ESOC Knowledge Management Roadmap

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ABSTRACT

Generally, the task of a roadmap is to make sure that from the given starting point we can achieve the final destination within the specified constraints. This paper describes the roadmap developed and followed to implement Knowledge Management (KM) in ESOC.
Once having recognized the need of KM and performed some benchmark activities, the first important step of the roadmap is to lay down the foundation for KM at ESOC.
This foundation consists of setting up the organization of KM, performing an analysis of the knowledge existing in the different technical domains and conducting the knowledge coverage and criticality analysis. Based on the obtained results, an appraisal is performed with the conclusion that specific actions such as the development of knowledge capture, sharing and preservation methodologies in ESOC, should be followed up.
Next phase of the roadmap is dedicated to expand existing KM tools as well as designing and launching new prototypes. The paper presents also the model developed for the expansion of the KM system. The model is based on the application of the Minimum Factor Law, known earlier in the agricultural field, to the field of KM. Finally, the last step of the roadmap is the institutionalization of the KM system.

Keywords: Knowledge Management, Knowledge Processes, Roadmap, Minimum Factor Law

1. INTRODUCTION

ESOC, the European Space Operations Centre of ESA, has recognized that the knowledge of the staff is the fundamental pillar for maintaining and strengthening its position in the field of spacecraft operations. Therefore, has established, as a strategic objective, the need to implement a proper KM System that fosters initiatives, processes and procedures.

ESOC is located in Darmstadt, Germany, and it is the establishment of the European Space Agency (ESA) responsible for the operations of the ESA satellites. These operations include the following major technical domains:

- Ground stations, communications network and their operations;
- Mission data systems;
- Flight Mechanics (dynamics, navigation and space debris);
- Actual mission operations (spacecraft/ payload);
- Human Spaceflight and Explorations Operations

ESOC knowledge base and abilities has grown considerably over the years by means of engineers who sometimes have spent decades working on the same project and learning from the senior members. Today, this institutional knowledge base may shrink for several reasons:

many of those individuals are retiring; there is an increase in staff mobility; new staff are immersed into new projects sometimes without a substantial introduction to the previous missions lessons learned.

The two main drivers for KM within ESOC are increased efficiency and reduction of risk for operations. The goal of KM is therefore to identify, analyse and share the core knowledge existing in ESOC so as to enhance operational efficiency and minimize operational risks.

2. STAGES OF THE ROADMAP

The KM roadmap consisted of several stages which were undertaken since 2006 towards the introduction of a knowledge management system in ESOC [2]. The KM activities undertaken at ESOC during the past years were organised into following major stages:

Stage 1 – Assess KM needs

- Preliminary studies and investigations on knowledge management systems for different organizations were conducted including a review of KM initiatives already existing in ESA. The aim of this stage was to assess the need of KM in ESOC and build the business case.

- Knowledge audits with respect to the questions of knowledge transfer and its barriers were performed to assess the KM situation and challenges. A model for knowledge audit was developed and applied successfully.

Stage 2 – Define KM strategy

- The ESOC KM strategy was developed and presented in the following Figure 1.

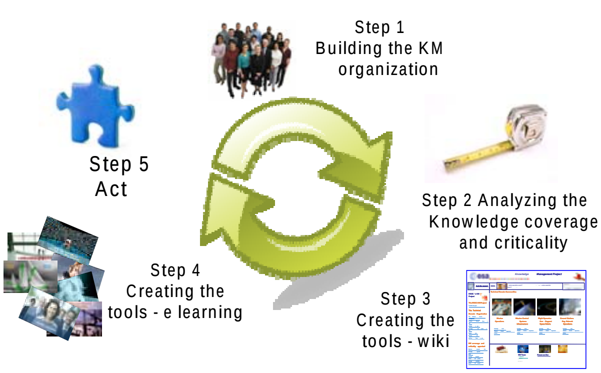

Figure 1 – KM Strategy

- The KM organization was defined in terms of roles and responsibilities of the technical domain custodians and assistants, the knowledge area leaders and the core team was an essential part of this stage.

- The next step was the identification and description for each Technical Domain of Knowledge areas, Knowledge fields and its components (which are a further specification of the Knowledge Fields in terms of methods, theories, tools and so on). Based on a common methodology, it was possible to:

  - Measure the critical importance of knowledge areas and fields in terms of importance for the role, speed of change and market availability;

  - Verify the knowledge coverage level of professional experts;

  - Identify general and individual development needs and possible plans.

- The inventory of the knowledge assets and the analysis of the knowledge criticality and coverage are essential to be able to identify the existing knowledge in specific areas and to perform a gap analysis.

- Through this analysis, it was then possible to identify those areas requiring improvement and to allow management to make educated decisions on whether it is worthwhile or not to invest in those areas to increase the knowledge level.

- The results from the coverage and criticality analysis for each technical domain were discussed between the knowledge custodian and leaders and this has resulted in an action plan of medium term horizon.

- The actions were divided in two major categories: those actions common to all technical domains and those specific to each technical domain. Moreover, the actions were grouped under 3 main topics:

- **Management –** i.e. actions that need to be taken by management (normally outside the scope of the KM project)

- **Knowledge –** i.e. actions relating to day-to-day KM

- **Training** – i.e. specific activities needed to address particular needs.

Stage 3 – Design and build prototype tools

- The Knowledge Management tools already available in ESOC were identified and new tools prototyped.

- The **KM Wiki –** shown in Figure 2 **-** was developed with the purpose to sustain the Technical Domain's knowledge building, sharing and capturing by means of a tool characterized by simplicity, usability, transparency of all information available.

Figure 2 – KM Wiki

- **A Multimedia video** for a specific Technical Domain and its core processes was prototyped to demonstrate the capability of presenting in a simple and attractive way the activities done in this knowledge area to both internal and external audiences.

Figure 3 – Snapshot of the video

Stage 4 – Expand KM activities

- The future development of the KM project will focus on the maintenance of the prototyped KM tools and activities as well in selecting and putting in place a range of other KM tools. The considerations to be taken into account and how to prioritize the activities in this stage are described in detail in the following Chapter 4.

Stage 5 – Institutionalize KM

- The establishment of a Knowledge Management Policy with the definition of the objectives of Knowledge Management, its management structure and its processes is the final essential step for rolling out KM in ESOC.

3. CURRENT ACTIVITIES

Based on the results of the KM appraisal, it has been decided to implement the key KM processes to facilitate knowledge capture, sharing and reuse. These processes have been selected from the actions formulated as result of the knowledge appraisal exercise in each ESOC technical domains.

Currently, the various aspects of knowledge capture are being analyzed. As knowledge capture cannot be isolated from the other knowledge processes, hence the activities related to identification, sharing and preservation are also included in the analysis. Based on the results of this analysis and the review of knowledge capture methodologies, recommendations for the knowledge capture procedure will be formulated.

4. KM FUTURE ACTIVITIES

KM Building Blocks

Knowledge management consists of several processes which all contribute to the successful functioning. Following the model of Probst [1], there are six basic building blocks (definition, identification, acquisition, development, distribution, usage and preservation) plus two pragmatic ones (goal and evaluation). In a reduced and simplified form and leaving out the pragmatic ones the following are selected:

- **identification** (how to achieve transparency in the available knowledge)

An important prerequisite for the identification of knowledge is transparency which must be supported by the organisation. The goal is to maintain an overview of data, information and capabilities.

- **development** and acquisition (how to create new knowledge, develop and acquire)

The development of knowledge refers to the building up of new capabilities, better ideas and more efficient processes.

- **capture** (how to secure knowledge)

The term knowledge capture is used for two types, the continuous capture during the course of a project (lessons learned) and the one at specific points in time when staff are leaving their posts (expert debriefing). Certain knowledge and experience can only be passed on in personal conversations.

- **sharing** and usage (how to route the knowledge to the appropriate place and how to ensure the correct usage)

In addition to the optimal knowledge distribution one further aim is to make the isolated information and hidden experience available to the entire organisation. Willingness of the employees to share their knowledge needs to be encouraged. Mature technologies ease the process.

- **preservation** (how to guard knowledge against losses)

This process includes the selection, the storage and the regular actualisation of the relevant knowledge including documents and experience.

In addition to the processes of knowledge management, three layers could to be considered i.e. organisation, people and technology. Of course, all of the three layers are required for each knowledge process, however, when considering only the prime importance for each individual processes, the following results can be obtained:

- The KM **organization** is of primary importance for the processes of identification, development and sharing
- The participation of the **people** is mandatory in all KM processes
- The KM **technology** is of primary importance for the sharing, capture and preservation process.

Considering the processes identified for each layer, one obtains fifteen building blocks which are primarily required for a successful KM. As mentioned above, the question needs to be answered which building block should be supported next? The following section shows how the Minimum Factor Law could be used to get guidelines for the answer.

Minimum Factor Law

The law of the minimum factor, invented by Carl Sprengel (1787-1859, Agronom) and popularized by Justus Liebig (1803-1873, Chemist), says, that the growth of a plant will be restricted by the shortest resource. This resource is also called the minimum factor. Moreover, the increase of a nutrient which is already available in excess, will not support the growth any further. The minimum factor cannot be compensated by the surplus of other sufficiently available elements. The law of the minimum factor is an important principle within the area of fertilizing.

The law was modified by Georg Liebscher (1853-1896, Agronom) to the law of the optimum in 1895, which says that the increase in the minimum factor becomes more effective when the other factors are already around their optimum.

The law was used within agriculture for many years. Within the past few decades it was also transferred to the area of economy and business. As an example the narrow pass strategy invented by Wolfgang Mewes (born May 1924, Berlin, Economist) in 1971 and the Theory of Constraints by Eliyahu Goldratt (born Aug. 1948, Israel, Physicist) in 1990 are derived from the law of the minimum factor.

In these days the law of the minimum factor is also used in other disciplines such as sociology in connection with groups of people and their growth or psychology in connection with education.

The law of the minimum factor states that the growth is controlled by the scarcest resource, which is called the minimum factor. i.e. the improvement of any other factor has no influence on the growth. Increasing the overall amount of resources does not increase the growth, only by increasing the amount of the limiting resource, the one most 'scarce' in relation to the need, can the growth be improved.

Figure 4 – Minimum factor law illustration (from Wikipedia)

Very often the law is illustrated by a barrel made of boards of different heights. Another representation is given by the proverb saying that a chain can only be as strong as its weakest element.

Application to Knowledge Management

As described above, fifteen building blocks contribute to the success of a KM system, but only some of them are of higher importance. Dependencies between building blocks can be identified, for example capturing without sharing would be in vain. The law of the minimum factor could be an additional method for the selection of the building blocks to be enhanced/improved successively.

According to this law, it makes more sense to apply the minimum factor law method than simply invest in those areas which at first sight would give a quick return but would have less effect.

The determination of the minimum factor for KM processes could be based on an assessment (ratings ranging from 0 to 5) of the individual blocks with respect to their availability and importance. The assessment could follow the general guidelines already established for the coverage and criticality analysis, such as not to use the same marks more than twice in order to avoid similar ranking for all of the building blocks.

At the very end a table could be obtained with a score for each individual block. As example, if the technology used for knowledge sharing has the minimum value, hence this block would need to be improved next. An example of KM processes scoring is provided in Table 1.

	Identify	Develop	Capture	Share	Preserve
Organisation	4	4	3	3	4
People	2	2	3	3	3
Technology	4	4	4	1	5

Table 1 – Example of KM Processes Scoring

6. CONCLUSIONS

The selection of what to do next cannot only follow the law of the minimum factor, there are further aspects which have to be considered. In the case of agriculture there are other parameters such as quality of seed, composition of soil and weather. The same holds for knowledge management. Other conditions have to be considered in addition to the law of the minimum factor. These could be time constraints (in case many people will leave the organization at once, knowledge capture will have to take priority), budget or available infrastructure. However, the law of the minimum factor can be considered as an additional valuable aspect in the selection process of the future activities.

7. REFERENCES

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