Full Length Research Paper

A systematic approach for knowledge auditing

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In today's business environment, a knowledge base approach toward all organization's aspects is inevitable. Having a method for identifying existed knowledge and experiences level and analyzing the need of knowledge acquisition from external sources or research and development to gain new knowledge, the organization will be able to reduce the gap between existed and needed knowledge toward achieving its strategic objectives. This method, which is known as knowledge audit, is an innovative and noteworthy field of research lately and is a basis for all attempts in knowledge management scope. This paper presented a new systematic approach to audit organization's knowledge and considered tacit and explicit knowledge. So the organization identified its knowledge state and prioritized knowledge fields. Proposed methodology presented a basis for identifying organization's knowledge state developing solutions toward reaching desired state. At the end of the paper the proposed methodology's implementation was described in an active Iranian company in industries' pollution controlling industry.

Key words: Knowledge auditing, knowledge management, tacit knowledge, explicit knowledge.

INTRODUCTION

Identifying organization's current state in under investigation fields is the first step in organizational improvement. This leads to identify principal needs of improvement in different scope, concentration and productivity of amending actions (Liebowitz, 2005). In order to benefit from knowledge management as a novel solution to improve organization's performance, recognizing organization's state in various scope, organization is able to implement knowledge management which making the organization prosper is their object. A set of action done toward identifying knowledge state or investigating the organization's knowledge health is called knowledge auditing (Liebowitz et al., 2000). In fact knowledge auditing helps organization identify known and unknown toward gaining competitive advantage (Debenham and Clark, 1994) in order to give a clear cognition of organization's knowledge state (Choy, 2004). Hence knowledge auditing could be known as a qualitative assessment which knowledge health is the under investigation factor in that (Liebowitz, 1999). The crucial point is difficulties in knowledge auditing which is mostly caused by knowledge

invisible inherent consequently uselessness of traditional auditing methods (Liebowitz et al., 2000). On the other hand, knowledge auditing should be done related to organization's objectives, visions and consequently anticipated knowledge state of the organization. This leads to relative auditing results, besides that because of need of comparison with an implicit state it increases complexities of knowledge auditing. So despite introduction of knowledge auditing approaches by various researches, a comprehensive and systematic approach which can meet different requisites of the organization in this field is not attained (Liebowitz, 2005). According to emphasized points of previous contributions in knowledge auditing and other requisites of an efficient auditing method this paper is to propose an efficient knowledge auditing method in order to meet the following points:

1. Identifying and accessing organizational knowledge
2. Identifying the organization's experts and specialists in various fields

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Table 1. Definitions of knowledge auditing.

Definition	Reference
Knowledge auditing can be known as identifying, defining and reporting organization's knowledge state which includes surveying organization's knowledge policies, knowledge structure and knowledge flows	(Rao, 2005)
Knowledge auditing is exact examination, investigating and assessing organization's knowledge potencies, resources and its current knowledge assets and KM activities.	(Lauer and Tanniru, 2001)
Knowledge auditing determines main information and knowledge needs and its exploitation in the organization. This process clarifies gaps, interactions, flows and the way of their impact on business objectives. As a primary in KM, it	(Liebowitz et al., 2000)
Knowledge auditing is examining and surveying the existed, needed, available, missed and applicable knowledge in the organization.	(Bontis, 2001)
Knowledge auditing is a practical solution to know what we know. This process determines holders, operators, applications and key features of substantial knowledge properties.	(Perez-Soltero et al., 2006)

3. Prioritizing organization's knowledge fields for knowledge state improvement
4. Identifying potential points to share knowledge among experts, departments and organizational units

In the second section of the paper a review of concepts and knowledge auditing methods is done. Third section assesses proposed knowledge auditing method together with all its implementation steps and in fourth section results and challenges of implementing the proposed methodology in a big active company at upstream industry's pollutions controller appurtenances engineering and construction in Iran is discussed. Ultimately this paper proceeds in conclusion and proposes future scope of researches.

Knowledge auditing

A key dimension in knowledge management, which according to empirical studies is utterly critical, but has been studied less than other methods is auditing organization's knowledge (Bontis, 2001; Marr et al., 2004; McInerney, 2002). It should be motioned that the difficulty of knowledge auditing, although it is one of the elemental factors in producing value and profits, is because of its invisible nature and impossibility of determining its exact share among other factors (Bose, 2004). As knowing the organization's knowledge state can work as a basis for developing other scopes of knowledge management. This evaluation can give a crucial insight to organization's managers for knowing critical knowledge scopes; it is important to investigate this field of knowledge management whereas efficiency of any knowledge management system is directly related to the clear determination of needed action and the scope of them in order to create maximum enhancing effect in organiza-

tion's knowledge growth, creation and development (Liebowitz, 1999). Various researches have proposed different definitions of knowledge auditing according to knowledge invisible nature and various objectives of knowledge auditing processes. In Table 1 some of these definitions are presented.

Generally the mentioned definitions agree on the point that knowledge auditing is a solution to become aware of the known and an endeavor to identify the unknowns.

MATERIALS AND METHODS

Organizational knowledge auditing methods

Previous presented models and methods for knowledge auditing investigate this field from a special view. Some of them have financial and overall view of organizational knowledge and generally determine the value of organization's knowledge asset. These kinds of methods have two approaches toward calculating organization's overall knowledge estimation value. One of them, the difference between organization's market value and shareholders' funds is introduced as organization's knowledge asset namely Market to Book Value (Stewart, 1997), The Invisible Balance Sheet (Sveiby, 1989; Rylander et al., 2000) and Method of Intangible Asset Measurement (Rodov and Leliaert, 2002). Also the other approach in methods like Value Added Intellectual Coefficient (VAIC) (Pulic, 2000; Pulic, 2004), Knowledge Capital Earnings (Lev, 2000; Osterland, 2001), and Total Value Creation (TVC) (Andersen and McLean, 2000) estimates organizational knowledge value return on investment or their future value as a basis for estimating organizational knowledge value. The major weakness of these methods is that they give just a general view about organization's knowledge and do not have the potency of calculating each of organizational knowledge value and organization's knowledge enjoyment level.

The other kinds of methods try to count each knowledge field's value and then have their cumulative value to reach the organization's overall value. Some methods such as Resource Costing and Accounting Human (Johansson, 1996; Grojer and Johanson, 1996) and Intangible asset valuation models (Sullivan, 2000;

Table 2. Categorizing organizational knowledge state assessment methods.

Categories	The most important used methods	References
Overall view based on financial indicators	Market to Book Value, The Invisible Balance Sheet ، Financial Method of Intangible Asset Measurement, Value Added Intellectual Coefficient (VAIC), Knowledge Capital Earnings, Total Value Creation (TVC)	(Stewart, 1997; Andersen and McLean, 2000)
Base on monetary value	Resource Costing and Accounting Human ، Intangible asset valuation models	(Johansson, 1996; Matsuura, 2004)
Methods based on factors and knowledge indicators	Balanced scorecard ، Skandia Navigator ، KP3	(Ahn and Chang, 2004; Edvinsson and Malone, 1997)

Matsuura, 2004) have this approach. Although, in first stage these methods consider knowledge fields separately and use a process base approach. It should be mentioned that it is very difficult and some time impossible to calculate monitory value for the majority of organizational knowledge. This significant problem makes this approach useless for public and governmental organizations.

There is another kind of method which generally assesses knowledge state based on factors and knowledge indicators. This method uses different approaches to measure knowledge. Some of them, like KP3, implement knowledge levels for organization's needed knowledge toward a desired performance. The most significant weakness of these methods is the ignorance of the organization's need of knowledge fields in different levels by considering solutions and organization's conditions toward desired organizational performance. Besides that these methods do not discriminate importance and organization's enjoyment level which prevents identifying and prioritizing knowledge fields according to problems which are consequent of poor organization's condition in them. Some other methods in this category consider some indicators in order to assess knowledge from different points of view and use experts and their consciousness about organization's vision. Methods like Skandia Navigator (Malone, 1997; Von Krough et al., 1999), Balanced scorecard (Edvinsson and Malone, 1997) are the most famous among these kinds of methods. Hence, these methods just pay attention to qualitative assessment. They only give an overall view of knowledge's qualitative state. They rely on human judgments and lack accurate assessment by linking them to explicit knowledge in the organization in addition to ignoring the weight of knowledge related to their position in hierarchies and their predecessor knowledge. This makes it impossible to gain policies for improving organization's knowledge position. The results of literature review are summarized in Table 2.

As it mentioned, knowledge assessment methods have their own strength and weaknesses. So there is an increasing need of an approach which can exploit the existed method strength and dissolve the gaps in assessing organizations' knowledge as much as possible and put forward a practical comprehensive methodology.

METHODOLOGY

According to discussed perspectives in the literature review section and investigated knowledge audit approaches' strength and weaknesses a methodology for auditing organization's knowledge is presented. Simultaneously considering both importance and exploit of knowledge is one of the most important features of the proposed methodology. This feature is used in analyzing and making decisions about knowledge situation improvement.

The proposed methodology for auditing organization's knowledge and its implementation procedure are in Figure 1. Detailed definitions of each stage are as follows.

Stage 1: Identifying organization's knowledge objectives

As it was mentioned one of the critical factors about the knowledge, which is considered in knowledge auditing, is its relation to the organization objectives. When treating knowledge auditing in relation to the organization's objective, the results of this procedure will adjust to reality, constraints and conditions the organization faces. On the other hand, identifying organization's knowledge objectives causes purposeful knowledge auditing and prevents considering uncritical factors. So in the first stage necessary knowledge level for meeting organization's objectives and visions should be identified. In other words, in this stage objectives should be interpreted to the knowledge level needed for reaching them. Knowledge level shows the organization's anticipated potency for reaching and managing needed strategic knowledge. According to mentioned elements above the main implementation steps in this stage are in the first row in Figure 1.

Stage 2: Identifying organization's experts

After determining organization's knowledge objectives, sources for scrutiny of knowledge situation and consequently knowledge audit should be identified. Key experts in strategic knowledge fields are one of the most significant sources for determining knowledge situation. Organization's experts are main references for investigating organization' knowledge situation based on appropriate assessment criteria. In fact because of experts' experiences in organization, various knowledge dimensions are the most suitable references for referee in knowledge auditing according to appropriate identified indices. For that matter in this stage the most experienced knowledge experts in various fields related to knowledge vision are identified. So the main steps of this stage are in the second row in Figure 1.

Stage 3: Identifying organization's knowledge documents

In order to survey the level of making knowledge potential which are gained from experiences by people and organization's group, after identifying the knowledge vision and objectives and before auditing organization's knowledge, all the knowledge documents which exist in the organization should be identified. Knowledge documents are documents that within time by observing various
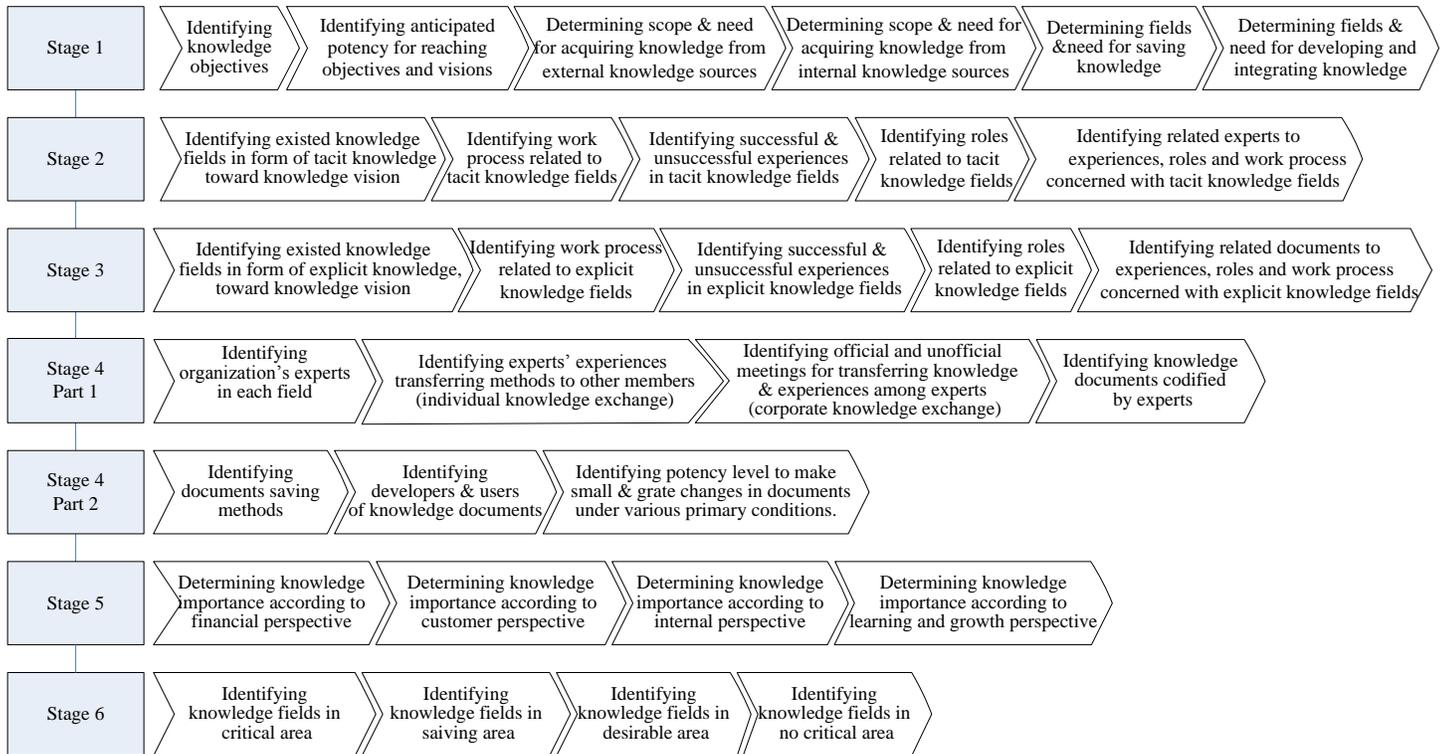
Figure 1. Proposed knowledge auditing approach.

occasions or analyzing and learning from successful similar cases, according to feature and special conditions of the organization are created completely or developed by the organization. Furthermore all the organizational documents which in form of knowledge transfer from external sources have been transferred into the organization are counted as a knowledge document. But it is crucial that the potency of implementing that document in various conditions or higher level of potency such as ability to transform it to adjust to the circumstances have been transferred efficiently to the organization. Main steps of this stage are in Figure 1.

Stage 4: Determining organization's enjoyment of knowledge

In this stage according to the information obtained from second and third stages, knowledge audit will be done from the tacit and explicit perspectives and according to knowledge vision and objectives. In the first section in this stage in order to investigate tacit knowledge, the organization's usage situation of experts in each of the organization field of work is determined. Also the way of transferring experts' experiences to the other members of the organization, the organizational meeting frequency in order to share experiences and organization's devices for maintaining experts are analyzed. For instance if there is just a few experts in one work field in an organization, because of uncertainty in knowledge, this field has low grade. Likewise if in one field in an organization, despite having prolific number of experts, but no specific device to transfer these experts' experiences to the fresh organization's members or prevent leaving the organization, the knowledge situation in those fields of work cannot be considered fortified. By considering mentioned hints from the tacit knowledge perspective by help of identified key experts in each field auditing can be done as it is shown in part 1 of Figure 1. In order to identify organization's

experts in each field from organization's members the below factors must be considered:

1. Professional experience and organizational roles authorized in that field
2. Incidents, crisis and losses in that field during role playing
3. Successful occasions in that field during role playing
4. Prepared knowledge documents

Knowledge documents codified by experts can be scientific articles published in conferences and professional journals, experienced manuals and work procedures, necessary safety hints which prevent overwhelming, principals and procedures to reach success or better way of doing work procedures.

In the second section of this stage, organization's situation from knowledge documents perspective is assessed. This stage's innuendo is to survey the benefiting level from knowledge documents produced based on organizational experiences or research and developments. So for organization's potency to make little or overall changes and updating them, the number of experts and creators of that kind of documents and level of knowledge documents usage, the organization's knowledge situation is determined. For example if the organization has bought knowledge from external sources such as consultants and contractors in a work field but it does not have the ability of making changes in the transferred knowledge, despite having those documents would not have a good situation in that field. By considering these notions using identified key experts' opinions in second stage we can assess organization from explicit knowledge perspective as it is shown in stage 4 of Figure 1. In this part, when organization's documents saving methods are going to be identified, possibility of systematic exploring and classifying knowledge documents, and possibility of developing and completing knowledge documents

Table 3. Importance ofdetermination indicators according to organizational visions.

Important determination criteria	Perspective
Creating and maintaining new value	
Creating new property and enhancing productivity	
Increasing benefits (earning per share)	financial
Decreasing purchase cost	
Thrift in production cost	
Developing new markets	
Making new profound relations and continues improvement in collaborating with customers	
Improving service and patronage of customer	
Developing organization availability, potency and Expansion	Customer
Ease of organization flourishing toward a more intelligent organization and producing intelligent customized productions	
Providing the possibility of accessing to newer expertise level in managing brand, popularity and other invisible instances which are important for the customers.	
Improving productivity and efficiency	
Increasing collaboration and cooperation	
Boosting organization toward a more eligibility for adjustment, response, dynamics and flexibility	internal
Boosting organization's potency for change management	
Enabling organization for a continues growth	
Decision making improvement	
New business model development and implementation	
Accelerating innovation	
Predispose to express new ideas and creativity	
Better preparation and prediction of the future	Learning and growth
Improving and accelerating learning	
Promoting knowledge workers to overwhelm increasing growth of information	
Converting the procedures' know how to a precious organizational property (knowledge convert)	

during time must be considered.

Stage 5: Determining knowledge importance

One of the most important outcomes of knowledge auditing is the possibility of prioritizing knowledge strength and weaknesses in order to make it possible to systematically plan for implementing methods of organization's knowledge situation progression. So besides determining organization's enjoyment of knowledge it is critical to survey the importance and each field's role toward organization's knowledge vision. Hence in this stage according to key experts' opinions and based on appropriate knowledge criteria, knowledge field's importance is investigated. Related to knowledge role in meeting organizational objectives and based on balanced score card perspectives (Table 3), criteria for determining knowledge importance are selected.

Stage 6: auditing organization's knowledge situation

In this stage according to the assessments done, auditing

organization's knowledge in each of organization's knowledge fields will be done. For this purpose knowledge situation assessment matrix is used. Assessment matrix consists of a two dimensional planes: its horizontal axis shows organization's knowledge score in each knowledge field (organization's enjoyment level of knowledge) and vertical axis presents knowledge building block weight (knowledge importance). This matrix has four areas shown in Figure 2.

Critical area: is the area in which knowledge weight is high but knowledge score is low. Those knowledge fields placed in this area must be in the first priority for the organization to improve.
Desirable area: in this area, both knowledge weight and score are high. Those knowledge fields in this area have desirable situation.
Saving area: is the area in which knowledge weight is low but its score is high. These knowledge fields can be promoted to the desirable knowledge area by making appropriate strategies.
Non crucial area: is the area in which both knowledge weight and score are low. The related knowledge fields are unimportant. The organization's enjoyment of them is low and there is no need for concentrating on them.
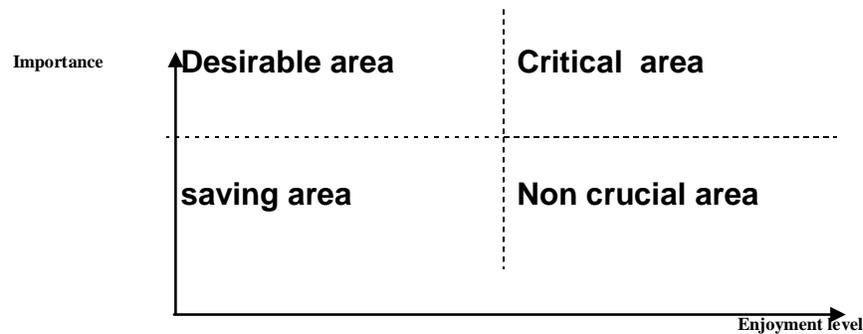
Figure 2. knowledge situation assessment matrix.

RESULTS, DISCUSSION AND CONCLUSION

In this part the implementation of the proposed method in an Iranian company is discussed. This company is one of the largest active centers in service and research in controlling upstream industry's pollutions and has done the majority of these kinds of projects in Iran. Because of its exclusive situation in upstream industry's pollutions controller appurtenances engineering and construction in Iran, it has a huge amount of tacit and explicit knowledge. The most predominant features that impart abundant amount of knowledge in this company are as follows:

1. Most of this company's activities in upstream industry's pollutions controller appurtenances engineering and construction field are the first case in that kind in the country.
2. This company has a lot of communication with eminent companies in upstream industry's pollutions controller appurtenances engineering and construction field in all over the world.
3. A lot of specialists and experts in upstream industry's pollutions controller engineering and construction field are in charge in this company.

According to the mentioned instances this company decided to implement the proposed method of knowledge auditing in order to audit upstream industry's pollutions controller appurtenances engineering and construction field knowledge toward these objectives:

1. Designing a method of auditing the knowledge of upstream industry's pollutions controller appurtenances engineering and construction.
2. Designing a system for permanent auditing the knowledge of upstream industry's pollutions controller appurtenances engineering and construction.
3. Planning for maintenance and improvement of existed knowledge in upstream industry's pollutions controller appurtenances engineering and construction field.
4. Quick and effective organizational knowledge distributing and enhancing its retrieval in the company.
5. Increasing benefits by more effective managing existed Knowledge in upstream industry's pollutions controller appurtenances engineering and construction.

According to these objectives and based on proposed methodology, by aid of knowledge management professions and technical specialist team knowledge auditing was done. Some of the most crucial points in implementation of the proposed approach in under study company are mentioned.

Identifying vision and knowledge objectives of the under investigation company by analyzing vision, missions and objectives of this company in cement industry also anticipated knowledge potency and the importance of them in a broad scale with the aid of experts in the following field was done:
1. Identifying, sharing and acquiring necessary knowledge for developing organizational, managerial and executive potencies to execute upstream industry's pollutions controller appurtenances engineering and construction field.
2. Achieving knowledge potency toward reducing final price, enhancing productivity and quality in order to enhance rival ability in engineering and construction of upstream industry's pollutions controller appurtenances.
3. Attaining creation and development knowledge of upstream industry's pollutions controller elemental appurtenances engineering and construction technology.
4. Identifying and acquiring knowledge of enhancing national made upstream industry's pollutions controller appurtenances.
5. Acquiring knowledge of utilization and maintenance in related parishes.
6. Identifying, sharing and developing knowledge of project management and accomplishment in upstream industry's pollutions controller appurtenances engineering and construction field in national and international level.
7. Enhancing national contactors' knowledge potency in accomplishing projects of upstream industry's pollutions controller appurtenances engineering and construction field.

In order to attain under investigation knowledge fields, in first step all the knowledge processes were identified. This was done in a hierarchy manner up to four levels by
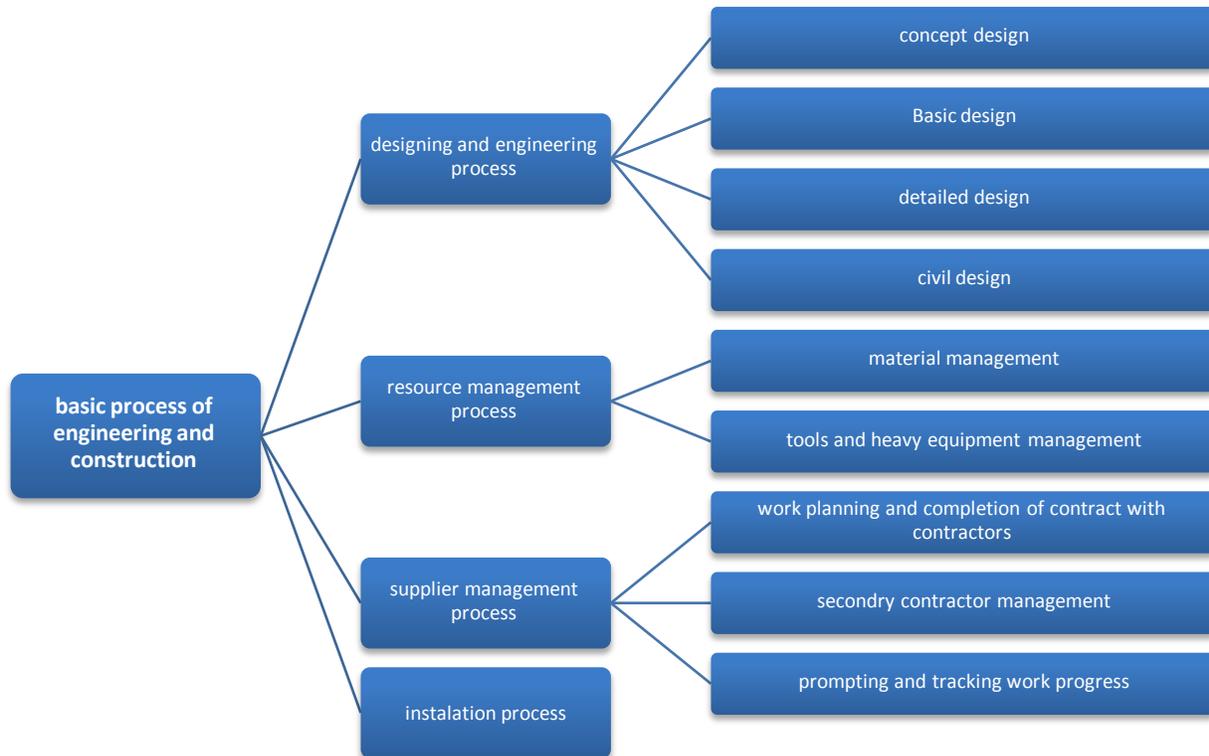
Figure 3. An instance of identified knowledge processes.

using organization's experts, process approach and reference patterns such as SAP and APQC related to upstream industry's pollutions controller appurtenances engineering and construction field. An instance of first and second level of knowledge process is represented in Figure 3.

Then using existed technical documents, reference guide books and organization's experts' opinions, knowledge based components of all the upstream industry pollutions controller systems are identified. An instance of first and second level from one appurtenances of upstream industry's pollutions controller is shown in Figure 4.

Under investigation knowledge fields are obtained by crossing rival levels of process and knowledge base subsystems hierarchies. For example designing and engineering of Deducting System compose a knowledge field which consists of sub components that can be obtained by crossing beneath level from process and knowledge base subsystems hierarchies.

By auditing knowledge, more than 300 knowledge fields related to engineering and construction of upstream industry's pollutions controller appurtenances, up to 11 organization's experts in essential knowledge fields, the most critical knowledge gaps in various fields and knowledge fields' priority by considering objectives and organizational visions were identified. So under investigation organization could meet the need of notification of

knowledge situation in each of related knowledge fields expeditiously. In those knowledge fields which the majority of knowledge is tacit and in organization's experts mind because of accurate identifying of them, the organization can access them quickly in necessary occasions. In addition the organization will have an appropriate basis for prioritizing and tracking implementation of knowledge situation improvement solutions effects in different fields.

Hoarding and fear of stating exact knowledge situation by company members in some departments were the most crucial challenge during implementation of knowledge auditing model. Despite few numbers of these cases they were considered. Educating, culture making and making them confide that their identity will be disguised helped a lot in solving this problem.

Another problem in implementation of proposed model was the expansion of company's departments and sections and dispersal of its experts because of company's project base nature which made it difficult to identify knowledge fields, experts and knowledge documents related to different fields. In dealing with this problem, up to down approach and identifying experts, documents and knowledge fields from general to detailed level made the actions in this field more objective.

In this paper after reviewing necessities and definitions of knowledge auditing as one of the most important actions toward knowledge management in organizations,
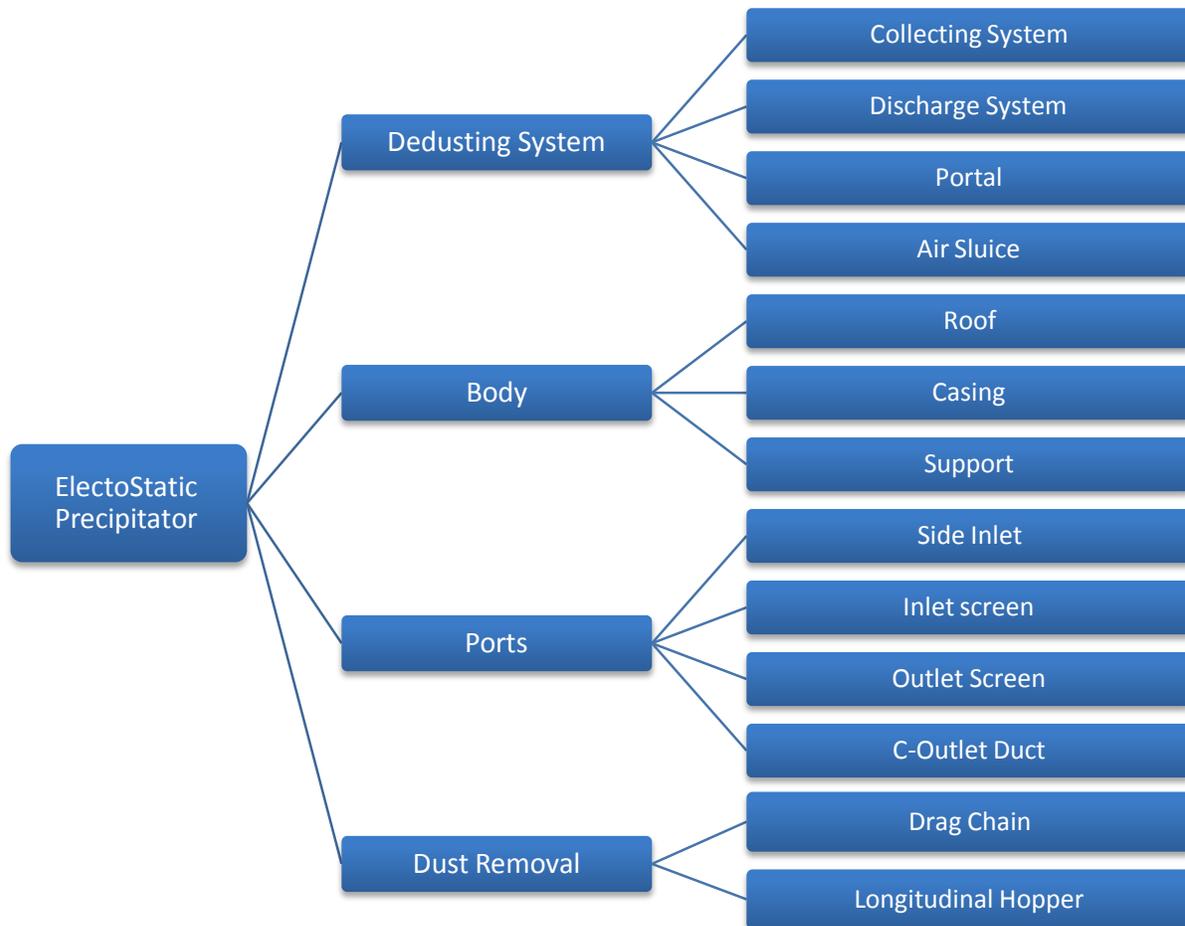
Figure 4. An instance of identified systems.

a systematic approach for auditing knowledge in organizations was presented which consists of effective dimensions of previous presented approaches in the literatures and other requisites for systematic identifying organization's knowledge situation. One of the most important features of the proposed method is that it involves tacit and explicit organizational knowledge and considers importance and enjoyment of knowledge together in different fields which make the auditing results comprehensive and practical. Since an important point in knowledge auditing is comparing present and desired knowledge situation; presenting a systematic approach for determining present and desired situation is a point for future research. In addition knowledge auditing should be done in different knowledge fields in the organization, making a systematic approach to identify and arrange knowledge fields and determining the relations between them in the future.

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