

# IDENTIFYING WORKER NEEDS AND ORGANIZATIONAL RESPONSES IN IMPLEMENTING KNOWLEDGE WORK TOOLS IN MANUFACTURING

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**Abstract:** This paper discusses the recent changes of the working world through an exploratory study of recent academic literature on the implications of the knowledge work trend for the workers in manufacturing industry. Manufacturing industry needs to offer new perceptions of production work – and redeem the made promises. Introducing knowledge work tools to shop-floor production workers can have several motivations, such as improving employee productivity and improving competence management through increasing learning and collaboration at work, empowering employees, and increasing employee satisfaction. However, many changes in the work environment call for fundamental changes in attitudes and management of production work, which makes it challenging to identify those tools and mechanisms that allow matching the worker needs and firm-level competence management. Therefore, the aim of this study is to address the changes in working

environments, and see how implementing knowledge work tools can be harnessed for reaching favorable outcomes and optimal alignment.

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## **1. Introduction**

This paper discusses the recent changes of the working world. In particular, attention is turned to the implications of the knowledge work trend for the workers in manufacturing industry. There has been a progress in many economies from a society of farmers, to a society of factory workers, to a society of knowledge workers (Shapiro and Varian 1999, David and Foray 2002). According to Pink (2008, 49), we live now in a society of creators and empathizers, of pattern recognizers and meaning makers. At the same time, there has been a move from local production within one company to global production and sourcing in networks of organizations (Castells 1996, Chesbrough 2003). Among the changes is that with the increasing complexity of products and importance of product- and production-related knowledge, knowledge work tools are introduced at all levels of manufacturing organizations. Thus, also production workers are becoming knowledge workers and expectations regarding their skills are becoming more demanding (Armbruster et al., 2007).

The above mentioned fits well to the notion that in order to attract the young generation of the 2000's in industrialized countries as potential employer, manufacturing industry needs to offer new perceptions of production work – and redeem the made promises (Kuivanen 2008, Karl and Peluchette 2006, Tews et al. 2012, Backhaus 2004, Lievens and Highhouse 2003). Future workplaces will be considerably different from those of today since the trends in working and employment are moving for example towards more flexibility, distant working, fast career shifting, and utilization of new technologies replacing some of the old work but also providing opportunities for new employment (Mack 2014). At the same time, the expectations of the young generations regarding the content and conditions of working, as well as employers' management processes are getting higher; it is not just about gaining basic income (Cisco corp. 2014). The traditional perception of manufacturing work as heavy, noisy, and sometimes unclean routine work at the production line has to be replaced with an understanding of the factory of the future with advanced manufacturing technologies and extensively knowledge-intensive management processes utilizing real-time information as basis for complex decision-making (Kuivanen 2008, Lampela and Papinniemi 2013). Based on the above discussion, introducing knowledge work tools to shop-floor production workers can have several motivations, such as improving employee productivity and improving competence management through increasing learning and collaboration at work, empowering employees, and increasing employee satisfaction.

Introducing knowledge work tools to shop-floor production is not straightforward activity, however. Knowledge work depends in many respects on the skills, behaviors, attitudes and motivations (i.e. competences) of those who undertake and manage it (Blackler, 1995). Therefore, the management of knowledge work requires a different approach compared to traditional industrial work. Furthermore, the productivity of knowledge work is one of the key issues for change from the managerial side (Davenport et al, 1995, Maruta, 2012). It cannot be taken for granted that the needs of employees and the management of competences match.

In fact, the separation between knowledge work and traditional production work in manufacturing industry has been long-standing in the literature (Maruta 2012, Alvesson 2004, Davenport et al., 1995). The problem is that the distinction between the two concepts is still often vague. This also means that the premises of transforming organizational processes and management practices from traditional forms into knowledge-based forms are less than clear (Alvesson 2004). Therefore, the aim of this study is to identify important theoretical views and factors, as well as further research questions related to the change of production work and to the introduction of knowledge work tools, especially from an individual worker and competence management viewpoints.

This study creates an initial framework of focal concepts and their possible linkages and limitations to guide further research work on the subject in an empirical context. The study incorporates multiple interdisciplinary research perspectives such as knowledge management, human resource management and advanced manufacturing environments, thereby bringing together elements from the extant theoretical discussion on knowledge work in manufacturing. The previous research on the topic seems to be scattered in the literature, and further understanding of the phenomenon is needed to map the relevant theoretical starting points and to focus future research work. The research is carried out as a desk study, analyzing literature sources and utilizing researcher triangulation in building a rich picture of the topic. The method can be described as exploratory, with low level of preliminary expectations. Instead of systematic literature review, a more narrative approach is taken (Baumeister and Leary 1997).

The research question this study addresses is:

- How requirements posed by changes in work trends can be met by matching individual worker needs to competence management at firm-level?

This question can be divided into two complementary parts:

- Which factors affect individual worker needs in implementing knowledge work tools in manufacturing?
- How can organizations respond to changing worker needs and new competence requirements through implementing knowledge work tools in manufacturing?

This study is a part of an EU-funded Factories of the Future project “Worker-centric workplaces in smart factories” (Facts4Workers). The primary goal of the project is to develop, pilot and evaluate a worker-centred smart factory solution that will connect workforce, organisation, management and technology. The aim is to support new models of work optimization, and utilization of production systems from a knowledge-based perspective. One of the main objectives is to increase cognitive job satisfaction of workers on the factory floor and to improve their working conditions in terms of safety, work organization and well-being. Cognitive job satisfaction is judged by how well certain facet of a job satisfies the holder’s objectives. By giving workers usable tools with dedicated worker-computer interfaces that allow them to find, use and contribute to that information on their terms, it is possible to increase both worker productivity and aspects of their job satisfaction and motivation. The project develops technologies focusing on workers’ and organizations’ needs and requirements for information and knowledge-based support in manufacturing (Facts4workers, 2014). Thus, the results of the study will provide valuable new insights for further research work in developing these worker-centric solutions and tools, as well as for management practice especially in manufacturing companies.

In the following, we will first discuss knowledge work in manufacturing in the light of different knowledge environments and competence and knowledge management generations, and then address the aspects of worker needs and needs assessment, followed by discussion on the possible organizational responses needed. Discussion on the findings suggests how the alignment of the

worker needs and organizational responses in competence management happens, and how knowledge work tools can contribute to this. Suggestions for further research conclude the paper.

## **2. Knowledge work in manufacturing**

### *2.1 Knowledge environments in organizations*

While the overall increase in knowledge work also in manufacturing can be seen, what makes the situation more complex is that knowledge environment can take different forms and have different dimensions. Table 1 below summarizes the three types of knowledge environments identified by Ståhle and Grönroos (2000). *The mechanic environment* is maintenance type of environment. Organizations are seen as ordered, regularly functioning, machine-like organizations. The common features are a clear hierarchy, predetermined objectives, emphasis on codified knowledge, and one-way, that is, top-down, information flows. Change is not welcomed and requirements for personal communication are also minimized. Knowledge environment could be also *organic*. Organization follows the logic of open systems that depend on constant interaction, and knowledge is tacit and experiential. Organic organization seeks controlled growth and continual change. In the organic environment relationship between individuals plays important role. *The dynamic environment*, in turn, is the platform for innovation and radical change. It is based on network structure, confidential relations, rich and chaotic flow of the information. According to Ståhle and Grönroos (2000), there could be dynamic environment also within the organization, if a specific part of the organization is flexible, fast reacting, and innovative. Knowledge in this type of environment is intuitive and potential, meaning that it is based on intuitive premonitions that demand analyzing to becoming knowledge. Dynamic environment is complex and therefore difficult to control.

**Table 1.**The three knowledge environments (Ståhle and Grönroos 2000, 127.)

<b>Knowledge environments</b>	<b>Mechanic</b>	<b>Organic</b>	<b>Dynamic</b>
<b>Objective</b>	Permanence	Managed growth	Continuous innovation
<b>Knowledge</b>	Defined, explicit	Experiential, hidden, tacit	Intuitive, potential
<b>Relations</b>	One-way	Multi-way	Chaotic
<b>Information flow</b>	Orders from management	Dialogue, agreed working methods, self-assessment	Networking skills, visions

Usually traditional production work appears to be connected to highly mechanic organizations, which are required to operate quickly and routinely according perfectly controlled action chains. However, the aim of this study is to address the changes in working environments. Every organization includes all three types of knowledge environments. The main point is to find out an optimal combination. Different strategies require different knowledge environment approach. Nevertheless, this knowledge environment model helps to identify the relevant focus areas for achieving desired objectives, and it may also be relevant in terms of identifying optimal competence management approaches.

## *2.2 Three generations of competence and knowledge management*

From the literature on competence management and knowledge management, Hong and Ståhle (2005) have identified the conceptual views that seem to form the major streams of development within competence management. They have presented a model of the three generations of competence and knowledge management (see Table 2 below). These generations of the competence and knowledge management help to find out how to manage knowledge and competence to reach organizational goals in different knowledge environments: the first generation supporting mechanic view, second generation is more like an organic environment and third generation exhibits a highly dynamic environment.

**Table 2.** The three generations of competence and knowledge management (based on Hong & Stähle 2003, Hong & Stähle 2005, see also Hyrkäs & Hong 2007)

	<b>1<sup>st</sup> Generation: Competencies as mapping the resources</b>	<b>2<sup>nd</sup> Generation: Competencies as preparation for future challenges</b>	<b>3<sup>rd</sup> Generation: Competencies as innovative new functional processes.</b>
<b>Key tools</b>  (Snowden, 2002; Tuomi, 2002)	Information systems,  IC accounting,  Competence mapping	Social learning,  Communities of practice,  Tacit-explicit knowledge conversion (Nonaka's SECI model)	Motivation of others and open innovation
<b>The character and components of the knowledge</b>  (Ahonen et al, 200; Blackler ,1995; Kakabadse et al, 2003)	Knowledge as discrete, measurable and codifiable skills,  Skills needed at present	Knowledge embedded and constructed in collective practices,  Preparing for the challenges of the near future	The capacity to create new knowledge and innovations,  Self-organizing capability
<b>Main points</b>	Locating and capturing knowledge	Sharing and transferring knowledge	Generating new knowledge

These steps can also be relevant when considering the developments from traditional to knowledge-based forms of work in manufacturing. On the first level the task is to acquire the equipment for gathering data from employees. This approach could be termed *competence as mapping resources*. This approach matches the mechanic knowledge environments. The second generation approach assumes that competence is the ability to use, share, and manage resources/competences. This could be called *competencies as to prepare for future challenges*. This approach emphasizes the importance of social learning and practical cooperation, thereby matching better to the organic and dynamic environments. On the third level, that takes *competencies as innovative new functional processes*, the organization should have the capacity to create new knowledge and innovations, and self-renewal, creativity and cooperation are important strands. An organization cannot renew itself if it does not know what kind of competence it already has: it also has to have the ability to foster

cooperation and collaborative learning. The generations of competence management are overlapping structures that are based on each other. (Hong & Ståhle 2005, see also Hyrkäs & Hong 2007)

Competence and knowledge management deal with constant change. Wenger (2000, pp. 226) argues that knowledge is primarily about communication: "knowing... is a matter of displaying competencies defined in social communities", while for Leonard-Barton (1995, pp. 3) knowledge is always in a state of flux and actually a source of new ideas and innovation:

*"Knowledge accumulates slowly, over time, shaped and channeled into certain directions through nudging of hundreds of daily managerial decisions. Nor does knowledge occur only one time; it is constantly aborning... knowledge reservoirs in organizations are not static pools but well-springs, constantly replenished with streams of new ideas and constituting an ever-flowing source of corporate renewal."*

One of the core topics of knowledge management, knowledge creation, is a central issue in organizational learning, while the key topic of organizational learning, organizational diffusion of innovations and practices, is a major topic in knowledge management (Lämsä, 2008). According to Teece (2000), the fundamental core of knowledge management is the development and astute deployment and utilization of intangible assets, of which knowledge, competence, and intellectual property are the most significant. Sanchez and Heene (1997) point out that the management of information and knowledge, and the related assertion of organizational learning, are absolute key questions in strategy work. Therefore, they are in the heart of knowledge work, and a range of tools are needed and can be valuable in the transformation of manufacturing.

### *2.3 Competences and knowledge work in smart factories*

Factory environments have evolved rapidly in recent years with the introduction of smart technologies enabling real-time data, machine to machine communication and advanced human-

machine interfaces (Mital et al. 1999). The concepts of “factory of the future” and “smart factory” have been developed to describe a production system based on advanced manufacturing and information and communication technologies (Hessman 2013, Zühlke 2010). The possibilities provided by, e.g., the internet of things, big data, social data gathering, etc. in a factory context are still on a conceptual level. Although the technology exists, the ways utilize to it and the organizational processes to support the utilization need to be created. Especially from the point of view of user acceptance of new technology, modifying the work processes and practices is essential (Zühlke 2010).

In smart factories, the underlying idea highlights the importance of information and knowledge processes and efficient utilization of knowledge on all levels of operations, not only in process control and management (Hessman 2013). This will have profound effects also on the job content of production workers, who will increasingly perform tasks that are typically regarded as knowledge work: information and knowledge processing, decision-making and problem-solving. However, the factory context, the tasks performed at the production line and the physical environment differ considerably from the typical office environments designed for knowledge workers. These differences have to be taken into consideration, when designing a system to support knowledge work.

It can be seen that the content of the production work is changing from well-documented routine tasks performed alone, increasingly towards situation-dependent innovative problem-solving in collaboration with others. New technologies and tools are introduced, and both of these developments set new requirements to the competences of the workers, as well as to the competence and knowledge management practices of the organizations that should match the worker needs (EFFRA, 2013).

### **3. Worker needs and needs assessment**

#### *3.1 Work motivation*

The above described characteristics of knowledge work suggest that the workers are in a central role. Therefore, how they perceive knowledge work is of relevance considering its success. Work motivation is naturally to be reckoned with. Maslow implemented The Hierarchy of Needs in 1954, and is the most often cited model when discussing human motivation. The Maslow's motivation model is a five-level pyramid. The lower level needs must be met before progressing to higher level needs on the hierarchy. The levels are:

1. Physiological Needs are considered as the basis of the hierarchy and basic needs of individuals that include air, food, water, sex, and shelter.
2. Safety Needs are having the feeling of being safe and protected against danger and harm.
3. Social Needs are inclusive of having a sense of belonging and being loved. A person needs safety, love, respect, and the need to belong in order to be motivated.
4. Esteem Needs are inclusive of attention, confidence, freedom, independence, recognition, and self-respect. According to McClelland (2001) the need for achievement (n Ach) is also included in esteem needs.
5. Self-actualization Needs are defined as "experiencing fully, vividly, selflessly, with full concentration and total absorption" (Maslow, 1965, p. 111). Self-actualization is the highest level of the Maslow's pyramid.

McClelland's (1988) theory focuses on individuals with an increased level of need for achievement (n Ach), which leads to an increased level of self-esteem. These kinds of individuals are always seeking ways to achieve new successes regardless of their surroundings. The theory identifies that if

a need is powerful enough within an individual, it can positively affect the intrinsic motivation of the individual to demonstrate behavior which leads to satisfaction to accomplish the need. McClelland also categorized humans into two categories: (1) those individuals faced with many adversities and challenges, but have developed a mindset to overcome those challenges to achieve success and (2) those who have no concerns or worries, nor a need to overcome challenges.

Motivation does not always lead to creating a cash incentive; however, it does lead to providing a path that allows individuals to distinctively express themselves and feel a sense of accomplishment and value (Wendover, 1995). At the same time, intrinsic motivation is defined as being laboriously progressing toward a goal for an individual's sake. Wendover (1995) indicated that individuals cannot motivate people, but can provide the stimulus for people to motivate themselves. These issues can be recognized in competence management practices. Acknowledging Maslow's Hierarchical Model, individuals must have their basic needs met, in order for motivation to increase. Although intrinsic motivation is linked to one's free will, extrinsic motivation depends on the attitude, behavior, and the perception of the individual (Hidi & Harackiewicz, 2000). Extrinsic motivation typically is an external factor that develops and extends beyond the activity itself (Prospero & Vohra-Gupta, 2007).

### *3.2 Job satisfaction*

Moving closer to work-related aspects, according to Spector (1994) job satisfaction can be defined as the extent to which people like (satisfaction) or dislike (dissatisfaction) their jobs. The concept of job satisfaction can be contributed to the psychological well-being at work (Robbins et al. 2003). Job satisfaction is the state in which employees feel pleasure from their jobs. It is the positive and emotional state of the employee as a result of the appraisal of his or her job and performance (Shaikh et al. 2012). The meaning of job satisfaction varies (Fritzsche and Parrish, 2005) from the feelings a worker has about his/her job (Smith et al., 1969) to “an effective reaction to a job, that results from

the incumbent's comparison of actual outcomes with those that are desired" (Cranny et al., 1992). Job satisfaction has also been defined as "a function of the perceived relationship between what one wants from one's job and what one perceives it as offering" (Locke, 1969), and as the extent to which an employee feels positively or negatively toward his/her job (Odom et al., 1990; Locke, 1976).

Job satisfaction relates also to the discussion of motivation (Vroom, 1964; Herzberg et al, 1959; Maslow, 1954) where the source of job satisfaction can connect especially to social belonging, self-esteem and self-actualization on the top of Maslow's hierarchy of needs (Maslow, 1954). Vroom's (1964) expectancy theory hypothesized that situational and personality variables combine to enhance job satisfaction. Expectancies were based on the worker's belief that effort would lead to a strong performance that would, in turn, lead to rewards.

These aspects are relevant considering the central characteristics of knowledge work. The complexity not only means that, while motivating, complex jobs may also require different instructions, empowerment, and collaboration.

### *3.3 Knowledge sharing and collaboration*

Moving from the lower levels of the needs hierarchy to the top levels of social needs, esteem needs and self-actualization, the role of knowledge sharing and collaboration between people that support creativity and problem-solving is highlighted in order to fulfil the needs of individuals. Sharing of knowledge between employees can be seen very important among workers. Lämsä illustrated in her studies that employees' knowledge and experiences changed daily, and their interaction with each other was regarded as one of the most useful channels for the smooth flow of knowledge (Lämsä, 2006, 2008, 2014). People may not have ready-made solutions for resolving practical problems in their field. As they encounter these problems in their daily work, they have to invent personal solutions, generally developing and maintaining their knowledge. People doing the same work and

facing the same kind of problems develop similar capabilities. At the individual level, employees experience being a part of the entity, the whole unit and the organization, even if they do not continuously cooperate with each other.

When people are collaborating, they may form various kinds of communities that are comprised of professionals from the same field (these are called also communities of practice; see for example, Wenger, 2000; Lämsä, 2006; Lämsä, 2008; Lämsä, 2014). The key issue is whether members value their collective competence and learn from each other, even if they come from various departments and/or professional fields. Barley and Kunda (2006) understand this kind of occupational community as a group of people who consider themselves to be engaged in the same sort of work; who identify (more or less positively) with their work; who share a set of values, norms, and perspectives that apply to, but extend beyond, work related matters; and whose social relationships meld the realms of work and leisure. Occupational communities of all types are marked by distinctive work cultures promoting self-control and collective autonomy for the membership. According to Barley and Kunda (2006), we can observe how each of several long-standing research domains within organizational studies – careers, conflict, loyalty, and innovation – can be enriched empirically and advanced conceptually by paying serious attention to the role occupational communities play within organizations.

The development of *collective meaning* can be viewed as one important prerequisite for creating sufficient cohesion to the group to make knowledge sharing and organizational learning possible (see e.g., Mittendorff et al., 2006). According to Gherardi (2014), a working practice is a collective activity undertaken in a particular place and at a particular time. It is a set of working practices that makes an occupation or a profession. Although these practices are constitutive of work and organizing, how they are executed depends on the specific situation. For example, the experts from two completely distinct areas (e.g. engineers and psychologists), might have difficulty in finding a “common language” and lack a sufficient level of mutual appreciation to enable knowledge sharing.

The issue of appreciation is strongly linked to the common mindset and valuations the group has created along the way. When people achieve a common understanding, it motivates, rewards, and improves the doing and the community of practitioners.

#### *3.4 Needs assessment process and tools*

To identify both worker and organizational needs in practice in a change situation, a needs assessment can be performed. Needs assessment is a specific type of organizational analysis aiming for improving organizational effectiveness, and based on action-oriented behavioral research (Caska et al, 1992). The objectives and methods of needs assessments are always context-dependent. Needs assessment techniques can be used for multiple purposes, and directed towards different actors and specific processes, for example a customer needs analysis to support product development (see Kärkkäinen et al., 2001), or an organizational needs analysis to support organizational change or even strategic transformation (Abdimomunova & Valerti, 2010). An organizational needs assessment is seen as a central tool for aligning strategy and human resource development (HRD) actions, and the two perspectives are tightly interconnected (McClelland, 1995).

A general classification to four types of organizational needs assessments has been created by Gupta (2007). In this classification, the target levels of assessment are divided to individuals, teams, units and organizations. The assessment can be directed to different aspects of learning and performance, e.g. knowledge and skills, jobs and tasks, competencies, or strategic needs. Four different types of approaches to needs assessments based on this classification are described in more detail in Table 3 below.

**Table 3.** Approaches to needs assessment (modified based on Gupta, 2007, p. 26-27)

Approach	Knowledge and skills assessment	Job and Task analysis	Competency-based needs assessment	Strategic needs assessment
<b>Purpose</b>	Identify knowledge and skills required to perform a job	Define responsibilities and tasks necessary to perform a job	Identify knowledge, skills and attitudes for superior job performance	Examine existing performance or address new requirements in relation to strategy Develop long-term performance improvement plan
<b>When to use</b>	Implementing new technology Identifying training needs Developing a training plan	Developing job descriptions/profiles, task listings, consistent training requirements	Identify required competencies Measure individual performance Develop training & performance measurement systems	Link performance improvement needs to business strategy Identify performance improvement opportunities
<b>Advantages</b>	Ensures training linked to learner needs Easy to implement	Stimulates interest Defines skill requirements Identifies additional knowledge and skills needed to move to another position	Distinguishing average from superior performance Provides information on current and future predictors of job performance	Develops long-term solutions to current performance problems or future performance needs Solves problems related to core business processes Eliminates non-value-adding activities
<b>Disadvantages</b>	Limited focus	Omits external factors Time-consuming and costly Assumes work is static, one best way to perform a job	Time-consuming and costly Requires high involvement of many people Requires good project management	Time-consuming and costly Requires that a business strategy exists

When deciding on the data gathering methods and tools for needs assessment, it is recommended to use multiple techniques, and at least one of the methods should be able to provide qualitative data for analysis. Possible techniques for data gathering include for example observation, archival methods (document analysis), questionnaires, interviews, focus groups, and force field analysis (Caska 1992; McClelland 1995; Gupta 2007). This is a central phase of the needs assessment process, as emphasized by Caska et al., (1992):

*“The selection and use of data gathering techniques are central activities in the organizational diagnosis. The methods used to gather data will influence results of the*

*organizational assessment. Success of the diagnosis depends upon choosing adequate techniques that are relevant to the particular situation, and will provide results that are useful and acceptable to the client.”*

#### **4. Organizational responses**

##### *4.1 Competence and knowledge management systems, tools and practices*

Competence and knowledge management require strategic cooperation and supporting tools. For example, if an organization wishes to leverage the competencies of its personnel in order to deliver different project services, it can only exploit them to the full through the integrated management of all related variables such as the organizational structure or system. It is not so self-evident that the structure will allow for working in different kinds of project teams, for example. The systems thus have to be flexible enough, especially to accommodate different knowledge environments. Human factors are also important and cannot be ignored. The usual practice is to deploy the best systems and to construct the most appropriate organizational structure, but this will not be successful if the competencies are not developed and well managed. (Heene & Bartholomeeusen 2000.)

Competence and knowledge management tools are two-folded. Human resource management brings with it appreciation of employees and their competencies. Competence management approach, on the other hand, is more concerned with competitive values (strategic management). Guest (1987; 1997) has pointed out that different kind of practical tools are derived from the HRM strategies; these tools include recruiting, training and development, evaluation, change management, work development and communication system. According to Hyrkäs and Hong (2007), the organization has to acquire tools in order to map employee competencies, and it has to be able to disseminate the competencies and use them as an organizational resource. Dissemination alone is not enough. The organization has to have the tools to find out what competencies it has, and the tools that support their dissemination.

Ikujiro Nonaka (1994) has described the ways in which individuals manage knowledge: knowledge is created only by individuals; organizations cannot create knowledge without them and therefore organizations can support creative individuals or provide contributory contexts to create knowledge (Nonaka and Takeuchi, 1995). And, whenever a wider spectrum of organizational competences and knowledge are needed for some purpose, for example for a demanding and long-term customer project, the cooperation in every level of the organization; between individuals, between teams and combining their competencies becomes crucial.

Knowledge sharing is the process where individuals mutually exchange their tacit and explicit knowledge, and together create new knowledge. Defining and describing knowledge sharing related to its specific context is important because of the characteristics of an organization: all of its units and individuals influence the creation, transfer, accumulation and utilization of knowledge (Argote et al., 2003). The academic research concerning the factors affecting knowledge sharing has identified a number of different variables, especially issues such as motivations (Ardichvili et al., 2003; Hall, 2001; Hinds and Pfeffer, 2003), and the organizational climate and communication climate (Hooff and Ridder, 2004; Moffett et al., 2003; Zárraga and García-Falcón, 2003). It is important to notice that the overall atmosphere of the organization increasingly influences knowledge sharing. The organization's management system, organizational structure, performance metrics, rewarding system and values are considered to be an important prerequisite for that atmosphere (Lämsä and Nätti, 2011). Openness in knowledge sharing is presumed not to be created by building up a competition between individuals and groups. Instead, it may be wiser to reward such function as common innovation activities and knowledge sharing.

Having a sense of identity is a crucial aspect of learning in organizations. For firms to benefit from the creativity of people they should support communities as a way to help them develop their identities (Wenger, 1998). These communities of practice are regarded as beneficial in various ways for the business, the community itself and for employees. They are efficient not only for sharing

knowledge and know-how, but also for achieving business results (Lämsä, 2014). First, they support faster and more effective problem-solving both locally and across the organization. Secondly, communities of practice help with developing and retaining expertise by building capabilities and knowledge competencies. They are very effective to diffuse created practices across the whole organization, as these communities create and innovate new practices which can be embedded into the procedures and working instructions.

#### *4.2 Towards worker-centric knowledge management in smart factories*

Advanced manufacturing organizations have good possibilities to build a system to support worker-centric knowledge management in their production processes, utilizing the versatile technological possibilities available. In smart factories with an advanced technical infrastructure it is possible to provide process-, job-, and task-level information to employees in a personalized form to support their daily work (Hessman 2013). Also new technical tools and practices to enhance knowledge sharing, communication and collaboration between employees are available, although seemingly not very widely used in shop-floor level manufacturing context at present. At the same time, supporting management processes and practices need to be created. In competence and knowledge management area, this could mean for example new types of training, incentives, and rapid feedback processes for employees. In addition, training workers in smart factories will have new forms and tools such as mobile devices, 3D-simulations and virtual environments with personalized learning content (Mavrikios 2013, Pennathur & Mital 2003, Mital 1999).

New types of jobs and tasks will be available in factories as robotics takes care of old routine tasks. Humans will still be needed for more complex tasks of collaborative problem solving, so there is a need to move to more demanding job contents (Mack 2014). This poses new requirements for skilled workers for example in utilization of different technical tools to process the available information

and knowledge, but at the same time this enables more interesting work profiles and possibilities for increasing empowerment, achievement and job satisfaction.

## **5. Discussion and conclusions**

In this study, we presented the question of how requirements posed by changes in work trends can be met by matching individual worker needs to competence management at firm-level. The starting point is in manufacturing work taking new forms. Nowadays, almost all types of work and work organizations appear to involve knowledge-intensive elements: employees need 'know-what' and 'know-how' in order for any firm to create sustainable competitive advantage (Quinn, 1992), they have evolving needs, and the competence and knowledge management need to be streamlined in order to match those needs and to utilize them for the organization's advantage.

The challenge is that misalignment of the needs of the employees and management of competences occurs easily in the varying knowledge environments, and therefore, the first task is to identify the nature of the work environment. It seems possible that a new, hybrid model combining aspects of all three of the knowledge environments described above is needed to accurately depict the situation in smart factories of the future and the corresponding knowledge work tools. The three-generation approach to competence management and knowledge management (see 2.2) is one way of understanding multidimensionality of the phenomenon, and it helps more find out how to manage knowledge and competence to reach goals. The three generations and approaches of competence management would be a suitable mapping tool for organizations to outline the present situation and goals in their competence and knowledge management (Hyrkäs & Hong 2007).

The findings further indicate that individual worker needs comprise various factors that need to be considered when implementing knowledge work tools. Relevant issues were identified from competence and knowledge management theories, motivation and job satisfaction theories, knowledge sharing and collaboration theories, and needs assessment models. The organizational

responses can be based on designing processes and practices supporting knowledge work, as well as on introducing new technologies and tools to manage knowledge and develop competences.

We have drawn ideas from the literature combining multiple theoretical perspectives of knowledge management, human resource management and advanced manufacturing environments to provide a rich picture of knowledge work in manufacturing, and of the possibilities and limitations for further research. Several relevant and useful models were found in the literature to study the topic further, for example utilizing the three-generation competence and knowledge management model to analyze manufacturing organizations, and the different approaches to needs assessment to guide the selection of the data gathering methods. The insights presented provide only a starting point, however.

Based on this exploratory study, there are several possible directions for further studies on the topic of knowledge work in manufacturing. Especially, the following suggestions can be introduced:

- To clarify the role of different knowledge environments in manufacturing and to develop a hybrid model of the organizational knowledge environment
- A state of the art study on knowledge sharing processes and practices amongst factory workers and a mapping of possibilities offered by new knowledge work tools
- Empirical data collection on the needs of the workers and of the current state and possible limitations set by the organizational knowledge environment and existing processes

With these lines of research, it will be possible to gain deeper understanding on the current, and future, work life related aspects.

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