Book of Proceedings of the 6th International Ergonomics Conference
ERGONOMICS 2016 – Focus on synergy
June 15th – 18th 2016
Zadar-Croatia

DEMOGRAPHIC CHANGE AND ITS IMPLICATIONS FOR ERGONOMIC STANDARDIZATION

M. Kleindienst[1], M. Wolf[1], C. Ramsauer[1], E. Winter[2], C. Zierler[2]
[1] Graz University of Technology, Graz, AUSTRIA, mario.kleindienst@tugraz.at
[2] Johannes Kepler University Linz, Linz, AUSTRIA, ernst.winter@arbeitsforschung.at

Abstract

Companies in different industries are facing the same challenge: demographic change. This leads to a need for action in the field of industrial engineering. At the same time, many of the ergonomic standards were written many years ago, when demographic change was not really an issue. The aim of this paper is to investigate the status quo of standards, which should cover the specific requirements of older workforce. Therefore a three step approach was conducted: First, the changes, which humans go through when they get older, are elaborated based on an extensive literature review. Based on that, age-critical factors that should be covered in ergonomic standards are derived. Second existing standards that cover workplace design were collated and finally the need for action within these standards was elaborated. The paper closes with eight steps, which should together enable ergonomic standards with respect to demographic change.

Keywords*: Demographic Change, Ergonomic Standardization*

1. INTRODUCTION

The topic of an on average increasingly older workforce in high cost countries is currently the focus of public discussions. On the one hand retirement plans reach their limits because ever more people retire and less young people follow up to pay for them. On the other side also industry suffers because of a lack of skilled workforce for the ever more complex tasks that have to be carried out in production. Looking at the employment situation of older people, it is apparent that it is much more difficult for them to find employment. The situation is particularly problematic for the age group 50+. In February 2015 an increase in registered unemployed persons by 14.6% was reached in this age group compared to last year, which means that at this time more than a quarter (26.2%) of all unemployed people were 50 years old or older. It can be assumed that demographic change and the associated general aging of the population represents a major challenge in the future for a variety of industries. As a result due to this fact there will be an increasing need for action in the future in the design of work tasks and workplaces in order to keep older people longer in working life. Therefore industrial standardization of work tasks and workplaces and in general of the work environment have to play a major role, as older workforce has different needs, abilities and disabilities than young workforce. Therefore in this paper first the changes of human workforce with increasing age are systematically compiled and the implications on industrial standardization are drawn. After reviewing the current consideration of

older workforce in specifically chosen standards that refer to the system "industrial workplace" the need for action within those standards is described.

2. CHANGES OF WORKFORCE WITH INCREASING AGE

Generally it is assumed that the elderly people are less physically powerful than their younger counterparts. These assumptions justify to partially outdated theories. Recent findings show that chronological age is not a sufficient criterion for evaluating the performance of an employee, but on the contrary, individual factors such as education, physical fitness and psychosocial values and settings are crucial for the performance.

The performance or work performance of people is made up of many factors. It is described as the capability of workforce to provide a certain performance over a longer period of time without suffering from health damages. Therefore each specific person as well as the environmental circumstances of this person are considered and identified as dependent factors of the performance of workforce. [1] Ilmarinen summarizes these factors in his "house of workableness" that is illustrated in Figure 1:

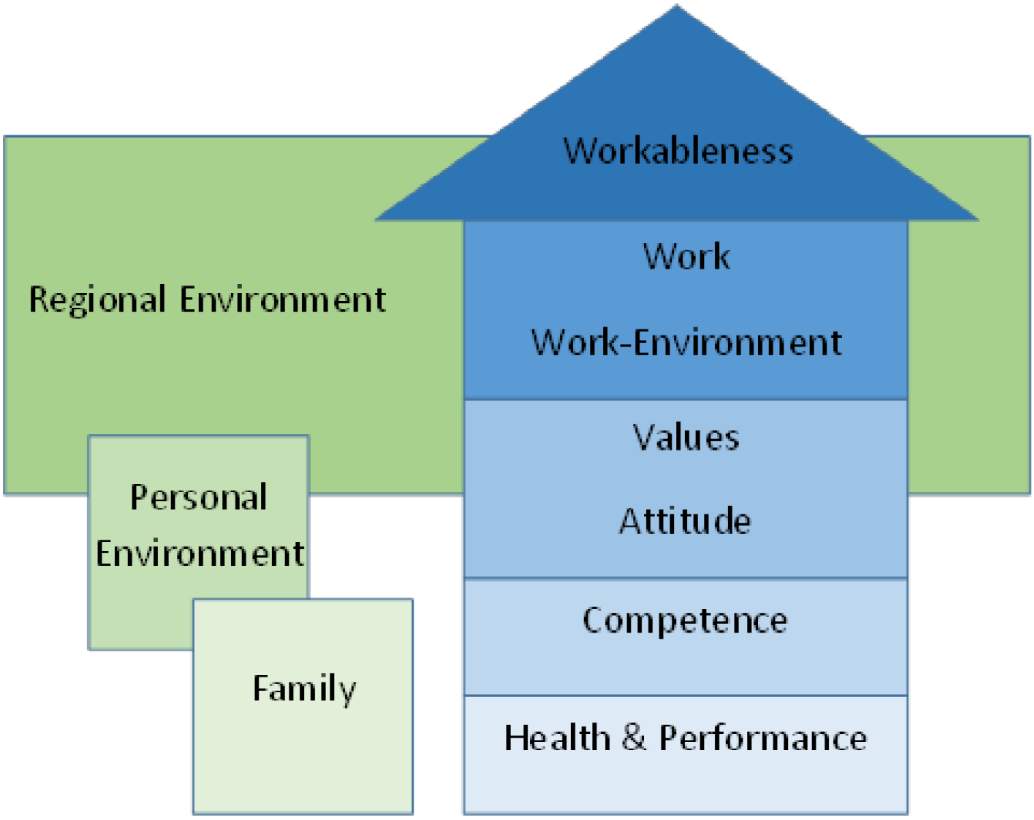

Figure 1: House of Workableness [2]

The foundation of the house of workableness is built by the health and performance of the individual that are supported by his or her social structure (community, personal environment and family). Starting from there, professional and social skills have to be present and expanded which are transformed into work within the work environment by the personal values and attitudes such as motivation. The working environment is finally determined by the design of the physical, psychosocial and organizational exposures of the worker. [3] The roof of the house represents the personal workableness

of a person which is given only if all the other factors are kept in a balanced ratio [2]. Thus, the working capacity is no more a detached single factor but seen as a combination of the identified work requirements and the individual functional capacity [2].
When talking about older workforce, these factors have to be taken into account, as many of them change with increasing age. In general Bruggmann (Table 1) has identified different personal factors that change when a person gets older.

Table 1: Changes in Performance of Human Workers with increasing Age [4]

Increasing	Constant	Decreasing
Ability to cooperate	Performance- and target-orientation	Physical capabilities
Ability to judge	System-thinking	Mental flexibility
Ability to communicate	Creativity	Speed of taking up and processing information
Considerateness	Decision-making ability	Short term memory
Awareness for quality	Physical and psychological endurance	Readiness to assume risk
Reliability	Ability to concentrate	Promotion orientation
Conscientiousness		Readiness to learn and further educate oneself
Conflict ability		
Life- and job-experience, job-relevant knowledge		
Positive work attitude		
Balance and stability		
Fear of change		

Out of these mainly qualitative changes of human behavior and capabilities direct influences on the work-abilities of older workforce can be deviated. Structured into physical, psychological & social, cognitive & mental and sensory changes Figure 2 shows summarized the relevant changes of human workforce that should be considered in the design of workplaces, work tasks and work environments [5-22].

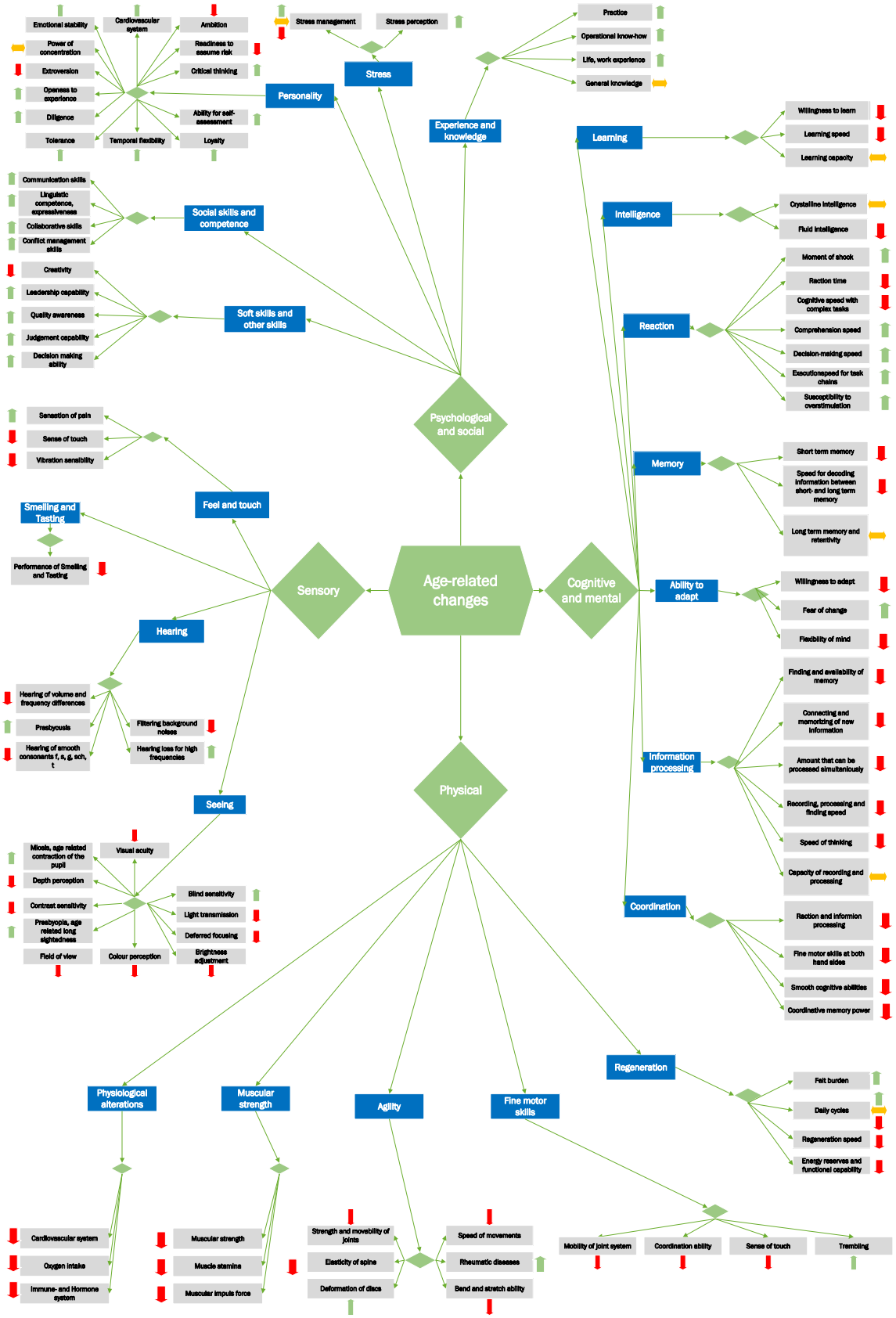

Figure 2: Summary of relevant changes of workforce with increasing age

The arrows besides the changing characteristics indicate the direction of change. Green arrows indicate an increase or improvement of the specific characteristic, red arrows indicate a decrease or worsening and orange arrows define characteristics that stay on

the same level with increasing age. In order to be able to set up workplaces in an appropriate way for elderly people, these changes should be considered to a certain extent in industrial standardisation. Not only could companies increase their labour productivity because of the elderly-tailored workplaces, some of the changing characteristics with increasing age could also lead to hazardous situations if not considered. As an example the decrease of the field of view should be mentioned that could cause injuries of an older worker if critical and endangering zones or parts are not placed according to the limitations of this worker. It has to be mentioned, that especially the limited physical and sensory abilities of older workers could lead to incidents and injuries. Furthermore it should be stated at this point that the changes of worker's characteristics with increasing age can only be defined for the majority of elderly people and do not have to be true for all older workers.

3. STATUS QUO OF INDUSTRIAL STANDARDISATION

In order to identify the most relevant industrial standards for investigating the proper treatment of the specific needs of older workforce in workplace- and work process-design, the REFA work system was used as a basis. The REFA work system defines the coexistence of all relevant elements at a workplace that are the worker him or her-self, the operating means, the work environment and the organisation of work. We added working-time and pauses as a fifth factor as the day-time of work and also the duration of work are very critical with increasing age and therefore should be considered independently from the other factors. Together with the identified personal changes of ageing workforce critical factors are derived that concretize the relevant aspects of industrial standardisation for work place design in accordance to the specific needs of older workforce. These critical factors are [2, 3, 23-28]:

1. Organisation of work:
Within the organisation of work it has to be considered that monotone work tasks that require a steady concentration and very complex, abstract and totally new work tasks should be prevented from being given to elderly workers. Furthermore high workloads with time- and/or performance-pressure as well as a highly takt-bounded and other-directed pace of work, interruptions and disturbances should be permitted much more for older workforce. Gratification risks are also a major concern for the organisation of work for elderly workforce.

2. Work environment:
Especially the decreasing visual capacity and the vulnerability to environmental conditions like illuminance or climate have to be considered more in detail. This means that labels and warnings for example have to be written in a proper contrast and size. Furthermore the increased sensibility to noise and vibrations as well as to the exposition to hazardous gases and electromagnetic fields should be considered in standardisation.

3. Operating means:
High requirements regarding the reaction- and movement-capabilities as well as fine motor skills and none-ergonomic design of operating means should be avoided. Furthermore selective and sub-divided attention and increased requirements regarding the manual precision of operating machines or tools are critical.

4. Worker:
Heavy loads to be carried, pulled or pushed as well as continued physical aerobic work with high necessary forces and sudden load-peaks should be completely avoided. Also constrained postures, longer static muscle-work and one-sided strain are much more critical to older workers. Moreover individual operating ranges and different body-forms are more important to be considered in work-place design for older workforce as their ability to adapt to non-optimal work and body postures decreases heavily.

5. Working- and break-time
Because of the changed bio-rhythm and the with age increasing inability to adapt to changing working times especially shift work over night has to be avoided. Proper breaks to guarantee recovery are of great importance. Also the possibility of flexible work- and break-times should receive greater attention.

With these factors industrial standards were screened in order to determine whether the specific characteristics of elderly workforce are treated well enough or if there is space for improvement. The relevant standards were identified via a web search on the Austrian Standards Institute. From over 31.000 standards that are valid in Austria 100 standards were selected that cover the field of industrial workplaces and contain aspects that could be critical in accordance to the above defined critical factors of elderly workforce. After the extensive review of the selected standards 77% of these standards were classified as standards with high or at least medium need for action in terms of elderly workforce. Therefore only 23% of the reviewed standards considered the specific characteristics of older workforce in a sufficient way.

4. NEED FOR ACTION IN INDUSTRIAL STANDARDISATION

For the 77% of the standards that were identified as not sufficient in covering the needs of older workforce specific indications for necessary changes were developed. In general critical values like required action-spaces, ergonomic heights or sizes of emergency buttons and warnings were checked if they correlate with the specific needs of elderly workers. All in all eight points were identified that, if implemented properly in standardization for industrial work-places, would improve industrial standardization with regard to the coverage of elderly workforce.

1. There are some standards that cover the specific needs of older workforce very well. However, if the content of those standards would be included in other standards or if those standards that do not cover the topic of elderly workforce would at least include references to proper standards a huge improvement would be possible.
2. As the topic of demographic change is increasingly of importance, we suggest a specific standard that exclusively covers ergonomic aspects for the design of work-places for elderly workforce. In comparison ORN CEN ISO/TR 22411 or the ISO GUIDE 71 / CEN CENELEC Guide 6 could serve as a guideline for this standard.
3. Furthermore a specific management-standard for the corporate management of older workforce like the management standard EN ISO 9001 would help both, companies and employees to master the challenge of demographic change.

4. As mentioned above, the working- and break-times are of increasing importance with ongoing age of workers. Therefore these topics should also be covered in a separate standard.
5. In the sense of ÖNORM EN ISO 15537 further standards should be established that cover all anthropometric aspects that are relevant with increasing age of workforce (body postures, noise or thermic environment).
6. Many of the critical values like those for the exposure of workers to vibrations are not defined in accordance to workers at different ages. Therefore we suggest further research in order to generate specific critical values for workers at different groups of age.
7. Within the standards of corporate health care older workforce is not treated individually. This should be changed, as elderly workers have other needs than their younger colleagues.
8. A lot of the disabilities that elderly workforce brings with it could be eliminated with the application of modern technological assistance systems. The application of and the collaboration with such systems like collaborative robots, driverless transportation systems or wearables should also be covered within a separate standard.

Within the company-interviews it was shown that companies have invented their own strategies to deal with older workers in production. Most of the companies transfer older workers to other workplaces where they are able to perform the required tasks. This habit also leads to the fact that workers that perform certain work very well since a long time but are not able to continue that work due to their physical inabilities are moved to other workplaces and take all their experience with them. Modern assistance systems would help at this point to keep workers for a longer time at their workplaces.

5. CONCLUSION

It was shown in this paper that industrial standardisation does not cover the topic of elderly workforce in an appropriate way. When looking at the demographic situation in most of the European countries there is definitely a need for improvement. Also the specific critical values for physical stress or environmental influences of workers many times are not explored specifically for elderly workers. This makes further research necessary in order to deeply understand how the human body changes with increasing age and how it reacts to different situations at industrial workplaces. Moreover the exploration of different technological and methodical innovations in the fields of assistance systems will be of increasing interest in research in the future as thereby many disabilities of older workers could be eliminated. Somehow industry will have to deal with the application of older workforce in the future. Industrial standardisation has to set the organisational basis and can be a first countermeasure to demographic change for companies, even if the current issues of the necessary application of elderly workforce might not be justified from an economic point of view. However, simply replacing older workers with less expensive younger workers will not work any longer, as the demographic change continues to change the working landscape.

REFERENCES

[1] Jaeger C.: *Being and staying productive*, in: Institute of applied work science (ed.): Productivity in the firm, Springer, Berlin Heidelberg, S. 27-39, (2015) (Original paper/book in German language)

[2] Ilmarinen J.; Tempel J.: *Working ability 2010 – What can we do so that you stay healthy?,* Hamburg, (2002) (Original paper/book in German language)

[3] Grabbe J.; Götz R.: Work- and employment-ability – *Basis for innovative and competitive capability,* in Klaffke M. (2014): Generational-Management: Concepts, instruments, good-practice approaches, Springer Fachmedien Wiesbaden (2014)

[4] Bruggmann M.: *The experience of older employees as a resource*, Deutscher Universitäts-Verlag Wiesbaden, (2000) (Original paper/book in German language)

[5] Riedel S.; Gillmeister F.; Kinne J.: *Effects of age-related changes of operating personnel on the safe use of hand machines*, in: Federal Institute for Occupational Safety and Health (Eds.): Research Project F 2118, Dortmund Berlin Dresden 2012. (*Available from* https://www.baua.de/de/Publikationen/Fachbeitraege/F2118.pdf?__blob=publicationFile&v=3 *Accessed* 2015-07-20) (Original paper/book in German language)

[6] Biermann H.; Weißmantel H.: *Rule catalog SENSI devices: user-friendly and accessible through the right design*, Institute of electro-mechanic constructions, Darmstadt 1997. (*Available from* http://www.emk.tu-darmstadt.de/~weissmantel/sensi/sensi.html, *Accessed 2015-07-20*) (Original paper/book in German language)

[7] Rensing L.; Rippe V.: *Aging - Cellular and molecular bases, physical changes and diseases, therapies,* Springer Berlin Heidelberg (2012) (Original paper/book in German language)

[8] Rinnerhofer S.: *Physical performance and measured energy consumption at different professional activities typical development of standard values*, Dissertation University of Graz 2012. (*Available from* http://unipub.uni-graz.at/obvugrhs/content/titleinfo/225109 *Accessed* 2015-07-21) (Original paper/book in German language)

[9] Schlick C.; Bruder R.; Luczak H.: *Industrial Engineering*, Springer Berlin Heidelberg, (2010) (Original paper/book in German language)

[10] Münch M.; Cajochen C.; Wirz-Justice A.: *Sleep and circadian rhythm aged*, in: Journal of Gerontology and Geriatrics, Volume 38, Supplement 1. Steinkopf Publishing Company, (2005) (Original paper/book in German language)

[11] Hecht K.: *Mature age and emotional stress,* In: Urologist [B], Springer Publishing Company, S. 338-343, (2001) (Original paper/book in German language)

[12] Zulley J.: *Chronobiology of aging*, Scientific Journal of the Humboldt University of Berlin. Series Medicine 41, 2, S. 86-94, (1992) (Original paper/book in German language)

[13] Kruse A.; Lehr U.; Rott C.: *Gerontology - an interdisciplinary science*, Bayrischer Monatsspiegel Verlagsgesellschaft mbH, Munich, (1987) (Original paper/book in German language)
[14] Prasch M.: *Integration of staff with changed performance in variant serial mounting*, Herbert Utz Publishing Company GmbH, Munich, (2010) (Original paper/book in German language)
[15] Winkler R.: *Older people as a resource for the economy and society of tomorrow*, In: Clemens W.; Höpflinger F.; Winkler R. (Eds.): Work in later stages of life-dead ends, perspectives, visions. Haupt Publishing Company Bern, S.84-104, (2005) (Original paper/book in German language)
[16] Ilmarinen J.: *Towards a Longer Work life! Ageing and the Quality of Work life in the European Union,* Finnish Institute of Occupational Health, Ministry of Social Affairs and Health, and Juhani Ilmarinen, (2006)
[17] Sakris J.: *Workplace health promotion for older employees. The application of salutogenetic principles in business*, Diplomica Publishing Company GmbH Hamburg, (2014) (Original paper/book in German language)
[18] Bijedic T.: *Developing entrepreneurial personality in the context of entrepreneurship education. Didactic teaching-learning design and empirical analysis for secondary education*, Rainer Hampp Publishing Company Munich Mering, (2013) (Original paper/book in German language)
[19] Holz M., Da-Cruz P.: *Demographic changes in company-challenge for strategic workforce planning*, Business Management Publishing Co. Dr. Th. Gabler | GWV Fachverlage GmbH Wiesbaden, (2007) (Original paper/book in German language)
[20] Blumberger, W.; Sepp, R.; Affenzeller, S.: *"Work - age - recognition"*, IBE-Research Report, 2 Vol., Linz, (2004) (Original paper/book in German language)
[21] Lohmann-Haislah A.: *Stress Report Germany 2012, Mental requirements, resources and being*, Federal Institute for Occupational Safety and Health, Dortmund Berlin Dresden, (2012) (Original paper/book in German language)
[22] Ritz A.; Thom N.: *Talent management, identify talent, develop skills, get achievers*, Gaber Publishing Company Springer Fachmedien Wiesbaden GmbH, (2011)
[23] Bullinger H.; Volkholk V.; Betzl K.; Köching A.; Risch W.: *Age and employment of the future,* Springer Publishing Company Berlin Heidelberg GmbH, (1993) (Original paper/book in German language)
[24] Brandenburg U.; Domschke P.: *The future looks old: challenges of demographic change for personnel management,* (1. Edition.), Gabler Publishing Company Wiesbaden, (2007) (Original paper/book in German language)
[25] Schlick C.; Bruder R.; Luczak H. (Eds.): *Industrial Engineering*, Springer Berlin Heidelberg, (2010) (Original paper/book in German language)
[26] Richter G., Bode S., Köper B.: *Demographic changes in working life,* Federal Institute for Occupational Safety and Health (Eds.), Dortmund, (2012) (Available from: www.baua.de/de/Publikationen/Fachbeiträge/Artikel30.html. Accessed: 28.7.2015) (Original paper/book in German language)

[27] Weger G.: *Age(ing) diversity in operation.* in: Age (ing) diversity in operation, strategies and actions for sustainable corporate policy in small and medium enterprises, workspace Gender and Diversity in Organizations. University of Economics Vienna (Eds), 1. Edition, S. 22-29, (2006) (Original paper/book in German language)

[28] Sandrock S.: *Ageing-appropriate work design - a building block for obtaining the performance*, in: Operating Practice & Work Sciences, No. 221, S. 42-45, (2014) (Original paper/book in German language)