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FACTORS INFLUENCING KNOWLEDGE APPLICATION: A REVIEW FROM THE KNOWLEDGE MANAGEMENT FIELD

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1. Introduction

Knowledge management (KM) is "one of the key enabling technologies of distributed engineering enterprises" [McMahon et al. 2004]. However, its adoption in the engineering industry is minimal [Vijaykumar and Chakrabarti 2008]. The ultimate goal of KM is applying the knowledge, in other words, turning knowledge into effective action [Alavi and Leidner 2001]. One reason for the lack of adoption of KM in the industry may be that "most studies concentrate their work on collection, storage and transfer of knowledge" but "whether knowledge is finally applied is neither supported nor measured" [Schacht and Maedche 2016]. Since the success of KM is determined by the application of knowledge, companies may not want to invest in KM because of the few support and evidence regarding knowledge application.

Successful KM requires a deep understanding of the barriers involved [Storey and Barnett 2000]. With the objective of understanding what leads to knowledge application, we conducted a literature review to collect the barriers in KM. A barrier represents an undesirable state of an influencing factor. Both terms are interchangeably used in literature so, while conveying the literature research, we always looked for both. From now on we will only refer to the neutral term factor.

According to [Webster and Watson 2002], major contributions in a field should be in the leading journals; thus, we performed a review in those of the engineering design (ED) field: Journal of Engineering Design, Design Studies, and Research in Engineering Design. We reviewed the table of contents of these journals in the last five years and we did not find any detailed study regarding the factors influencing knowledge application.

Contrary to ED, literature in the field of KM provides numerous studies that discuss the factors influencing successful knowledge application. We conducted 6 semi-structured interviews with design engineers from the Bavarian automotive industry and we asked them about their problems applying knowledge. They named factors listed in the KM literature like, for example, the structure of the repositories or the language. Therefore, we assume that reviewing journals in the superordinate field of KM will bring us factors which are representative of the ED field. Thus, we collected influencing factors for knowledge application presented in the papers of the most relevant KM journals.

During the literature review we realized that factors are analysed and classified using different KM models which are not comparable. [Carro Saavedra et al. 2015] argued that this lack of consensus in the KM model hampers understanding the real influence of the factors in successful KM and, therefore, proposing solutions to overcome the barriers. Besides, authors often focused on organizational processes and functionalities of KM solutions rather than on individual's behaviour [Schacht and Maedche 2016].

But individuals are the ones applying the knowledge and therefore, they should constitute the focus of understanding what leads to successful knowledge application. In order to unify the influencing factors for knowledge application in one model that considers the individual as central element, [Carro Saavedra et al. 2015] proposed the Worker-Centered-Model (WCM). The WCM represents an attempt to understand a phenomenon that has been rarely studied (knowledge application) from a point of view that has been little considered despite its significance (individuals point of view).
In the paper at hand, we present the literature review of influencing factors for knowledge application that we conducted within KM journals. We use the WCM to structure the factors and allow their comparison. We obtained as final result 21 influencing factors classified into 4 categories: infrastructure, knowledge, psycho-social, and strategic factors.
The paper is structured as follows: section 2 presents the Worker-Centered Model, section 3 explains the research methodology, section 4 presents and discusses the results, section 5 presents the conclusions and summarized result, and section 6 describes the further work.

2. The Worker-Centered Model

The Worker-Centered Model (WCM) represents "the factors influencing knowledge application during knowledge intensive activities from the point of view of the knowledge worker" [Carro Saavedra et al. 2015] A knowledge worker is defined as "a worker whose main capital is his knowledge" [Goncalves 2012]. The model does not only allow the consideration of a single individual but also of different knowledge units in the organization such as groups of individuals or groups of individuals with documented knowledge (see Figure 1a). The boundaries of the knowledge unit subject of study are flexible and they must be defined depending on the particular purposes of the study that uses the model.

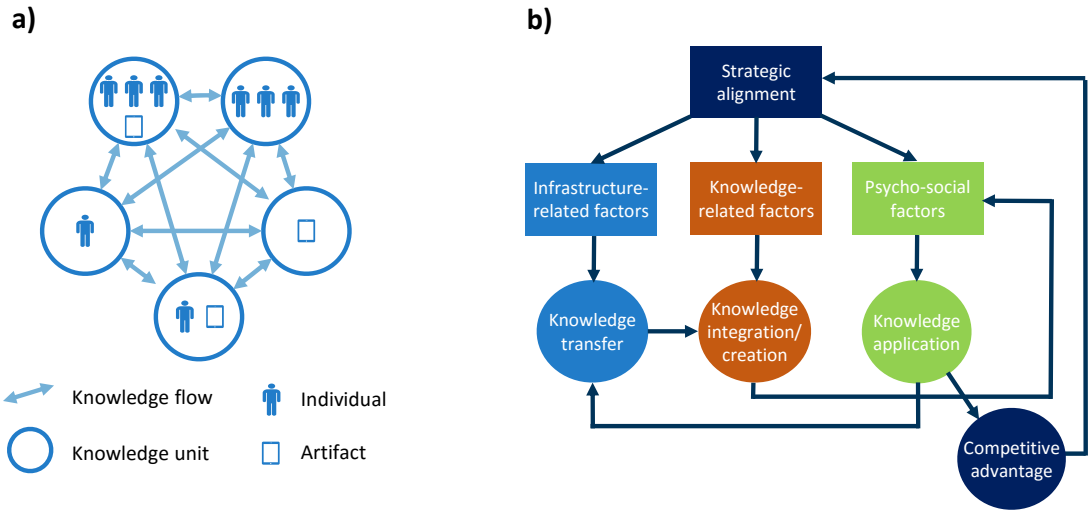

Figure 1. a) WCM view of the organization; b) Factors influencing the knowledge processes and their relations

The model proposes three main knowledge processes to which influent factors are one-to-one allocated. The three processes considered and their factors influencing them are depicted in Figure 1b:

- Knowledge transfer: "the process by which knowledge available within one unit of the organization (individual, team or a division of organization) is made available to other unit(s) of the organization" [Manohar and Gupta 2014]. Knowledge transfer is influenced by factors related to the company's infrastructure. Knowledge transfer influences directly knowledge integration/creation.
- Knowledge integration/creation: process of integrating external knowledge with previously existing internal knowledge in order to create "new knowledge" [Grant 1996] Knowledge integration/creation is influenced by factors related to the knowledge itself. Knowledge integration/creation has a moderating role on the impact of knowledge transfer on knowledge

application [Carro Saavedra et al. 2015] and it influences knowledge application through the fact that the "new created knowledge" influences the psycho-social factors like for example the individual attitude towards applying knowledge.

- Knowledge application: process where the "knowledge is turned into effective action" [Alavi and Leidner 2001]. Knowledge application is influenced by socio-psychological factors. It is the source of competitive advantage [Alavi and Leidner 2001] and leads to knowledge transfer because, every time an action is conducted, its effects can be observed, therefore, transferred.

Strategic alignment affects infrastructure, knowledge, and psycho-social factors [Zack 1999]. Strategic alignment can be considered as an exception in this one-to-one factor-process allocation because the factors in this category do not directly influence a process but the factors of the other three categories as Figure 1b shows.The infrastructure, knowledge, and psycho-social factors influence directly one process, but indirectly the other two. Factors classified into strategic alignment influence directly the factors of the other three categories, and indirectly the three knowledge processes The transparent factor-process representation simplifies the analysis of failures in knowledge application. The model is used in this paper as the basis for understanding and structuring the factors collected from the literature review. Thus, the paper contributes also extending the model.

3. Research methodology

To collect the factors from literature and analyse them, we followed the procedure described in Figure 2, which consists of seven steps:

		Conditions	Results
1	Selection of the leading journals	Location: Web of Science Keywords: Knowledge Management AND (Barrier OR Factor) in all text fields Time window: Between 2005 and 2015 Selection criteria: The 3 non-proceeding journals with greatest number of citations	- Journal of Knowledge Management - Knowledge Management Research & Practice - Information & Management
2	Selection of relevant papers	Location: The three selected research journals Keywords: Barrier OR Factor in the title Time window: Between 2005 and 2015	- Journal of Knowledge Management: 30 papers - Knowledge Management Research & Practice: 9 (not available) - Information & Management: 4
3	Collection of all factors	Collection all factors in an Excel sheet	- 364 factors from 31 papers - 3 papers had no factors
4	Filtering of out of scope factors	Out of scope criteria: - The factor is too abstractly defined - The factor impact crosses firm's boundaries - The factor is a process or strategy itself - The factor is a variable of individuals' behaviours	- 254 factors considered - 110 out of scope factors
5	Filtering of duplicated factors	Duplicates Criteria: - Exact duplicates - The factor is written as barrier or vice versa - Synonyms and antonyms - The meaning of a factor is contained into another	- 142 non-duplicated factors - 112 duplicates
6	Classification into the four WCM categories	Classify the factors into the four categories of the WCM	- Infrastructure factors: 26 factors - Knowledge factors: 16 - Psycho-social factors: 77 - Strategic factors: 23
7	Grouping into similar factors	Grouping of similar factors into more widely described ones	21 final factors

Figure 2. Procedure to collect and analyse the factors

1. Selection of the leading journals. We selected the leading journals because the major contributions to the topic (factors influencing knowledge application) are likely to be there

[Webster and Watson 2002]. We used Web of Science as reference and searched in all text fields with the term "knowledge management AND (barrier OR factor)". Then, we selected the three journals with the greatest number of results between 2005 and 2015: Journal of Knowledge Management, Knowledge Management Research and Practice, and Information and Management.

2. Selection of relevant papers[1]. We selected all papers from these journals between the years 2005 and 2015 that contained in the title the words "factor" or "barrier". We did not used the term "knowledge management" as search criteria because we supposed all papers in these KM journals were covering KM topics. As a result, we selected 30 papers[2] from the Journal of Knowledge Management, 9[3] from Knowledge Management Research and Practice, and 4[4] from Information and Management. However, we were later obligated to discard the 9 papers from the Knowledge Management Research and Practice journal since we had only access to 1[5] of them.
3. Collection of all factors. We extracted all factors present in the 31 of the 34 papers. Three[6] had no factors so we discarded them. In total, we collected 364 factors.
4. Filtering of out of scope factors. Since the selection of papers was made with little restrictive criteria and the authors of the different papers define the factors in many different ways, we added a scope criteria not at the paper level but at the factors level. 68 factors like the absorptive capacity are too abstractly defined to fit into the WCM. According to [Cohen and Levinthal 1990], absorptive capacity refers not only to assimilate, but also to apply the knowledge; this means that absorptive capacity influences two processes of the WCM: knowledge integration/creation and knowledge application. Besides, [Cohen and Levinthal 1990] define absorptive capacity as the factor that influence the performance of both integrating/creating and applying knowledge, so it can be understood as the sum of all psycho-social and knowledge-related factors. We also did not consider 21 factors like "Clash of personalities between the organizations (especially among top management)" that crossed firm's boundaries, 10 factors like "knowledge transference" or "personalization knowledge" that in fact were not factors but knowledge processes or strategies themselves, and 11 like "affirmative effect" or "lack of positive attitude" because they are variables that predict individuals behaviour. Apart from the affirmative effect, which represents the irrational component of individuals' behaviour [Jang and Ko 2014], the other factors refer to Ajzen's [1991] theory of planned behaviour. The WCM uses the theory of planned behaviour to explain how phsycho-social factors influence knowledge application in the same way it uses Nonaka's [1994] SECI model to explain how knowledge-related factors influence knowledge integration/creation. This means that the

1 Papers not explicitly cited in text are referenced providing the DOI in endnotes
2 doi:10.1108/13673271011015633; doi:10.1108/13673270710738898; doi:10.1108/13673271211218861; doi:10.1108/13673271211276155; doi:10.1108/13673271111179271; doi:10.1108/JKM-02-2015-0052; doi:10.1108/13673271211198963; doi:10.1108/JKM-08-2013-0300; doi:10.1108/JKM-08-2013-0316; doi:10.1108/JKM-06-2013-0233; doi:10.1108/13673271011050139; doi:10.1108/13673270810852377; doi:10.1108/13673271011015606; doi:10.1108/13673271111108693; doi:10.1108/JKM-03-2014-0080; doi:10.1108/13673270810852368; doi:10.1108/13673271211198954; doi:10.1108/13673270810859550; doi:10.1108/13673270910962860; doi:10.1108/13673270510610341; doi:10.1108/JKM-08-2013-0324; doi:10.1108/13673270810875886; doi:10.1108/13673270510602746; doi:10.1108/13673270710728231; doi:10.1108/13673270910988097; doi:10.1108/13673270910997105; doi:10.1108/13673271211246167; doi:10.1108/13673270610679408; doi:10.1108/13673270510602773; doi:10.1108/13673270510590236
3 doi: 10.1057/kmrp.2011.2; doi: 10.1057/kmrp.2012.24; doi: 10.1057/kmrp.2010.13; doi: 10.1057/kmrp.2013.30; doi: 10.1057/kmrp.2013.37; doi: 10.1057/kmrp.2013.45; doi: 10.1057/palgrave.kmrp.8500153; doi: 10.1057/kmrp.2012.9; doi: 10.1057/kmrp.2013.54
4 doi: 10.1016/j.im.2010.03.001; doi: 10.1016/j.im.2010.08.003; doi: 10.1016/j.im.2008.03.003; doi: 10.1016/j.im.2011.11.001
5 10.1057/kmrp.2013.30
6 doi:10.1108/JKM-02-2015-0052; doi:10.1108/13673270810852377; doi:10.1108/13673270910988097

affirmative effect, attitude toward the behaviour, subjective norm, and perceived behavioural control are variables of individual's behaviours located between psycho-social factors like culture or trust and the process of knowledge application. Thus, we do not consider these variables factors themselves and they are out of the scope of this paper.

5. Filtering of duplicated factors. Many factors were exact duplicates, many others not but referred to the same concept. Because a barrier is the undesirable state of a factor [Carro Saavedra et al. 2015], many papers define barriers, others define factors. If the same concept is defined as barrier in one paper and as factor in other (relationship and arduous relationship for example), one (or more) of the two (or more) repeated factor is eliminated as duplicate. Some factors like trust and untrustworthiness were synonyms or antonyms and one (or more) of them were removed as duplicate. The fourth criteria for filtering duplicates were that one factor was more restrictively defined than the other; in other words, one factor is contained into the other, for example interpersonal trust is more restrictedly defined than trust. We filtered out 112 factors as duplicated ; by eliminating them we obtained a final list of 142 items.
6. Classification into the four WCM categories. In order to be able to understand how each of the 142 factors influences knowledge application, we classified them into the four categories of the WCM: infrastructure-related factors, knowledge-related factors, psycho-social factors, and strategic alignment. For the case of this paper, we renamed all categories apart from the third one: infrastructure factors, knowledge factors, psycho-social factors, and strategic factors. The criteria for classifying each one of the 142 factors into the four categories was analysing which process is directly influenced by the factor; for example, we classified trash information into infrastructure factors because mountains of useless documented knowledge hampers people from finding the knowledge they need, it makes slower and more inefficient the transfer of knowledge through the boundaries of the knowledge unit. This classification is presented in section 4.
7. Grouping into similar factors. Because 142 factors are quite too much and unmanageable, and because some authors talked about barriers and others about factors, we grouped the factors into 21 we defined in a neutral way; this means that we defined the 21 as factors and not as barriers. This grouping is explained in detail in section 4.

4. Results and discussion

Following the seventh point in the methodology, we grouped the factors and barriers into 21 categories, which are also classified in the four categories of the WCM. The following sections analyse this grouping and classification: section 4.1 explains the infrastructure factors, section 4.2 the knowledge factors, section 4.3 the psycho-social factors, and section 4.4 the strategic factors.

4.1 Infrastructure factors

Infrastructure factors are defined as those that ease or hamper the transfer of knowledge from one knowledge unit to another by means of crossing the boundaries of both units [Carro Saavedra et al. 2015]. Companies' infrastructure comprises organizational and technical means that define the transfer channels in the company. The latter can also be divided into the IT systems and the physical layout of the buildings. Thus, we differentiate three factors: organizational structure, physical structure, and IT structure. From our experience, the three factors are tightly interrelated and one should support the others; it is quite useless if we define a process for knowledge transfer based, for example, in a personalization strategy and we modify the organizational structure but the IT or the physical structure are not shaped in consequence. Explaining an easy example, imagine that two head engineers of two different centres of competence (CoCs) which are located in different countries and collaborate in the same mechanical design have weekly meetings to coordinate the design process. Imagine that both CoCs have schedule the activities of the different people (organizational structure) to exchange the greatest amount of knowledge; however, the conference device (IT structure) has a very bad performance interrupting the conversation the whole time and allowing these head engineers to transfer only the third of the knowledge they intended in a one-hour meeting. Bringing these two people together in the same room (physical structure) makes no sense because it requires almost one-day traveling by plane. To face

this situation they could change the organizational organization setting three hours meetings instead of one hour (modifying the organizational structure to influence knowledge transfer), bring both CoCs to the same location (modifying the physical structure), update to better conference devices (modifying the IT structure), or think of using a codification instead of a personalization strategy; a change in the knowledge strategy that has not only implications in the knowledge transfer (infrastructure factors) but also in the other two knowledge processes. This interrelation among factors, therefore, are not the exclusive preserve of the infrastructure factors, but to the 21 factor groups object of this study; for example, the one-hour meeting can also be a failure if at least one of the head engineers does not properly speak English, and they have no other verbal way for communicating each other. Thus, this coordination among factors is responsibility of the strategic factors, which are explained in section 4.4.

Organizational structure
Simple versus complex knowledge
No set process to facilitate the knowledge transfer
Decentralization (silo structure, turfism, with powerful departmental structures)
coordination among employees and departments
Relationship network
Structure (Vertical - horizontal)
Trash information
Distance between the echelons of knowledge source and receiver
Lack of intangible mechanisms: unscheduled meetings, informal seminars, or conversations
Communication and knowledge flows are restricted into certain directions
Size of business units often is not small enough and unmanageable to enhance contact and facilitate ease of sharing
Flexible structure and design
Relationship with the existing structure
Roles of members and supporting functions
Too much administration, too much involvement to bureaucracy
Failure to develop a transactive memory system

IT Structure
Legacy systems
Useless technology
Available technology (Does IT support knowledge requirement?)
Knowledge system modification
Information systems
Lack of technical support (internal or external) and immediate maintenance of integrated IT systems
Lack of compatibility between diverse IT systems and processes
User-friendliness

Physical structure
Office design to increase interaction
Physical proximity among collegues

Figure 3. Factors of the category "infrastructure factors"

Classifying the factors into the three infrastructure factors categories was not an easy task; each author defines the factors and barriers en many different ways. Simple versus complex knowledge, for example, can seem to be a knowledge factor: however, it refers to the complexity of the distribution of the knowledge in the company [Kamesh and Jolly 2008], which is part of the organizational structure. Consequently, we will consider the three groups of factors (organizational, IT, and physical structure), which are neutrally defined, as factors themselves, and the factors and barriers defined by other authors object of this study as examples that support and help understanding the three factors we defined. The same also applies to the knowledge, phycho-social, and strategic factors.

4.2 Knowledge factors

"Factors related to the knowledge itself affect the efficiency of knowledge integration/creation" [Carro Saavedra et al. 2015]. Similarly to what we did with the infrastructure factors, we grouped the 16 factors and barriers into the following four groups: knowledge affinity, learning aptitude, knowledge breadth and knowledge depth. Knowledge factors represent the characteristics of the transferred knowledge or the characteristics of the relation between sender and receiver's knowledge. Knowledge affinity is the degree to which the recipient possesses the required knowledge base so as to cover the missing elements of the transferred knowledge [Carro Saavedra et al. 2015]; in other words, the similarity between the transferred knowledge and the knowledge base of the recipient.

Knowledge affinity
Language
Knowledge distance
Relatedness of transferred knowledge with existing knowledge
Cultural distance
Cultural awareness
Primary knowledge and Shared identity
Complex nature
Knowledge gaps between members
Lack of awareness
Low awareness and realisation of the value and benefit of possessed knowledge to others
Low awareness and realization of knowledge sharing

Learning aptitude
Learning aptitude of individual
Learning aptitude of team
Lack of retentive capacity

Knowledge breadth
Causal ambiguity

Knowledge depth
Overly technical terminology

Figure 4. Factors of the category "knowledge factors"

Maybe the most obvious example found in the literature is the language, which may restrict individuals absorpting knowledge effectively [Duan et al. 2010]. Learning aptitude refers to receivers' competence to handling new learnings [Yih-Tong Sun and Scott 2005]. Knowledge breadth is sender's ability to asses the relevance of knowledge across domains while knowledge depth is sender's knowledge in one specific task [Majchrzak et al. 2013].

4.3 Psycho-social factors

According to [Carro Saavedra et al. 2015], psycho-social factors shape knowledge application because "applying or not the available knowledge is in the end a decision of the individual". Psycho-social factors represent individual/environmental characteristics and perceptions that influence individuals' behaviours. It is by far the category compiling the more factors (12) and the one in which the grouping was the most difficult; several aspects are still open for discussion. We identified 12 groups among the 77 factors and barriers collected from literature: perceived risk, perceived benefit, knowledge as power, commitment, trust, workload, personal relationships, culture, personality, social skills, mind openness, and past experiences. To classify and understand how these psycho-social factors influence knowledge application, we use the theory of planned behaviour [Ajzen 1991]. This theory says that individuals' behaviours are influenced by a reasoned analysis of the outcomes and of the social pressure, and by the "perceived ease or difficulty of performing the behaviour". Perceived risk and benefit refer to the basic components of the reasoned analysis of the outcomes, the individual may perform the behaviour if the balance between risks and benefits tips toward the latter. The knowledge as power refers to considering the knowledge as a strategic asset used to gain or maintain a competitive position or advantage. Commitment refers to the quality of the dedication to a cause [Birch and Hooper 2012], in the case of the KM it may be the degree to which individuals are decided to apply knowledge in order to help the company getting competitive advantage. Trust is the "belief in the reliability, truth, or ability of someone or something" [Birch and Hooper 2012]; it is a context-specific factor of social interaction [Ferreira Peralta and Francisca Saldanha 2014]. Workload and personal relationships may also be contextual factors. Workload refers to the relation between the time required to complete the scheduled tasks in a certain time window and the duration of this time window. Personal relationships characterise the interaction among two or more people; for example, tie strength represents the frequency and the closeness of interaction among people [Granovetter 1985]. The next four factors, culture, personality, social skills, and mind openness, are not context specific factors and we will explain them using the categorization of the cultures made by [Hofstede 1991]. He made an analogy between people's minds and computer programs (he worked in IBM). Within these mental programs, he established three levels: human nature, culture, and personality. Human nature refers to the parts of the mental code that all humans have in common. Because human nature is inherited and impossible to modify so as to influence people's behaviours, we do not consider it. Personality, which is inherited and learned, represents the different mental programs of each individual person. Culture, distinguished from personality and human nature, refers to the behavioural characteristics that are common to a particular social group; it is not inherited but learnt through social interaction. Following [Hofstede 1991], we may consider that social skills and mind openness are characteristics of both personality and culture; in Hofstede's words, social skills and mind openness may represent a part of the mental program code of an individual (personality)

or of a group of individuals (culture). In short, culture and personality, and social skills and mind openness may not be mutually exclusive. Finally, past experiences, formerly named in section 2 "new created knowledge", represent the WCM link between knowledge integration/creation and psycho-social factors. The knowledge individuals possess due to past decisions and experiences influence their behaviours. Maybe, comparing new created knowledge with past experiences may bring the the reader into confusion, which we do not intend. According to [Nonaka and von Krogh 2009], knowledge represents the capacity to act; besides, according to the WCM, every time individuals perform their behaviour they are creating new knowledge by means of combining the knowledge they already have (past experiences) with new insights.

Perceived Benefit
Perceived relative advantage
Perceived expectation
Making every-day work easier and faster
Rewards
Lack of performance appraisal
Formal acknowledgement

Perceived Risk
Perceived risk
Worried about reward, recognition, criticism, and
Fear of reducing job security

Knowledge as power
There is fear of ''losing the edge''. The perceived power base .
Suspicion of whether other teams are sharing the knowledge in the same open way as we are doing. Competition with others
Knowledge may be perceived as a threat
Fear of loss of ownership and control of knowledge property and individual competitive edges/professional
Internal resistance (protect interests of organization/business unit)
Fear of undermining position
Power
Afraid that knowledge may be inadequate or unimpressive
Need to gain acceptance into the team
Acceptance of the team by the organization
Norm of reciprocity

Workload
Individual management of time
Lack of slack times and heavy workload
High level of stress and fear of disadvantage/risk
Knowledge cost
Lack of contact time and interaction between knowledge sources and recipients

Commitment
Organizational commitment
Membership
Divergent objectives and/or hidden agenda
Team has other aspirations than knowledge transfer
Team benefit maximization vs organizational benefit maximization
Divergent aspirations of teams: Innovation as a threat
Manager commitment

Past Experiencies
Past experiences of conflicts that arose due to learning transfer
Perceived irrelevance of the knowledge for future purposes
Ambiguity
Prior relationships
Not evidence-based
Non-validated knowledge
Abstence of negative past experiences linked to unit responsible for KM
Differences in experience levels

Personality
Personality differences (lack of rapport within individual members)
Different individual characteristics
Age differences
Gender differences
Differences in education levels

Personal relationships
Relationship
Tie strength
Poor relationship between knowledge source and receiver
Lack of contact time and interaction

Social skills
Skills of communication and persuasion
Articulability
Transfer capacity
Difficulty of concrete expression
Lack of competence of staff
Emotional Intelligence

Culture
Knowledge-centered culture
Organizational context
Learning culture and teamwork
Lack of sharing culture
Culture and cultural characteristics

Mind Openness
Openness
Favourable environment for questioning

Trust
Team confidence in the individual/acceptance of the individual
Individual's values are in variance with team values (e.g. trust, honesty, and integrity etc.)
Can the individual be trusted?
Team value system (e.g. can the team be trusted?)
Unprovenness
Info not perceived as reliable
Fear of contamination
Credibility
Accepting willingness
Trust
Mutual trust
Doubt about whether the knowledge is updated
NIH syndrome
Lack of trust in system (security)
Trust culture

Figure 5. Factors of the category "psycho-social factors"

4.4 Strategic factors

Strategy can be defined as "a set of actions that the managers take to increase their company's performance relative to rivals" [Hill and Jones 2008]. In other words and with the WCM perspective, we can define strategy as the actions managers take to influence infrastructure, knowledge, and psycho-social factors. Within this category we found in the literature 23 factors and barriers we classified in two groups: strategic alignment and leadership. As already mentioned in section 4.1, the alignment of all factors is vital to increase knowledge application; this is what we define as strategic alignment, the degree to which the 21 factors should help the strategy implementation so as to increase knowledge application and competitive advantage. Leadership refers to the ability of leading people [Birch and Hooper 2012], leadership is the ability "to give an organization a sense of direction" [Hill and Jones 2008]. Therefore, for the WCM leadership could be seen as the ability managers possess to influence strategic alignment.

Strategic Alignment
Inconsistent organizational strategy, systems, policies, practices and KM processes
Culture (knowledge strategy)
K Strategy implementation
Lack of fitness between knowledge and important organizational goals
Poor targeting of knowledge
Knowledge-centered HR practices
Lack of fit between innovation and organizational assumptions and beliefs
Unrealistic expectations of technology
Objectives and focus
Unclear job description ("not my job" phenomenon) and/or strict job description
Strict rules and regulations
Difficulty of standardization
KM-centred training actions within overall training planning
Formal inclusions of KM duties in job design
Lack of integration of IT systems and processes

Leadership
Lack of top management support
Leadership styles
Knowledge-oriented leadership
Organizational support
Authority to perform knowledge activities
Cultural support
Consolidation of team members' perceptions to one message
Lack of communication and demonstration of all advantages of any new systems over existing ones

Figure 6. Factors of the category "strategic factors"

5. Conclusions

The Worker-Centered-Model (WCM) represents an attempt to understand a phenomenon that has been rarely studied (knowledge application), from a point of view that has been little considered despite its significance (individuals point of view). Within this paper, we extended the WCM by identifying the factors that influence the knowledge processes experienced by individuals working with knowledge. We realized a review of the factors influencing knowledge application from relevant literature in the field of knowledge management (KM). We collected 364 factors named by the authors of 31 journal papers. Then, we analysed and classified them into the 4 categories of the WCM, and later grouped reducing them to 21. Figure 7 shows paper main outcome.

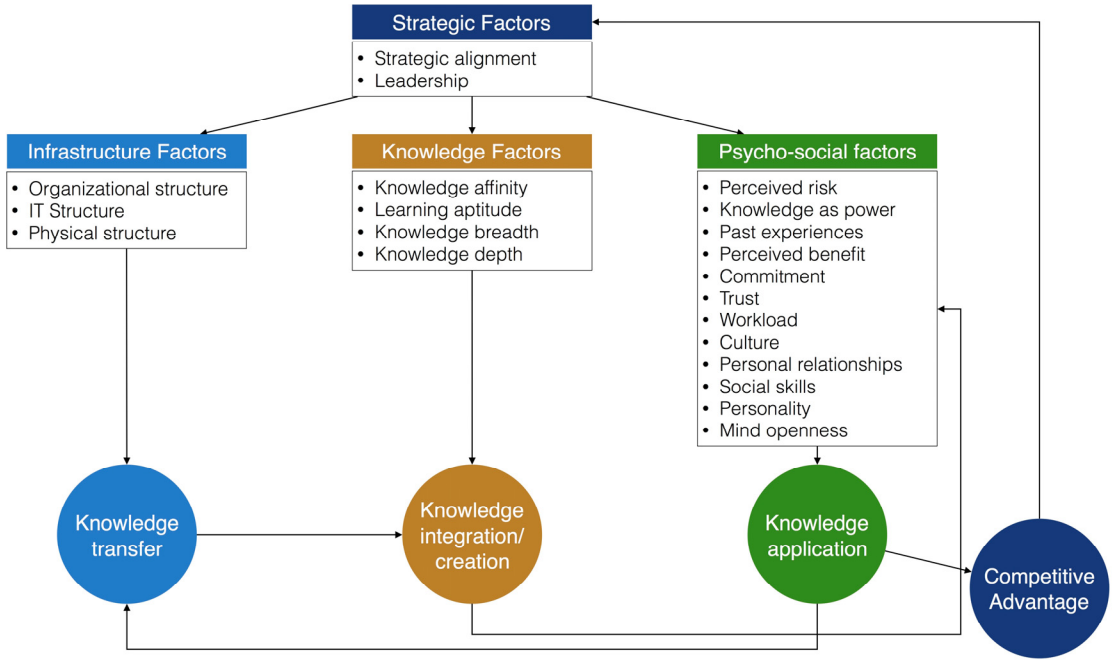

Figure 7. Worker-Centered Model with the final influencing factors

This work contributes to the research community providing a summary of a large amount of hardly comparable research results aligned to one unique model. The initial 364 factors found in literature are summarized to 21. Furthermore, each factor is allocated influencing directly one knowledge process on

the WCM. This brings transparency to understand how factors influence knowledge application. The WCM can now be used as a base to develop new approaches to support knowledge application and understand to which factors new approaches contribute positively or negatively.
From practitioners' perspective the paper can be used as checklist to evaluate the current status of factors influencing knowledge application in the company. Based on this analysis, weaknesses or strengths in the company's knowledge processes can be identified. Then, the checklist can be used again to evaluate the impact of implementing measures to overcome the identified weaknesses on other influencing factors and the complete model can be used to estimate their consequences to knowledge application. Therefore, the model can work as a tool to supports the selection of appropriate measures. The extended WCM was briefly discussed with two industry experts; they quickly understood it and commented the following: "The model gives the impression that it is reduced to the required and therefore easy to understand. We believe that the acceptance of a model for KM is directly linked to its clarity."
One limitation of the work is the criteria for selecting the 31 papers with factors and barriers. We followed [Webster and Watson 2002], but we later had to set our own criteria to constrain the results to a manageable pool.
Other limitation is the subjectivity of the clustering and allocation of the factors. Paper authors discussed together the clustering and allocation according to the criteria they established for each individual factor of the initial 364 factors until achieving a consensus for the final results. However, the results are not validated in detail with researchers or practitioners that were not involved in the research process.
KM is a superordinate discipline that can be applied in the context of engineering design (ED). The factors presented in this paper are limited to the field of KM but it seems reasonable to assume that the factors influencing knowledge application obtained from KM are also the factors influencing knowledge application for ED. What we cannot say is which factors are more relevant in ED or if there is any factor to be added because of some special characteristic of knowledge management in ED.

6. Further work

In order to make the results generalizable, we will validate the clustering of the 21 final factors and their allocation to the Worker-Centered-Model (WCM) with industry experts. With the purpose of specifying the WCM for the field of engineering design (ED), we will also ask experts from ED industry to identify the relevant factors they see in the context of ED. We plan to fulfil both objectives within a survey for engineering designers.
We will also consider the possibility of realising a case study for one specific company to evaluate the current status of the 21 factors influencing knowledge application using them as a checklist.
As long-term objective, several ED companies can be analysed to derive the most common failure factors when applying knowledge and thus set the foundations to develop new approaches for knowledge application.

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