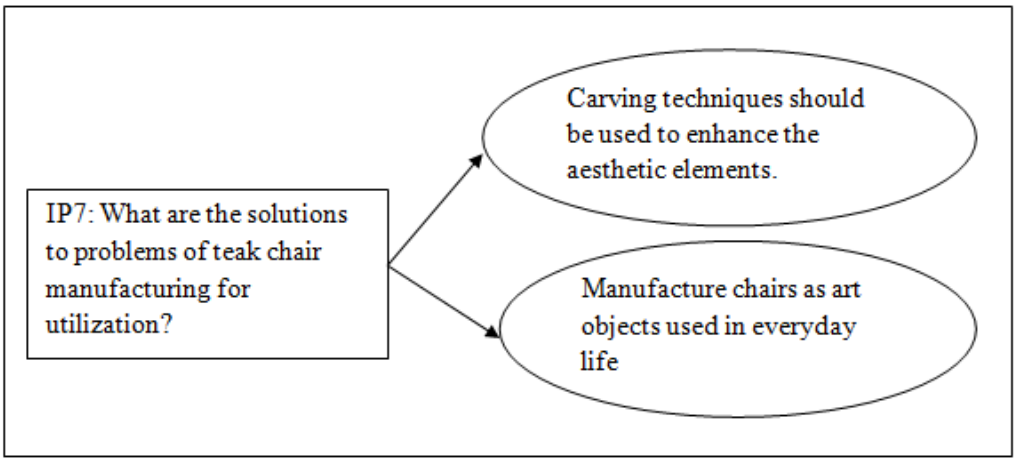

Figure 4.24 Inference and Domain concept of the solutions to problems of Teak chair manufacturing for utilization

Figure 4.24 illustrates the inference and domain concept related to be the solutions to problems of Teak chair manufacturing for utilization shown that the Carving techniques should be used to enhance the aesthetic elements. Manufacture chairs as art objects used in everyday life.

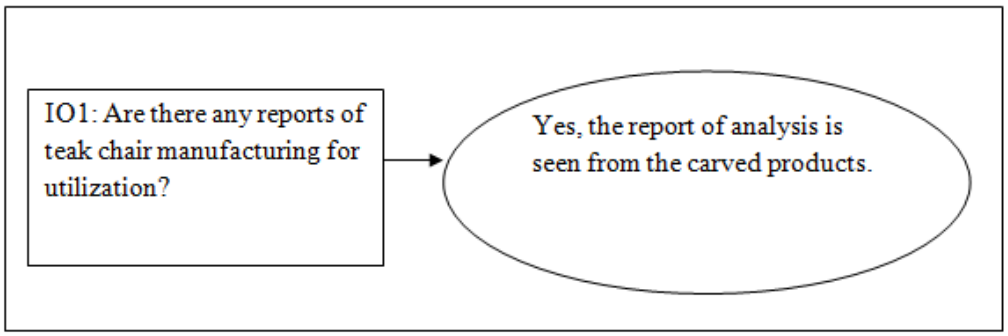

Figure 4.25 Inference and Domain concept of any reports of Teak chair manufacturing for utilization

Figure 4.25 illustrates the inference and domain concept related to any reports of Teak chair manufacturing for utilization shown that the report of analysis was seen from the carved products.

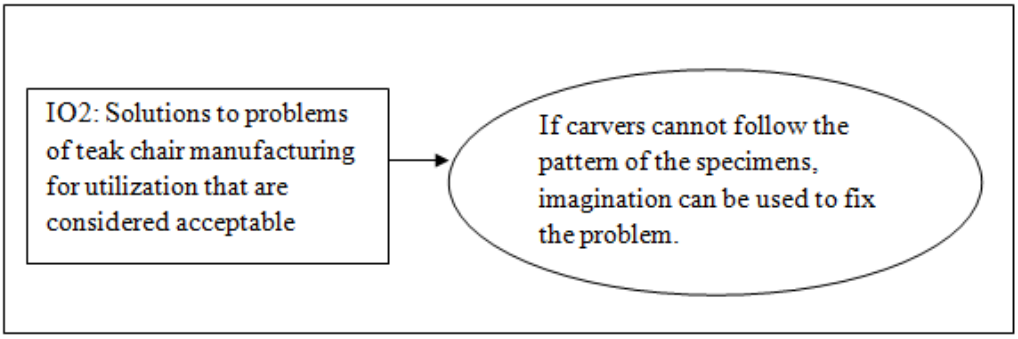

Figure 4.26 Inference and Domain concept of Solutions to problems of Teak chair manufacturing for utilization

Figure 4.26 illustrates the inference and domain concept related to Solutions to problems of Teak chair manufacturing for utilization that are considered acceptable shown that If carvers cannot follow the pattern of the specimens, imagination could be used to fix the problem.

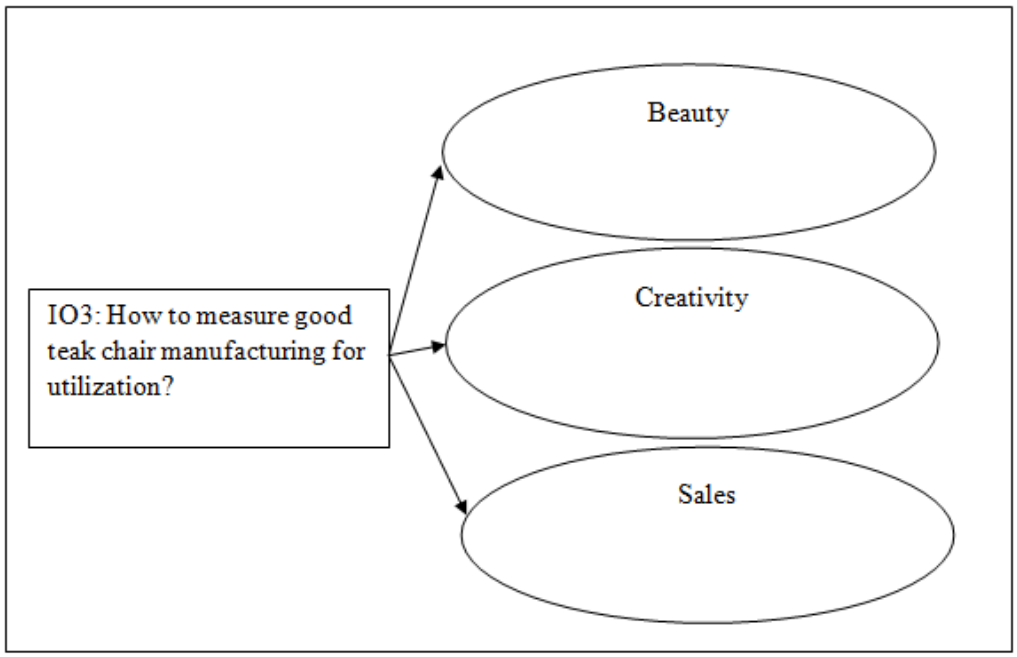

Figure 4.27 Inference and Domain concept of measure good Teak chair manufacturing for utilization

Figure 4.27 illustrates the inference and domain concept related to measure good Teak chair manufacturing for utilization shown that Beauty, Creativity, Sales.

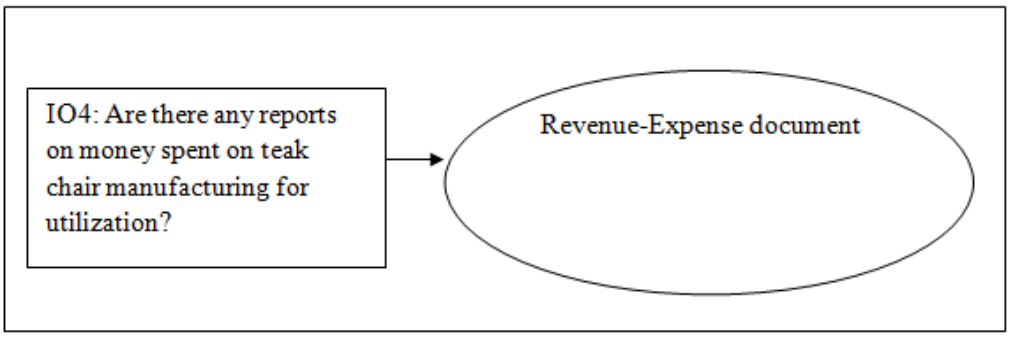

Figure 4.28 Inference and Domain concept of any reports on money spent on Teak chair manufacturing for utilization

Figure 4.28 Illustrates the inference and domain concept related to any reports on money spent on Teak chair manufacturing for utilization shown that Revenue-Expense document.

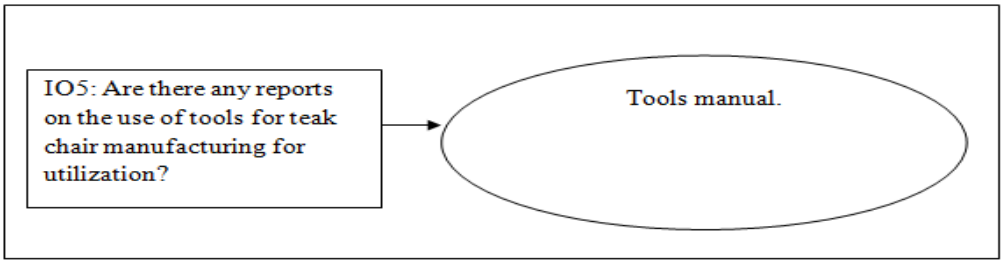

Figure 4.29 Inference and Domain concept of any reports on the use of tools for Teak chair manufacturing for utilization

Figure 4.29 illustrates the inference and domain concept related to any reports on the use of tools for Teak chair manufacturing for utilization shown that Tools Manual

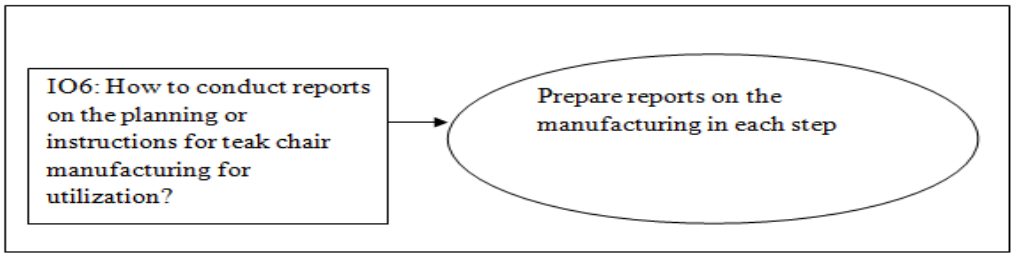

Figure 4.30 Inference and Domain concept of conduct reports on the planning or instructions for Teak chair manufacturing

Figure 4.30 illustrates the inference and domain concept related to the conduct reports on the planning or instructions for Teak chair manufacturing for utilization shown that Prepare reports on the manufacturing in each step.

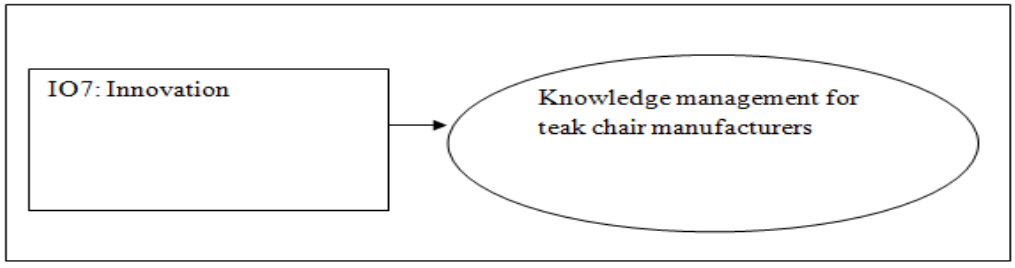

Figure 4.31 Inference and Domain concept of Innovation

Figure 4.31 illustrates the inference and domain concept related to Innovation shown that Knowledge management for Teak chair manufacturers

In this subsection, the results (knowledge transcript and knowledge map) of applying the knowledge engineering on Teak furniture manufacturing technique are presented. The results had shown that the knowledge engineering (IPO template) could be used to capture the experiences from the knowledge workers and then develop the knowledge model on Teak furniture manufacturing technique explicitly and systematically. This knowledge model, especially the inference (what to think) and domain concepts (how to think) will then be shared and combined in the SECI state to develop new knowledge for the value creation of the Teak furniture.

(3) Combination (C): The knowledge engineering methodology, especially the classification template, was utilized to capture, analyze, and synthesize the knowledge related to the colonial style and architecture, which was used to model the knowledge relevant to the colonial style and architecture more explicitly and systematically. This model contains the inference and domain concept of the colonial style and architecture, which could then be used in this thesis for the selected groups of knowledge workers when the designing and constructing the Teak furniture are required.

The knowledge model of the colonial style and architecture, which represents the result of the knowledge engineering (classification template) application, was given in Table 4.1. These results (or so called the knowledge pack on colonial style in this research) are obtained by applying the analytical tools developed and explained. In brief summary, the colonial style was created and evolved during 1700 to 1780. Furthermore, it combines the characteristics of William and Mary, Queen Anne, and Chippendale. Colonial furniture tended to be more conservative and less ornate than English and European furniture of the same style period.

Table 4.2 Characterization of Colonial style furniture

task-type	class	object	attribute	feature	
Furniture-style	Colonial	Chair - Colonial	Appearance	Graceful and Refined	-Elegant Appearance (Federal style shown)
			Chair Arms	Outward Flare	-Arms had slight upward curve
			Chair Back Material	Cane Upholstered Wood	-Woven rattan -Cushioned and fabric covered -Solid wood, horizontal slats, vertical slats, or vertical splats
			Chair Back Shape	Fiddle back Ladder back or Slat back Solid Spindle	-Fiddle-shaped central splat -Equally spaced horizontal flat slats, either straight or curved - One piece or solid panel chair back - Simple turned vertical slats

Table 4.2 Characterization of Colonial style furniture (Continued)

task-type	class	object	attribute	feature	
			Chair Leg	Cabriole	-Curved leg in the shape of an animal's leg The cabriole leg increased the stability of seating pieces and reduced the need for underbracing
				Decorated Cabriole	-Cabriole leg with decorative carving, usually on the knee
				Elaborate Turning	-Turned leg with multiple types of turnings
				Round	-Round, usually shaped or turned leg
				Simple Turning	-Turned leg with a few types of turnings
				Straight	-Straight leg, vertical to chair seat

Table 4.2 Characterization of Colonial style furniture (Continued)

task-type	class	object	attribute	feature	
			Chair Seat Material	Cane	-Woven rattan.
				Rush	-Woven rush
				Upholstered	-Cushioned and covered with fabric
				Wood	-Various types of wood
			Chair Seat Shape	Horseshoe	-Horseshoe shaped seat with a rounded front.
				Square	-Square shaped seat
			Drawer Pull	Bat Wing Plate with Bail	-Bat shaped solid or pierced cast brass back plate with a bail handle The size of the back plate varies from 2.75 to 4.5 inches wide by 2 to 3.25 inches high
				Carved Wood (Simple)	-Simple carved handle made of wood
				Turned Wooden Knob	-Elongated, turned wooden knob, often 3 inches long and 1.25 inches in diameter

Table 4.2 Characterization of Colonial style furniture (Continued)

task-type	class	object	attribute	feature	
			Fabric	Chintz	-Plain woven sometimes glazed cloth imprinted with patterns or designs, often floral with five bright colors.
				Crewel	-Embroidery using wool on closely woven cotton, linen, or wool, often of floral motifs and vines
				Damask	-Medium weight, glossy fabric with a reversible pattern and a figured intricate weave, often of linen, cotton, silk, or wool
				Needlepoint	-A type of counted thread embroidery in which yarn was stitched through an open canvas weave
				Tapestry	-Heavy weight fabric with decorative designs

Table 4.2 Characterization of Colonial style furniture (Continued)

task-type	class	object	attribute	feature	
			Finish	Gilding	-Gold leaf
				Oil Varnish	-Clear finish that emphasized the grain of the wood
				Paint	-Opaque, pigmented finish that obscures the grain of the wood
				Wax	-Paste finish over a sealer, stain, or bare wood
			Foot	Block	-Flat-surfaced foot
				Bracket	- Angular curved foot, usually used with case furniture
				Bun	-Rounded foot, flatter than a ball foot
				Continuation of leg	-Leg does not terminate into a foot
				Drake	-Simple carved animal paw
				Pad	-Simple, rounded carved foot

Table 4.2 Characterization of Colonial style furniture (Continued)

task-type	class	object	attribute	feature	
			Hardware Material	Brass	-Yellowish metal made from copper and zinc
				Iron	-Grayish-brown metal with a dull finish
				Leather	-Animal hide, used in strips as pulls
				Wood	-Various types of wood, carved or turned
			Joint	Dovetail	- An interlocking wood joint in which a series of wedge-shaped projections fits into a series of alternating grooves
				Mortise and ten on	- Wood joint in which a projecting ten on of one board was fitted into a mortise or hole of another board.
			Line	Cyma or S-Curve	- S-shaped curve, partly concave and partly convex
				Straight	- Straight lines

Table 4.2 Characterization of Colonial style furniture (Continued)

task-type	class	object	attribute	feature	
			Motif	Acanthus leaf	-Conventionalized leaf
				Floral	- Flowers, such as roses, sunflowers, and tulips
				Oriental Patterns	- Oriental figures, usually painted or lacquered
				Seaweed	- Very delicate marquetry representing a marine plant
				Shell	- Fan shaped shell
			Ornamentation	Carving	-Cutting or chipping the surface of wood to create a shape or design
				Finial	-Decorative turning affixed to the tops of case furniture, and chair and bed posts
				Inlay	-Contrasting material set into the surface of wood to create a shape or design

Table 4.2 Characterization of Colonial style furniture (Continued)

task-type	class	object	attribute	feature	
				Marquetry	-Combinations of veneer used to create pictures or patterns
				Stenciling	-Painting through a template to create a shape or design on the underlying wood surface
			Proportion	Medium	- Moderate dimensions (Queen Anne style shown)
			Underbraci-ng	Moderate	- Moderately proportioned stretchers (William and Mary style shown)
			Wood	Ash	- Whitish-gray American hardwood with similar graining to oak
				Black Walnut	- Dark brown American hardwood with a wide range of figures
				Elm	- Red-brown American hardwood

Table 4.2 demonstrated the Colonial knowledge which the applied Knowledge Engineering principle, especially Classification Template. The Colonial style was generally difficult to communicate among workers, especially designers. However, the results showed that the applied Knowledge Engineering in this thesis was capable of analyzing and synthesizing knowledge of Colonial Style in a simpler and systematic way. The knowledge obtained was thus easy to communicate and put into practice.

(4) Internalization (I)

(4.1) Knowledge Management process

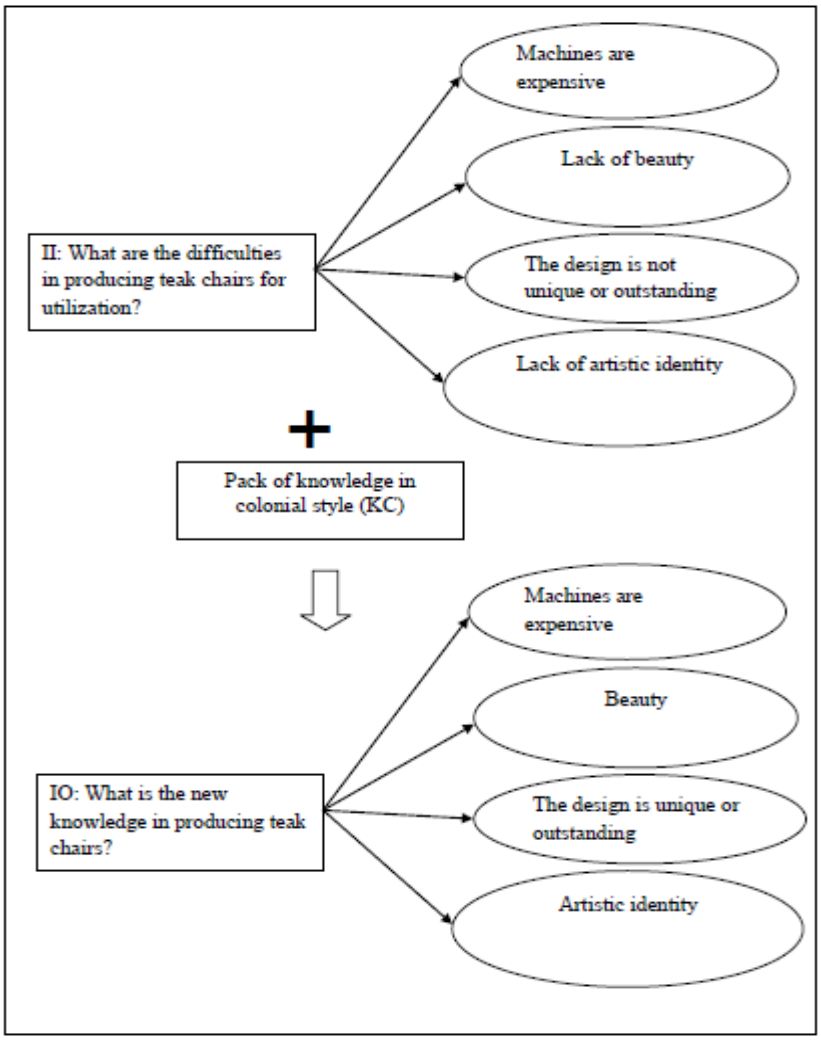

Figure 4.32 Inference and Domain concept when combine KP1 and KC

Figure 4.32 illustrates the inference and domain concept related to combine KP1 and KC shown that Machines are expensive, Beauty, The design was unique of outstanding, Artistic identity.

(4.2) Product Process

Table 4.3 Shown Product process and Knowledge Management process after combine KP1 and KC

Process	**Traditional Product Process Cycle 0**	**Cycle 1**
Feature	No Style	With Colonial
Beauty	Less	Unique
functional	Less	Less
Cutting	Machine	Machine
Build	Nail	Nail
Packing	Manufacture	Manufacture
Picture		

From table 4.3, it was found that the combination of KP1 and KC changes the inference and domain. This causes the transform of Knowledge Management process and effected to some next step of product process for example the style of work changing into colonial style which was not machine skill because it was needed the delicateness. This phase was also used nails. This was conflicted to the colonial style.

(4.3) Comparison Product Output

Figure 4.33 The traditional chair created from cycle0

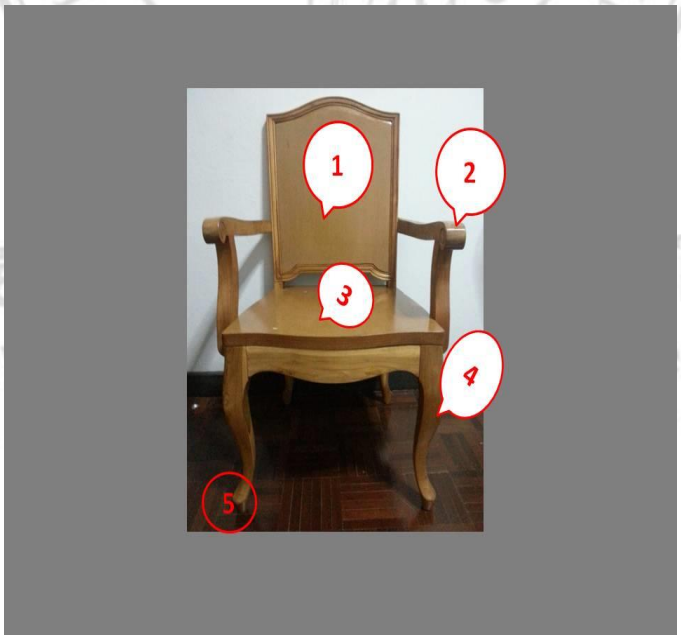

Figure 4.34 The Colonial-style chair in cycle 1 created from the proposed solution methodology

Figure 4.34 shown the Colonial- style: appearance, where it was Graceful and Refined, Elegant Appearance, where, No.1 Chair Back Shape: One piece or solid panel chair back, No.2 Chair Arms: Outward Flare - Arms had slight upward curve, No.3 Chair Seat Shape: Horseshoe shaped seat with a rounded front, No.4 Chair Leg: Curved leg in the shape of an animal's leg and No.5 Chair foot: Block-Flat-surfaced foot.

From Figure 4.34 chair from cycle 1 had more unique, style than Figure 4.33 chair from cycle 0. So figure 4.34 chair from cycle 1 should had value added too.

4.2.3.2 The second cycle of knowledge creation

(1) Socialization (S) was applied by creating a bulletin board system for the collect of knowledge the experts of Knowledge workers from the Carving. Meetings and interview are held once a month for the period of 6 months.

Figure 4.35 Illustration of Carving Knowledge meeting and interview

From Figure 4.35, the carving knowledge meeting and interview for self knowledge exchange and working corporation using the IPO template. Environment was an open space with recording equipment. Presenting and representing the carving process. Focus on for carving was sociability. This interview had scoping meeting agenda for the interview.

(2) Externalization (E)

Analysis and knowledge model development of Teak Aesthetic Carving

In this subsection, the knowledge model of Teak carving technique was presented. The knowledge engineering methodology, especially the Input/Process/Output framework, was utilized to capture, analyze, and synthesize the experiences from the experts in wood crafting. The interviews were conducted by the following the agenda and hidden agenda of the scoping, knowledge capture, case study, and validation meetings. Note here that, 5 human experts with experiences more than 10 years in carving are selected. Since this selection was based on the intelligent tutoring system architecture, these 5 human experts represent the national expert, the good teacher, and the good students. The knowledge transcript of wood carving technique could be summarized as followings.

Table 4.4 The knowledge transcript of wood carving technique

Inference Input	Inference Process	Inference Output
• II1 Requirement to excel wood carving - Strong interest - Students are required to study theory before actual implementation. - Passion - Gifted - Be responsible	• IP1 Are there any manuals / standards for wood carving? - No standards / depend on the determination of the students. - No manuals / manuals are the ideas and imagination. - Standards are the determination of the students. - No manual. Carvers follow the design of the specimens. - Carvers strictly follow the patterns of the orders, the samples shown in the shops. - The standards are the customer satisfactions.	• IO1 Are there any reports of wood carving? - Yes, the report of analysis was seen from the carved products.

Table 4.4 The knowledge transcript of wood carving technique (Continued)

Inference Input	Inference Process	Inference Output
• II2 Complications in wood carving - Students are not interested in carving. - Procurement of raw materials such as Teak - Pattern design - Tools and equipment must be prepared before using.	• IP2 Solutions to the complications of wood carving - If get stuck, carvers had to take a break until they could resume the works. - Students must be able to find the answers in the works. - If get stuck, carvers should not push themselves to continue the work.	• IO2 Carving solutions are acceptable consideration. - If carvers cannot follow the pattern of the specimens, imagination could be used to fix the problem.
• II3 What are the qualities of a good teacher? - Patience - Encourage students to be passionate in works and arts. -Students should focus on the carving assignments, not the monetary rewards.	• IP3 What could be the methods of carving development? - Support the students to work better than their teachers. - Encourage students to view the assignments as their priority, not the monetary rewards. - There was no need to imitate other people's works.	• IO3 How to measure good carving? - Beauty - Creativity

Table 4.4 The knowledge transcript of wood carving technique (Continued)

Inference Input	Inference Process	Inference Output
• II4 What was the budget required for excellent carving? - Teaching wood carving does not require a budget. - If the carvings are of good quality, they could be sold. - In good economy, more products could be sold. - Students had to buy hammers and chisels. The tuition fee was 6,000-7,000 THB for Thai people and 15,000 THB for foreigners. - Teaching students was similar to teaching people in the same family.	• IP4 What are the methods to find funding/how to spend money on wood carving? - Request for the budgets from the SAO - Request for wood from FIO	• IO4 Are there any reports on money spent on carving? - No

Table 4.4 The knowledge transcript of wood carving technique (Continued)

Inference Input	Inference Process	Inference Output
• II5 Tools and equipment required for wood carving. - The main tools are chisels and hammers.	• IP5 How to use the carving tools? - Tools must be used correctly with the types of assignments.	• IO5 Are there any reports on instruments used for carving? - Main equipment essential for carving was chisel and hammer. However, the most important tool was chisel. Chipped chisels cannot produce good works as some works could be very small and require delicacy.
• II6 How to plan / organize the process of wood carving? - No planning (local wisdom) - Practice well, students will be able to do it naturally. - Prior learning - Must be willing to learn	• IP6 How to manage plan / sequences of carving? - From easy to difficult steps.	• IO6 Are there any reports on plans or process of carving? - Study the designs - Draw the design on wood needed to be carved - Start carving using chisels and hammers - Finish the fine details - Paint or lacquer coating the works Note: most of the works display the natural quality of wood texture and therefore, the lacquer coating was not needed.

Table 4.4 The knowledge transcript of wood carving technique (Continued)

Inference Input	Inference Process	Inference Output
• II7 What are the precautions / limitations of wood carving? - Students need to be familiar with tools. - Tools must be used carefully. - Tools must be used properly with the types of tasks. Damages could be occurred if tools are used improperly. - Students should learn how to use the tools properly before working.	• IP7 Solutions of wood carving - Take a break if there was a problem. - Be patient.	• IO7 Innovation - Knowledge management for carvers

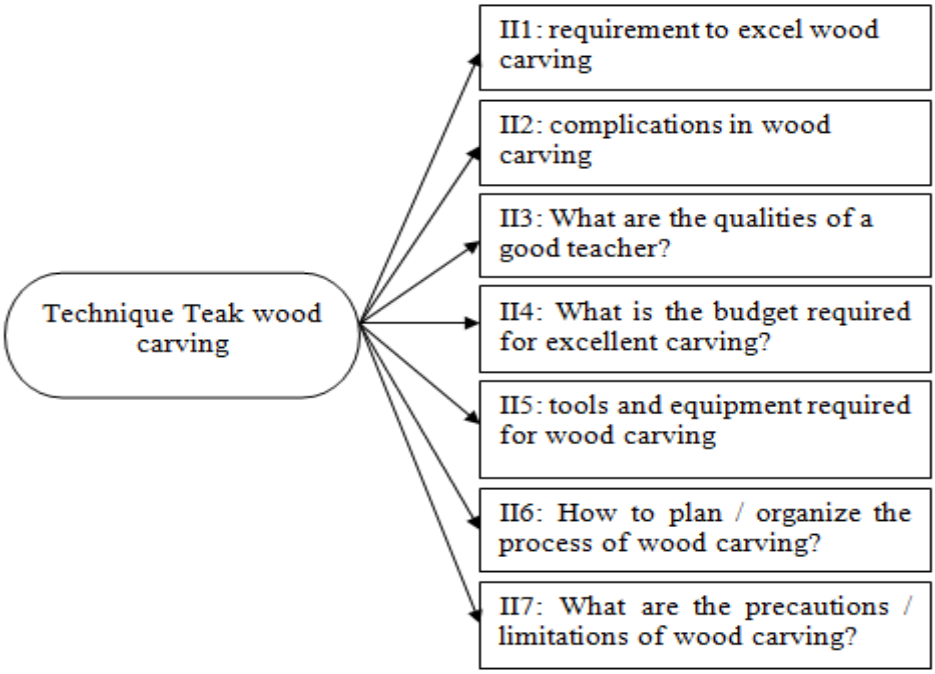

Figure 4.36 Task and Inference of input technique wood carving

Figure 4.36 illustrates Task and Inference related to the technique of Teak wood carving, where the requirement, complications, manpower, budget, tools, plan and precautions are desired.

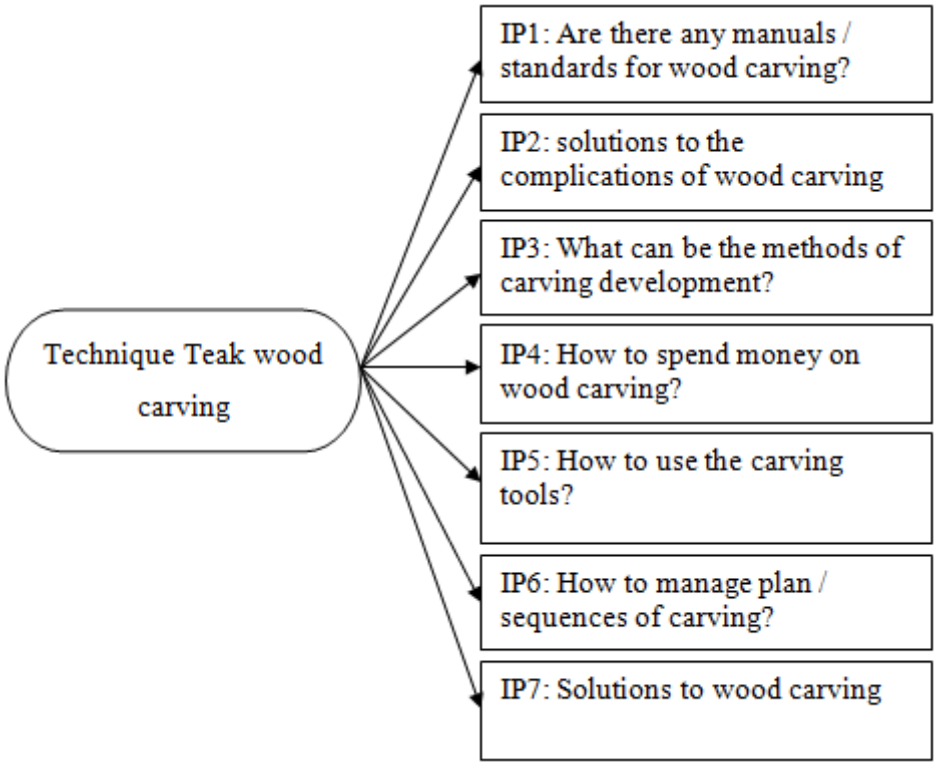

Figure 4.37 Task and Inference of process technique Teak wood carving

Figure 4.37 illustrates Task and Inference related to the technique of Teak wood carving, where the technique, problem solution, learning, budgeting, tools, scheduling and prevent are involved.

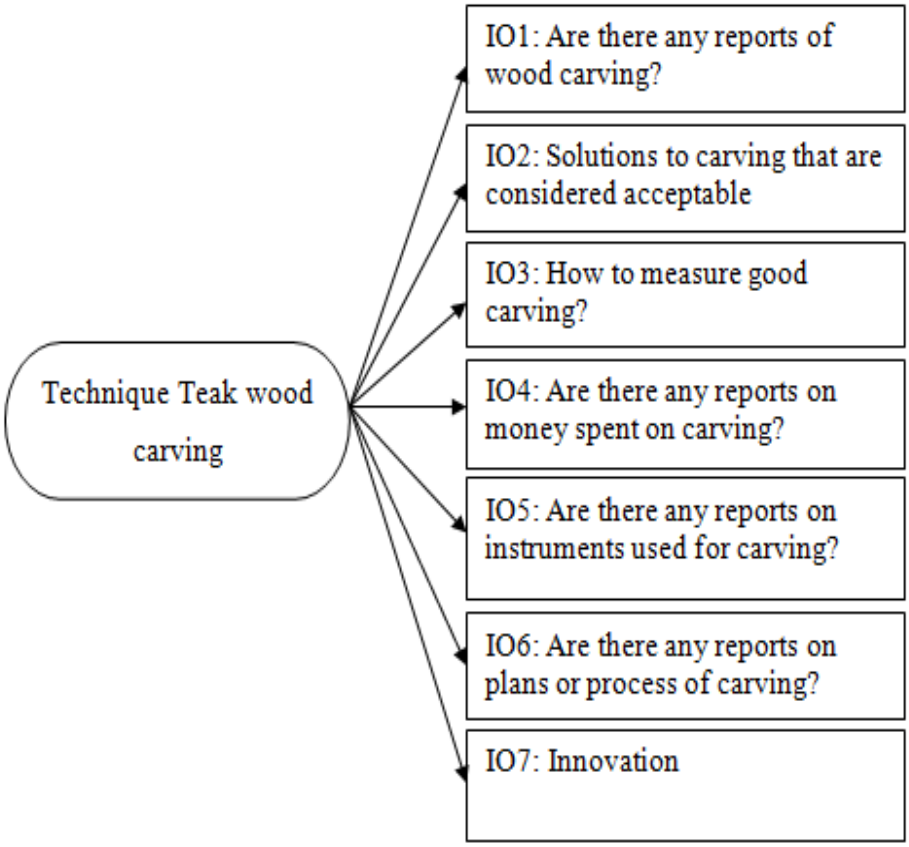

Figure 4.38 Task and Inference of output technique Teak wood carving

Figure 4.38 illustrates Task and Inference related to the technique of Teak wood carving, where the report, solution, working performance, financial report, KPI, project management report and innovation are involved.

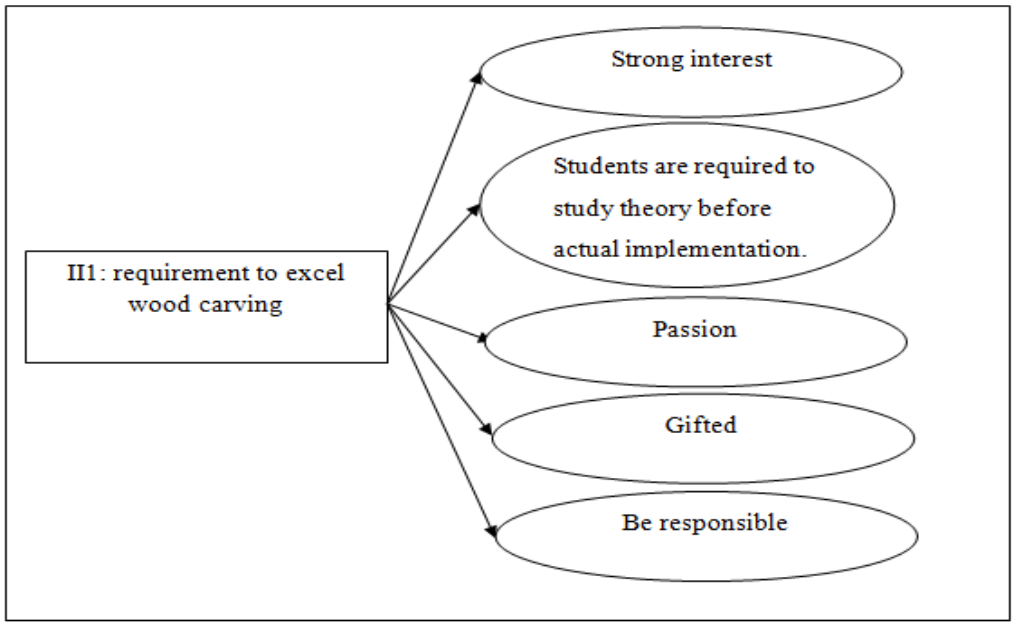

Figure 4.39 Inference and Domain concept of requirement to excel wood carving

Figure 4.39 illustrates the inference and domain concept that related to the requirement of the wood carving excel, where the strong interest, passion, gifted and be responsible. Students are required to study theory before actual implementation.

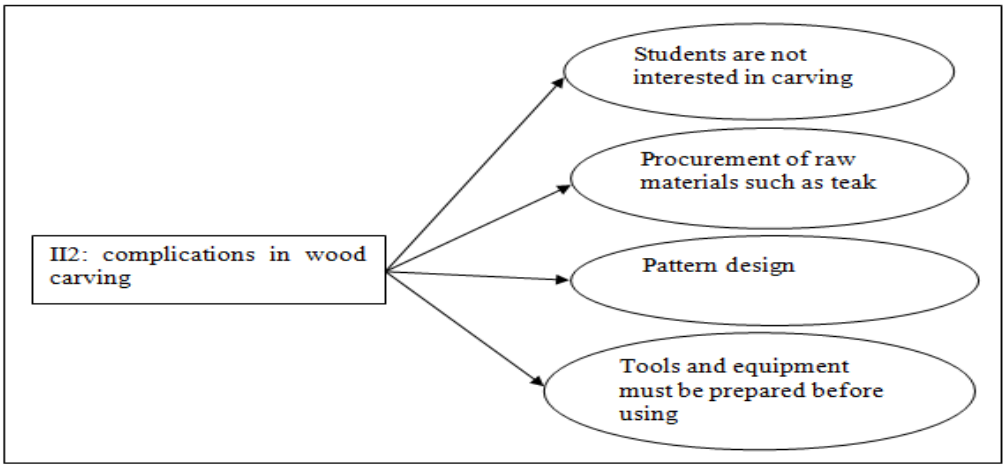

Figure 4.40 Inference and Domain concept of complications in wood carving

Figure 4.40 illustrates the inference and domain concept related to the complications in wood carving, where the students are not interested in carving.

Tools and equipment must be prepared before using. Procurement of raw materials such as Teak and Pattern design are difficult.

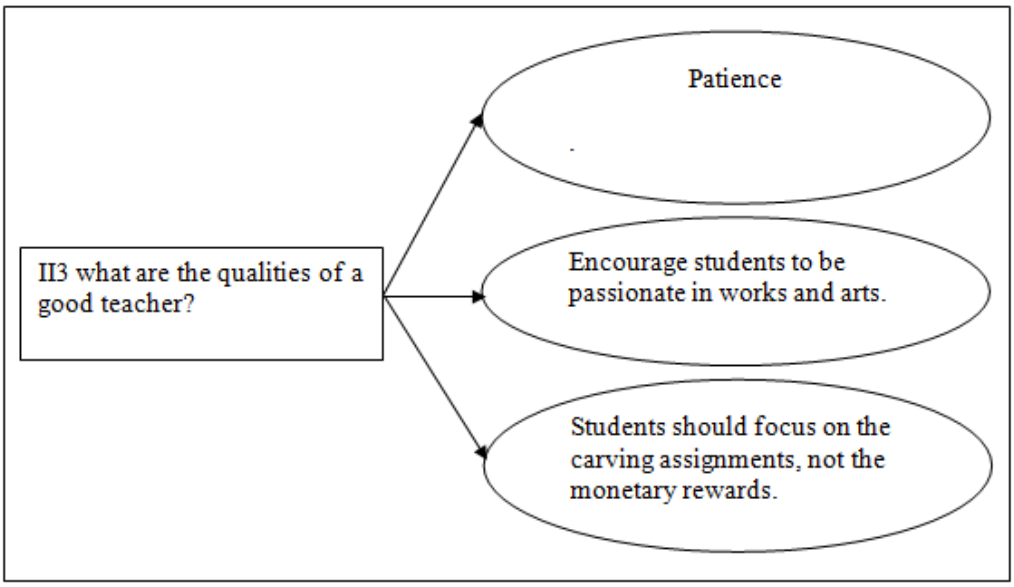

Figure 4.41 Inference and Domain concept of qualities of a good teacher

Figure 4.41 illustrates the inference and domain concept related to be the qualities of a good teacher, which was shown the teacher patience. Encourage students to be passionate in works and arts. Students should focus on the carving assignments rather than the monetary rewards.

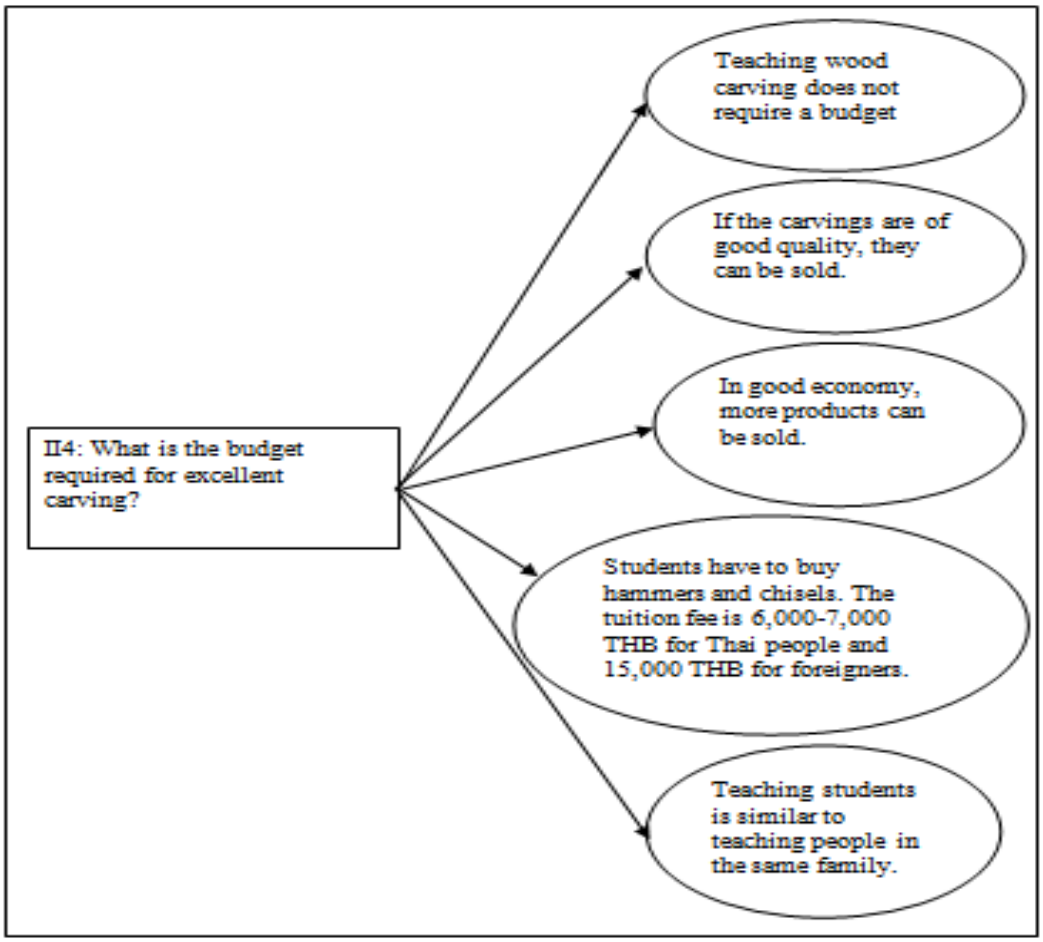

Figure 4.42 Inference and Domain concept of the budget required for excellent carving

Figure 4.42 illustrates the inference and domain concept related to be the budget required for excellent carving, which was shown that Teaching in wood carving does not require the budget. If the carvings are the good quality, they could be sold. In good economy, more products could be sold. Students had to buy hammers and chisels. The tuition fee was 6,000-7,000 THB for Thai people and 15,000 THB for foreigners. Teaching students was similar to the teaching people in family.

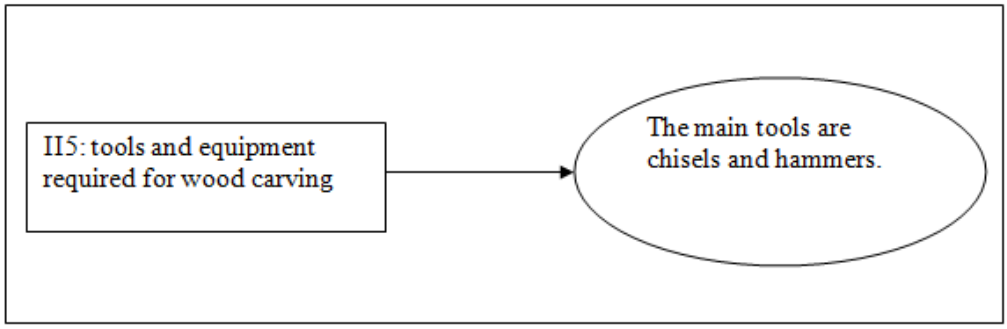

Figure 4.43 Inference and Domain concept of tools and equipment required for wood carving

Figure 4.43 illustrates the inference and domain concept related to tools and equipment required for wood carving shown that the main tools are chisels and hammers.

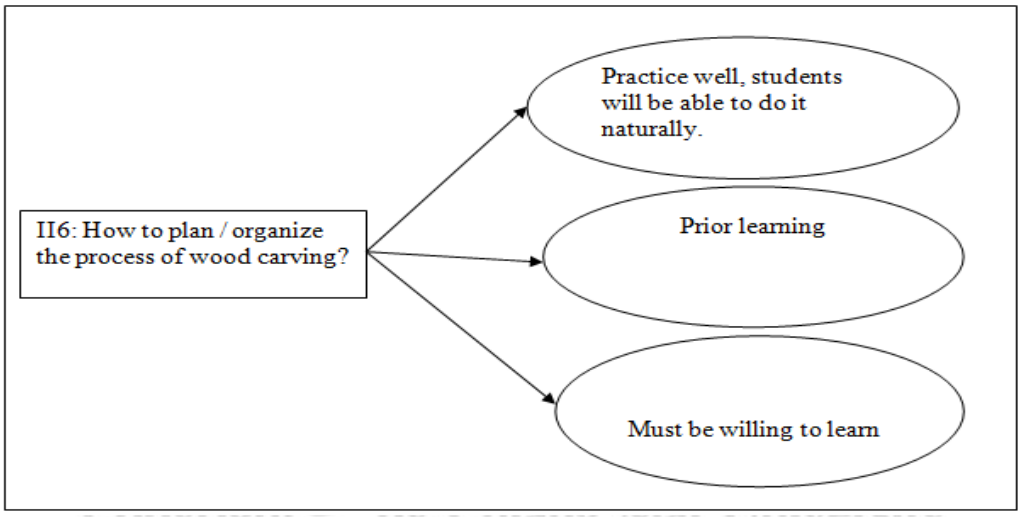

Figure 4.44 Inference and Domain concept of plan and organize the process of wood carving

Figure 4.44 illustrates the inference and domain concept, which was related to the plan and organize the process of wood carving, where there was no planning (local wisdom), Prior learning. Practice well, where the students will be able to do it naturally and must be willing to learn.

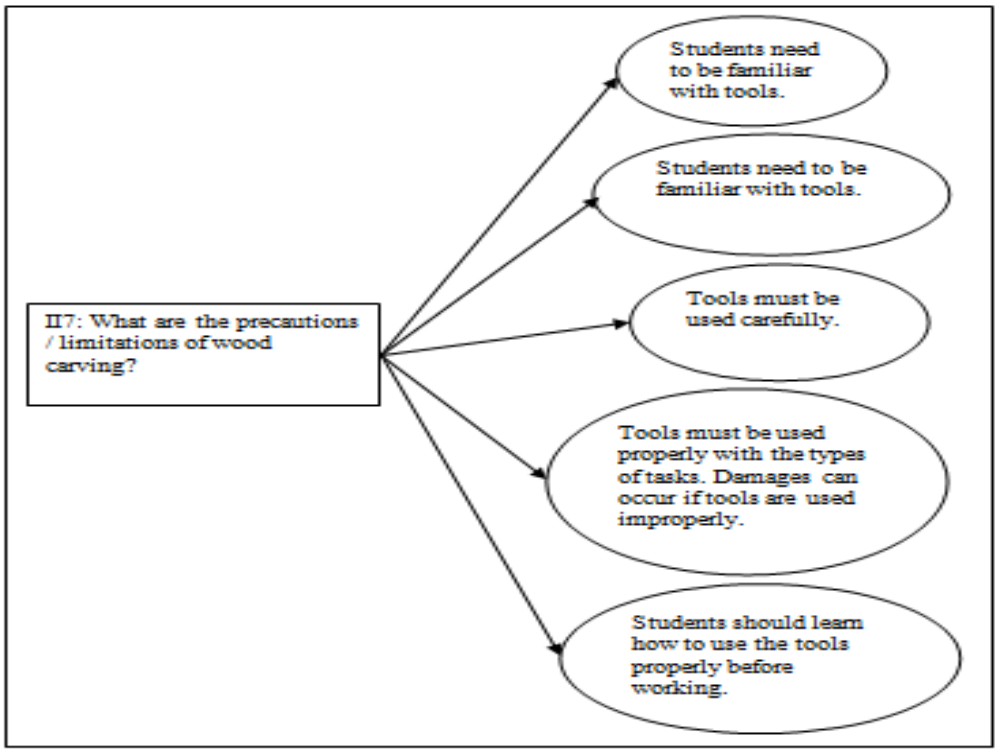

Figure 4.45 Inference and Domain concept of precautions and limitations of wood carving

Figure 4.45 illustrates the inference and domain concept related to precautions and limitations of wood carving shown that students need to be familiar with tools. Tools must be used carefully and properly with the types of tasks. Damages could be occurred if tools are used improperly. Students should learn how to use the tools properly before working.

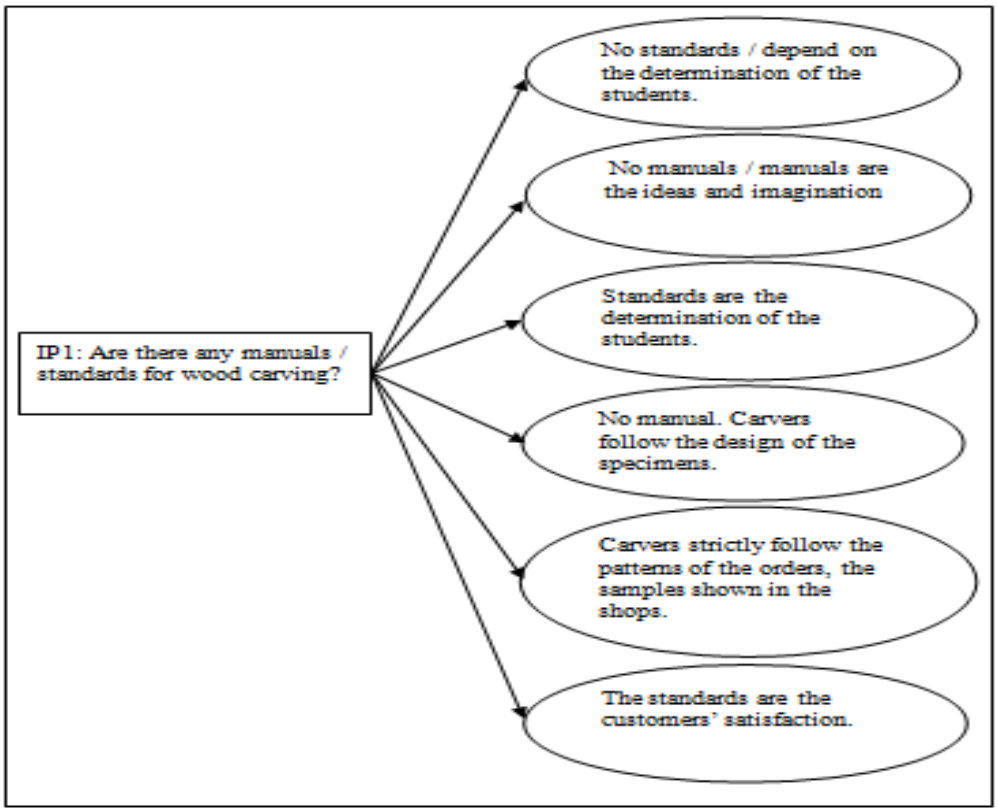

Figure 4.46 Inference and Domain concept of manuals and standards for wood carving

Figure 4.46 1illustrates the inference and domain concept related to the manuals and standards for wood carving shown that there was no standards. It depends on the determination of the students. No manuals and manuals are the ideas and imagination. Standards are the determination of the students. No manual. Carvers follow the design of the specimens. Carvers strictly follow the patterns of the orders. The samples are shown in the shops. The standards are the customer satisfactions.

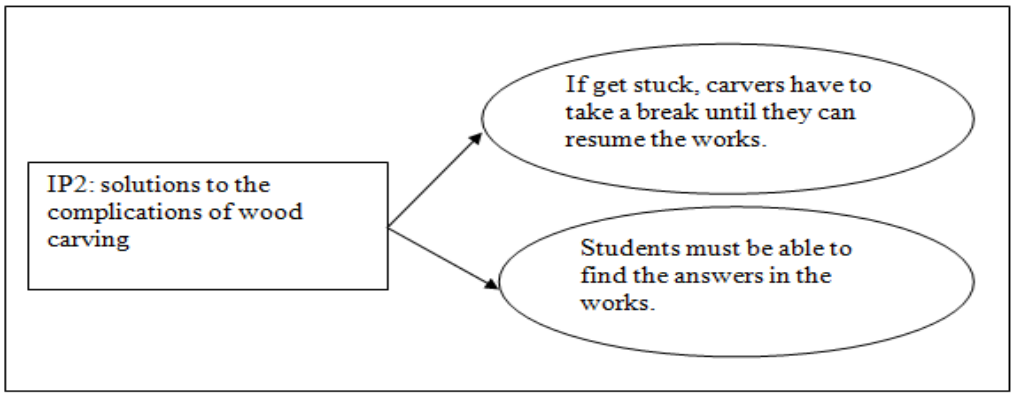

Figure 4.47 Inference and Domain concept of solutions to the complications of wood carving

Figure 4.47 illustrates the inference and domain concept related to the solutions of the complications of wood carving shown that If get stuck, the carvers had to take a break until they could resume the works. Students must be able to find the answers in the works.

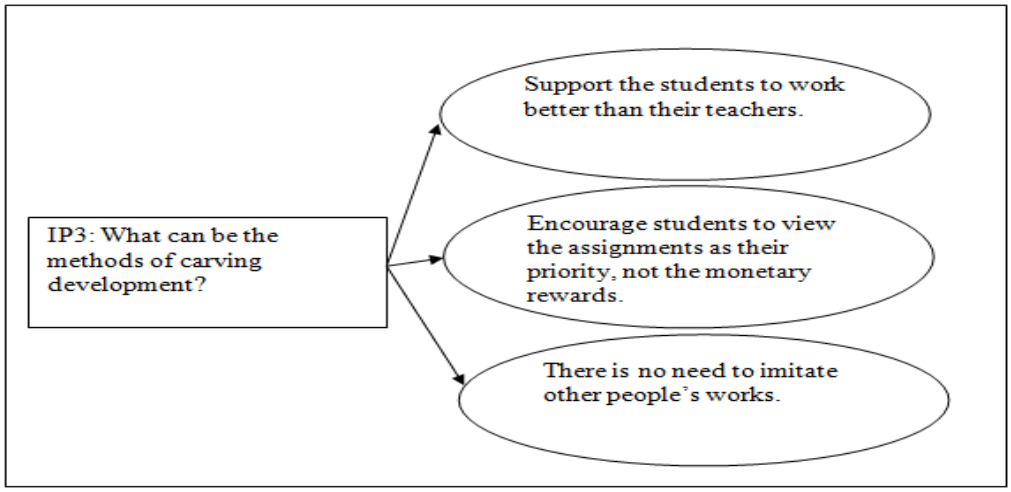

Figure 4.4 Inference and Domain concept of the methods of carving development

Figure 4.48 illustrates the inference and domain concept related to the methods of carving development shown that Support the students to work better than their teachers. Encourage students to view the assignments as their priority. It was not the monetary rewards. There was no need to imitate other people's works.

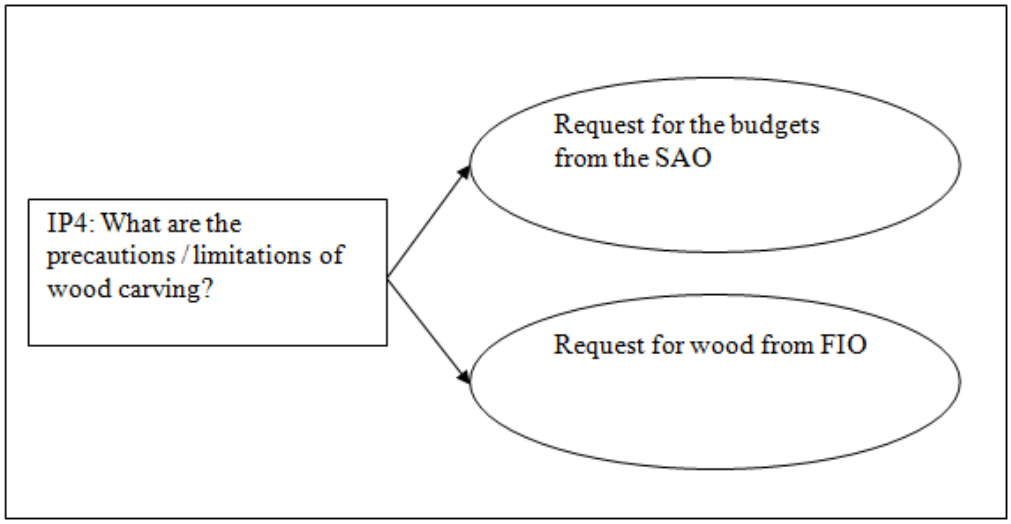

Figure 4.49 Inference and Domain concept of are the methods to find funding

Figure 4.49 illustrates the inference and domain concept related to be the methods to find funding shown that Request for the budgets from the SAO. It requests for wood from FIO.

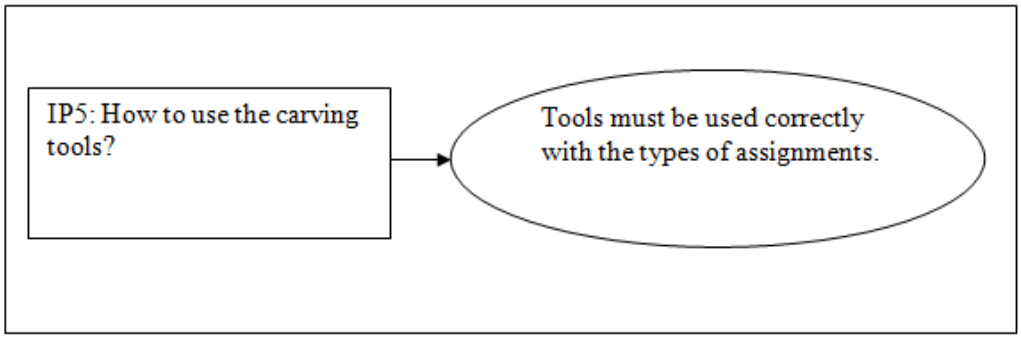

Figure 4.50 Inference and Domain concept of use the carving tools

Figure 4.50 illustrates the inference and domain concept related to use the carving tools shown that Tools must be used correctly with the types of assignments.

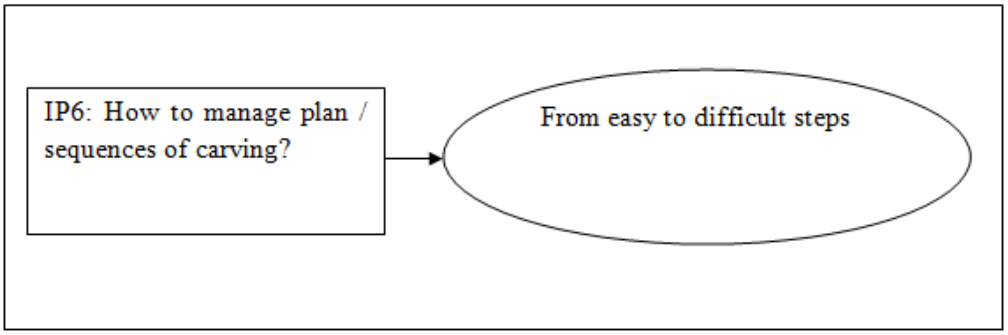

Figure 4.51 Inference and Domain concept of manage plan and sequences of carving

Figure 4.51 illustrates the inference and domain concept related to manage plan and sequences of carving shown that from easy to difficult steps.

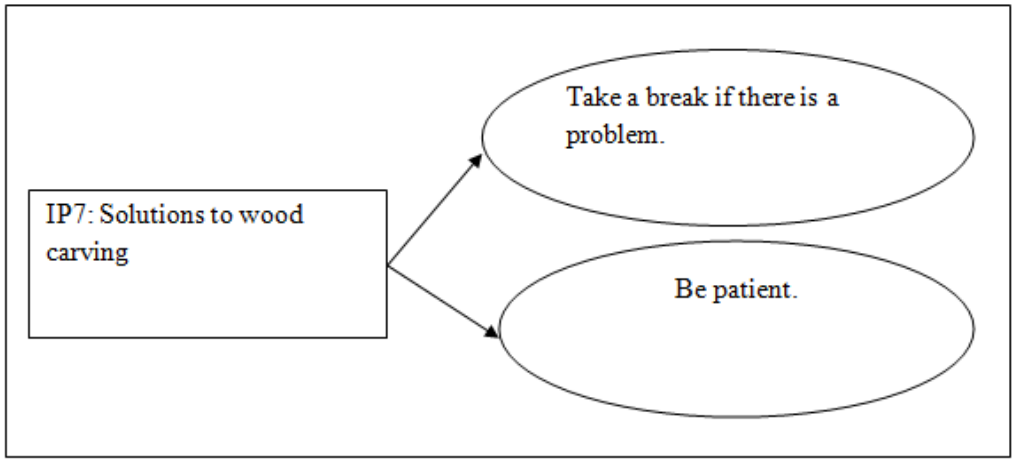

Figure 4.52 Inference and Domain concept of Solutions to wood carving

Figure 4.52 illustrates the inference and domain concept related to Solutions to wood carving shown that from easy to difficult steps. Take a break if there was a problem. Be patient.

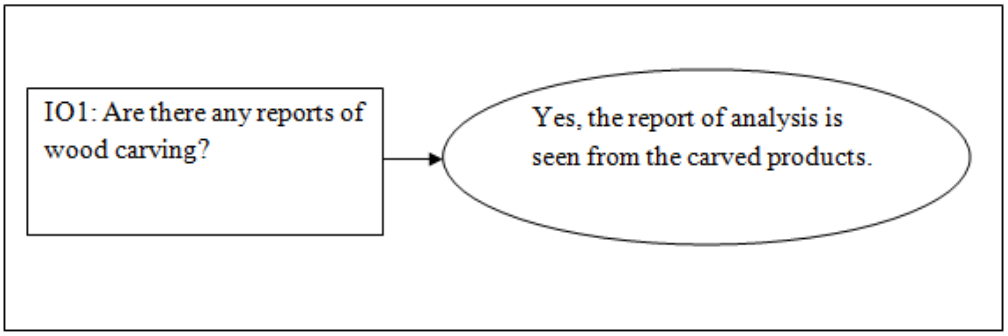

Figure 4.53 Inference and Domain concept of reports of wood carving

Figure 4.53 illustrates the inference and domain concept related to be reports of wood carving shown that the report of analysis was seen from the carved products.

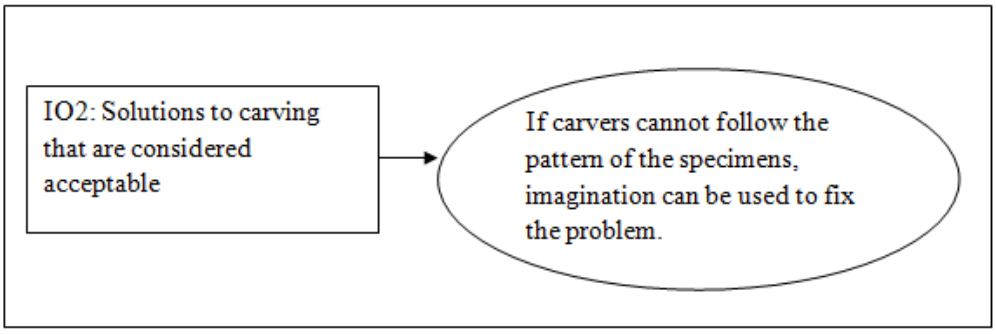

Figure 4.54 Inference and Domain concept of Solutions to carving that are considered acceptable

Figure 4.54 illustrates the inference and domain concept related Solutions to carving that are considered acceptable shown that If carvers cannot follow the pattern of the specimens, imagination could be used to fix the problem.

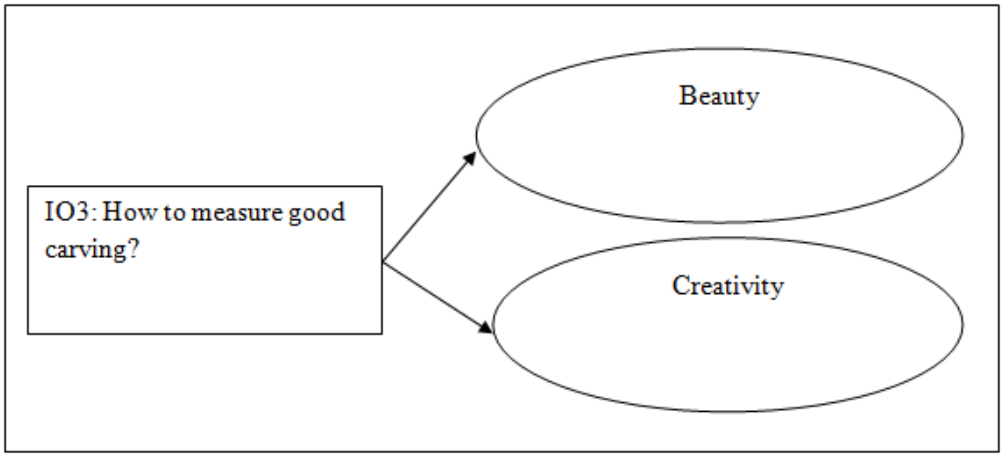

Figure 4.55 Inference and Domain concept of measure good carving

Figure 4.55 illustrates the inference and domain concept related to measure good carving shown that Beauty and Creativity.

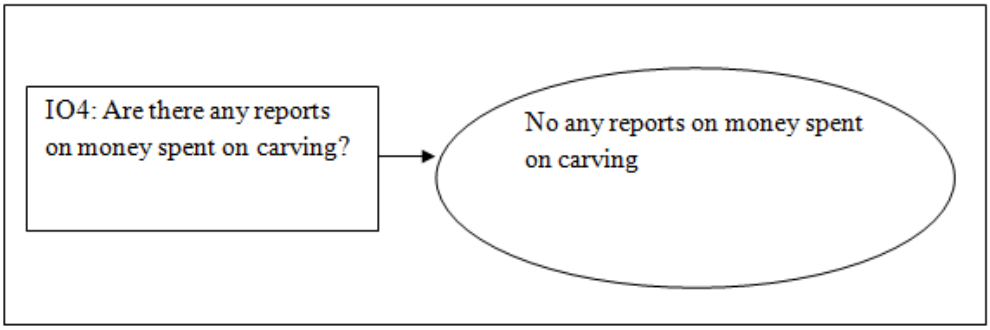

Figure 4.56 Inference and Domain concept of reports on money spent on carving

Figure 4.56 illustrates the inference and domain concept related to reports on money spent on carving shown that no reports on money spent on carving.

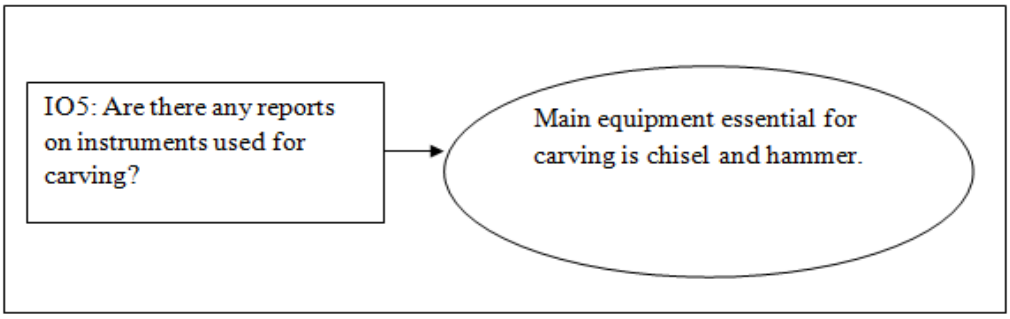

Figure 4.57 Inference and Domain concept of reports on instruments used for carving

Figure 4.57 illustrates the inference and domain concept related reports on instruments used for carving shown that Main equipment essential for carving was chisel and hammer. However, the most important tool was chisel. Chipped chisels cannot produce good works as some works could be very small and require delicacy.

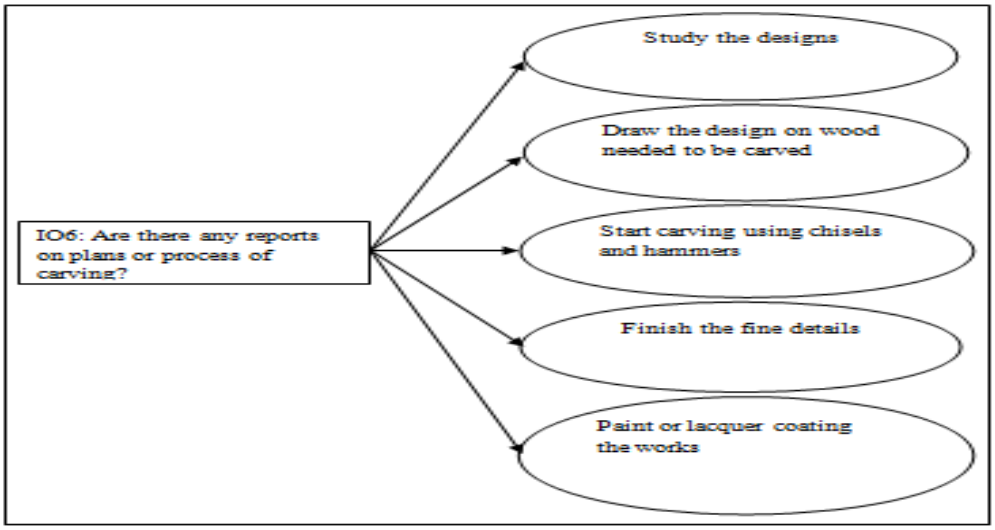

Figure 4.58 Inference and Domain concept of reports on plans or process of carving

Figure 4.58 illustrates the inference and domain concept related to the reports on plans or process of carving, which was shown that the study and design on wood are needed using chisels and hammers, where the fine details could be paint or lacquer coating the works.

Note: Most of the works display the natural quality of wood texture. Therefore, the lacquer coating was not needed.

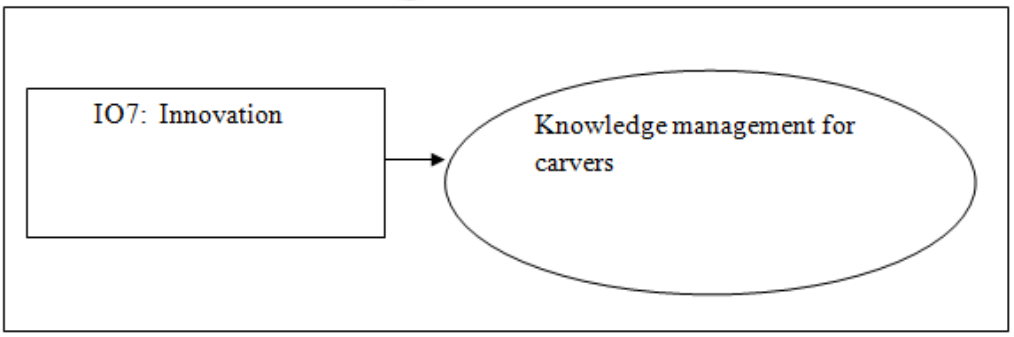

Figure 4.59 Inference and Domain concept of Innovation

Figure 4.59 illustrates the inference and domain concept related to the Innovation shown the knowledge management for carvers.

In this subsection, the results (knowledge transcript and knowledge map) of applying the knowledge engineering on wood crafting technique are presented. The results had shown that the knowledge engineering (IPO template) could be used to capture the experiences from the knowledge workers and then develop the knowledge model on wood crafting technique explicitly and systematically. This knowledge model, especially the inference (what to think) and domain concepts (how to think) will then be shared and combined in the SECI state to develop new knowledge for the value creation of the Teak furniture.

(3) Combination(C)

Set of Carving Knowledge was developed and combined with the (KP1+KC). The result of sharing knowledge was shown in Figures 4.60

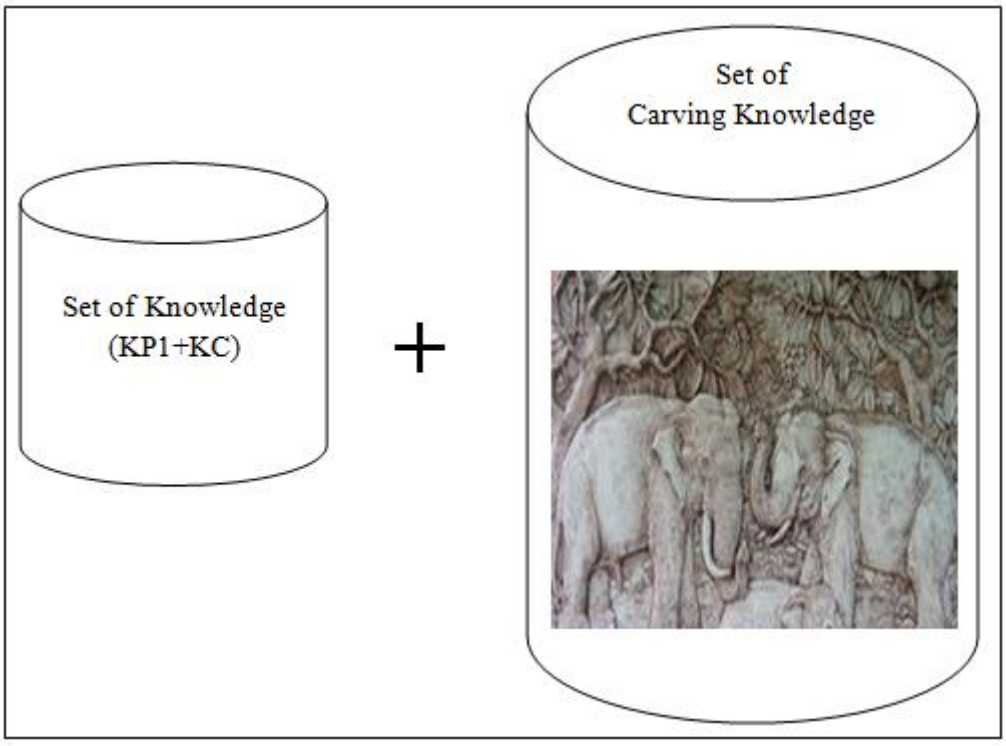

Figure 4.60 Set of Carving with sharing knowledge

(4) Internalization (I)

(4.1) Knowledge Management process

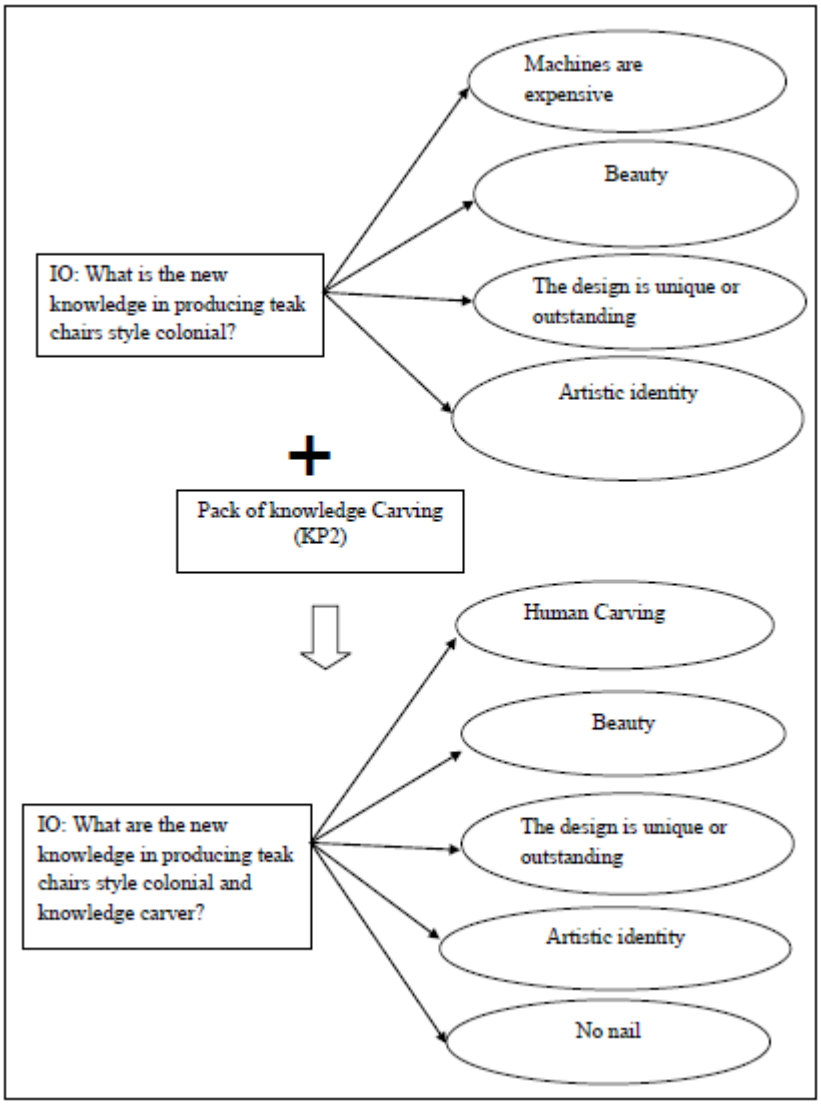

Figure 4.61 Inference and Domain concept when combine KP1, KC and KP2

Figure 4.61 illustrates the inference and domain concept related to combine KP1, KC and KP2 shown that Human carving, Beauty, The design was unique of outstanding, Artistic identity, No nail.

(4.2) Product process

Table 4.5 Shown Product process after combine KP1, KC and KP2

Process	**Traditional Product Process Cycle 0**	**Cycle 1**	**Cycle 2**
Feature	No Style	With Colonial	With Colonial
Beauty	Less	Unique	Unique
functional	Less	Less	Less
Cutting	Machine	Machine	Machine & Human-Carving
Build	Nail	Nail	Nail
Packing	Manufacture	Manufacture	Manufacture
Picture			

From table 4.5, it was found that the combination of KP1, KC and KP2 changes the inference and domain. This causes the transform of Knowledge Management process and effected to some next step of product process for example the Cutting of work changing into colonial style Machine & Human- Carving.

(4.3) Comparison Product Output

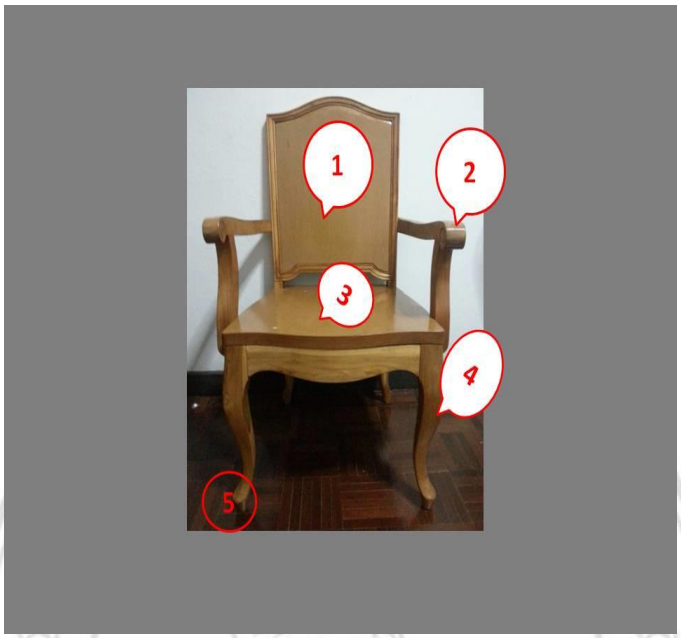

Figure 4.62 The Colonial-style chair in cycle 1 created from the proposed solution methodology

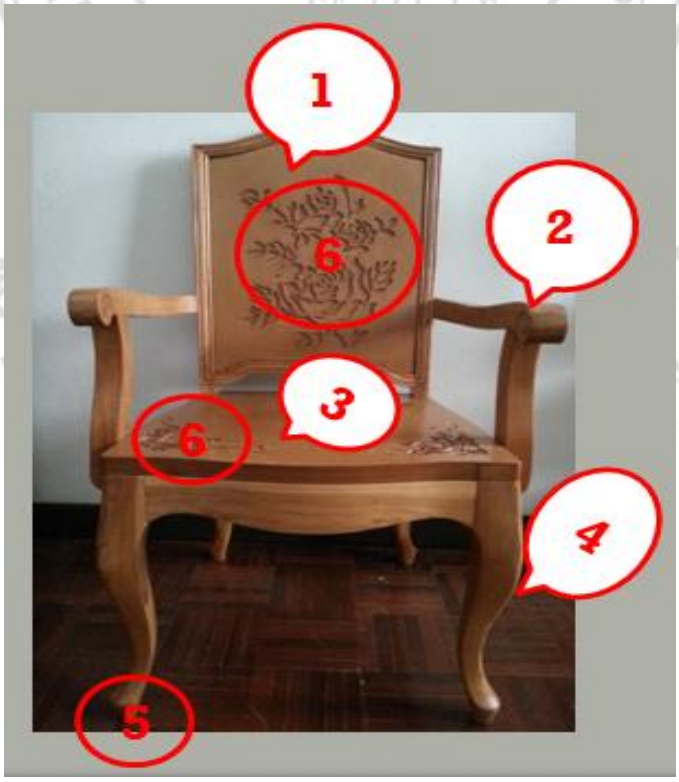

Figure 4.63 The Colonial-style chair in cycle 2 create from carving for value added

Figure 4.63 shown the Colonial- style and No.6 Carving: Cutting or chipping the surface of wood to create a shape or design.

From Figure 4.63 chair from cycle 2 had more beauty from carving, unique, style than Figure 4.62 chair from cycle 1. So figure 4.63 chair from cycle 2 should had value added.

4.2.3.3 The third cycle of knowledge creation

(1) Socialization(S)

Figure 4.64 Illustration of Carving and Manufacturing Knowledge sharing conference

From Figure 4.64, the carving and manufacturing knowledge sharing conference for self knowledge exchange and working corporation used the IPO template. Environment was air conditioned meeting room. The meeting room had recording equipment, microphone, white board, computer, paper, pen, snack and water. Focus on exchange knowledge between manufacturing and carving. Based on the proposed idea in this researched to develop new knowledge for value added by integrating functionality (manufacturing) with aesthetic (carving).

(2) Externalization (E) was the process of collecting all relevant documents and of creating storing system of studies related to Teak chair manufacturing

as art objects in colonial style and Teak carving. Data base, in which experts are allowed to add or edit the information, was also created.

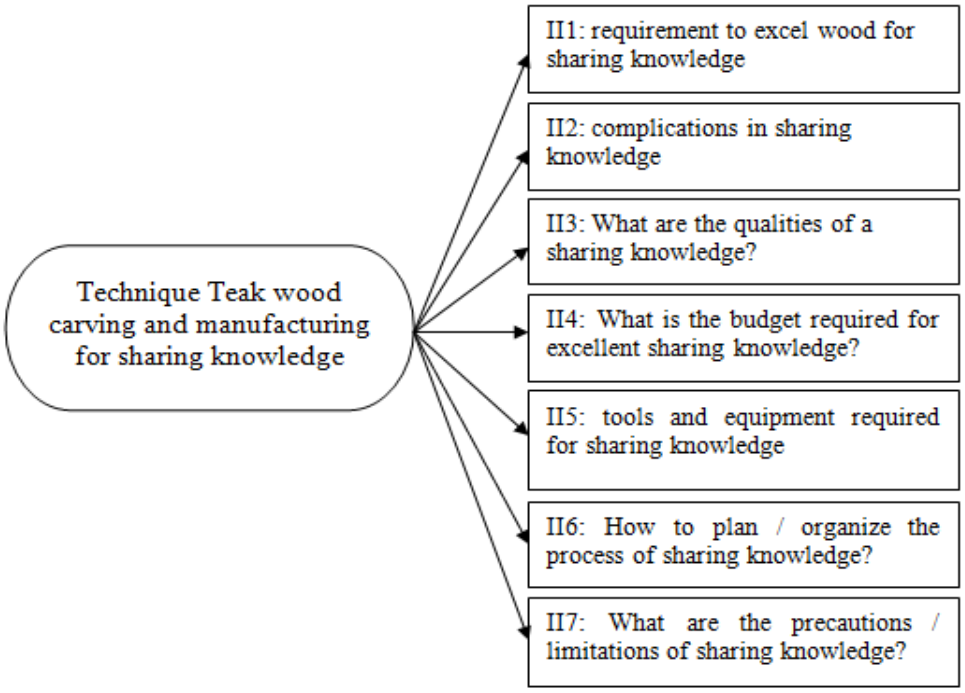

Figure 4.65 Task and Inference of input technique Teak wood for sharing knowledge

Figure 4.65 illustrates Task and Inference related to technique Teak wood for sharing knowledge shown that requirement, complications, manpower, budget, tools, plan and precautions.

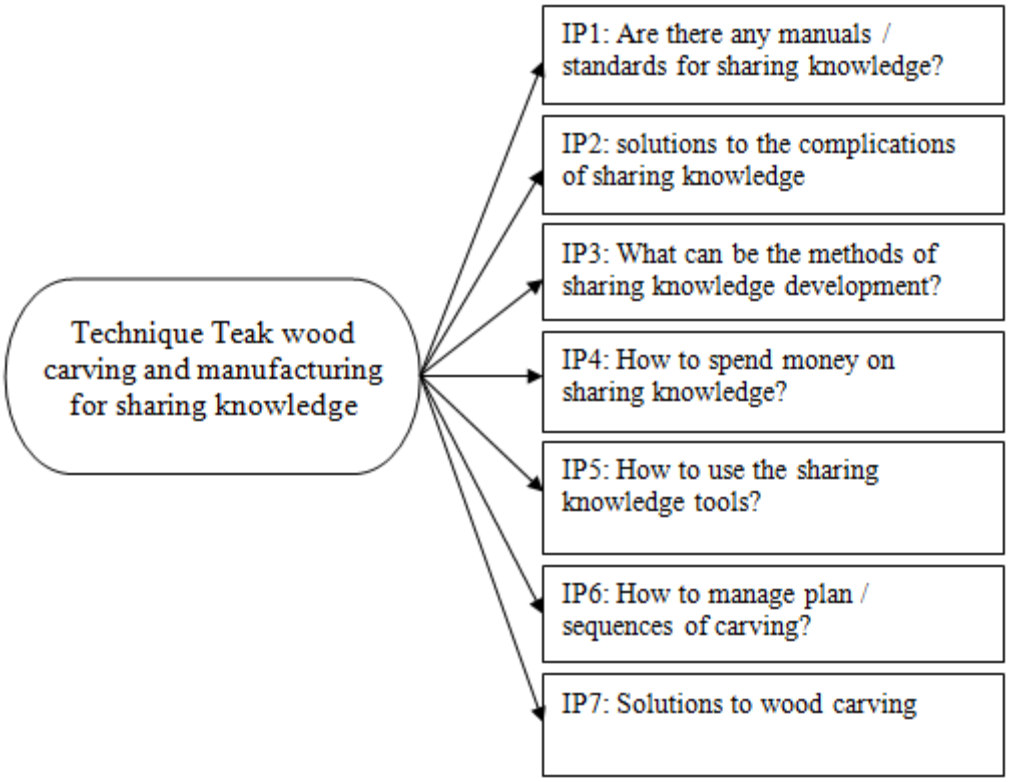

Figure 4.66 Task and Inference of process technique Teak wood sharing knowledge

Figure 4.66 illustrates Task and Inference related to the technique Teak wood sharing knowledge shown that technique, problem solution, learning, budgeting, tools, scheduling and prevent.

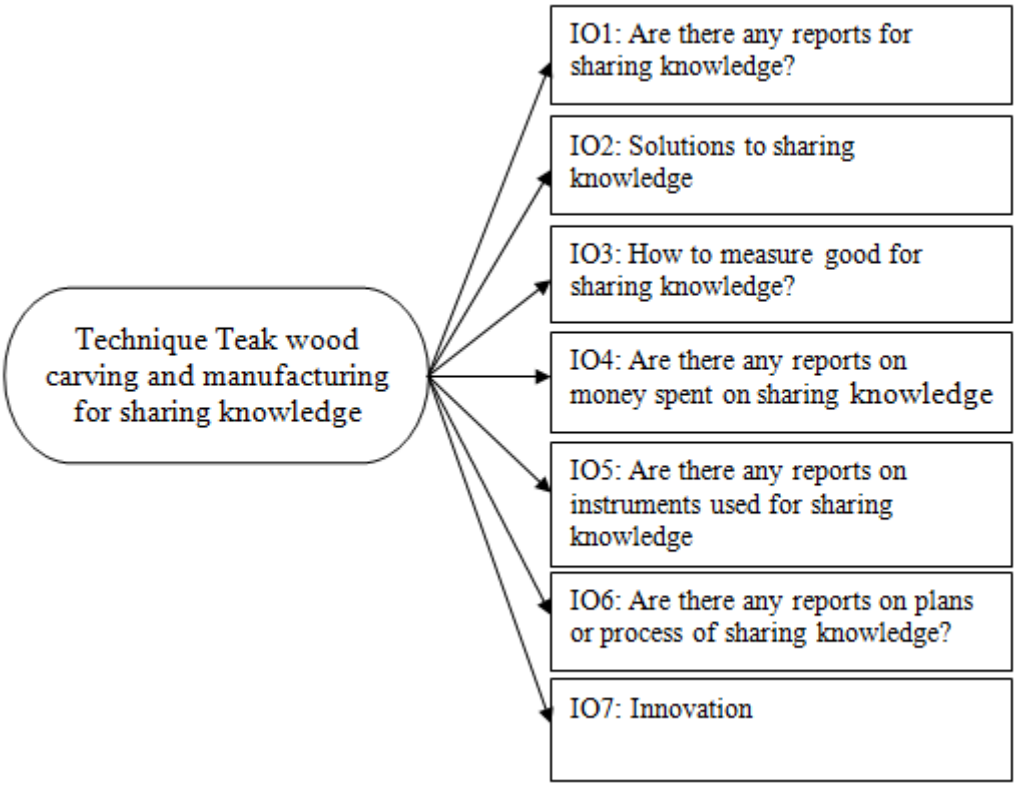

Figure 4.67 Task and Inference of output technique Teak wood knowledge sharing

Figure 4.67 illustrates Task and Inference related to the technique Teak wood sharing knowledge shown that report, solution, working performance, financial report, KPI, project management report and innovation.

From the IPO template, the relationship between Task and Inference was created by the selected important points from the knowledge sharing between Carving and Manufacturing.

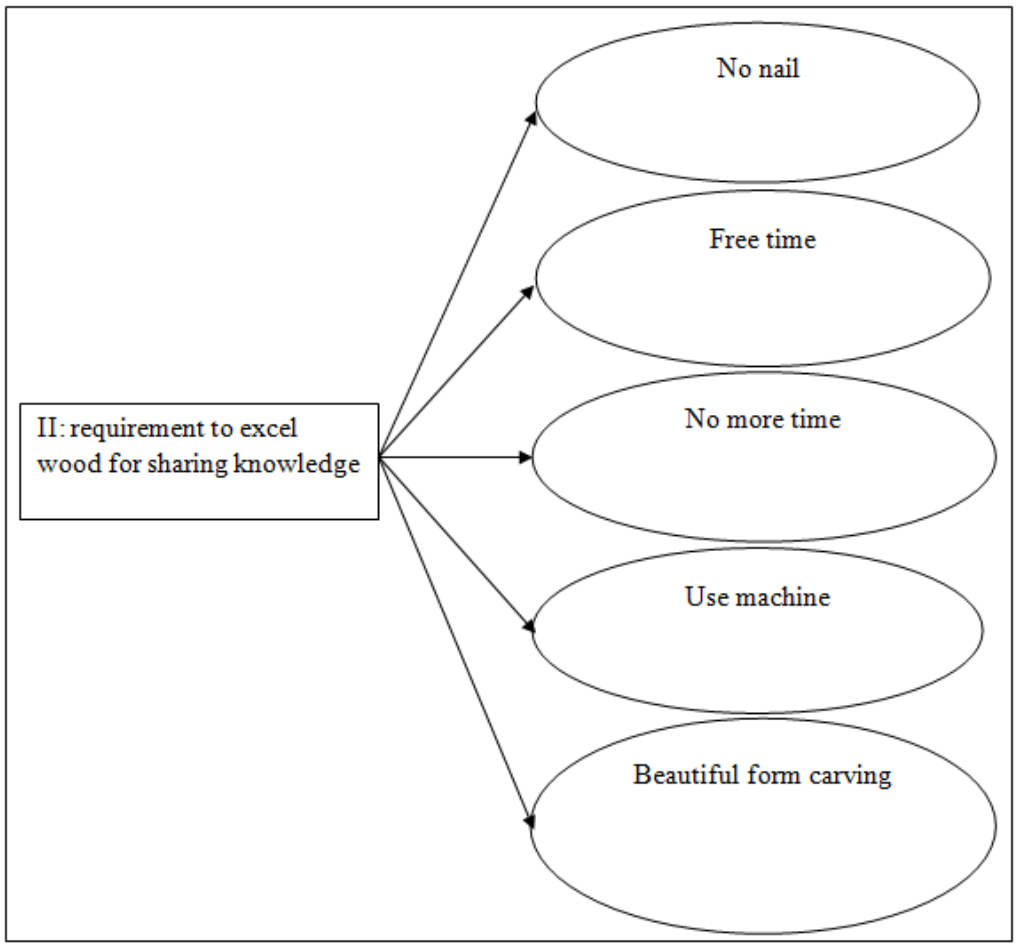

Figure 4.68 Inference and Domain concept of requirement to excel wood for sharing knowledge

Figure 4.68 Illustrates the inference and domain concept related to the requirement to excel wood for sharing knowledge shown that No nail, free time for wood carving, where no more time for production, using machine form manufacturing and beautiful for caring.

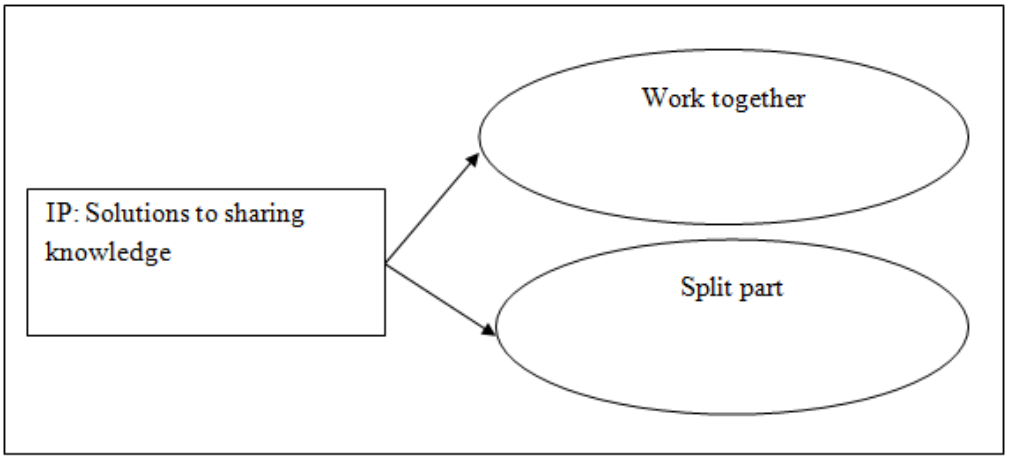

Figure 4.69 Inference and Domain concept of solutions for sharing knowledge

Figure 4.69 Illustrates the inference and domain concept related to the Solutions for sharing knowledge shown that work together and split part.

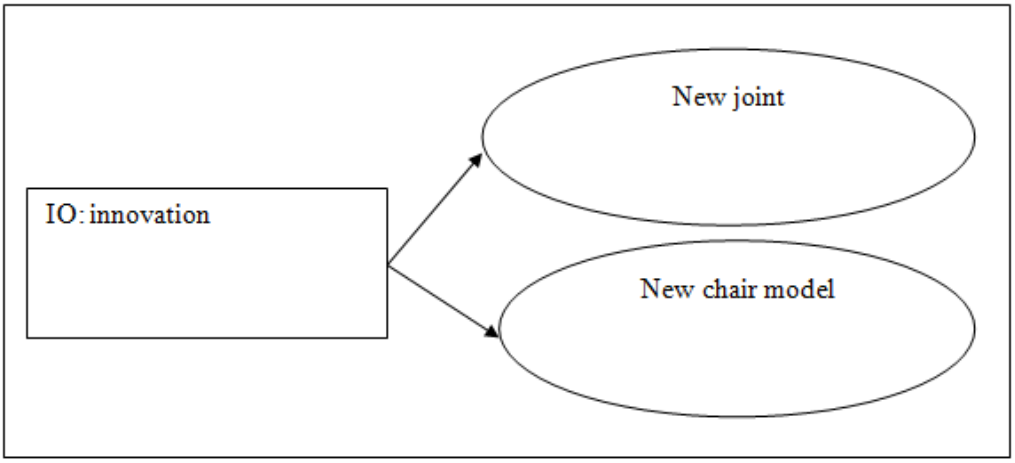

Figure 4.70 Inference and Domain concept of innovation for sharing knowledge

Figure 4.70 illustrates the inference and domain concept related to the innovation for sharing knowledge shown that new chair model and new joint.

(3) Combination (C)

Nonaka's SECI model in the process of combination generated new knowledge for both groups of experts. Different parts of chairs such as legs, back, seat, and arms were manufactured by the manufacturer group based on the use of machinery. The carver group will be given the parts needed to be carved. The carved

woods were assembled afterward. The new knowledge obtained was centered on the joint method, which was evident in traditional Thai houses. Instead of using nails, joints were used to link or bridge the wooden parts. Similarly, nails were not needed for chairs in Colonial style architecture. The 2 groups of experts then agreed to use joints instead. Yet, the space on chairs was limited and challenging for joint method. New pattern of joints was developed and combined with the (KP1+KC+KP2). The result of sharing knowledge was shown in Figures 4.71

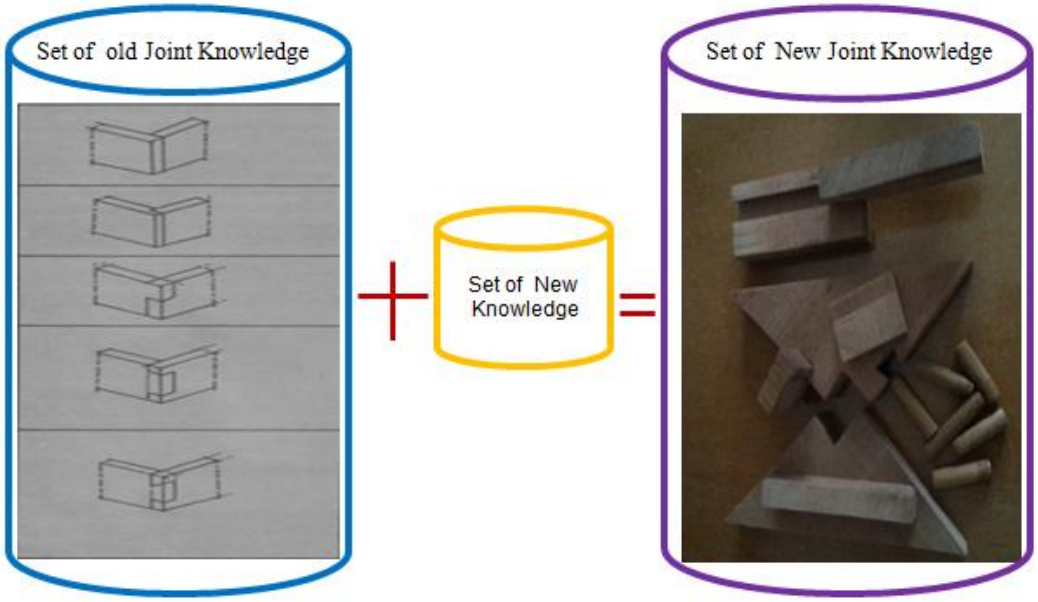

Figure 4.71 The innovative joint with sharing knowledge

(4) Internalization (I)

(4.1) Knowledge Management process

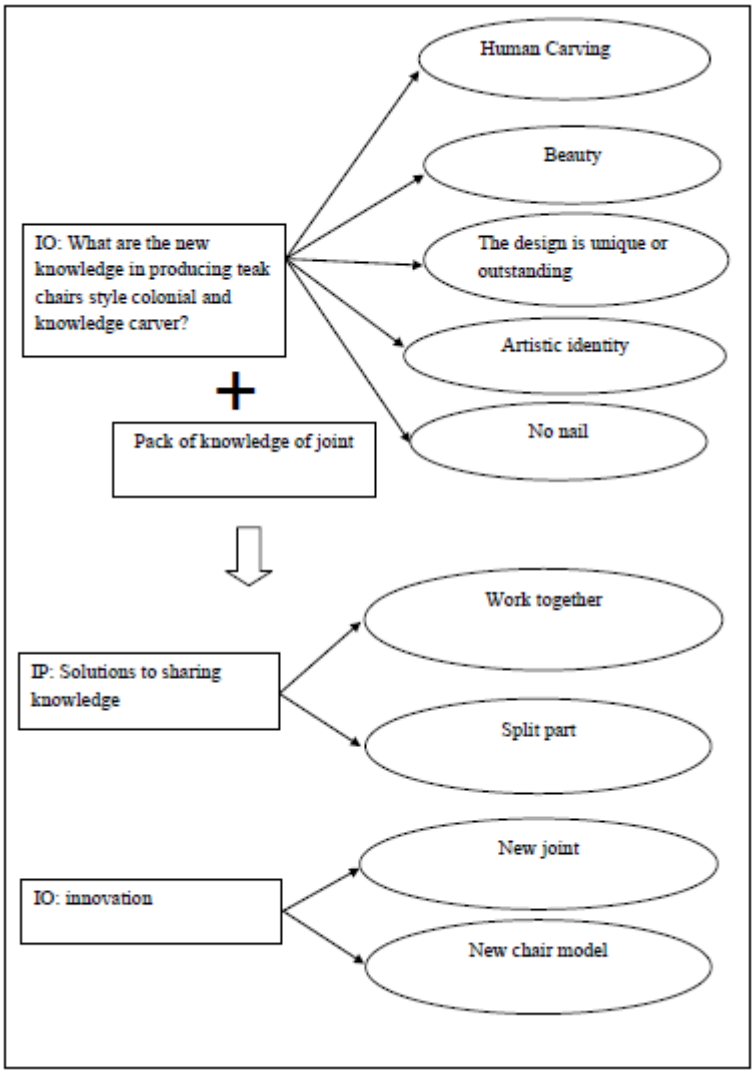

Figure 4.72 Inference and Domain concept when combine KP3 and joint

Figure 4.72 illustrates the inference and domain concept related to combine KP1+KC+KP2 and joint shown Work together, Split part, New joint, New chair model

(4.2) Product process

Table 4.6 Shown Product Process after combine KP1, KP2, KP3 and joint

Process	**Traditional Product Process Cycle 0**	**Cycle 1**	**Cycle 2**	**Cycle 3**
Feature	No Style	With Colonial	With Colonial	With Colonial
Beauty	Less	Unique	Unique	Unique
functional	Less	Less	Less	Maximum
Cutting	Machine	Machine	Machine & Human-Carving	Machine & Human Carving
Build	Nail	Nail	Nail	Joint
Packing	Manufacture	Manufacture	Manufacture	Separated pieces to assemble at home.
Picture				

From table 4.6, it was found that the combination of KP1+KC+KP2 and joint changes the inference and domain. This causes the transform of Knowledge Management process and effected to some next step of product process for example the functional of Teak furniture changing was maximum, Build by joint, Packing with Separated pieces to assemble at home.

(4.3) Comparison Product Output

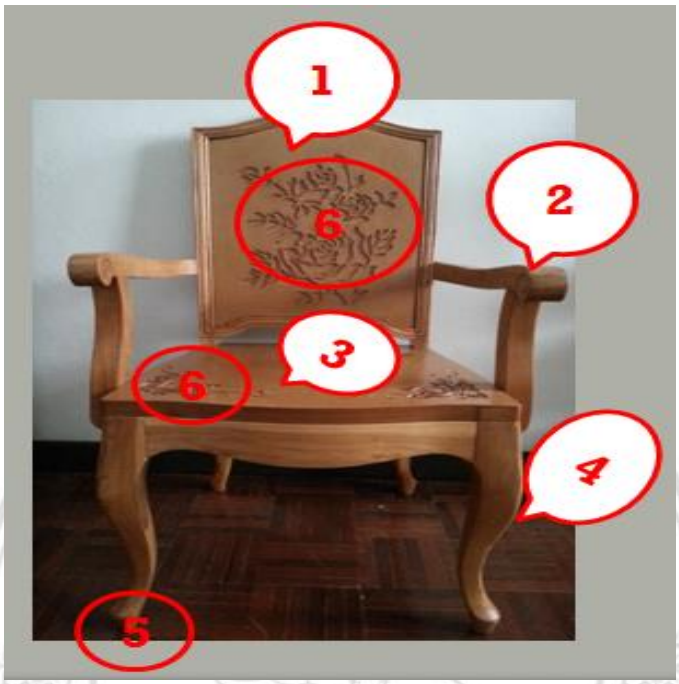

Figure 4.73 The Colonial-style chair in cycle 2 create from carving for value added

Figure 4.74 Apply joint for the Colonial-style chair from cycle 3

From Figure 4.74 chair from cycle 3 had more maximum functionality than Figure 4.73 chair from cycle 2. So figure 4.74 chair from cycle 3 should had value added.

As a result, models of chairs in Colonial style in cycle 3 were created as art objects used in daily life with the features of aesthetics and functionality as shown in Figure below.

(4.3.1) Joint application by nail replacement based on Colonial style as shown in Figure 4.75

Figure 4.75 The using of Joint replacement by nail in the small area

(4.3.2) Knowledge was combined for manufacturing chairs as art objects used in daily life. The focuses were as follows:

(4.3.2.1) Carvings were used to display the aesthetic elements as shown in Figure 4.76

Figure 4.76 The usage Parts sent to carvers

(4.3.2.2) The maximum utilization for daily use was assured. Functional aspect includes,

- The patterns of the backs of the chairs could be changed as shown in Figure 4.77

Figure 4.77 The backs of the chairs

- The legs could be changed as shown in Figure 4.78

Figure 4.78 Leg of chairs

- The feet could be changed as shown in Figure 4.79

Figure 4.79 Foot of chairs

- The arms could be changed as shown in Figure 4.80

Figure 4.80 Arms of chairs

- The old backs of the chairs could be used to decorate the wall as shown in Figure 4.81

Figure 4.81 Decorates the wall by back of chairs

- The repair could be very convenient as only the fault parts need to be repaired as shown in Figure 4.82

Figure 4.82 Easy to repair the part of chair

- Transportation and packing could be easily done as shown in Figure 4.83

Figure 4.83 Easy to Transportation and packing

Based on the SECI implementation, it was found that the use of various parts required for the assembling of chairs through the joint innovation could produce the effectiveness of the manufacturing.

4.3 Value Add Analysis of Teak Furniture in Colonial Style

4.3.1 Value add analysis of House and Furniture Comparison Prices

Table 4.7 The relationship among space, selling prices, and cost of furniture

No.	Companies	Space (square meters)	Selling prices (Baht)	Cost of furniture (Baht)	% Cost of furniture and selling prices
1	AP	1-50	4 million	60000	1.5
2	SANSIRI	50-100	12 million	150000	1.25
3	QH	101-200	34 million	700000	2.0 QH
4	PERUSA	201-300	42 million	800000	1.9
5	L&H	>300	58 million	12000000	2.0

Table 4.7 shown the ratio of cost of furniture and selling prices and space, which corresponded in the same direction. In other words, larger space of house led to higher selling price. The furniture in the house, which accounted for 2% of the selling price of the house, was also more expensive. The reason was Colonial style houses had special features such as balcony around the house and that required a large space. Consequently, the selling prices of Colonial houses as well as Colonial furniture decorated in the houses were rather high. In conclusion, Colonial furniture that was used to decorate Colonial style architecture houses gained higher prices and thus increased the value for Teak furniture.

A house with such well-known architecture as Colonial architecture will had a higher selling price than a house with normal architecture. Accordingly, golden Teak furniture produced with Colonial architectural patterns had a higher value. As stated by Thanapornpan (1996), cultural products are products and services that had culture embedded as a part of that product or service. Generally, consumers buy that

product or service not only because of the product or service itself, but they also receive the culture embedded in that product or service too. As a result, the value was created beyond the product or service itself.

4.3.2 Value Add Analysis using Carving and Style

From questionnaires for price rate of colonial Style chairs and chairs in other styles without uniqueness.

Table 4.8 Results from the Comparison of Price Rate of Colonial Style Chairs and Chairs in Other Styles without Uniqueness

Samples	**Select Colonial Style (C-001) with the highest price**	**Select other styles without uniqueness with the highest price**	**Note**
50	50	0	
Percentage	100%	0%	

Table 4.8 involved the total 50 respondents of the questionnaires concerning the price rate of Colonial style chairs and chairs in other styles without uniqueness. It was found that all 50 respondents chose to purchase Colonial style chairs and gave them the highest price, compared to other unknown style chairs. This represented 100 percent of the respondents and showed that colonial style furniture could had higher added value than the furniture in other unknown style, or without uniqueness. This finding was consistent with an explanation of UNCTAD that creative economy originated from two main factors; the capital of intelligence and the creative skills for developing products and services into various forms. This could be done by, for example, combining or integrating arts, culture, and history to reflect spirits, beliefs, feelings, and values to the products and services.

From questionnaires about the price rate based on aesthetic carving by skilled carvers

Table 4.9 Results from the Comparison of Price Rates between Two Different Styles of Chairs

Samples	Select the Style with Carving by Skilled Carvers (C-001) as the Highest Price	Select Other Styles Without Carving by Skilled Carvers as the Highest Price	Note
50	50	0	
Percentage	100%	0%	

Table 4.9 above showed the result from the questionnaire concerning the price rates between the chairs with carving by skilled carvers and the chairs without carving by skilled carvers. It was found that all 50 respondents chose to purchase chairs with carving by skilled carvers to be the highest price, which accounted for 100 percent of the respondents. This reflected that furniture which integrated carving by skilled carvers into the products could had higher added value than furniture without carving by skilled carvers. This was consistent with the principle of Creative Economy, which recommended that wood carvings could be used to add more values to wood furniture in terms of aesthetics, art, and culture to generate national income.

4.3.3 Customer value Add Analysis

Table 4.10 Effect of house price, area and style to furniture selection

No.	Space	Style	Selling prices	Purchased chairs				
				C-001	C-002	C-003	C-004	C-005
1	20	-	1	-	-	-	2	48
2	30	-	3	-	5	8	16	19
3	50	-	20	12	31	5	1	1
4	150	-	40	37	22	1	-	-
5	240	colonial	60	50	-	-	-	-

From Table 4.10, it was found that there was a common tendency that respondents purchased furniture.

(1) For houses with selling price of 1 million Baht, 90% of the respondents purchased furniture at the lowest price, 10% of the respondents purchased furniture at the lowest price in the category of (C-004).

(2) For houses with selling price of 3 million Baht, 38% of the respondents purchased furniture at the lowest price in the category of (C-005).

For houses with selling price of 3 million Baht, 32% of the respondents purchased furniture at the lowest price in the category of (C-004).

For houses with selling price of 3 million Baht, 16% of the respondents purchased furniture at the medium price in the category of (C-003).

For houses with selling price of 3 million Baht, 10% of the respondents purchased furniture at quite high price in the category of (C-002).

For houses with selling price of 3 million Baht, the respondents did not choose expensive furniture.

(3) For houses with selling price of 20 million Baht, 38% of the respondents purchased furniture at the lowest price in the category of (C-005).

For houses with selling price of 20 million Baht, 32% of the respondents purchased furniture at the lowest price in the category of (C-004).

For houses with selling price of 20 million Baht, 16% of the respondents purchased furniture at the medium price in the category of (C-003).

For houses with selling price of 20 million Baht, 10% of the respondents purchased furniture at quite high price in the category of (C-002).

For houses with selling price of 20 million Baht, the respondents did not choose expensive furniture.

(4) For houses with selling price of 20 million Baht, 38% of the respondents purchased furniture at the lowest price in the category of (C-005).

For houses with selling price of 40 million Baht, 32% of the respondents purchased furniture at the lowest price in the category of (C-004).

For houses with selling price of 40 million Baht, 16% of the respondents purchased furniture at the medium price in the category of (C-003).

For houses with selling price of 40 million Baht, 10% of the respondents purchased furniture at quite high price in the category of (C-002).

For houses with selling price of 40 million Baht, the respondents did not choose expensive furniture (C-001).

(5) For Colonial style houses (No. 5 of the Table), 100% of chairs (C-001) were chosen by respondents, which was the Colonial style chair, though (C-001) had the highest price.

Duration for manufacturing before exchanging knowledge and the duration for manufacturing after exchanging knowledge of the carving group

4.3.4 Production Time Analysis

Table 4.11 Production time usage in each step before knowledge sharing of the producer

List	Description	design	Cutting (minute)	Assembling (minute)	Polishing (minute)	Usage time (minute)
1	Leg	-		30	-	30
2	Back	10	20	-	-	30
3	Seat	10	30		-	40
4	Whole chair	-	-	-	60	60
5	Total					160

From Table 4.11, the time consumer of the specific chair manufacturing before knowledge sharing was used. It was 160 minutes per chair before the knowledge sharing being used.

Table 4.12 Time consumer in each step of chair production before knowledge sharing of carver being used

List	Description	Forming (minute)	Carving minute)	Assembling (minute)	Usage Time (minute)
1	Leg	60	-	20	80
2	back	-	300	30	330
3	seat	-	300	30	330
4	Whole chair	-	-	60	60
	Total				800

From Table 4.12, it was found that the chair carving production time of the specific chair style was 800 minutes per chair before the knowledge sharing being used.

Table 4.13 Chair production in each step of knowledge sharing

List	Description	Forming (minute)	Carving minute)	Assembling (minute)	Usage Time (minute)
1	leg	30	-	10	40
2	back	-	150	15	165
3	seat	-	150	15	165
4	Whole chair	-	-	30	30
	Total				400

From Tables 4.12 and 4.13, it was found that, after the 2 groups exchanged knowledge, the duration for chair manufacturing was shorter than before exchanging knowledge. The time required for chair manufacturing was 50% less than the duration previously required for chair manufacturing. However, the usage time in production by machinery was minimized but the product was lacked of pretty carving, which was affected to the added value and the low price obtained. Therefore, the knowledge sharing technique was suitable and the higher prize obtained.