

A Know-How and Knowing-That Cartography for Improving knowledge Management in Medical Field

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Abstract: As a tool of Knowledge Management, knowledge cartography is used, in this paper, to enhance knowledge identification, sharing, representation and visualization in a healthcare organization as well as to deliver healthcare services and improve communication between healthcare professionals. The Know-How and Knowing-That concepts are used, in this paper, instead of the knowledge concept. Know-How is defined as the capacity to perform an action and Knowing-That is defined as a belief state related to a description which can be factual or prescriptive. For the construction of Know-How and Knowing-That cartography, a knowledge cartography methodology is proposed. It is composed of three steps: (i) identifying the concepts to visualize, (ii) identifying the graphical elements and (iii) choosing the cartography technique. This cartography is experimented in the ASHMS (Association of Protection of Motor Disabled of Sfax) to facilitate Know-How and Knowing-That identification, characterization and visualization.

Keywords: Healthcare knowledge management, knowledge identification, Know-How and Knowing-That cartography, knowledge visualization, Know-How, Knowing-That

1. Introduction

Confronted with demands of care quality, optimality, dynamicity and complexity, medicine is obliged to well manage their medical knowledge which is increasing (Stroetmann and Aisenbrey, 2012). To reach, this objective, each healthcare organization must integrate a healthcare knowledge management (Nadeem et al., 2012).

Medical knowledge known also by healthcare knowledge *«is dynamically contextualized to interpret the patient's evolving health status, and to derive treatment interventions that will work for a specific patient in a specific healthcare setting. [It] can transform healthcare practices to achieve high levels of patient safety, care quality, team-care, patient centeredness, and cost-effectiveness»* (Abidi, 2008). This knowledge is created through different modes like communication, exchanging and sharing knowledge between practitioners (global assessment), interrogation examination and assessment stored in medical records and other knowledge related to experiences and skills (Henry, 2010; Chen, 2013).

Healthcare Knowledge Management (HKM) is the confluence of formal methodologies and techniques to facilitate the creation, identification, acquisition, development, preservation, dissemination, modeling and use of various facets of a given healthcare enterprise's knowledge assets. To enhance growth, development, communication and knowledge preservation in healthcare organizations, HKM allows healthcare professionals to reach rapid and assertive responses linked to the decisions they need to take (Rocha et al., 2012), to share tacit knowledge, collaborate, exchange, and identify the most crucial knowledge, preserve some knowledge at risk of loss, and improve the care quality and healthcare delivery (Morr and Subercaze, 2010).

HKM proposes tools and methodologies for the creation, identification, acquisition, development, preservation, dissemination, sharing and use of medical knowledge in healthcare organizations (Abidi, 2001). We distinguish between HKM methods and tools derived from knowledge engineering for knowledge modeling in the form of ontologies and those for the identification and preservation of medical knowledge. In particular, knowledge cartography is used as a tool of knowledge identification. Knowledge cartography is defined as the set of processes, tools and methods for knowledge analysis used to discover its characteristics,

meanings and visualization (IBM Global Service). Knowledge cartography is also a tool for knowledge representation and visualization using graphical entities to convey meaning for knowledge sharing, transfer and creation between at least two persons (Grey, 1999; Speel et al., 1999; Vail, 1999; Hylton, 2002; Vestal, 2005; Burkhard, 2005; Ebener et al., 2006; Bertschi et al., 2011; Aslizadeh and Ghaderi, 2015). The knowledge cartographies proposed in literature do not take into account knowledge, its stakeholder, its creators, its users, the actions performed through knowledge and the different descriptions related to knowledge.

In this paper, we propose a Know-How and Knowing-That cartography to enhance Know-How and Knowing-That identification, sharing and visualization between organization's members. Know-How and Knowing-That are two types of knowledge and are used instead of knowledge to distinguish between its different natures (Fantl, 2012). We define Know-How as the capacity to perform an action and Knowing-That as a belief state related to a description (Ghrab et al., 2016) which can be a propositional attitude of having some attitude, stance, take, or opinion about a proposition or about the potential state of affairs in which the proposition is true (Schwitzgebel, 2014). A methodology for the construction of Know-How and Knowing-That cartography is proposed and it is based on three steps: (i) identifying the concepts to visualize, (ii) identifying the graphical elements and (iii) choosing the cartography technique.

Know-How and Knowing-That cartography is experimented in the ASHMS (*Association of Protection of Motor disabled of Sfax*) where our research group conducts their researches. Previous researches of our research group were taken into account for Know-How and Knowing-That cartography building.

The plan of the paper is structured as follows. The next section is a literature review which encompasses a comprehensive and exhaustive coverage of available appropriate and contemporary literature details about the importance of knowledge cartography in healthcare and its use. A conceptual analysis of the knowledge concept is conducted in the third section. The fourth section details the methodology proposed for Know-How and Knowing-That cartography construction. The fifth section describes our application context and the results of the experimentation of Know-How and Knowing-That cartography in the ASHMS. The next section is about findings and discussion. The last section provides a general overview of the contributions proposed in this paper and we present the research perspectives hopefully to be achieved in the future.

2. Literature review

Visualizations and knowledge cartographies are used in healthcare in numerous ways ranging from the study of the basic principles of creating knowledge cartographies, to the cognitive processes underlying their use, as well as how knowledge cartographies communicate complex information and knowledge.

In this section, we summarize the most recent works which stress the importance of knowledge cartography in healthcare and its benefits.

(Stroetmann and Aisenbrey, 2012) propose a systematic knowledge management approach of Siemens Healthcare to facilitate access to reliable, relevant medical information with adequate depth by improving knowledge creation and sharing processes in the organization. Existing and new knowledge are stored in the Clinical Knowledge Base (CKB). Any input to CKB is evaluated and commented by the medical experts and adopted to the need of the organization. For the sharing operation, Siemens Healthcare implements push-pull strategies which are designed to meet the needs of the organization. The pull services (self-service) contribute and retrieve knowledge as and when one's need it whereas push services (facilitate knowledge transfer) are driven by the need of the organization. The CKB identifies the medical knowledge extracted from a long career of Siemens with the experts, diseases and patients. This knowledge can be shared, transferred, organized and captured through the organization.

(Panahi and al., 2012) examine the contributions of social media to facilitate tacit knowledge sharing among physicians. It is a tacit knowledge identification and localization method. A deep analysis is undertaken proving that most of physicians share their tacit knowledge, experience and know-how among social media in forms of tips and tricks, personal clinical opinions, day-to-day clinical experiences and lessons learned, demonstrating clinical skills through videos, best practices, writing about unusual cases, developing discussions around particular cases, or asking clinical questions. This can let physicians easily identify tacit knowledge embedded in their mind on the one hand and improve the knowledge transfer, sharing and internalization. The identified

contributions of social media for tacit knowledge sharing are resumed especially in the ability to socialize online, best practices demonstration, networking with colleagues, interactive story-telling, increasing visibility of information, openness, trust and archiving articulated knowledge.

Brahmi et al. (2013) propose a new mapping approach based on the Boolean modeling of critical domain knowledge and on the use of different data sources via the data mining technique in order to improve the process of acquiring knowledge explicitly. The result of the mapping of critical knowledge is refined through a symbolic automatic learning process graph-based induction for know-how map improvement.

(Berkani and Chikh, 2012) propose a Semantic Based Approach for Knowledge Capitalization in Communities of Practice of E-Learning (CoP) which can be applied in the medical field (the community of practice of E-learning can represent the staff of healthcare teachers and apprentices or trainers: the learning teacher-trainee). CoP are groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis. The capitalization operation is based on an ontology-based framework structured into three layers: (i) the ontology layer, (ii) the semantic annotation layer, and (iii) the asset layer. The framework provides a common vocabulary within a CoP to enable a shared understanding between its members, a semantic support to annotate its knowledge assets facilitating their retrieval and reuse, and a means of storage and indexing its different assets.

The works presented in this section stress the importance of medical knowledge that is why most of healthcare organizations draw attention to well identify and locate this knowledge. Medical knowledge identification can affect explicit knowledge as well as tacit knowledge. The first type of knowledge is easily acquired and identified but the second type is difficult to identify, manipulate and manage. That's why the focus should be on tacit knowledge because healthcare professionals' tacit knowledge is the most valuable source of their experiential know-how acquired in critical situations of patient management. This knowledge is increasing in order to select the latest news in medicine, use innovation process and products to solve problems and improve the care quality. In fact, the process of healthcare innovation gives birth to a worthwhile amount of explicit and tacit knowledge (Omachonu and Einspruch, 2010). This amount must be capitalized in order to choose the most important and crucial knowledge which are still not validated. The different methodologies proposed and already mentioned above do not clarify how knowledge identification can be applied on healthcare and do not distinguish between knowledge related to the action or related to its description. For these reasons, we conduct a conceptual analysis of the knowledge concept to better describe and characterize knowledge.

3. Conceptual analysis of knowledge

Knowledge is an abstract notion discussed in different disciplines. Many knowledge definitions are proposed in the literature, but it is difficult to attribute a unique and consensual definition to knowledge while taking into account the different concepts related to it and its use domain. According to Burkhard (2005), the need for knowledge in organizations restricts its definition. If the organization's objective is to ensure a given solution's storage, then knowledge is defined as an object. While the organization's objective is the optimization of the knowledge processes such as identification, creation, or sharing, knowledge is defined as a process. In this paper, knowledge is not an object (Grundstein, 2009). It is related and mobilized in human action (Grundstein, 2009). It is related to the organization's processes (Nonaka and Takeuchi, 1995). We partially share this point of view. In fact, some knowledge can be linked to actions (for example, knowledge related to the detection of a disease) or to descriptions (for example, knowledge related to or about a specific disease). The first type is known as Know-How and the second type is Known as Knowing-That. This first type is not taken into account in most definitions of knowledge. In an organizational context, these two types of knowledge are more important and are closely dependent. This distinction is proposed, also, in epistemology (Fantl, 2012).

3.1 Know-How

Know-How is defined as the capacity to perform an action (e.g. Know-How to drive a car) (Ryle, 1949; Lewis, 1990; Maier, 2011). The concept of capacity is defined as the ability to perform an action (Maier, 2011). We are interested mainly in intentional action which is related to intentions (e.g. driving a car is an intentional action). For Know-How, we distinguish between tacit/explicit, individual/collective and internal/external dimensions. An individual Know-How is Know-How which is borne by a human (e.g. knowing how to drive a car) whereas

Collective Know-How is Know-How which is borne by a group, i.e. collective (e.g. knowing how to play a symphony. This Know-How is held by the orchestra's members. It is related to the action of playing symphony collectively by these members). In the organization, we distinguish between the Know-How of the organization and the organizational Know-How. Know-How of the organization is a Collective Know-How held by an organization whereas Organizational Know-How is Know-How held by an organization unit (it is a proper part of an organization and is managed by the organization on which it depends) or an individual affiliated to the organization.

An Internal Know-How is a Know-How held by an individual or a collective who is affiliated to the organization in order to perform its actions. Contrarily, External Know-How is Know-How necessary for the organization. It is held by an individual or a Collective external to the Organization (unaffiliated to the organization) in order to accomplish and perform the organization's actions for a predetermined duration.

Tacit Know-How is Know-How «[...] *rooted in action, procedures, routines, commitment, ideals, values and emotions*» (Nonaka et al., 1996). It is «*difficult to formalize and often time and space-specific, tacit knowledge can be acquired only through shared direct experience, such as spending time together or living in the same environment, typically a traditional apprenticeship where apprentices learn the tacit knowledge needed in their craft through hands-on experiences*» (Nonaka and Toyama, 2003). For example knowing how to prepare a cake is a tacit knowledge acquired by the experience. Explicitable Know-How is a specific Tacit Know-How and represents the part of Tacit Know-How which can be stored on a physical or numerical support. Contrary to Tacit Know-How, Explicit Know-How is «[...] *uttered, formulated in sentences and captured in drawings and riting*» (Nonaka and Krogh, 2009). It is easily formalized, accessible and transferable.

3.2 Knowing-That

Knowing-That represents the relation between a proposition and a thinker (Stanley and Williamson , 2001). It assigns a truth value to a proposition. The predicate "S knows that P" affirms that S is an agent, while P is a proposition and the agent S knows that the proposition S is true. In general, a proposition is an assertion of a given situation, in other words, it is a type of description. Another type of description can be mentioned here is instructional description which describes a set of operations to perform, very often an action or a very specific task (to do this and then do that ...) (e.g. For the cake recipe, prepare first of all ingredients, beat then the eggs, add after that flour, mix then the different ingredients and put the cake in the oven). This type of description is a semantic content showing some process or a set of instructions to follow. By analogy with the proposition, it is possible to assign a truth value to descriptions. The assignment of a truth value to a description allows to study the certainty and the reliability of this description. The belief degrees proposed by (Schwitzgebel, 2014) are adopted in our work for descriptions degrees detailed below:

- 0 indicates absolute certainty of the falsity of a description
- 1 indicates absolute certainty of the truth of the description
- 0.5 indicates that the subject considered the description can be as true as false.

In general, Knowing-That is a belief state and attributes a truth value to a description. A belief or a belief state is «*a propositional attitude, then, is the mental state of having some attitude, stance, take, or opinion about a proposition or about the potential state of affairs in which that proposition is true—a mental state of the sort canonically expressible in the form "S A that P", where S picks out the individual possessing the mental state, A picks out the attitude, and P is a sentence expressing a proposition*» (Schwitzgebel, 2014). A description of Knowing-That can be factual (a proposition) (e.g. the weather is nice / good today) or prescriptive (Do this, then do this and finally do this) (e.g. good practice guide, care and hygiene protocols).

4. Research design and methodology

The method of knowledge cartography that we propose is composed of three steps: (i) identifying the concepts to visualize, (ii) identifying the graphical elements and (iii) choosing the cartography technique.

4.1 Step1: Identify the concepts to visualize

This step is based on visualized concepts' filtering in order to identify the most pertinent and relevant concepts for the organizations such as crucial Know-How/Knowing-That and sensitive processes. We use, for thus, the

crucial knowledge identification method proposed by (Saad, 2005) and the sensitive processes identification method proposed by (Turki et al., 2011).

The Know-How and Knowing-That cartography allows to focus only on the Know-How and Knowing-That that can be useful for the organization. The concepts to be visualized in the Know-How and Knowing-That cartography are already identified by the COOK ontology (Know How, Knowing That, Capacity, Description) (Ghrab et al., 2016) and the COOP ontology (Action, Individual Action, Collective Action, Collective, Process Of Organization, Organization) (Turki et al., 2014). These ontologies are not detailed in this paper.

As of the Know-How and Knowing-That evaluation on a set of criteria, each Know-How and Knowing-That is classified in a decision class and characterized by a set of properties that distinguish between the explicit / tacit dimension, the internal / external dimension, the individual / collective dimension and the shared / non-shared dimension. The concepts to be mapped are often interconnected by already defined relations in the COOK and COOP ontologies:

- The Bears relation (reciprocal relation isHasBorneBy): is defined between an individual or a collective who holds the Know-How or Knowing-That.
- The relation IsThemeOf (reciprocal relation isHasForTheme): is defined between an action and a Know-How or a description and a Knowing-That.
- The IsAgentOf relation (reciprocal relation is HasForAgent): is defined between an individual or a collective and an action (which can be individual or collective).
- The relationship isAffiliatedToAt: is defined between an individual or a collective and an organization to which it belongs.

4.2 Step 2: Identify the graphical elements

This step allows to identify all the graphical elements which represents Know-How and Knowing-That cartography basis. The graphical elements used for mapping Know-How and Knowing-That are color and form. Other elements are the perception levels' choice and the spatial distribution of the concepts to be mapped.

4.2.1 Sub step1: Choose colors

The color is used in the cartography to distinguish between different levels of organization processes (OP, TLP, SLP, FLP and sensitive process) (Turki et al., 2011), types of Know-How and Knowing-That (tacit / explicit, shared / non-shared) and decision classes (Cl1 for "non-crucial Know-How and Knowing-That", Cl2 for "Know-How and Knowing-That may be crucial" and Cl3 for "crucial Know-How and Knowing-That") (Ghrab et al., 2014).

The choice of colors to visualize in the cartography is not arbitrary but it is based on the meaning of each color in the psychology of color. This discipline is interested in the study of the human perception of colors and the impact of colors on human activity (Laurent, 2009). The use of color contrasts favors the implementation of certain characteristics of the concepts to be mapped. We mainly use "color contrast in itself", the "light / dark contrast", the "hot / cold contrast", the "complementary contrast", the "simultaneous contrast", "quality contrast" and "quantity contrast".

For Know-How and Knowing-That, the red color is used to refer the decision class Cl3 ("crucial Know-How and Knowing-That") for which Know-How and Knowing-That are crucial. This color highlights the importance of Know-How and Knowing-That. The green color is used to designate Know-How and Knowing-That belonging to the decision class Cl2 which refers Know-How and Knowing-That may be crucial. Blue color is used to denote Know-How and Knowing-That belonging to the decision class Cl1. Aside colors, we use also numbers to prioritize the three decision classes. A decreasing preference scale is used. Number 1 refers the highest priority decision class (Cl3). Number 2 refers the decision class Cl2 and number 3 refers the decision class Cl1. This twinning between color and number gives a more meaningful view of the decision classes (Cl1, Cl2, Cl3) representation. For the distinction between processes, we mainly used five colors. Pink color denotes an OP process. Dark color refers to a sensitive process to show its importance. The blue color refers to a TLP process. The green color refers to an SLP process. The light yellow color refers to a FLP process (Table 1). The OP represents an elementary process which is not composed of other processes. The TLP and SLP can be composed of finite number of process. The FLP corresponds to an organizational objective (Turki et al., 2011).

Table 1: List of visual variables used for concepts' characterization

Color	Signification
	Tacit/unsharable Know-How
	Tacit/sharable Know-How
	Explicit/unsharable Know-How or Knowing-That
	Explicit/sharable Know-How or Knowing-That
	OP (Organizational Process) Process
	Sensitive Process. A sensitive process is a particular OP
	TLP (Third level Process) Process
	SLP (Second level Process) Process
	FLP (First level Process) Process
	Crucial Know-How or Knowing-That (belongs to decision class CL3)
	Likely Crucial Know-How or Knowing-That (belongs to decision class CL2)
	Non Crucial Know-How or Knowing-That (belongs to decision class CL1)

Since we work in a multicriteria decision-making context, several characteristics must be taken into account for the characterization and evaluation of Know-How and Knowing-That.

The tacit/explicit and shared/non-shared dimensions are combined and represented by a codecolor according to the typology of the SECI model (Socialization, Externalization, Combination and Internalization) (Nonaka, 1994).

As we have already mentioned, Know-How can be tacit or explicit and Knowing-That is explicit. Indeed, the colors pink and yellow are valid only for Know-How. The light pink color refers to unspoken tacit Know-How. The yellow color refers to shared tacit Know-How. The blue and green colors are valid for both Know-How and Knowing-That. The blue color refers to Know-How or explicit Knowing-That not shared and the color green refers to Know-How or explicit Knowing-That shared. These colors are used as backgrounds for the forms attributed to Know-How (circle) and Knowing-That (ellipse). These colors are chosen so as to have a clear shade and allow the visualization of the other colors.

4.2.2 Sub step2: Choose forms

We refer to the psychology of form for the choice of forms to be used in cartography (Palmer, 1999; Auger, 2012). We attribute the circle form to Know-How and the oval form to Knowing-That. The form assigned to the process is a rectangle and the form assigned to an action is a rectangle with rounded corners.

To avoid cluttering Know-How and Knowing-That cartography, we choose not to use several forms. For the other remaining concepts to be visualized in the cartography, we assign for each concept a pictogram: paper pictogram for the documentary support concept, computer pictogram for the digital support concept, pictogram man for the actor concept, pictogram of set of individuals for the concept collective and pictogram

company for the organization concept. The pictograms' use at this stage makes the concepts' visual representation more meaningful (Table 2). Some attributes may be valid for several concepts like the individual/collective dimension and the internal/external dimension.

Table 2: List of pictograms and forms used

Pictogram/Form	Signification
Circle	Know-How
Oval	Knowing-That
Rectangle	Process
Rectangle with rounded corners	Action
	Organization
	Actor
	Volunteer
	Collective
	Paper
	Digital
	Individual
	Collective
	External
	Internal

4.2.3 Sub step3: Choose the concepts'spatial distribution

Like any cartography, it is necessary to divide the concepts to be visualized in the cartography space. The reconciliation or distance between the concepts of Know-How or Knowing-That is ensured according to a distance that we define referring to the geographical location of Know-How or Knowing-That (internal or external to the organization). Near Know-how and Knowing-That are internal to the organization, but distant Know-how and Knowing-That do not belong to the same organization. This distribution facilitates the identification of internal and external Know-how and Knowing-That for the organization.

In addition to that, we also use the FDP (Force Directed Placement) spring algorithm (Force Directed Placement) which allows to position the nodes of a graph using a force system. The FDP principle deals with the assimilation of the graph nodes to particles of the same charge and the graph arcs to springs.

For each graph, loading, adding or deleting one or more nodes, the forces are calculated according to the vertices' position and their position evolve according to the forces which are exerted on them. At a given moment, the forces of attraction and repulsion are balanced and the graph representation becomes stable. The application of this algorithm ensures a better concepts' visibility (Know-How, factual knowledge, processes, actions, actors, supports).

4.2.4 Sub step4: Choose perception's levels

In Know-how and Knowing-That cartography, different levels of perception have been implemented. We distinguish between three levels of perception:

- Selectivity: is ensured by the visual variables color and form. It allows the easy distinction between the different concepts to be mapped (Know-how, Knowing-That, process, action, etc.).
- Scheduling: is ensured by the visual variable size. It mainly concerns Know-how and Knowing-That. It is possible to have a Know-how and Knowing-That scheduling according to a criteria sub-family (vulnerability, use duration or contribution degree of the organization's objectives) or by criterion (complexity, scarcity, accessibility, etc.).
- Association: is ensured by both color and form. It is sometimes necessary to make grouping to visualize Know-how and Knowing-That having common properties (in the same organization, having the same complexity, the same degree of vulnerability, etc.).

4.3 Step 3: Choose the cartography technique

The visualization technique that we adopt for Know-How and Knowing-That cartography is the graph technique. Sometimes, this technique is combined with other visualization techniques (tree technique, process-based knowledge mapping technique and functional knowledge mapping) to generate better visualization. The graphs allow easier manipulation of the concepts represented by the nodes and the relations interconnecting the nodes. The cartography technique choice is an important and delicate step. It ensures good visualization by reorganization's concepts and relations and taking into account the users' types of Know-How and Knowing-That cartography. Know-How and Knowing-That cartography generated must take into consideration a set of constraints: many concepts to visualize, different characteristics of the concept to visualize, several criteria used for the concept evaluation, many relations between concepts, different standards for cartography quality, available space for mapping, user expectations and mapping use scenarios.

5. Application context

Our application context is the medical field where we experiment our theoretical framework. It represents the continuity of the EGIDE/CMCU (*Joint Committee of University Cooperation*) project objectives. The EGIDE/CMCU project is a part of the PHC-Utique program, which started in 2010 and ended in 2013. The aim of this project is the development of a knowledge management system for crucial knowledge to improve medical and social care of disabled children. The partners of this project are MIS laboratory (*Modeling, Information, System* laboratory) at the University of Picardie Jules Verne, Amiens-France, MIRACL laboratory (*Multimedia, InfoRmation systems and Advanced Computing* laboratory) at the University of Sfax, Sfax-Tunisia and the ASHMS.

The first results of this project were published as a doctoral study (Turki, 2012). This study proposed a multicriteria method and a core ontology of organization's processes for the identification of sensitive processes. The application context of this thesis is the ASHMS (Association of Protection of Motor Disabled of Sfax). The ASHMS is a non-profit association. Its goal is the protection of children having motor disabilities in different fields (social, medical, educational, familiar). We are particularly interested in the early care process of children having a Cerebral Palsy (IMC) (Figure 1). This process is complex that is to say it mobilizes an amount of Knowledge related to different specialties (neonatology, neuro-pediatrics, physical medicine, orthopedics, physiotherapy, psychiatry and occupational therapy). Some of this knowledge is stored in databases, medical records and good practice guides. This type of knowledge is explicit. The other part, which is the most important, is embodied in the mind of healthcare professionals (doctors, healthcare technicians). In order to take collective/individual decisions and to have suitable information for the examinations of the IMC child, healthcare professionals (having the same or different specialties) communicate, share and exchange knowledge between each other.

Most healthcare professionals participating in the early care process of IMC children in the ASHMS are volunteers; most of the knowledge produced and used in this process is volatile. Other healthcare professionals are affiliated to Hospital University, medicine faculty, ASHMS or others. Some internal healthcare professionals (healthcare technicians) communicate with other external healthcare professionals (private doctor, healthcare technician, volunteer doctor) who are geographically dispersed (hospital-university, medicine faculty, other association) (Figure 1).

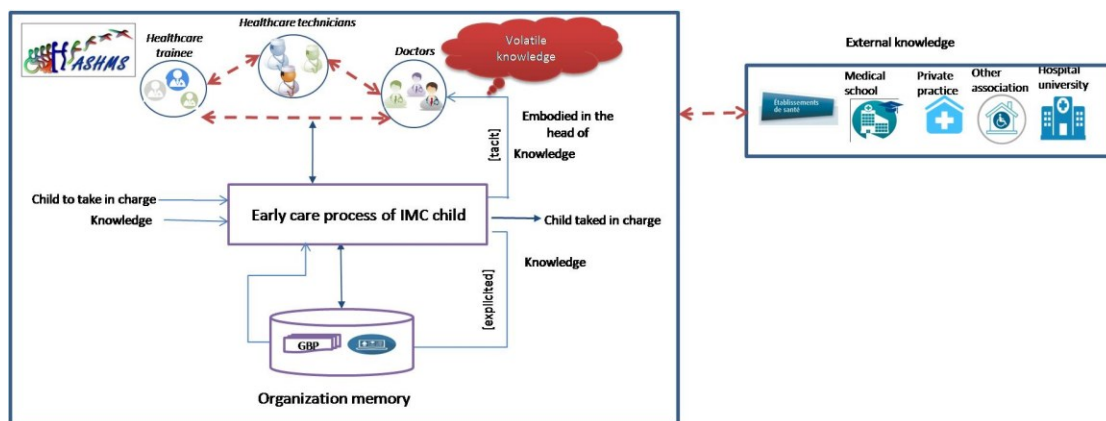


Figure 1: Early care process of IMC child in the ASHMS

For these reasons, the ASHMS healthcare professionals have difficulties to acquire appropriate knowledge, identify knowledge stakeholders, communicate between healthcare professionals, share and transfer their experiences, their points of view, their knowledge in the ASHMS or with other professionals affiliated to other organizations.

Through this paper, we demonstrate the role of cartography in identifying knowledge needed for the ASHMS. The cartography proposed for the ASHMS is based on the extension of the method of Saad (2005) for identifying crucial knowledge.

Know-How and Knowing-That identified in the ASHMS will be mapped for healthcare professionals to facilitate their sharing and identification.

In this section, we highlight the role of cartographies in facilitating the visualization of Know-How and Knowing-That of the ASHMS. The Know-How and Knowing-That cartography is based on a graphical language to guide the map's users to read and understand easily and efficiently the content of the cartography (Ghrab et al., 2017). This graphical language is based on the graphical elements already detailed in the fourth section (set of icons, colors, pictograms and pictures) (Figure 2).

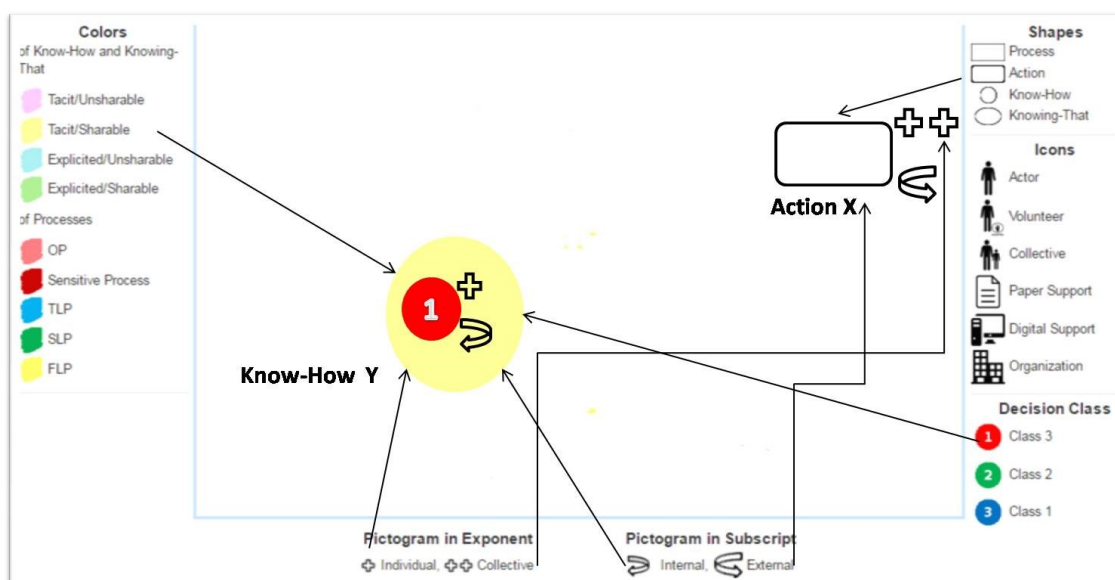


Figure 2: A print screen of the set of icons, colors and pictograms used by the graphical language

We distinguish between two color-coding. The first color-coding is used to distinguish the characteristics of Know-How and Knowing-That (tacit or explicit, sharable or unsharable). The second color-coding is used to distinguish processes' levels. In previous works, our research group distinguished between four processes' levels (Turki et al., 2011): FLP, SLP, TLP and OP.

CK-Cartography generates different types of maps which are the process map, Know-How and Knowing-That map, personal map and ranking map. These maps provide an overview of all concepts and a detailed view at the user request. Each one of these maps has its own objective.

5.1 Process map

This map visualizes all the organization processes with its different levels (FLP, TLP, SLP, OP and sensitive process). For the achievement of this map, we mainly rely on the work of (Turki et al., 2014) related to the identification of sensitive processes. In the beginning, the process map visualizes the FLP processes mobilized in the organization (for example, the “process related to the social care of motor disabled”, the “process related to the medical care of motor disabled” and the “process related to the educative care of motor disabled”) (Figure 3). Clicking on a FLP process will display the SLP processes for the selected FLP process. The “process related to the medical care of motor disabled” visualizes on the request of the user the SLP processes like the “process related to the early care process of children having a cerebral palsy”, the “process related to the medical process of children having a myopathy”, the “process related to the clinical study of children having a cerebral palsy” and e.g. The “process related to the early care process of children having a cerebral palsy” visualizes on the request of the user the TLP processes like the “process related to the early care process of cerebral palsy children having an hemiplegia form”, the “process related to the early care process of cerebral palsy children having a paraplegia form” and etc.

The same procedure is used for other processes’ types (TLP and OP). Figure 3 shows a global view of the process map with a zoom on the “process related to the early care process of cerebral palsy children having a hemiplegia form”. This process is composed of many OP processes. For instance, “care process of IMC children in kinesitherapy (IMC having an hemiplegia)”, “care process of IMC children in occupational therapy (IMC having an hemiplegia)”, “care process of IMC children in neuropsychiatry (IMC having an hemiplegia)”.

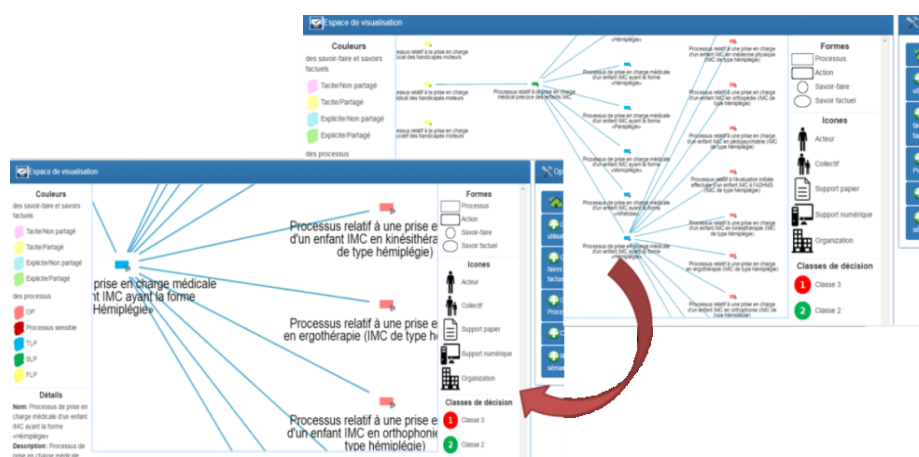


Figure 3: Screenshot of the process map from one level to another finer granularity level (FLP-SLP-TLP-OP)

5.2 Know-How and Knowing-That map

This map visualizes only at the beginning, the set of Know-How and Knowing-That mobilized on a given process. Each Know-How or Knowing-That is mapped through a structure representing who holds Know-How, where it is stored and which theme it has. Clicking on a specific Know-How or Knowing-That generates a Criterion map. Its objective is the visualization of a set of criteria used for Know-How or Knowing-That evaluation and characterization. These criteria are classified into three sub-families: vulnerability, use duration and contribution degree.

Three types of Know-How and Knowing-That map are generated by the CK-Cartography: Know-How and Knowing-That map related to a specific process, Know-How and Knowing-That map for Know-How/ Knowing-That characterization and Know-How and Knowing-That map for Know-How/ Knowing-That properties (actors, storage support).

Clicking on the "care process of IMC children in neuropsychiatry (IMC having an hemiplegia)" of the process map (Figure 4) allows to display the list of Know-How and Knowing-That mobilized in this process.

For example, clicking on the "Know How to detect hypertonia and hypotonia" allows to display a more specific view (Figure 4).

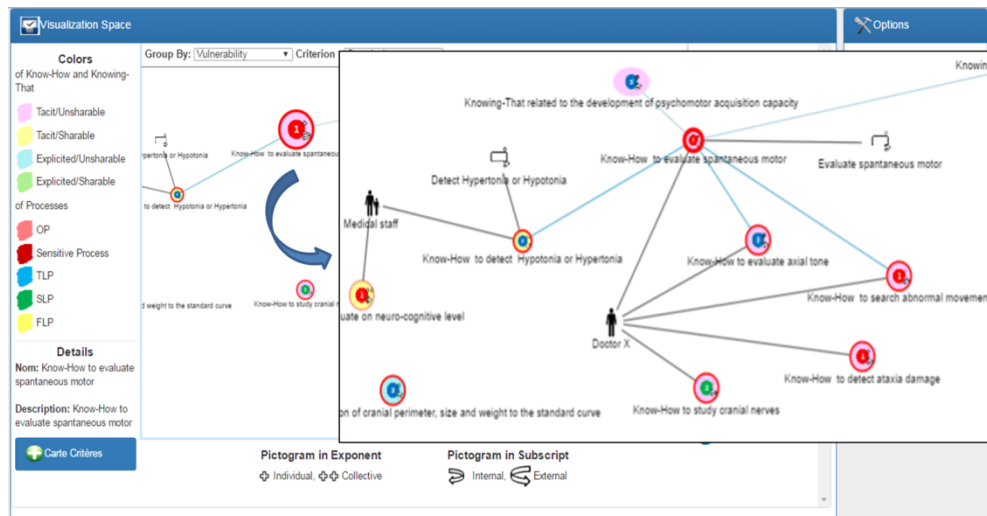


Figure 4: Screenshot of the Know-How and Knowing-That map related to "Knowing how to evaluate spontaneous motor skills"

The circle which represents this Know-How, is greater than other circles, which means that this Know-How is composed of other Know-How and Knowing-That. In Figure 4, "Know how to evaluate spontaneous motor skills" is a know-how composed of "Know the development of psychomotor acquisition capacity", "Know the neurological anomaly for motor development", "Know how to find an abnormal movement" and "Know how to evaluate the axial tone".

"Know how to evaluate spontaneous motor skills" is linked to the action "evaluate spontaneous motor skills" which is an individual internal action. A tacit Know-How (pink color) is owned by the healthcare professional Doctor X.

5.3 Personnel map

The personnel map gives an idea about the actors' individual and collective actions in an organization, the actors' localization, the Know-How or Knowing-That mobilized in these actions and the processes in which the actors participate. It allows the administrator to identify the actors involved in the IMC children medical care (Figure 5).

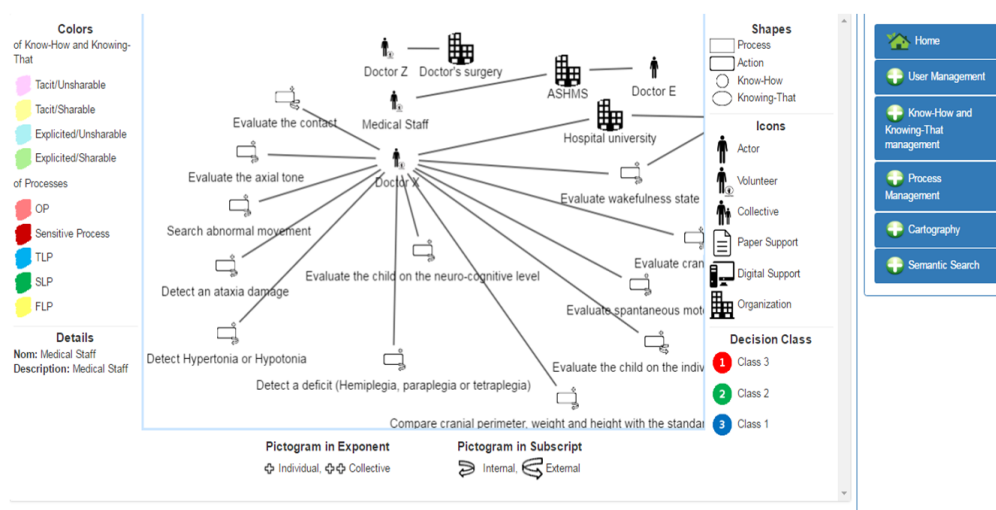


Figure 5: Screenshot of the personnel map

These actors (individuals or groups) can be internal to the organization (affiliated to the ASHMS) or external. Most of the actors involved in medical care are volunteers and are affiliated to other organizations (Habib Bourguiba University Hospital or Faculty of Medicine) or to the doctor's surgery. The distinction between employers in the ASHMS, the healthcare professionals' volunteers or others external actors or collective is ensured by the graphical element already detailed. Each actor type is visualized by a specific pictogram. The actor "Doctor Z" is a volunteer whereas "Doctor E" is an employee in the ASHMS.

The personnel map visualizes for each actor the organization where he is affiliated (ASHMS, CHU Habib Bourguiba, Faculty of Medicine, etc.), the actions which he can perform in such process and Know-How or Knowing-That mobilized for the action performance.

5.4 Ranking map

The purpose of this map is to rank crucial Know-How and Knowing-That between each other in order to prioritize them and classify them in equivalence classes. This map is displayed at the request of the administrator.

The ranking map is used by the administrator. Its main objective is to guide him in the decision making process. The decisions taken give priority to the highest priority Know-How (Figure 6). For the generation of this map, we use the ranking algorithm stored in the model base of K-DSS platform. This algorithm is applied to the crucial Know-How.

In Figure 6, KH1 "Knowing how to evaluate spontaneous motor skills" is the Know-How which outclasses other crucial Know-How. KH2 "Knowing how to detect an abnormal movement" and KH14 "Knowing how to evaluate the child on a neuro-cognitive plan" have the same priority.

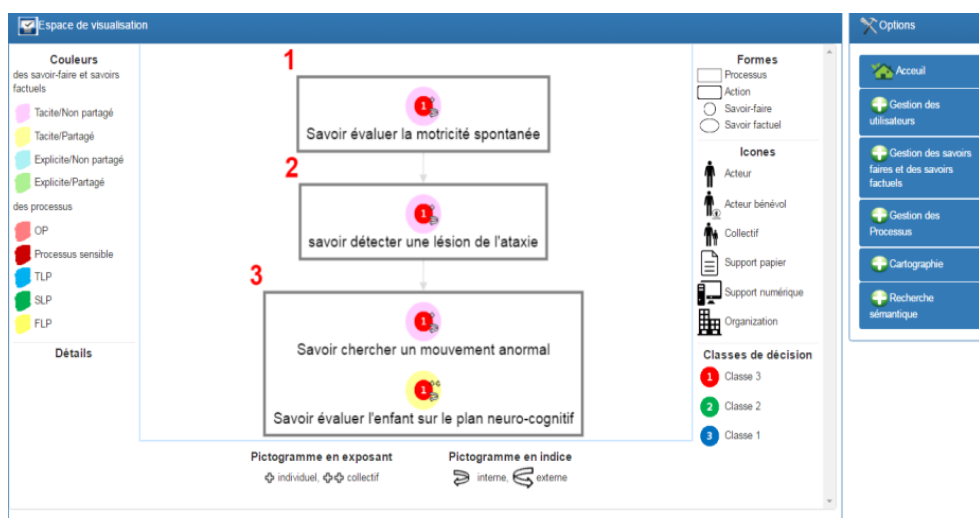


Figure 6: Screenshot of the ranking map

6. Findings and discussion

In the ASHMS, Know-How identification is a complex and difficult task because most healthcare professionals are volunteers which can cause Know-How volatility. The informal communication, the actors' geographical dispersion, the complexity of Know-How and Knowing-That in the medical field and the specificity of this domain require the adoption of a specific methodology to take into account these specificities and to enhance knowledge identification and sharing. Particularly, Know-How and Knowing-That cartography is used in the ASHMS to effectively identify Know-How and Knowing-That as mobilized in the ASHMS processes as well as to guide healthcare professionals to take the suitable decision for the IMC child.

Early in this project, healthcare professionals were not aware of the importance of sharing their Know-How, Knowing-That and experience with each other. This can be justified by the voluntary work of healthcare professionals and the research and scientific nature of IMC children care project. In fact, research results are still under validation and experimentation. This solution is still to be studied and validated.

Many difficulties are mobilized in the ASHMS. We cite the complexity of the early care process, the uncertainty of Know-How and Knowing-That, the difficulty in accessing Know-How and Knowing-That across the different specialties (neonatology, neuropsychiatry, physiotherapy) and the difficulty supporting healthcare professionals participation in the staff meeting every three months for the evaluation of IMC children health status,. Taking into account these difficulties, a collective decision should be taken by healthcare professionals for each IMC child rehabilitated in the ASHMS. Two decisions can be taken: the continuity of rehabilitation or its stoppage.

Taking into account the healthcare professionals' needs, we propose Know-How and Knowing-That cartography which is used almost by all healthcare professionals who are the users of this cartography. These users are integrated in the creation, modeling and conception of Know-How and Knowing-That Cartography. Their needs and requirements are taken into account.

The evaluation of Know-How and Knowing-That cartography is completed iteratively i.e. before, after and during the construction of the cartography. Each phase of the theoretical framework of Know-How and Knowing-That cartography is validated by healthcare professionals. Moreover, each interface is validated by them. Occasionally, healthcare professionals suggest other information in the different maps generated and a re-conception of some interfaces thanks to story-boards. Healthcare professionals propose to have graphical interfaces for which they will be guided and helped by the system during the cartography's use. The models proposed by healthcare professionals are simple which do not contain much information and are targeted for a well-defined objective for each interface. For each phase of the design of Know-How and Knowing-That cartography, story-boards are used to validate the interfaces generated by the cartography.

7. Conclusion

Healthcare Knowledge Management is becoming more and more important in healthcare organizations because of their benefits to provide suitable information for suitable healthcare professionals and suitable patient, to facilitate healthcare services' delivery, to enhance knowledge sharing and exchanging, to sustain competitive advantage in the digital age and to be up to date about the latest news in this field (be aware of the role of the communication means and its effects in medical field).

In this paper, we propose a Know-How and Knowing-That cartography for healthcare professionals to better identify and visualize Know-How and Knowing-That. For thus, we propose four different maps: process map, Know-How and Knowing-That map, personnel map and ranking map. The process map has for objective to identify and visualize the set of organization's processes. The distinction between processes' types (FLP, SLP, TLP, sensitive process) is guaranteed by the choice of colors used. It's possible to generate a Know-How and Knowing-That map for a specific process. This map provides for its users the set of Know-How and Knowing-That mobilized in this process, its stakeholders and the support where Knowing-That is stored. The personnel map gives an overview about the organization's employees, the users and the creators of Know-How and Knowing-That. The ranking map is designed mainly for the administrator in order to help him to take the suitable decision. This map classifies crucial Know-How and Knowing-That into equivalence classes and gives them priorities.

The main features of proposed Know-How and Knowing-That cartography, in this paper, are to collapse and expand cartography nodes', to have hierarchical organization of the concepts to be mapped, to have whole and detail view and to have viewable relationships between the different concepts mapped. This cartography allows the organization, visualization, analysis, memorization, creation, exchange and archival of Know-How and Knowing-That as well as other concepts (support, user, stakeholder, action, organization...).

For building Know-How and Knowing-That cartography, we propose a methodology composed of three steps. The first step is the identification of concepts to visualize. The second step is the graphical elements identification like forms, colors, perception's levels and spatial distribution of concepts. The third step is the choice of the cartography technique. In this paper, the cartography technique used is the graph.

Know-How and Knowing-That identification in the ASHMS is a complex and difficult task because of most healthcare professionals are volunteers. This can cause Know-How or Knowing-That volatility. The informal communication, the actors' geographical dispersion, the complexity of Know-How and Knowing-That in the

medical field and the specificity of this domain requires the adoption of a specific methodology to take into account these specificities and to enhance knowledge identification and sharing. Particularly, Know-How and Knowing-That cartography is used in the ASHMS to effectively identify Know-How and Knowing-That mobilized in the ASHMS processes as well as to guide healthcare professionals to take the suitable decision for the IMC child.

The main graphical elements used for Know-How and Knowing-That cartography are color, form, perception's levels and spatial distribution. These graphical elements are named static visual variables. There is another type of visual variable known as dynamic visual variables which are used to highlight the concept dynamic aspect.

In future works, we hope to integrate dynamic visual variables in our Know-How and Knowing-That cartography in order to study the duration of the use of Know-How and Knowing-That and their evolution in the organization.

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