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A Structural Traceability Approach to Explicate Knowledge Focusing on Know-how

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Abstract- Knowledge management focuses on explicit and tacit knowledge experienced by employees who contributed in different stages of a process. Although literature provides several different models to manage explicit/ tacit knowledge, use case based approach structurally has not been addressed to explicate know-how. Know-how is referred to the package of knowledge asset attained empirically by an organization in real cases structurally and gradually over the time. The empirical structural knowledge i.e. know-how influences directly the quality of a product/ service, and then know-how is evaluated as a crucial issue by all organizations. In this paper to manage and codify know-how effectively, a structural mapping based on a backward-forward use case requirements approach named knowledge chain is proposed. A real case study in a manufacturing car body is used to explain practically the map proposed in this paper.

Keywords- *Know-how, knowledge chain, tacit knowledge, knowledge management*

I. INTRODUCTION

Nowadays quality is known as a fundamental approach to satisfy both internal and external costumers. Although process control statistically is an effective approach to achieve quality goals, explicating technical knowledge documentary has also an essential role to achieve the goals corresponding to technical specifications of products/processes. The package of technical knowledge experienced over the time structurally by an organization is referred to as know-how in the industrial literature. The package of the knowledge usually is addressed by tacit and explicit types. Know-how is known as a valuable knowledge and it influences the outlook of quality of a process directly. Furthermore, know-how as a sellable product may be transferred to an external organization. Hence it is important for an organization to know that the process is capable to lead the organization to codify and explicate effectively the experimented technical knowledge. An effective approach to lead companies to codify workmanship of the different stages of a process is very important.

Holsapple and Joshi [1] focused on description of three main factors affect directly the knowledge management of an organization. The report introduced three groups of factors including managerial, resources and environmental as the main factors which may address the success of knowledge management efforts. Wang and Noe [2] focused on five areas corresponding to sharing knowledge in an organization. The five areas include organizational context, interpersonal and team characteristics, cultural characteristics, individual characteristics, and motivational factors. In this report Wang and Noe [2] discussed about the success factors of efforts corresponding to management of knowledge which directly relate to the effectiveness of the share phase. The results lead an organization to focus on individual knowledge; however when the technical area of knowledge is focused on in an organization the knowledge associated with know-how is referred to a structural consideration. In another words analyzing individual knowledge alone is not capable to lead effectively an organization to attain empirical structural knowledge, i.e. know-how. When transferring of the technical knowledge is also considered, in this case, documentation of know-how is evaluated as a knowledge-centered activity by an organization. In real, contribution of people of an organization to share systematically individual empirical knowledge is very important basically. Atashgar [3] discussed about details of know-how, but his discussion is not capable to lead one to explicate the experiments systematically. The model proposed by Atashgar [4] also only helps practitioners to control the quality of know-how.

In this paper explicating know-how to meet effectively all requirements, stage by stage of a process, addressed by experts is approached. The proposed approach emphasizes: 1) a structural logic based on a backward and forward moving of requirements, 2) the requirements are related to the all stages i.e. internal costumers allocated in the process, and 3) meeting the requirements of the both internal and external customers.

Next section of this paper provides description of the importance of the role of know-how. Section 3 includes the concept of forward and backward requirements and introduces the knowledge chain approach to explicate know-how in a process. Section 4 provides the discussion of the proposed approach. Section 5 explains the application of the proposed approach focusing on a case study corresponded to a car manufacturing line. Finally conclusions are provided in Section 6.

II. KNOW-HOW AND ITS REQUIREMENTS

The knowledge corresponding to technical area experienced gradually in practice by people who work in an industrial or in a service center, is referred to as know-how. Since the valuable knowledge, i.e. know-how is provided by people skills inferred from the fact rules of real cases; one

cannot find completely the knowledge easily referring theory sources. Weber [5] introduced a conceptual meaning of know-how by categorizing experienced knowledge of an organization. Literature also addresses different researches such as Nass [6], Katz [7], Zack [8], Hatchuel [9] and Atashgar [3] have contributed to explain the factors are due to know-how issue. Atashgar [3] analyzed know-how issue categorizing the technical documents as 1) product know-how, 2) production know-how, and 3) process know-how. Atashgar [4] also introduced profile of knowledge to analyze know-how of a process. Atashgar [4] named the proposed approach POK. The analysis of Atashgar [4] is capable to lead practitioners analyzing know-how using quality approach.

Know-how documentation is allocated as an action based knowledge and then the document embraces a set of interaction of practical information associated with technical efforts addressed by empirical evidences. The interactions may be 2-order, 3-order or higher order combinations. Investigation of know-how issue addresses that the technical knowledge first belongs to tacit knowledge type and hence, replacing the individual knowledge i.e. the tacit knowledge to an organizational knowledge by codifying structurally is known as an important effort. Know-how itself is also known as a transferable product in the real scope of industrial market, and then explicating or codifying the tacit technical knowledge is considered as a valuable asset. Oakland [10] investigated a documentation system when the quality of technical documents is approached. The approach to document knowledge emphasized by Oakland [10] involves two requirement types: 1) the requirements of the final costumer, 2) the requirements corresponding to internal costumers. The approach to ensure the requirements will be met finally emphasizes to map the knowledge by focusing on real requirements described by both internal and external costumers. To provide this aim, literature addresses providing work teams to analyze a process to identify 1) the existence knowledge (tacit type and explicit type), and 2) needed knowledge to recognize a) where knowledge is needed, and b) what knowledge is needed. This process is referred to as process knowledge mapping. Functional knowledge mapping is also referred to detail information related to each of the people. In other words this approach focuses on only knowledge individually. There exist different techniques to map knowledge in literature. Table 1 provides a type of the summary of literature corresponding to knowledge mapping. As shown in Table 1 know-how are not followed structurally by the techniques as an asset to provide enhancing the quality level of the performance corresponding to people who work in a process. It means that the requirements of customers and the people who use the knowledge are not emphasized by these proposed mapping. Mapping literature shows technical knowledge asset specifically has not been approached to provide two capabilities:

1) Transferring the technical knowledge to an external organization.
2) Retrieval of know-how to address removing technical gaps to provide enhancing the quality of the performance of the process structurally.

III. EXPLICIT KNOW-HOW USING KNOWLEDGE CHAIN APPROACH

In this section a new approach to explicate technical knowledge i.e. the tacit technical knowledge type is introduced. The approach follows the logic of the relationships exist between different stages of a process. The proposed method may be considered as a result oriented method. The approach helps practitioners to monitor continuously the result of the efforts experimented actually in practice and to revise documentations permanently. This proposed approach also is capable potentially to enhance technical capability of a process continuously in practice.

TABLE I. COMPARISON BETWEEN DIFFERENT MAPPING TECHNIQUES (SOURCE: JAFARI ET AL. [11])

	Yellow page	Information Flow Analysis	Social Network Analysis	Process Knowledge Mapping	Functional Knowledge Mapping
Used tools for data gathering	Question and answer systems skills dictionary and reports	Interview, skill inventories, and extensive surveys information flow diagram	Questionnaire Socio gram Graph theory	Brainstorming or conduct interview with the process owners	Survey and interview
Used tool for knowledge map evaluation	Skills dictionary	Questionnaire, interview and sign-out sheets	In Flow, Krackplot, and Net Miner	–	Observations, interviews, internal reports
Objective	Crate transparency as to the location of knowledge in the organization by registering individual competencies in a database or similar	Determining who is accessing process and how often	Discover interaction patterns between members	Define the knowledge needed, Decision milestones, the knowledge available to support a business process, Routes for access and retrieval of knowledge and gap between required skills and current skills	Locate knowledge sensitive areas Identifies and characterizes areas of process related critical knowledge spots
Knowledge mapping approach	Project – based	Relationship – based	Relationship – based	Process – based	Process – based
Create static or dynamic map	Static	Static	Dynamic	Dynamic	Dynamic
Support tacit or explicit	Explicit	Tacit	Tacit	Explicit-Tacit	Explicit-Tacit

As stated before, literature of quality management introduces two costumer types: 1) internal costumer and 2) external costumer. Internal costumer refers to all the personal who work in different work stations of a process to produce a physical or a non-physical good. However external costumer is referred to a final costumer who uses finally the finished good or the service produced contributing all internal costumers. In practice the relationship between the stations (as internal costumers) may be defined based on the technical requirements. In another word, the capability to meet real requirements of costumers systematically is vital, not only between the producers and final costumer but also between the work stations allocated in an organization. This concept addresses the core of the mapping proposed in this paper.

The analysis of a production line or a service process indicates there is a relationship between all the stages of work stations allocated within the process. Oakland [10] describes that although the operations corresponding to the allocations follow a process designed to produce a specific good, really each of the stages individually has a role of a provider for its next stage and the other hands each stage roles as a costumer/user for its previous station. Since the operational flow of the process, the work stations, is defined based on an approved technical procedure to meet both explicit and tacit requirements, it is possible to conclude that there are two roles for each work stations. The first role is defined when a station works to supply a specified product for its next station, i.e. the role of the provider, and the second role is defined when a specified product is delivered to this station by the previous station, i.e. the role of the costumer/user. The logic leads one to understand that there is a correlated chain between technical requirements associating to users and providers exist in a process. This chain which describes relationships of different sections of a process for a specified good is used in this paper to perform interpreting and finally explicating know-how embraced in each work station. The relationship is named knowledge chain in this proposed use case mapping. The concept of the knowledge chain is shown in Figure 1. The figure shows the concept of existence of a relationship like a chain between the providers (P) of knowledge who supply goods based on technical requirements stated by the next station i.e. user, and users (U) of products who produce a good based on requirements supported by the previous station. This chain starts from the first stage to the final stage of a process. This chain of knowledge in real distributes structurally a specified technical knowledge over a process/ organization. It means one can find know-how over the organization structurally in the shape of knowledge chain. As shown in Figure 1, the latest ring of the chain of the process finally links to an external customer. In this approach really a package of knowledge managed structurally supports an external customer.

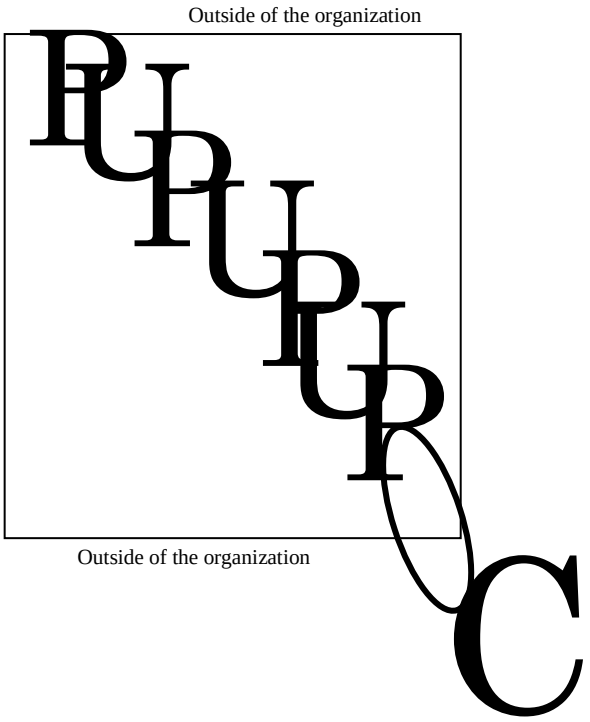

Figure 1. Knowledge chain (H: Provider, U: User, C: External Costumer)

IV. DISCUSSION

The knowledge chain introduced in this paper to map know-how reveals distributed real requirements. The requirements really correspond to different technical dimensions of a good that should be considered by all the people who work in the process. These technical requirements may have not been really documented or expressed before in

details addressed by real cases. However the proposed structure leads all to know associated technical requirements of each stage and follow a system to share correlated technical knowledge unexpectedly. The procedure practically and potentially leads a company to transfer tacit and explicit knowledge types systematically. In this case a package of practical documents associated to technical knowledge experienced gradually in practice is provided.

As discussed before, in this knowledge chain approach each work station of a process has two roles to explicate the technical knowledge simultaneously. Table 2 describes the roles clearly. The chain approach addresses that documenting and transferring technical information regardless requirements of internal users may be evaluated as an insufficient effort.

It is recommended to focus on identifying the factors that affect the process of documentation and transferring (sharing) knowledge. Table 3 provides the factors considered by several researchers when transferring of know-how is focused on. One of the most important aspects of knowledge management addressed by Nonaka [12] considered the transfer of knowledge. Knowledge chain can be also evaluated as an effective approach when transferring of know-how is considered by an organization. Quality of conformance as an important issue is also available using knowledge chain approach. Some researchers such Szulanski [13] and Gupta and Govidarajan [14] addressed the transferring does not take place efficiency or effectively always, however knowledge transferring is considered as a key to achieve competitive advantage. Knowledge chain approached a result oriented increases gradually the competitive advantages of an organization.

TABLE II. TASKS OF A WORK STATION IN KNOWLEDGE CHAIN APPROACH TO EXPLICATE KNOW-HOW

No.	AS the costumer	As the provider
1	Identification of the immediate provider	Identification of the immediate user
2	Advertisement and documentation of requirements	Explicating requirements of immediate user
3	Defining a continuous communication to review requirements continually	Explicating techniques and tools to meet the documented requirements
4	Confidence of meeting the requirements and the measuring terms used by immediate provider	Measuring the quality level of requirements (to satisfy immediate user) supplied by the techniques
5	Approving documentations related to specifications of product and technical procedures	Enhancing capabilities to enhance the quality level of requirements reviewing the factors affect the satisfaction
6	Contributing to review know-how documentation	Reviewing documented know-how

As a summary of the discussion, the following advantages are addressed when knowledge chain is approached:

1. Know-how embedded documentary affects interactions of people follows knowledge chain. It provides a basis to enhance the competitive advantage of a process.

2. The characteristics of the source of knowledge affect the quality of know-how transferring. Szulanski [15] focused on analyzing these characteristics. The reliability of the source is one of the factors considered by Szulanski [15]. The proposed model follows a chain to ensure enhancing of the reliability of the source of the knowledge explicated / documented by contributing the people crossly in an organization.

3. Operational approach to document knowledge provides the opportunity that right knowledge be available for all work stations effectively. Hinds et al. [16] stated transferring expertise and knowledge from experts to novice of a process should be focused on by organization. Knowledge chain approach helps organizations to access this type of goals effectively.

4. Although there are different mapping techniques in literature, real cases of organizations indicate the lack of an approach to satisfy real characteristics of processes. Knowledge chain approach provides the expectation following the real capability of the hardware, software and human resources in an organization.

5. Knowledge chain is capable to lead an organization to measure a) the quality of knowledge shared between the work stations, and b) improving knowledge asset and maintenance of it over time, easily. The capability of measuring helps managers to determine which work station operates well and what degree of inconformity has been improved. The measuring may be followed using defect rate, cycle time and manufactured cost terms.

6. Knowledge chain approach helps engineers to document technical knowledge i.e. know-how effectively.

TABLE III. THE FACTORS INFLUENCE ON TRANSFER KNOWLEDGE

No.	Factor	Reference
1	Knowledge source	Foss and Pederson [17]
2	Considering three types of know-how including product know-how, production know-how, and process know-how	Atashgar [3]
3	Characteristics of the transferred knowledge	Zander and Kogut [18] Szulanski [13] Simonin [19]
3	Absorptive capacity of knowledge receivers	Szulanski [13] Lyles and Salk [20] Lane and Lubatkin [21] Gupta and Govindarajan [14] Lane, Salk and Lyles [22] Minbaeva et al. [23]
4	Organizational context in which the transfer takes place	Szulanski [13] Simonin [19] Bresman et al. [24] Gupta and Govindaraian [14]
5	Nationality, education, political, justice, economic, and other systems, corporate governance, management styles, and incentive scheme	Doz and Santos [25]
6	Profile monitoring of know-how	Atashgar [4]

V. A CASE STUDY

In this section to investigate the knowledge chain approach in a real case, a car manufacturing factory is considered. It is assumed that all parts and all main subassemblies of the car that must be assembled by different processes of this factory, are manufactured completely (excepting paint operations) before delivering to the factory by different external suppliers. The complete knocks down (CKD) parts which are used by the studied factory to produce the car are defined as the raw materials. Figure 2 shows the flow chart of the production of the car in this factory. In this investigation we focus on the first process located to weld the body of the car. CKD parts of body first are delivered to this process as the first step of the production line named body manufacturing shop. As the logic of knowledge chain described before, the warehouse section plays the provider role (supplier) of body manufacturing shop. Here, the first work station group of the welding process of the body is referred to as the first users for the warehouse of CKD of body parts. Delivering conformed (accepted) CKD parts to work stations allocated to operate as the first steps of the production of the body is defined as the first problem. In this process after operating a few spots welding by different work stations to produce all subassemblies of the body using several jigs and fixtures, the subassemblies are delivered to a main jig station. In a car body welding process the main jig is designed to assemble high precisely the subassemblies completed by the welding work stations before. The main jig station is considered as the most important station for this process. After completing the operations of the main jig station, the assembled body is carried over a fixture to assemble doors, bonnet and lid truck by workers. Figure 3 shows the assembled body graphically from four views.

Two of the important technical specifications here known as gap and step are measured by quality control inspectors. Gap is defines as the distance between body and assembled doors. The technical documents indicates the gap between bonnet and fenders, lid trunk and frame sides, front doors and fenders, front doors and frame sides, and finally rare doors and frame sides must be measured. Step is defined as vertical distance of a body part compared to another parts assembled adjoining parts. The main jig station has an essential role to follow a body the technical specifications of gap and step. Figure 3 also addresses gaps and steps of the car body where must be inspected.

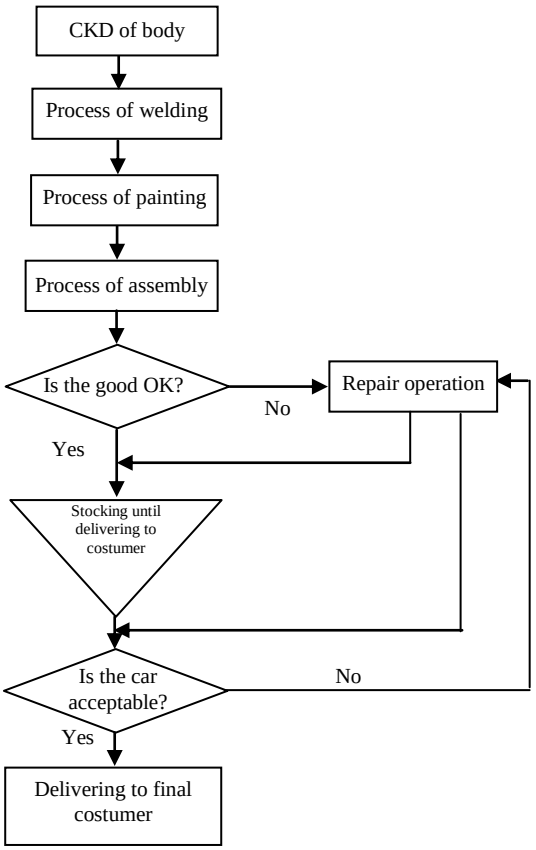

Figure 2. The process of production of car

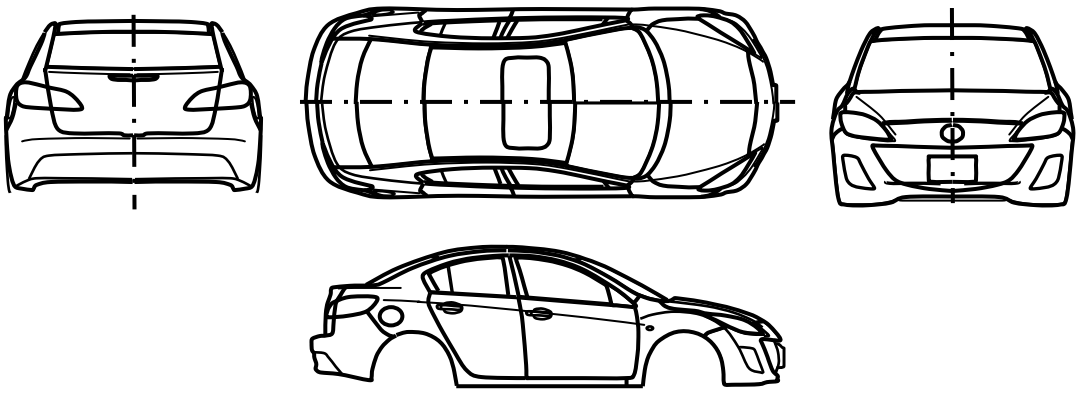

Figure 3. 4 views of a body of car and the position of gaps on the body

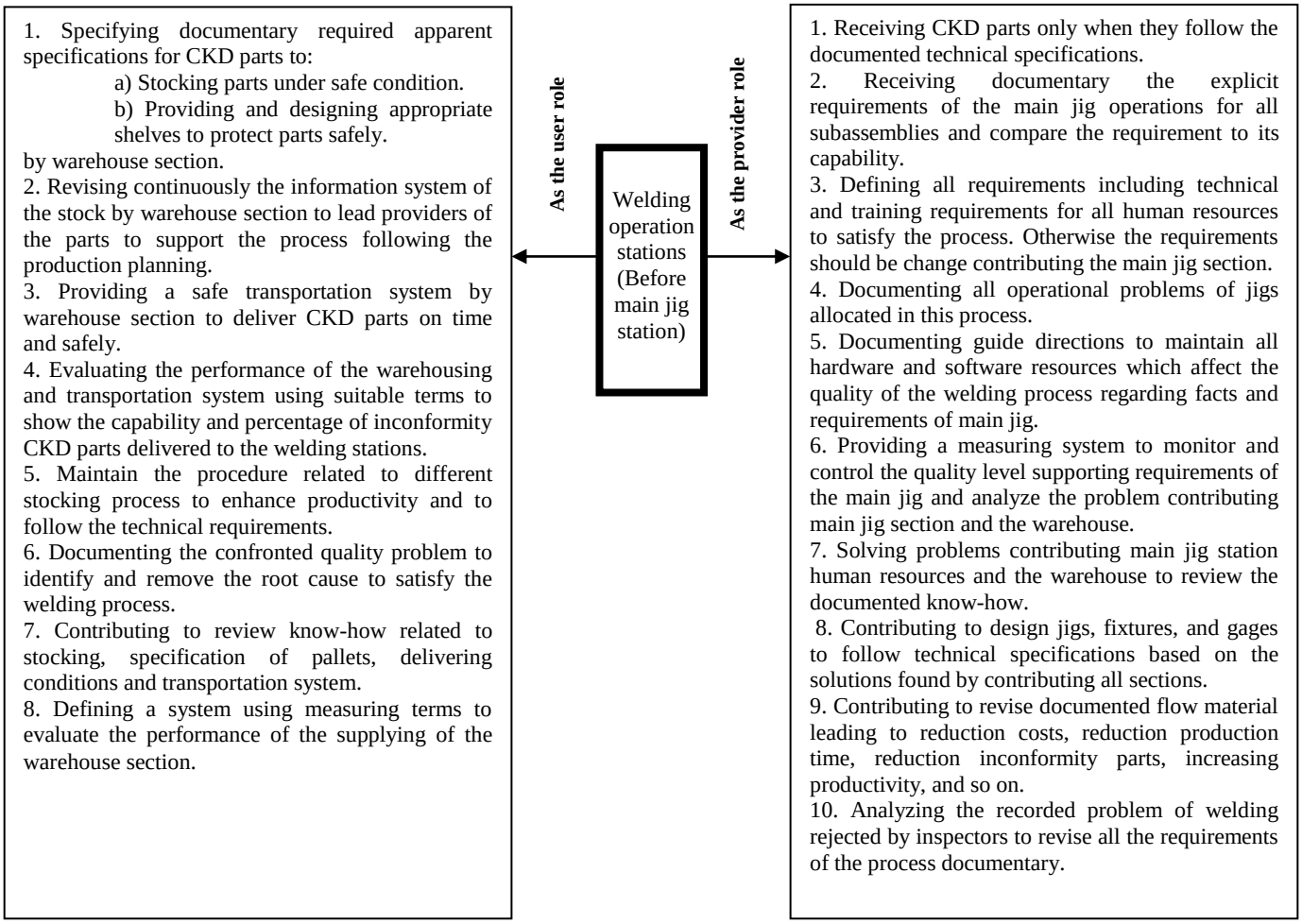

Figure 4. Communications of welding stations

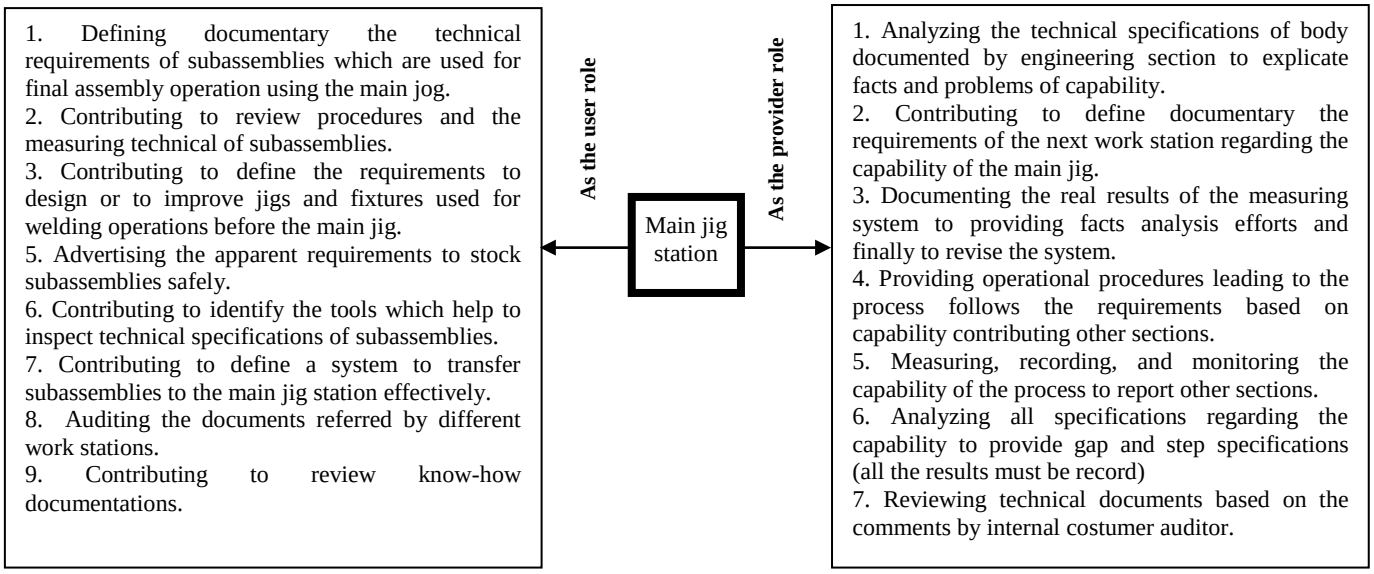

Figure 5. Communication of the main jig station

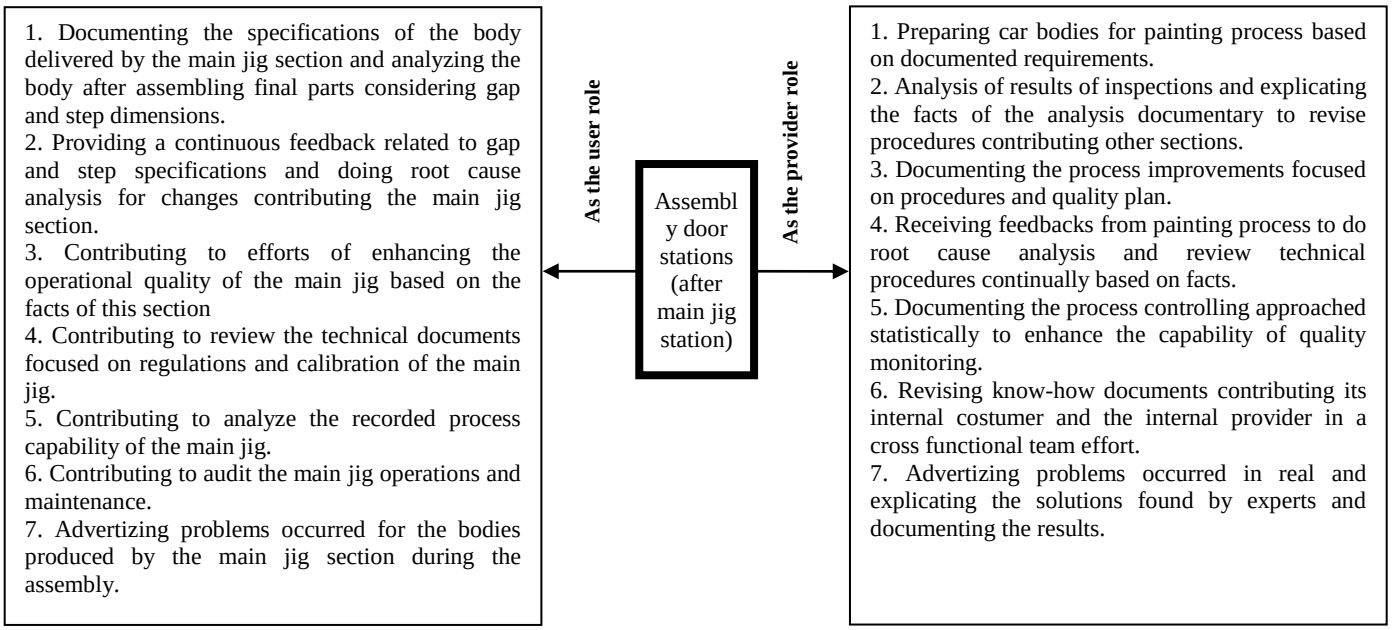

Figure 6. Communications of the assembly station

To the sake of simplicity, we categorize the considered welding process to 3 main phases. The first function group is defined as all the welding stations belong to before the operations of main jig. The second and the third categorizes are defined as all the welding operations of main jig and assembly operations of different doors of the body after main jig, respectively. In this case we only focus on the gap and step data related to the lid trunk and frame sides of the car manufacture in a plant in Iran and apply the proposed approach to analyze the process leading to know-how documentation. There exists a set of origin source documentation to lead labors to operate the sequenced operations. In this real case, the knowledge chain approach helps engineers to review practically and revise the used sources. Figures 4, 5, and 6 show the communications based on requirements and finally to revise know-how documents by each of the categorized sections, respectively.

VI. CONCLUSION

Know-how is referred to the valuable knowledge experienced in practice by a process structurally. This type of knowledge is known as an organizational asset when the experienced knowledge including details of technical information is documented structurally. The embraced structural type of know-how allows an organization to achieve competitive advantages. In this paper a new approach named knowledge chain introduced to document expert knowledge, i.e. know-how effectively. This structural use case approach helps effectively to explicate documentary the technical knowledge of each stages of a process. The analysis of advantages of the proposed approach showed the individual tacit knowledge experienced by employees can be explicated effectively using this forward backward traceability approach. The effectiveness approach helps organizations to enhance the quality of the process along with documenting tacit knowledge structurally. The valuable documented knowledge provides the capability of transferring know-how to other organizations.

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