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DECISION MAKING AND INNOVATION DIAGNOSIS WITHIN AERO-SPACE SECTOR

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Abstract
The triggering cause of the present research is given by the high complexity of the interdisciplinary technical projects carried out by means of Systems Engineering (SE) methodology, and implicitly by the well acknowledged needs in the field for more advanced decision making tools to increase the projects efficiency and innovativeness. This study takes into consideration a novel theoretical decision making and knowledge creation diagnosis model for SE, entitled DiagnoSE, which is based on the Cognitive-Emotional and Explicit-Tacit knowledge dyads, for applying it within Romanian aero-space sector, implicitly upon 197 SE decision makers, for contributing to the Romanian SE management efficiency. Based on the principle that distinguishes the first dyad as a mechanism for accessing knowledge from the second dyad, and on numerically quantified pairwise comparisons, there was diagnosed the Romanian aero-space SE professionals' perceptions on decisions making, and also knowledge creation dynamics within interdisciplinary teams. The quantitative research revealed notably results especially by the high weight of Emotional Criterion with respect to Romanian SE experts' preferences for accessing their own

experiences, and furthermore, by the need for achieving innovations through continuous knowledge spirals. The herein study brings a practical and unique image upon the Romanian interdisciplinary working environment based on SE in the aero-space sector by applying DiagnoSE instrument in order to determine and analyze the decision making and knowledge creation aspects of paramount importance in enhancing the Romanian SE teams' management, and even furthermore, in providing a basis for other researches regarding SE based working environments in aero-space sectors and not merely.
Keywords: Decision making, Knowledge creation, Systems Engineering (SE), DiagnoSE, Cognitive-Emotional, Explicit-Tacit, Knowledge, Dyad.

1. INTRODUCTION

Due to the globalization and technological revolution started in the 20th century, it emerged the knowledge based society (Drucker, 1993), implicitly with the real needs in the economic sector to achieve the right abilities to innovate by creating new knowledge (Nonaka & Takeuchi, 1995) and making decisions and judgments efficiently, through the benefit of knowledge management (Saunila and Ukko, 2012; Lawson and Samson, 2001; Branzei and Vertinsky, 2006), including the involvement of information technology (Chang, Hsu, and Yen, 2012), and with neuro-psycho-economics related aspects (Sanfey, Loewenstein, McClure, & Cohen, 2006; Camerer, Loewenstein, & Prelec, 2005). More than that, it has arisen the request in the literature for behavioral decision research which could contribute and streamline efficiently project engineering methodologies, implicitly increasing innovativeness and bringing economic benefits.

With respect to decision making process functionality in the frame of neuroscience, besides its cognitive main component, this is attested to be influenced in some cases by emotions when based on the anatomical "body loop" system, the somatic states signals act to somatosensory and insular cortices, implicitly influencing the neural and the decision-making processes (Bechara, 2004). Also in line with this vision upon decision making and more on creating knowledge, the Japanese intellectual tradition and its economic sector advocate a new epistemology of knowledge, distinguishing between tacit and explicit knowledge and arguing that the key to continuous innovation at the level of individual, group, organizational and inter-organizational lies precisely into the conversion of these two knowledge dimensions (Nonaka & Takeuchi, 1995; Nonaka, Toyama, & Byosiere, 2001). Consequently, in the frame of knowledge management literature, it has emerged the concepts of the two knowledge dyads, namely Cognitive-Emotional and Explicit-Tacit, extremely comprehensive for the way of thinking, creating knowledge and making decisions in the Eastern and Western cultures characterized by oneness, and by dualism of body and mind respectively (Bratianu, Mandruleanu, Vasilache, & Dumitru, 2011).

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On the other hand, it is emphasized the high level of complexity in the technical projects carried out by means of Systems Engineering (SE) methodology (Pyster, Olwell, Hutchison, Enck, Anthony, Henry, & Squires, 2012) especially within the innovative burgeoning and complex aero-space sector where the projects foresee high uncertainty and as well huge economic benefits for society (The National Aeronautics and Space Administration [NASA], 2007; European Space Agency [ESA] Annual report, 2011). In other words, SE methodology involves "sequence of activities and decisions towards identifying technological and market opportunities" (Tantau, Vizitiu & Valeanu, 2014, p.112) with the purpose to build system solutions compliant with stakeholders' needs and environmental constraints, taking into consideration that the entire information treatment chain encompassed by SE requires more and more new advanced decision making tools to obtain an increased efficiency of the process (NASA, 2007; NASA, 1995), and in the same time the well acknowledged general need for knowledge transformation or dynamics, being highlighted the knowledge creating process or innovation stimulation (Vizitiu & Valeanu, 2012).

Based on the literature request on involving more decision sciences in the SE real practice and on identification the knowledge dynamics, the herein proposed research, in the frame of knowledge management with aspects of psychology, is taking into consideration the theoretical novel decision making diagnose instrument suitable for SE activities, entitled DiagnoSE and developed by Vizitiu (2014), in order to apply it and, consequently, determine a practical and unique image upon decision making and knowledge creation dynamics in Romanian aero-space SE based environment.

DiagnoSE is based on the two knowledge dyads, namely Cognitive-Emotional and Explicit-Tacit, accommodated on the Analytic Hierarchy Process (AHP) mathematical model, and constitutes a psychometric instrument whereby individuals' perceptions on the knowledge dyads related decision making patterns in the frame of SE projects are analyzed and interpreted as well at group level, providing in this way a new perspective upon gaining more efficiency in decision making process, and implicitly in creating new knowledge and operationalizing the engineering projects in the SE context (Vizitiu, 2014).

The herein study has been applied DiagnoSE instrument within the Romanian aero-space sector in order to prove its valuable contribution oriented to enhance the SE management efficiency and effectiveness in the frame of SE research and development projects.

In the following sections of the study, it is provided a review upon both DiagnoSE instrument including the Cognitive-Emotional and Explicit-Tacit knowledge dyads along with their connection, but also towards SE methodology illustration and the impact of decision making on engineering projects. The

core aspect of the study stands in the quantitative research methodology applied on the interdisciplinary working environment of Romanian aero-space sector, as well in the research data interpretation together with the conclusions, all these presented in the second part of the paper.

2. COGNITIVE-EMOTIONAL AND EXPLICIT-TACIT KNOWLEDGE DYADS AND THEIR CONNECTION

Being considered the world we are living as a living paradox due to our effort to understand the unlimited universe using our limited minds, it is well known stated in the literature that the solution to this paradox lies in building at individual level the mental models or the cognitive approximations illustrating the real world and being of utmost importance in the way we take action (Bratianu, 2011; Plesu, 2003; Senge, 1990). In this context, knowledge consists in representations and interpretations through our mental and emotional mind components upon the world, and whose purposes are to undertake decisions and actions (Vizitiu & Valeanu, 2012).

In some knowledge management perspectives, the Cognitive-Emotional knowledge dyad is seen as being more comprehensive than the Explicit-Tacit dyad, and besides this, their origins seems to point out cultures characterized by different thinking philosophies. Thus, while the former may reflect the Japanese epistemology labeled as the oneness of body and mind involving direct personal experience and stressing the helicopter way of thinking, the latter could be oriented towards Cartesian dualism of mind and body stressing individual thinking (Bratianu & Orzea, 2009; Goldberg, 2008).

Based on the explicit-tacit knowledge epistemology, in the mid-1990, Nonaka and Takeuchi argued that the knowledge creation process consists exactly in the interaction between explicit knowledge and tacit knowledge at the level of individuals and more, at the level of groups of individuals, whereas the tacit knowledge comes from personal direct experience and is highlighted as being the kernel of continuous innovation. In this Japanese epistemology, explicit knowledge regards formal and systematic knowledge as mathematical and grammatical statements, specifications, principles etc., easily conveyed across individuals through manuals, formal courses and so forth, while tacit knowledge is hard to be articulated with formal languages because it represents the "*personal knowledge embedded in individual experience and involves intangible factors such as personal belief, perspective, and the value system*" (Nonaka & Takeuchi, 1995, p. viii). Hence, the interaction between tacit and explicit knowledge presents four modes of knowledge conversion which actually compose the engine of the knowledge creation process through Socialization, Externalization, Combination, and Internalization (SECI) involving transformation of explicit to tacit knowledge and vice versa, and as well transferring tacit to tacit

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knowledge and explicit to explicit knowledge, all these undertaken in a wide ontological range, from individual level to a whole project team, and even more (Nonaka & Takeuchi, 1995; Vizitiu & Valeanu, 2012; Bratianu, 2010). Tacit knowledge is presumed to be stored in the non-conscious part of the brain and is non-rational since we use without being aware of it, while explicit knowledge is rational because we use it in a conscious way by explaining and transferring it further through communication (Bratianu et al., 2011).

As it was made the metaphorical connection in the Japanese tradition between tacit and explicit knowledge where explicit knowledge is seen just as the tip of the iceberg, while tacit knowledge constitutes the significant rest of the iceberg knowledge body, in the same metaphorical way it has been illustrated by Heath and Heath (2010) the interaction between rationality and emotions under the form of the relation between an elephant with its rider, stressing the precarious control of rider (i.e. rationality) upon the elephant (i.e. emotional side), and implicitly the power of emotions upon individuals.

Even if there is asserted in the psychology that the relation between cognition and emotion may remain a scientific dilemma (Eysenck & Keane, 2002), during time researchers determined that emotions are very much determined both by the explicit and tacit knowledge, and as well by the operational processes of rationality, but despite its connection with cognition at conscious or non-conscious level, there is proven the enormous power of emotions in influencing judgments and behaviors (Ortony, Clore, & Collins, 1990; Resnick, 2012; Zerbe, Härtel, & Ashkanasy, 2008). With regard to cognition, this seems to include the processing capacity of the explicit knowledge, recognizes patterns and enables planning, aspects also influenced in some cases by the tacit knowledge as the personal direct experiences of individuals (Churchland, 2002). Emotions are generally determined by negative or positive experiences in the past, and in case of emergencies, these have the potential to enable the body to react in a certain way based on the explicit and tacit knowledge detained by the individual, and through a short-cut to the mind, emotions may outrun the rational cognitive processes in decision making (Hill, 2008; Bratianu et al., 2011). Also in the emotional context, due to individual's antecedents, learning consequences and so forth, there are different types of emotions as standard emotions or emotion-inducing perceptions in which cognition could have no involvement at all or a very high weight (Ortony et al., 1990). Furthermore, Zerbe, Härtel, and Ashkanasy (2008) asserted that, generally, the organizational decision making process is not always undertaken deliberately or influenced by cognition, whereas emotions and cognition could be seen as ways to access the stored knowledge, stressing the high potential amplitude of emotional side.

Hence, in the light of the above illustration regarding the two knowledge dyads, it can be noticed the relation between the dyads, also expressed by Vizitiu (2014) in composing the DiagnoSE instrument,

namely that Cognitive-Emotional and Explicit-Tacit knowledge dyads are different in the field of action, and while the latter (i.e. Explicit-Tacit dyad) is directing towards structuring and storing knowledge, the former (i.e. Cognitive-Emotional dyad) is emerging as a slow vs. quick, deliberate vs. intuitive mechanism for accessing knowledge from the latter dyad and use them accordingly in decision making processes. More than that, as stated in the Japanese economic sector, Explicit-Tacit knowledge dyad has also the potential to create new knowledge and innovations by conversing and transferring knowledge at different ontological levels.

The herein research, in the field of knowledge management, has the objective to use in practice the novel decision making diagnosis instrument suitable for SE methodology based projects, DiagnoSE, in order to diagnose and draw some main conclusions upon the Romanian SE based interdisciplinary working environments in aero-space sector, raising awareness for knowledge creating dynamics within the project teams, and despite the situations when cognition works together with emotionality, for the specific technical project teams' predisposition on making decisions with respect to rationality, emotionality and objective procedures.

3. SYSTEMS ENGINEERING (SE) METHODOLOGY AND THE WEIGHT OF DECISION MAKING PROCESS IN COMPLEX PROJECTS

The interdisciplinary SE methodology is focused on "*understanding stakeholder needs; exploring opportunities; documenting requirements; and synthesizing, verifying, validating, and evolving solutions while considering the complete problem, from system concept exploration through system disposal*" (Pyster et al., 2012, p. 1). More than that, SE is evidenced to bring huge economic benefits involving large capital investments on long term and enabling Corporate Entrepreneurship strategy in the aerospace business sector with the purpose of implementing successfully innovative and complex products/services also in the benefit of society (Vizitiu, Valeanu, & Tantau, 2013), based mainly on the knowledge creation process (Vizitiu & Valeanu, 2012). SE methodology has been preponderantly used in the aerospace sector in the last six decades due to its capability of balancing efficiently among stringent system requirements, resources and technological advance, in the frame of systems with high complexity (The International Council on Systems Engineering [INCOSE], 2000), where a "system" could involve a wide range of type of components, namely from technological prototypes till complex interconnecting networks of individuals, technologies, knowledge and processes, with the purpose to achieve a clear objective (Tantau et al., 2014; Department of Defense, 2001). SE encompasses the two main domains of technical knowledge and systems engineering management (Department of Defense,

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2001; INCOSE, 2006) pointing out aspects as follows: importance of quantitative, but even more, of qualitative decision making process based on individuals' experiences in multidisciplinary working environments; consideration of the system in its entirety with awareness on environment conflicting constraints and stakeholders' requirements; compliance of functionality and interfaces among all the system sub-components developed through different engineering disciplines (Kossiakoff, Sweet, Seymour, & Biemer, 2011).

The National Aeronautics and Space Administration (NASA) distinguishes in the SE methodology several phases to characterize a project life cycle, namely Pre-Phase A (i.e. advanced studies) focusing on creating/discovering an idea, Phase A (i.e. preliminary analysis) and Phase B (i.e. definition) orienting towards system feasibility and specifications, respectively, Phase C (i.e. design) and Phase D (i.e. development) completing the design and integrating/verifying the whole system, respectively, while the last phase, Phase E (i.e. operations) regards the system utilization to fulfill the opportunity and as well a proper system disposal (NASA, 2007; NASA, 1995).

The whole SE methodology is marked by the continuous process of daily decision making upon technical feasibilities and formal configuration management, the latter activities entitled as *Control Gates* (Forsberg & Mooz, 1991) and known as Key Decision Points (NASA, 2007), and whose purposes culminate in acceptances to pass in the next project phases. More than that, decision making at this level targets verification and validation activities within project team and/or stakeholders (Pyster et al., 2012), while related to the Control Gates importance, The International Council on Systems Engineering (INCOSE, 2006) stressed that skipping the laborious decision making activities within SE Control Gates could increase risks with respect to schedule and costs, and as well reduce substantially the technical development quality. The decision making process specific to SE may consist in qualitative/quantitative assessments in the frame of cost analysis, technical issues, effectiveness, trade-off studies, being emphasized the need of both objectively/subjectively criteria to be involved in solving this kind of evaluations (Pyster et al., 2012). Furthermore, there are even recommended the qualitative estimations for making decisions on risk management by quantifying the probability of occurrence and corresponding consequences of events all the more so as SE includes concurrent engineering with multidisciplinary teams whose members' expertise is needed throughout the system life cycle (NASA, 1995).

Regarding the coordinating aspect of team members' effort, the systems engineers are the proper individuals with technical and management aptitudes by involving the project personnel in exploring the risks of the life of the system and making the formal critical decisions in due time, without jeopardize the project objectives (INCOSE, 2006; Pyster et al., 2012). SE methodology is seen as a technical and

management composite defined as "*to guide the engineering of complex systems*" implying individual and collective judgments (Kossiakoff et al., 2011, p.xxiv), and being based on the interaction between knowledge practices and perspectives regarding individuals' experiences and visions (i.e. tacit knowledge), along with knowledge principles with respect to problem solving algorithms in engineering disciplines (i.e. explicit knowledge) (Sage, 1992).

Thus, it seems that decision making processes have a paramount importance and contribution in SE methodology, domain where there is utilized a large interdisciplinary amount of knowledge and where the individuals' explicit, and more, tacit knowledge shall be extremely valued.

In order to explore solutions to increase the efficiency at SE decision making level, also as required by NASA (2007,1995), the herein research proposes through DiagnoSE practical implementation to obtain an image upon the collective interdisciplinary individuals' interactions in terms of knowledge creation dynamics, but also in terms of individuals' decision making predisposition among rationality, emotionality and standard project procedures. Based on these results, it can be taken different type of actions by SE leaders on improving the SE management efficiency.

4. REVIEW ON THE NOVEL DECISION MAKING MODEL: DIAGNOSE SE

The theoretical approach of DiagnoSE is based on two cornerstones where the first consists in the Cognitive-Emotional and Explicit-Tacit knowledge dyads disposed in a particular context to comply with certain psychological and knowledge management philosophies within SE, while the second cornerstone is represented by Saaty's mathematical method (2009) called Analytic Hierarchy Process (AHP). The first cornerstone is defined by the principles resulted in the knowledge dyads literature review, namely the Cognitive-Emotional and Explicit-Tacit knowledge dyads may be different in the field of action, distinguishing the former as a slow vs. quick, deliberate vs. intuitive mechanism for accessing knowledge from the latter, responsible at its turn with knowledge creation, and use it accordingly in decision making processes, while the second principle regards the fact that organizational decision making process is not always undertaken deliberately or influenced by cognition therefore it can be identified a specific decision making predisposition of individuals between rationality, emotionality and procedural protocol. The accommodation of the dyads algorithm described above in a psychometric model used the second cornerstone consisting in the AHP methodology, methodology which belongs to the group of Multi Criteria Decision Making (MCDM) methods.

Mainly, the AHP philosophy involves structuring multiple choice criteria and activities into a hierarchy, and choosing the best of a discrete set of activities for each criterion, determining a ranking of activities

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and criteria according to a given goal. Taking into account that comparison related decision making activities "*are fundamental in our biological makeup*" (Saaty, 2009, p.1), the measurements involved in comparisons are assumed to be interpreted subjectively as individuals' perceptions and preferences, and therefore AHP prescribes the right decision according to the proposed goal.

Hence, the main components of DiagnoSE are organized systematically on three levels in format of a hierarchy relationship by means of AHP (see Figure 1) and explained in the following section.

The top level represents actually the goal level and corresponds to "*Increasing decision making efficiency within SE*". The second level corresponds to criteria or strategies formulated for achieving the goal, and which consist actually into the Cognitive-Emotional dyad elements together with the procedural component. Thus, we define the components of the criteria level equivalent with the strategic level, as follows: the Cognitive Criterion (C1) translated as the rational, quantitative and objective criterion based on the individual's own judgment; the Emotional Criterion (C2) seen as the subjective and qualitative criterion based on the individual's own preferences and perspectives; the Procedural Criterion (C3) based on the objectively administrative project procedures, standards and work plans which are totally unrelated to individual' preferences, but needed in some moments of SE projects progression. The third level of DiagnoSE consists in the activities that support the criteria on the second level and further implement the goal of increasing decision making efficiency within SE through the considered criteria. This may represent the level of implementation of whose components are the Explicit-Tacit knowledge dyad elements in the form of Japanese view regarding SECI knowledge creation engine. More exactly, the third level components are constituted from the interaction between Explicit and Tacit knowledge as follows: Socialization and Combination which reside to knowledge transfer activities among individuals through tacit to tacit knowledge and explicit to explicit knowledge, respectively, while Internalization and Externalization which regard knowledge conversion activities in terms of explicit to tacit knowledge and tacit to explicit knowledge, respectively. According to knowledge creation literature, Combination is resulted through social and formal interactions as virtual or face to face meetings, as well documents collection, Socialization is enabled through shared context related experiences among individuals in the form of informal meetings, Externalization is given by articulating tacit knowledge into explicit knowledge and represents the key to knowledge creation process, being enabled when individuals try to clarify concepts or set down skills, whereas Internalization is seen as learning by doing, as result of embodying explicit knowledge into tacit knowledge (Nonaka & Takeuchi, 1995; Nonaka et al., 2001; Bratianu, 2010).

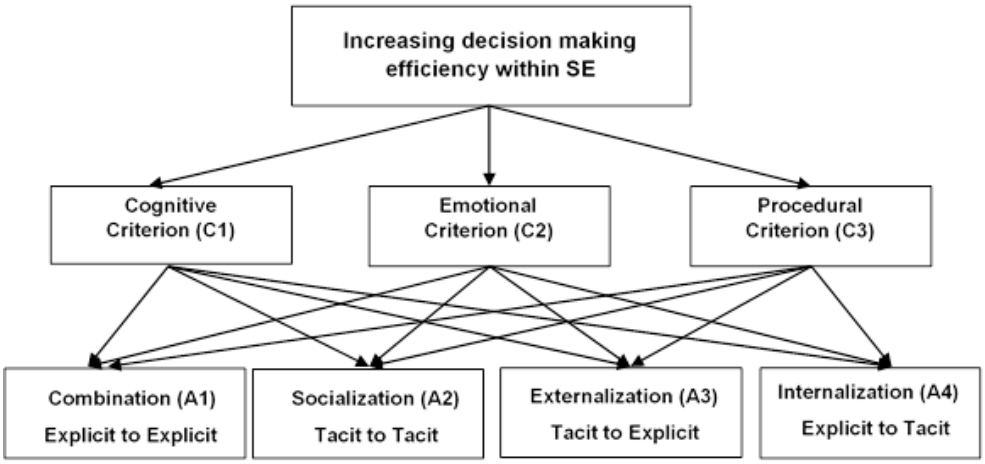

FIGURE 1 – DIAGNOSE ACCORDING TO AHP METHOD

Source: Vizitiu (2014). The decision making diagnose model according to AHP method, whose main components are constituted mainly by the Cognitive-Emotional and Explicit-Tacit knowledge dyads corresponding mainly to the second level elements and third level in the form of knowledge creation activities, respectively.

Taking into account that SE methodology is based both on the interdisciplinary teams whose members' expertise is needed concurrently throughout the entire system life cycle for dealing with, applying and creating knowledge, and in the same time, on individuals that make critical decisions upon the collective judgments, DiagnoSE fulfills in this way the collective and individual knowledge creating activities through SECI level, while through criteria level pursues diagnosing decision making predisposition.

DiagnoSE instrument has been applied as an empirical research within the Romanian aero-space sector in order to gain a better understanding upon the decision making diagnosing aspect within SE methodology based on the knowledge creation and dynamics.

5. RESEARCH METHOD

5.1 Participants

The survey questionnaires were sent to a number of 330 individuals, but the received valid answers consisted in 197 questionnaires, where the rate of response was 59%. The 197 respondents (155 men, 42 women) with a mean age of 45 years (range = 25 – 65) were all Romanians, working in aero-space research and development projects both in public institutions and private sector.

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All participants subjected to the survey have been involved in their careers in research and development projects by means of SE methodology, either as systems engineers, or as representatives assigned by their teams within larger multidisciplinary technological projects, both categories with decisional power at some points in time upon critical technological and management issues.

5.2 Survey Procedure and Data Processing

The survey questionnaires were delivered to the subjects exclusively by hard copies and consisted in a quantitative methodology of gathering data, namely on paired comparisons of criteria, seen also as strategies, with respect to implement the goal of increasing decision making efficiency within SE, and afterwards on paired comparisons of activities with regard to each criterion defined at the second level of hierarchical structure. These pairwise comparisons were numerically quantified through the individuals' perceptions, being used a Likert scale with a range from 1-equally important to 9-extremely important.

As concerns the *data processing,* the quantification of the pairwise comparisons yielded matrices of judgements, also known as decisional matrices. Therefore, per each questionnaire it was determined one matrix with respect to pairwise criteria comparisons with respect to the goal and three matrices corresponding to pairwise activities comparisons with regard to C1, C2 and C3 criteria. The matrices were positive, reciprocal, and with main diagonal elements equal with 1. Decisional matrices were involved in eigenvalue problems, whose solutions materialized in one vector of priorities for each decisional matrix.

The matrices were analysed for consistency or inconsistency. More detailed, according to Saaty's theory (2009), in case of consistency the decision vector is actually the eigenvector associated with the highest eigenvalue, whereas in case of inconsistency the associated decision vector becomes the eigenvector associated with the highest eigenvalue of the normalized matrix.

The priority vectors per subject were computed through Gauss 9.0 Software, while the next phase of aggregating the priority vectors of all 197 questionnaires was carried out by means of Microsoft Excel 2013.

The aggregation process regarded arithmetical average of all individual vectors of priority per category of criteria and activities with respect to each criterion. The resulted values of vector of priorities for criteria constitute the ranking of criteria in the perception of all 197 subjects for indicating the keys to implement the goal of increasing decision making efficiency in SE projects, while the values of the vectors of priorities of activities with respect to each criterion suggest in the perception of the subjected

individuals the ranking of activities with respect to each criterion, as the right support for the respective criterion in achieving the goal.

There is also provided the global priority vector or the ranking of activities as implementing directly the goal in the view of the 197 individuals, and this approach give an ample image on the impact of the knowledge dynamics upon decision making efficiency in the frame of SE aero-space research and development projects.

6. RESULTS

By applying DiagnoSE upon distinct groups of professionals performing research and development projects by means of SE methodology, it can be identified according to their perceptions the importance of the considered criteria in increasing decision making efficiency in SE working environments and as well the importance of the considered knowledge creating activities in supporting each criterion and even more in implementing the goal. Thus, the aggregation priority vectors computed in the frame of this research indicate exactly the ranking of criteria as importance with respect to the goal, and as well of activities with respect to each criterion and directly to the goal.

6.1 Criteria Ranking in Increasing Decision Making Efficiency

In the view of all 197 individuals' perceptions it emerged the fact that within SE projects it must be taken into account very much all three criteria (see Figure 2) in order to streamline the decision making process, criteria with weight surprisingly close to each other. In this context, the Procedural Criterion (C3) has the highest percentage, namely 40%, and regards specific aspects of SE projects imposed in a certain extent to individuals, as guidance, regulation, standardization, organization, schedule, finance and so forth, while the Cognitive Criterion (C1) emerges as almost with the same importance as the Procedural Criterion, and targets information processing and application based solely on individual's rationality and objectivity, mainly by means of quantitative approaches.

About the Emotional Criterion (C2), this is surprisingly a lot taken into consideration by the SE professionals with a weight of 24% in increasing the decision making efficiency, and consists in enabling the individuals to access and have recourse to their own experiences, perspectives, problem solutions and so forth. It appears that besides the Procedural Criterion which is more or less imposed to SE decision makers, the Emotional Criterion supports immensely the Cognitive Criterion at individual level in the frame of SE.

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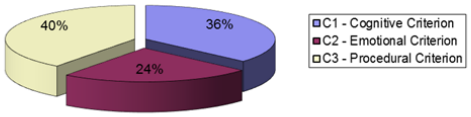

FIGURE 2 – CRITERIA RANKING WITH RESPECT TO THE GOAL. CRITERIA RANKING IN INCREASING DECISION MAKING EFFICIENCY WITHIN SE ACCORDING TO THE ALL 197 INDIVIDUALS' PERCEPTIONS

6.2 Activities Ranking in Implementing the Goal

With respect to activities ranking in implementing the goal of increasing the decision making efficiency in the view of all the subjected individuals, all considered types of activities are almost equally considered (see Figure 3) and this can be interpreted as being required the achievement of a knowledge creation spiral due to the continuous and dynamic interaction between tacit and explicit knowledge both at individual and group of individuals levels.

More than that, it can be distinguished the Socialization type of activities as the prominent type of activity among the others with the highest percentage, and represents the process of sharing context related experiences among individuals, along with the main key activity in tacit knowledge creation under the shape of technical skills and perspectives.

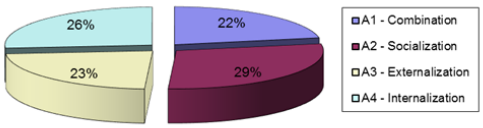

FIGURE 3 – ACTIVITIES RANKING WITH RESPECT TO THE GOAL. ACTIVITIES RANKING IN IMPLEMENTING THE GOAL OF INCREASING DECISION MAKING EFFICIENCY WITHIN SE ACCORDING TO THE ALL 197 INDIVIDUALS' PERCEPTIONS

In other words, with respect to achieving a higher efficiency in decision making, the flow of information in the frame of SE projects shall dominantly tend towards the knowledge creation process.

6.3 Activities Ranking in Supporting Cognitive and Emotional Criteria

It has to be remarked the fact that in the cases of measuring the weight of activities in the view of all the subjected individuals in supporting the Cognitive Criterion (C1) and Emotional Criterion (C2), the

activities ranking is the same (see Figure 4 and Figure 5), namely Socialization and Externalization on first and second places corresponding to 30% and 28%, respectively, while Internalization and Combination occupy the last two places with approximately 25% and 17%, respectively. If Socialization, as a tacit knowledge transfer process among individuals may be on the first rank as expected with respect to supporting the Emotional Criterion, in the case of the Cognitive Criterion, Socialization it is also highlighted as having the highest potential in influencing and enhancing the rational and quantitative judgments.

Regarding Externalization activities in this context, it can be stated that in order to create knowledge in SE working environments is mandatory the involvement in an equivalent extent of rationality and emotionality, or in other words, articulated knowledge and pure context related experiences. In supporting both the Cognitive and Emotional Criteria for enhancing decision making efficiency, it is revealing the need of activities concerning the followings: collective environments where there shall be undertaken and organized informal meetings/networking, brainstorming camps residing to Socialization, debates and concept clarification residing to Externalization, and as well experiencing the documented experiences of other individuals residing to Internalization.

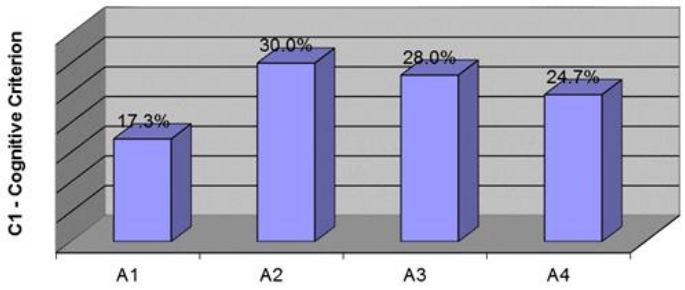

FIGURE 4 – ACTIVITIES RANKING WITH RESPECT TO C1 CRITERION. RANKING OF THE ACTIVITIES CONSIDERED IN SUPPORTING THE COGNITIVE CRITERION (C1) ACCORDING TO THE ALL 197 INDIVIDUALS' PERCEPTIONS

Placed on the last rank in supporting both the Cognitive and Emotional Criteria, Combination can be translated through the SE professionals' perceptions as their need for reducing the formalities and bureaucracy in some cases for increasing the decision making efficiency. More detailed on these aspects, for supporting the Cognitive Criterion in increasing decision making efficiency, it shall be reduced the level of formalities within individuals' official interactions by letting aside their titles together with their level of authority each upon other, and facilitated a freely speaking environment where all involved individuals would be able to express their needs and recourse to their own experiences (i.e. tacit knowledge) to remove potential project obstacles.

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Similarly, for supporting the Emotional Criterion in increasing decision making efficiency, it is emerging the need for a permissive inner regulations and procedures which to tolerate failures, and more, to stimulate risk taking, proactiveness and knowledge dynamics on the vertical and lateral informal communication levels within the multidisciplinary team members.

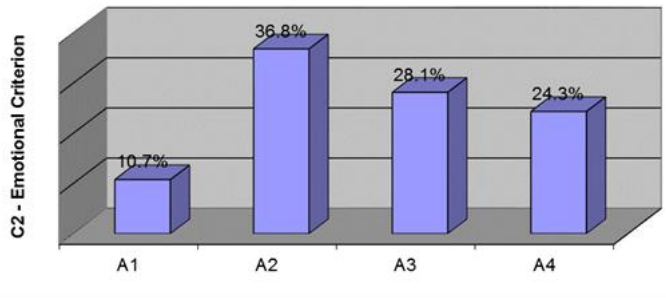

FIGURE 5 – ACTIVITIES RANKING WITH RESPECT TO C2 CRITERION. RANKING OF THE ACTIVITIES CONSIDERED IN SUPPORTING THE EMOTIONAL CRITERION (C2) ACCORDING TO THE ALL 197 INDIVIDUALS' PERCEPTIONS

6.4 Activities Ranking in Supporting Procedural Criterion

With respect to the activities which endorse the Procedural Criterion (C3) to enhance the decision making efficiency within SE, and as it can be noticed in the Figure 6, the most important activity type in the perceptions of all 197 individuals consists, as expected, in Combination with 33%, pursued by Internalization with the close percentage of approximately 29%, and afterwards Socialization and Externalization with 23% and 15%, respectively. It can be established the fact that in order to engage the Procedural Criterion it requires the social and formal face to face/virtual interactions between individuals plus combination of documents, serried with activities of learning by doing.

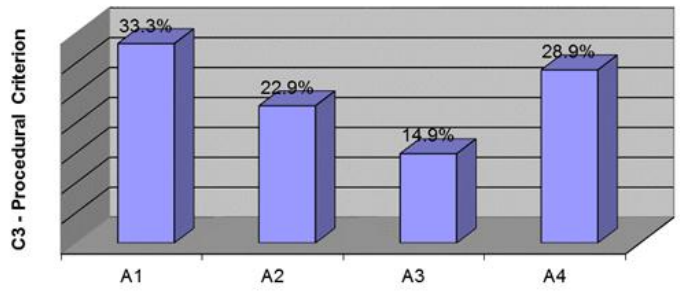

FIGURE 6 – ACTIVITIES RANKING WITH RESPECT TO C3 CRITERION. RANKING OF THE ACTIVITIES CONSIDERED IN SUPPORTING THE PROCEDURAL CRITERION (C3) ACCORDING TO THE ALL 197 INDIVIDUALS' PERCEPTIONS

Furthermore, to sustain Combination and Internalization, the shared tacit knowledge among individuals with SE similar administrative experiences residing to Socialization represents important aspect for discovering solutions on project administrative general issues and consequently implementing a proper SE administrative management. Regarding Externalization in the Procedural Criterion, this type of knowledge creating activity is the most disadvantaged due to the high level of administrative bureaucracy that lies on the SE working environment.

7. CONCLUSIONS

DiagnoSE, the knowledge management psychometric instrument based on the Cognitive-Emotional and Explicit-Tacit knowledge dyads as criteria to increase the decision making efficiency and as activities to support each criterion in enhancing the judgments quality within SE working environments, respectively, has the utility to diagnose the SE professionals' predisposition among rationality, emotionality or standardized project procedures, in appealing to at conscious or non-conscious level within critical decisions making. More than that, DiagnoSE through the third level structure, has the capability also of diagnosing the dynamics of knowledge within multidisciplinary teams in order to identify those types of activities properly for supporting mainly the Cognitive-Emotional dyad to enhance decision making process, as well to implement directly the goal and facilitate innovations.

Taking into consideration the need for more decision making advanced tools in SE methodology, as notified by NASA, DiagnoSE instrument residing to knowledge management with aspects of psychology, has been applied as an empirical research upon 197 Romanian SE decision makers within aero-space economic from the initially targeted 330 individuals, in order to present its potential contribution in the Romanian SE management efficiency.

This research applied upon the general sample of diversified Romanian SE professionals revealed notably results which attest that besides the Procedural and Cognitive Criteria in increasing the decision making efficiency, the Emotional Criterion was surprisingly a lot taken into consideration with 24% by individuals and whose rank meaning regards the access to their own experiences and perspectives. Besides other important results, there is highlighted also the activities ranking with similar percentages in expressing the knowledge dynamics within teams and as well implementing the goal, and which concluded in a continuous and dynamic knowledge spiral and consequently in stressing the achievement of the knowledge creation process due to the continuous Explicit-Tacit knowledge dyad interaction elements.

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The herein paper provides a real and unique image upon the Romanian interdisciplinary working environment based on SE in the aero-space sector, with great potential in illustrating and analyzing SE based decision making process and knowledge creation dynamics in Romanian culture.

In this context, the SE project leaders will be aware of the teams' perceptions and consequently they will be able to invest, improve and more often deploy the specific activities arisen, with the purpose to gain more efficient SE decision makers and in consequence more efficient and effective projects.

More than that, the quantitative study presented on Romanian SE based aero-space culture could severely contribute in other studies (through DiagnoSE or other decision making related psychometric instruments) made on other cultures with respect to SE working environments, with benefits in noting SE based cultures' correlations and/or discrepancies, and implicit in SE management efficiency.

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