Knowledge management performance methodology regarding manufacturing organizations

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Abstract. The current business situation is extremely complicated. Business must adapt to the changes in order (a) to survive on the increasingly dynamic markets, (b) to meet customers’ new request for complex, customized and innovative products. In modern manufacturing organizations it can be seen a substantial improvement regarding the management of knowledge. This occurs due to the fact that organizations realized that knowledge and an efficient management of knowledge generates the highest value. Even it could be said that the manufacturing organizations were and are the biggest beneficiary of KM science. Knowledge management performance (KMP) evaluation in manufacturing organizations can be considered as extremely important because without measuring it, they are unable to properly assess (a) what goals, targets and activities must have continuity, (b) what must be improved and (c) what must be completed. Therefore a proper KM will generate multiple competitive advantages for organizations. This paper presents a developed methodological framework regarding the KMP importance regarding manufacturing organizations. This methodological framework was developed using as research methods: bibliographical research and a panel of specialists. The purpose of this paper is to improve the evaluation process of KMP and to provide a viable tool for manufacturing organizations managers.

1. Introduction
The current business situation is extremely complicated. Organizations are increasingly confused due to the deep economic and financial changes at the local, regional and worldwide level. However these changes cause frequent and rapid progress of organizations. Business must adapt to the changes in order (a) to survive on the increasingly dynamic markets, (b) to meet customers’ new request for complex, customized and innovative products. It should also be mentioned that organizations have to adjust their activities also taking into account the innovative products delivered by the suppliers; phenomenon that generates progress. So organizations, especially the manufacturing organizations, are continuously under pressure. As a consequence they must have very efficient methods, techniques and systems (standardized and non-standardized) in order to resist and overcome the pressure exerted by the markets and by the stakeholders.

In modern manufacturing organizations it can be seen a substantial improvement regarding the management of knowledge. This occurs due to the fact that organizations realized that knowledge and an efficient management of knowledge generates the highest value. Therefore many manufacturing organizations have invested many resources (human, structural and financial) in knowledge management (KM). Even it could be said that the manufacturing organizations were and are the biggest beneficiary of KM science [1].
KMP evaluation in manufacturing organizations can be considered as extremely important because without measuring it, they are unable to properly assess (a) what goals, targets and activities must have continuity, (b) what must be improved and (c) what must be completed [2, 3, 4]. What cannot be measured consequently cannot be managed properly [2]. In order to improve the KMP measurement process, the development of a methodology with a proper method plays an important role in having an effective assessment and monitoring of KM.

Even though it can be seen in the literature that the identification and development of methods, models, methodologies and indicators associated with the evaluation and analysis process of KMP plays an extremely important role, it is surprising that very few researchers have focused in the field [2].

This paper is organized as follows: in Sect. 2 we discuss about knowledge management in manufacturing organizations. In order to do so we clarified the relationship between data, information and knowledge; we presented and explained the KM concept and the KM processes; we described the most important factors which influence the KM (barriers to success of KM); we approached in a broad sense the current situation of KM in manufacturing organizations. In the Sect. 3 it’s presents the research methodology. In the Sect. 4 we present developed methodology regarding the importance of KMP.

2. Knowledge Management in manufacturing organizations

The importance of an efficient management regarding the knowledge has exponential growth in manufacturing organization. Also (a) the increasing levels of globalization, (b) the new issues in terms of market diversity, (c) the shorter product lifecycles, (d) the rapid changes in customer demand, (e) the new technological breakthroughs, (f) the rethinking process of organizational management, plus (g) other social factors push the manufacturing organizations to change.

2.1. Knowledge

For centuries philosophers have tried to understand, to define and to explain concretely the term “knowledge”. Interest regarding the source and nature of knowledge exists since Socrates, Plato and Aristotle, and this interest continues even today [5]. In the literature exist many definitions regarding the knowledge, but most relevant is the fact that is “justified belief” or “justified belief that increases an entity's ability to take effective action” [5, 6].

In order to understand correctly the process of how organizations manage their most valuable asset - knowledge, it is absolutely necessary to clarify the relationship between data, information and knowledge (Table 1).

| Main aspect | Explanation |
|-------------|-------------|
| Data        | The data are objective facts of a process or event that has little utility unless converted into information. They could be seen as quantitative, numerical or otherwise attributes, obtained through observations, experiments or calculations [7]. The data, as primary form, are simple structures [8]. |
| Information | Information is data endowed with relevance, meaning, and significance and are organized for a specific purpose. The data is converted into information through condensation, contextualization, calculation, categorization and correction [7]. Information is considered to be the extent in which organizations reflects a structure or set of structures. Along with the data, the information structure is meaningless in the absence of recognition and their interpretation [8]. |
| Knowledge   | Knowledge is a complex mix of values, experiences, contextual information and |
also intuition, which provides a framework for evaluating and incorporating new experiences and information. Knowledge is based on information summarized and organized to increase the understanding; they are the basis of decisions [7].

Knowledge is a creation of the human mind, a result of associative structuring; used as descriptors of information and underlying the capacity (potential or actual) to act effectively in uncertain situations. When knowledge is described and stored in databases or books, it is stored only the informational part of them. Knowledge reflects the (a) understanding, (b) meaning, (c) intuition, (d) creativity, (e) judgment, and (f) the ability to anticipate the results of actions [8].

So it could be said that “knowledge is a blend of experience, insights, expertise, intuition, judgment that exist in the mind of the knower” [9] and is the basis unit for decision making process agent.

It is certain that data, information and knowledge develop a relationship of interdependence that is characterized sometimes by a relative bias. So for some people in certain situations, certain data and information can be knowledge, and in other situations simple data and information. Therefore it is sometimes difficult to make a clear distinction between data, information and knowledge, especially because they are all KM objects [10].

2.2. Knowledge management

KM has attracted the attention in the academic as well as in the private management, because in this dynamic environment the knowledge is the highest source of power [5]. KM does not have a universally valid definition given the many prisms through which it can be seen [11]. Through the simple fact that KM is associated with multiple elements associated with organizational environment, and not only, is extremely difficult to be approached and understood from some definitions [12]. In the case of manufacturing organizations the knowledge can come from shareholders, owners, production managers, supervisors, employees, suppliers, customers, consulting firms, specialists, conferences, specialized articles in journals, media, market orientation, portals, knowledge, forums knowledge, books, case studies, research papers and so on [13]. Nevertheless, we can say that KM is the organizational process of “creating, acquiring, capturing, sharing and using knowledge to enhance learning and performance in an organization” [9]. KM can be generally defined as all data and information, methods, mechanisms, processes, structures, policies, strategies, human resource, that have the ability to create, capture, collect, store, query, use and transfer knowledge, with the purpose to improve the organizational efficiency [5].

In the literature exists if we can say so, a widely-accepted definition of this subject; so the KM is defined as “largely concerned with the exploitation and development of the knowledge assets of an organization with the view of furthering the organization objectives” [13]. To this definition it must be added the fact that the KM include also the tacit and subjective knowledge. “KM is a complex adaptive system with many possibilities and opportunities” [8] that use as resources the (a) Human capital [2, 15, 16, 17, 18], (b) Knowledge capital [2, 19, 20, 21], and (c) Intellectual capital [2, 15, 22]; it integrates people, processes and technology to achieve sustainable results and to increase the organizational performance - resulted mainly from the process of knowledge acquisition. Regarding the processes associated to KM in the literature we find a series of works that present different management processes (Table 2).
According to Dalkir in the KM literature are four models that are mostly used: Zack KM model, the Bukowitz and Williams KM model, the McElroy KM model and the Wiig KM model. This widespread use of these four models is because they are easy to understand, to implement and respect the profile literature [14].

In the following according to the literature we present the process of KM complex system:

2.2.1. Knowledge acquisition (KA)

The concept of KA occurred in the 30’s, when knowledge as organizational assets was considered that it can be traded. In KM literature are many theories and models, but all lead to the fact that organizational KA is part of the KM complex system and implicitly to organizational learning process. KA together with the knowledge dissemination actively serves to achieve the organizational goals. KA it can be seen as a process/ stage of the KM complex system at which the organization acquiring knowledge.

In the KA process knowledge workers/ agents develop a better understanding of the organizational processes and systems by gaining useful knowledge with the main goal to perform and to improve their job tasks and activities.

The knowledge can be obtained from seminars and workshops, trainings, archives, internet or even from suppliers and customers [2], organization staff, new personnel employed, experts and specialists (tacit knowledge) [23] and so on.

In order to improve job performance and to solve problems the knowledge acquired can be combined and modified thus resulting superior and usable new knowledge.

2.2.2. Knowledge creation (KC)

The KC process implies generation of new ideas, new practices or solutions [2] in order to improve organizational processes and systems, services or products. This process can be seen as a central part of organizational innovation.
KA requires that everyone form an organization to be involved in a non-stop process at the level of all organizational units or department [2]. Also KA process increase the level of (a) task understanding, and (b) information understanding, regarding organizational personnel – required to fulfil organizational activities [5].

It should be mentioned also fact that from some points of view KC is part of the KA - in the case of knowledge gained outside the organization. Consequently this external knowledge will be converted in new knowledge across the organization.

2.2.3. Knowledge utilization (KU)
KU implies a proper use of knowledge to improve the sustainable growth of organization and for winning competitive advantages. A type of KU widely used in practice is to adopt the various relevant knowledge from other organizations (adopt best practices) and to put it into practice [2]. Knowledge must be utilized by organizations in order to (a) increase organizational learning and performance, (b) improve efficiency, and (c) reduce costs [24, 25]

2.2.4. Knowledge sharing/ dissemination (KS)
On the KS process the organizational knowledge acquired and owned (tacit and explicit knowledge) is disseminated and transferred into entire organization. KS process is composed mainly from two types of activities: (a) formal activities (i.e., organizational meetings, various seminars and discussions, some educational programs for human resource) and (b) informal activities (i.e., mentorship, different collaboration and various interactions) [2]

2.2.5. Knowledge accumulation/ storing (KAS)
KAS process implies the storing process of all knowledge (and their artifacts) considered important for the organization; this process we consider that involves the following: (a) identifying relevant knowledge (and their artifacts), (b) knowledge collection, (c) establishing formal framework for knowledge retention, (d) organization of the knowledge, (e) storing knowledge in databases or organizational archives, (f) updating all knowledge considered as significant. Thereby KAS involves: the use of organizational database and archives in order to store knowledge regarding: specific tasks, assessment of fulfillment of various important tasks and activities, relevant legislation who was useful for solving some important tasks or problems, feedback from the organizational external environment, documents who were used to solve various important activities, information about all education programs, results of various education programs and so on [5].

2.2.6. Knowledge security/ protection (KP)
KM security it can be described as the process that secured organizational knowledge from unauthorized use or access, from potential losses or even from theft. So KP process is absolutely necessary for an organization in order to protect its intellectual property [2].

2.3. Barriers to success of KM
The KM literature indicates the fact that there are various factors which influence the success of the KM system; these factors can be viewed as barriers of KM activities and performance. Thereby in the following table will be listed the most important factors of KM (Table 3) [13]:

| KM INFLUENCE | INFLUENCE |
|--------------|-----------|
| (*)organizational culture, (**) management leadership and support, (***) organizational infrastructure and technology, (****) strategy [2] |
| (*) top manager attitude to risk, (**) staff resistance to change [26] |
| (*) low technological expertise, and (**) education [27] |
| (*) organizational culture, (**) technology, (***) measurement [28] |
As it can be seen in the previous table many factors may influence the success of KM (design, implementation, real integration, and correct operation of KM complex system). In literature however we find a number of KM factors which are mentioned quite often by the researchers and scholars, such as: organizational culture, leadership, human resource and informational technology - due to the fact that they have profound implications in KM success. Nevertheless does not exist a common corpus of factors to be unanimous valid to any organization; always it must to take into account the organizations particularities (a. organizational structure b. organization size c. the type of activity, and so on).

2.4. Current situation of KM in manufacturing organizations
As we mentioned previously in the paper, manufacturing organizations were and are the biggest beneficiary of KM science; thus at their level it can be seen most of the times, an availability of knowledge. However in some cases this knowledge is not used properly by the organizations. This phenomenon occurs under the effect of several factors among which it is worth mentioning that the knowledge is not well structured, or human resource does not know of its existence [1].

In generally KM in manufacturing organizations is implemented most of the times from the top down (hierarchical) but in this way is not captured the real needs and the organizational problem. KS (between productive sections, between departments, between various stakeholders, and so on) involve a series of problems, such as: correlation of different types of knowledge, poorly structured knowledge or incomplete knowledge, human resource resistance to change, problem of reasoning, solving problem based on experience and so on. And also it should be mentioned that identification, retention, updating and use of tacit knowledge it still a real problem in industrial practice [1].

However it can be made various remarks regarding the KM complex system in manufacturing organizations, such as [1]: (a) knowledge focuses on a particular product, service, process, system or technology in order to solve various problems; consequently it can be observed the need for a single system to manage organizational knowledge; (b) it is necessary to exist transparency (business processes); (c) the common interest at organizational level it is imperative - will substantially improve the knowledge sharing process (it’s a big issue in current practice); (d) it must be improved and speed up the transition from traditional approaches to knowledge based approach; (e) organizational human resource must be both: source and user of knowledge, and so on. Furthermore the multitude of general and specific problems associated KM in manufacturing organizations reveals the necessity to develop new methodologies that actively will contribute to their solving [1].

3. Research methodology
Research methodology is “a system of methods, procedures, techniques, rules, postulations, principles and tools, as well as the corresponding know-how, involved in the process of scientific knowledge” [35, 36].

The main objective of this paper is to develop a methodological framework regarding the KMP importance in manufacturing organizations (KMP evaluation methodology with an adapted method).

In order to accomplish its main objective we:

a. conducted an analysis of the literature regarding the KM and KMP (issues covered: the relationship between data, information and knowledge; KM concept and the KM processes (KA, KC,
KU, KS, KAS, KP); most important factors which influence the KM; KMP approaches; current situation of KM in manufacturing organizations;

b. used a panel of specialists (15 specialists) from the NE Romania, [through a “modern focus group” (telephonic investigation, e-mail, discussion face to face)] in order to approach, theoretical and practical, about the issues mentioned in the previous point (1) – along with another significant issues. The panel was composed from: university professors, directors of large organizations, managers of security-quality-environmental departments, specialists in KM, economics and environmental research, and so on [5, 36].

This methodological framework could be achieved using as research methods: bibliographical research and a panel of specialists. Thus concretely the proposed methodology mainly takes into account: a. the organizational knowledge management system; b. the factors (barriers) that significantly influence the organizational knowledge management system; and c. manufacturing organizational characteristics.

The purpose of this paper is to improve the evaluation process of KMP and to provide a viable tool for manufacturing organizations managers.

4. Proposed evaluation methodology regarding the importance of KMP

In this paper we propose to evaluate the importance of KMP using a mixed analysis; so combining an adapted methods (adapted AMDEC method) with the classical approach (which uses survey method and the questionnaire as a tool; and for the analysis the SPSS program) – regarding the most important aspects associated to KM (Figure 1). For each relevant aspect of KM complex system is observed the level of use regarding specific activities (Table 4). For the classical approach, each KM specific activity can be adapted and considered to be an item/ or a group of items, in order to collect it by a questionnaire [5, 36].

\[\text{Figure 1. Proposed methodology regarding the importance of KMP (differential analysis) [5, 36]}\]
Legend  Figure 1: KA - knowledge acquisition; KC - knowledge creation; KU - knowledge utilization; KS - knowledge sharing/ dissemination; KAS - knowledge accumulation/ storing; KP - knowledge security/ protection; CCDTQ - classic collecting data through questionnaire; SPSS - Statistical Package for the Social Sciences program; MOC - manufacturing organizational characteristics (a. organizational structure b. organization size c. the type of activity)

We consider that these assessments should be made periodically in the manufacturing organizations, with the main purpose to study the evolution of KMP. This proposed methodology assesses and analyzes the KM complex system importance in manufacturing organizations and considers that through this differential analysis/ mixed analysis (using an adapted industrial method – AMDEC, and through a classic investigation) actively contribute to obtain relevant information about KMP (about the management of “knowledge”). Of course the manufacturing organizations managers can use this proposed methodology separately - not as a mixed analysis to obtain a situational report: (1) first collecting data from the organizational documents/ records (using Table 4 as a starting point) and then using the AMDEC adapted method, or (2) using proposed KM processes with proposed specific activities (Table No.4) as items for a questionnaire survey - and then analyzing data using statistic program SPSS [5, 36].

Table 4. Processes and specific activities of KM/ KMP (adapted after Herghiligiu [5, 36] and Lee et al. [37])

| No. | Processes of KM | Specific activities |
|-----|----------------|--------------------|
| 1.  | KA - knowledge acquisition | a. organizational staff participation to seminars and workshops, trainings, international conferences, congress and so on; b. the existence and use of organizational archives; c. current use of the internet to acquire information and knowledge related to manufacturing process; d. acquire various information and knowledge from suppliers and customers; e. developing an organizational environment that encourages collaboration between all internal stakeholders; f. hiring personnel; g. use of experts and specialists; h. acquisition of know-how; |
| 2.  | KC - knowledge creation a. the understanding level of KM task b. the level of understanding the KM information | a.1. using an electronic dashboard for KM tasks; a.2. correct explaining of KM task by managers; a.3. proper understanding of the most important knowledge for current tasks and activities; b.1. the use of brainstorming sessions to share information; b.2. the use of different electronic sources of knowledge from organization level for carrying out the current tasks b.3. optimum use of different software; b.4. the use of alternative knowledge for solving tasks and activities; c. the existence of a creation/ innovation/ research and development department; d. new organizational practices or solutions; |
| 3.  | KU - knowledge | a. using education programs for organization stakeholders; |
b. manufacturing research;
c. use of knowledge from external database;
d. use internal policies to stimulate new ideas;
e. the existence of an organizational culture that encourages knowledge sharing;

4. KS - knowledge sharing/ dissemination
   a. sharing of information and knowledge by different methods (formal activities: organizational meetings, various seminars and discussions, some educational programs for human resource; and informal activities: mentorship, different collaboration and various interactions);
   b. using the results from the transfer of information and knowledge;
   c. using the intranet and internal electronic bulletin – regarding specific manufacturing problems;
   d. transfer of information and knowledge between different teams or departments;

5. KAS - knowledge accumulation/ storing
   a. use of organization's databases to store various tasks (associated to KM);
   b. storing information regarding assessment from fulfillment tasks and activities (relevant to KM);
   c. storing relevant legislation who was useful for solving tasks and activities;
   d. storing feedback from the external environment of the organization's environment – relevant for KM system;
   e. storing documents who were used to solve various organizational problems;
   f. storing all education programs related to KM;
   g. storing the results of KM education programs;

6. KP - knowledge security/ protection
   a. use of various protocols in order to secured unauthorized access of important knowledge;
   b. use of various protocols in order to secured unauthorized use of important knowledge;
   c. use of various protocols, procedures or even systems in order to prevent potential losses or even from theft;
   d. encouraging patenting created industrial assets;
   e. the existence of organizational guidelines to protect intellectual and industrial property.

Proposed adapted AMDEC method

The proposed method to assess the KMP importance is based on AMDEC method (Analyse des Modes de Défaillance the effects et de leur leur Criticites) applied for the first time to the aircraft industry and later extended to other sectors [5, 36].

This method allows the prioritization of characteristic aspects of a phenomenon/ or even a system (in our case the KM specific activities - associated to the KM processes) by identifying their important impacts, based on the following criteria: the impact/ occurrence importance, frequency or probability of occurrence, persistence, other criteria [5, 36].
In the case of KMP, the adapted method [36] of measurement regarding the identified impacts considers the following criteria [5, 36]:

1. the importance of the impact (I) – if the KM activities (KA+KC+KU+KS+KAS+KP) bring a positive contribution on the following: a1. increasing the effectiveness of the activities carried out; a2. increasing the efficiency of performed tasks; a3. increasing the overall organizational benefits (direct or indirect);
2. impact frequency (F) – if KM activities are carried out: b1. daily = significant frequency; b2.2-4 times/ week = average frequency; b3.1-4 times/ month = frequency low/ occasional;
3. impact magnitude (M) - if KM activities are carried out: c1. significant = of / with more than 50% of people directly interested/ involved; c2. medium = approximately 50% of staff interested/ involved; c3. minor = more than 50% of staff interested/ involved;
4. user activity opinion (O) - if the activities of KM are evaluated by the staff which is directly involved and interested (through periodic surveys) as: d1. a significant positive activities for the organization and employees = significant; d2. activities with a positive impact on the organization = average opinion; d3. does not exist an opinion.

For these criteria there is set a scale (Table 5), each criterion taking positive values and having a weight coefficient, depending on its importance in the process of quantification [5, 36].

Table 5. Cotation grid regarding specific activities impact of KM [5, 36].

| Criteria | Weight coefficient | 10 points | 5 points | 1 point |
|----------|--------------------|-----------|----------|---------|
| I        | 7                  | (a1+a2+a 3) major | (a2+a3) medium | (a3) minor |
| F        | 4                  | (b1) daily | (b2) medium | (b3) occasional |
| M        | 5                  | (c1) significant | (c2) medium | (c3) minor |
| O        | 2                  | (d1) significantly positive | (d2) medium | (d3) no opinion |

Score (S): 1×7+F×4+M×5+O×2 [score of importance for each KM specific activity]

Therefore we proposed a scale of obtained impacts [5, 36]:
1. if score (S) is equal to 18 points – insignificant impact of KM specific activities;
2. if score (S) it is between 18 and 60 points – medium impact of KM specific activities;
3. if score (S) is greater than 60 points – significant impact of KM specific activities;

For the assessment of KMP it will be retain only scores higher than 60 points (S>60), so only the significant impacts of KM specific activities.

The impact generated by a certain process of KM to which it has been associated \( n \) number of specific activities is calculated as follows [5, 36]:

\[
IF_{a_i} = \frac{\sum_{i=1}^{n} IF_i}{n}
\]  

where: \( IF_{a_i} \) - impact of KM process; \( n \) – KM process specific activities.

The overall impact of all KM processes (KA+KC+KU+KS+KAS+KP) within which is developed \( a_n \) specific activities is calculated as follows:
\[
IF_{\text{global}} = \sum_{i=1}^{a_n} IFa_i
\]

where: \(IF_{\text{global}}\) – impact of all KM processes; \(a_n\) – number of KM processes.

5. Conclusions and Future Work

Improving organizational performance and increasing innovation capacity should be the first priority of the manufacturing organizations, or to any organization. So in modern manufacturing organizations it can be seen a substantial improvement regarding the attitude towards “knowledge” and to KM complex system. This occurs due to the fact that organizations realized that an efficient KM generates the highest value. Thereby through a good management of KM system the manufacturing organizations could: increase the rate of organization innovation, simplifies the organizational processes, reduce the risk of departure regarding the employee with precious knowledge for the organization, reduced the competitive pressures, increase the mobility of human resources, prevents unwanted loss of knowledge, increase the competitiveness of the organization, and so on.

Performance measurement of KM represents an area in KM science extremely important from a practical perspective, for manufacturing organizations; this is because enables managers to base their decisions; without knowing the current situation is impossible to develop future actions.

This paper proposed methodology framework for KMP; it’s improves the evaluation process of KMP and provides a viable tool for manufacturing organizations managers. Thereby they can improve the work processes efficiency and the activities effectiveness. Considering the developed framework in this paper we support the fact that proposed methodology and the adapted method used properly can assess the quality of organizational knowledge.

Regarding to the future work we intent to test and implement the developed KMP methodology due to its influence on the organizational performance and also to test the developed adapted method that quantify partial or total the importance level of this organizational system.

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