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Preparing Employers and Employees with Autism Spectrum Disorders for 21st-Century Jobs

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Abstract

The global workplace has become increasingly diverse and inclusive. Students with Autism Spectrum Disorders (ASD) have social communication impairments that may prevent them from finding fulfilling employment. Simultaneously, students with ASD have unique attributes that employers could find attractive and beneficial in achieving corporate goals. Schools have an opportunity to prepare students with ASD to be career ready. A course of study that includes explicit teaching about workplace behaviors, social communication skills, and other career skills has helped prepare students for their careers. A survey conducted by a college in the northeastern United States has examined a program, known as the Employment Readiness Experience (ERE), which has proven to help students develop the skills they need to use their unique abilities to become contributing members of society. The ERE program includes direct instruction, cooperative learning, computer-based skills development, and part-time employment with specifically chosen employers to develop students' career preparedness. Completing a program like the ERE can provide employers with workers who are ready to become strong contributors and embrace the diversity in the world.

Keywords: Autism Spectrum Disorders; ASD; Employment; career preparation; cooperative learning inclusion, diversity

1. INTRODUCTION

The concept that neural differences are part of the human genome and are a natural part of the human population is not news. Researchers have found that as many as 1 in 5 college students are neurodivergent and may need accommodations to succeed in their educational journey (National Center for Learning Disabilities [NCLD], 2017). Educating neurodivergent college students, especially those with Autism Spectrum Disorders (ASD), is challenging because no two students are alike in their needs. According to the Centers for Disease Control (CDC), 1 in 54 people have a diagnosis of ASD (Maenner, Shaw, Baio, et al., 2020). Although the diagnosis for most people in Maenner et al. 's study involved children, ASD is a neuropsychiatric condition that will persist throughout a person's life, affecting collegiate studies and their career. According to the College Autism Network (2018), half of the people with ASD experienced interruptions in postsecondary schooling and employment. "Many individuals on the autism spectrum have the capabilities businesses need, and with an under- or unemployment rate nearing 80%, they can become a key part of the solution" (Annabi et al., 2019, p. 4). Preparing students with ASD to become employable is imperative, not only because of the often-hidden strengths that exist but also to allow these people to contribute their unique talents to society.

2. THE WORKPLACE AND EMPLOYEES WITH ASD

ASD manifests commonly as a social communication impairment, and as such, is often a hidden disability. ASD may appear in employees as difficulties with interpersonal communication, a lack of understanding of nonverbal communication, or unexpected responses to external stimuli such as light, sound, or touch. A person with ASD may present as a persona with poor communication skills and poor understanding of interpersonal dynamics (VanBergeijk, Klin, & Volkmar, 2008). Visible aspects of ASD may include unexpected hand gestures (called flapping), rocking, vocalizations, or pacing. The noticeable elements of ASD are often self-soothing behaviors, which means that they

are working to self-regulate their discomfort, often unconsciously (Mazefsky, Herrington, Siegel, et al., 2013). These social deficits, visible or invisible, may manifest as socially obnoxious or otherwise less-acceptable behaviors that may displease employers and colleagues, even if the person is otherwise qualified to do the work. However, people with ASD have hidden skills that may be unrecognized because of the pervasive prejudice against people who do not fit the typical employee stereotype.

Kwon (2019) noted that work environments have become more complex than ever before as innovative technologies and increasing uncertainty manifest in businesses of all types and all industries. The workplace has become more social and less programmed than ever before. According to Baron-Cohen (1991), a person with ASD could have deficits in joint attention, which pertains to multiple people paying attention to the same thing simultaneously. In the workplace, this joint attention deficit could lead to challenges stemming from the employee's recognition of the relationship between people and content and a potential deficit in professional communication's reciprocity. Jacob, Scott, Falkmer, and Falkmer (2015) commented that an employee with ASD could experience more workplace challenges, especially when experience changes needed to achieve or maintain a competitive advantage because of inherent deficits in joint attention and relational reciprocity. In the modern workforce, organizational inclusion and diversity are vital in cultivating and supporting talent (Friedman, 2020). Employees with ASD are part of a drive for inclusiveness that employers need to develop innovative solutions for their challenges.

3. PREPARING STUDENTS WITH ASD FOR 21ST-CENTURY EMPLOYMENT

The process of educating a student does not end when they exit college – or any school, for that matter. Like anyone else, they continue to learn about their world and themselves. For people with ASD, they may not know where or that their social deficits exist. Similarly, students with ASD may not be aware of the unique gifts they bring to the workplace. People with ASD often have the following attributes that make them particularly attractive candidates (Nelson & Coplan, 2019):

- Deep passions, interests, and skills in a specific area
- Honesty and loyalty
- Strong detail orientation
- Preference for repetitive or highly structured tasks
- Punctuality
- Strong visual thinking, logical, and pattern identification abilities

People with ASD could be top employees if they have jobs that work with their strengths. Education plays a significant role in preparing students for employment by supporting learners' development of valuable workplace skills (Giannakaki, McMillan, & Karamikas, 2018). Collegiate studies allow students with ASD to focus on and develop their innate talents into practical workplace skills.

Lombardi, Izzo, Gelbar, et al. (2017) noted that students with ASD need added college support to prepare them for careers. These supports include enhanced technological skills, social skills development, and critical thinking skills. Therefore, students with ASD need more than the collegiate learning involved in reaching a degree. They need more supports to make them workplace ready, specifically explicit instruction in workplace behaviors, self-advocacy ability, and social communication skills.

4. PARTICIPANT STUDY AND RELEVANT DATA

A study conducted from 2017-2020 at a tertiary school in the northeastern United States involved offering a collegiate course during which students spend classroom time discussing employment situations that commonly challenge people with ASD. Later the same day, the student worked at a specially chosen on-campus, paying job with a supervisor trained to observe, guide, evaluate the student's work, and then report this evaluation to the

professor. The course's purpose has been to offer explicit teaching about common social behaviors and techniques for managing challenging workplace situations such as stress, interpersonal conflict, and professional development. This course has proven to improve the students' work experiences by using feedback from the employer, the professor, and the student's reflections about daily learning and successes and challenges in their daily work.

Work experiences for students in the course have included entry-level work in the following:

- Office administrative roles such as filing, supply tracking, and inventory
- Video creation in conjunction with the college's research department
- Database creation and maintenance with the college's marketing and communications department
- Administrative tasks with the college's health service department
- Image and marketing projects with the college's office of student activities and the office of internships and career placement

Students were placed in roles according to their indicated interests, aptitudes, and matches with supervisors. Students for the course interviewed with potential supervisors to decide job fit and to practice interviewing skills.

In the data gathered between 2017-2020, the following information emerged. Table 1 has demographic data about student participation in the course.

Table 1. Participant Data

Number of participants	42
Number of graduates who had taken the course.	16
Category of degrees of the graduates:	
Bachelor of Arts (B.A.)	5
Associate of Arts (A.A.)	9
Associate of Science (A.S.)	2
Percent of participants continuing with an internship or employment after taking the course	50%

Participants in the course engaged in guided discussions about their work experiences each day and reflected on both positive and challenging experiences. Another essential piece of curriculum used was an internet-based resource called "Am I Job Ready?" (PSI Services, 2020). This resource had 16 modules with vignettes, questions, and specific guidance about common job-related issues such as decision-making, teamwork, conflict resolution, and other workplace-specific topics. Students reflected daily on their work experiences in a document shared by the student, the employer, the professor, and the director of careers and internships at the college. The combination of learning, reflection, work at a paid on-campus job, and communication among the relevant personnel led to robust discussions about employment challenges for people with ASD and a chance for skill improvement. Students in the course completed an exit survey during the 2018-2019 classes. Table 2 has information captured in an exit survey in which the students self-identified their skill development due to taking the course.

Table 2. Improvement Based on Work Completed During the Course

Number of participants who completed the survey	27
Skills Assessment – self-reporting some or substantial improvement in the following areas:	
Managing stress in work situations	69%
Working in a team	53%
Problem Solving	80%
Interpersonal communication	79%
Planning and organizing work	80%

5. DISCUSSION

This program, known as the Employment Readiness Experience (ERE) at the college, has offered students the opportunity to gain necessary job experience paired with explicit instruction and discussion about workplace challenges. Of the students who completed the program, 86% have responded that they agree or strongly agree that the ERE program made them feel better prepared to enter the job market. Similarly, 57% of students who have completed the ERE reported that the "Am I Job Ready" Strengths Assessment (a part of the computer program) helped them better understand themselves as employees. The two following case studies highlight two student's experiences following the program.

5.1 Case study 1

Student A completed the program, graduated from the college, and performed an on-campus internship at Landmark College's research center. In 2018, he joined SAP's Neurodiversity Institute Summer Program. In 2019, he completed a credit-bearing paid internship at Prudential and returned for continued employment at Prudential in summer 2020.

5.2 Case study 2

Student B completed the program and enrolled in an on-campus internship. Upon completing his bachelor's degree, he secured employment with a local food processing corporation doing production work and later secured a more responsible position.

The ERE program has grown from a single offering in January 2017 to sessions offered semiannually as of 2019. Class sizes include ten or fewer students to promote individualized instruction and camaraderie among the students in each cohort. Students have the daily opportunity to reflect on the previous workday's experiences and engage in cooperative learning with their peers and instructor to strategize about handling workplace challenges.

The ERE program met challenges. The college's challenges in running this program for students with ASD have been finding supervisors who are willing to offer students the guidance they need to succeed at their worksites. Additionally, students sometimes do not have career-ready skills, such as understanding nuances about confidentiality and social behaviors, including bodily hygiene. However, the students have reflected that it was better to make the mistakes in a school setting than in real-world employment.

6. ACTIONS EMPLOYERS COULD TAKE NOW

In the evolving culture of inclusivity in the workplace, hiring diverse employees is gaining momentum. Employers such as Microsoft, Ernst & Young, SAP, and many others are starting to realize the benefits of neurodiversity as another avenue in which they may find exceptional employees. "The business case for diversity has highlighted the importance of 'diversity of thought' – get people with different perspectives, backgrounds, and experiences in a room, and your team will be more innovative and creative" (Chartered Institute of Personnel and Development [CIPD], 2018, p. 4). During this time of significant social change, employers who use neurodiversity are beginning to realize the value that employees with ASD may bring. The question becomes one of how to prepare college students with ASD for employment.

Employers have a unique opportunity to hire a person with ASD because of the innate skills and strengths that these people have. The employer must take care to select and screen these people, as they likely do with other

employees, to ensure that they choose the right candidate for a job. Suggestions for current and potential employees include the following:

- Share the interview questions with the prospective employee before the interview. This promotes a level of predictability that allows a person with ASD to prepare answers appropriately.

- Provide meeting topics in advance to allow employees with ASD to know what to expect. Doing so will reduce employees' anxiety about potential ambiguity that commonly exists during workplace meetings.

- Please collaborate with the employee to develop a list of tasks that they should complete and explicit directions for multi-step tasks. This allows the employee with ASD to have the facts they need to conduct their assignments.

- Allow employees to have items, such as noise-canceling headphones, to allow them to remove sensory distractions. This will mitigate anxiety about the sensory issues people with ASD may experience.

- Supply explicit written directions about tasks. This practice removes ambiguity for everyone involved and avoids miscommunication. If ambiguity in an assignment is inevitable, then address that fact to prepare the employee.

- Be aware that employees with ASD may need a coach for social and emotional intelligence in the workplace. This coach could offer direction and guidance to help the employee succeed.

- When providing feedback to the employee with ASD, be direct and fact-based. This approach will appeal to the employee with ASD because of the common preference for factual, honest explanations.

By practicing these suggested behaviors, employers promote inclusion and social justice in an increasingly neurodivergent world, creating opportunities that help the business and its stakeholders. For 21st-century employers, the challenge is to include talent, whatever form it takes, and dispel antiquated notions of "normal" because neurodivergence is now the standard. Rising to this challenge is not simply good business. It is the new best practice that helps all people involved.

7. CONCLUSION

Preparing students with ASD to use their unique skills in fulfilling employment has increased in importance as employers strive to create inclusive, diverse workplaces. In running this multi-year study, the school validated what researchers have found about preparing people with ASD for employment: They need explicit guidance, an opportunity to develop their skills, and the chance to build their social communication abilities. Given that 20% of college students have ASD, offering specifically designed courses to these students has become imperative to promote inclusive, diverse workplaces. Schools should implement and deliver an employment-preparation system so that all students have the chance to contribute their unique skills to an increasingly diverse workforce.

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The Impact of Support-Network Quality on the Burnout promoting Effect of poor Supervisor Support

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Abstract

This contribution combines the fields of social networks, burnout research and support research. In the field of support research, but also in burnout- and network research, there is a lack of results that adequately reflect the "systemic" effects of social support networks on burnout-promoting workloads. Furthermore, there is a lack of the possibility to evaluate statements about the quality of relationships and collective problem-solving ability. Both dimensions are summarized in this study as "support network quality". Based on the feedback of test persons in the context of a quantitative study (N=338), the effect of social support (perceived support) by the direct superior on the three burnout dimensions according to Maslach was examined. In connection with this, it was to be found out whether the quality of social support networks in the private sphere (family & friends) as well as in the work context (secondary environment) have a moderating effect on this relationship, or whether a direct influence on burnout can be proven. The German version (MBI-D) of the Maslach Burnout Inventory, the EVOS (Evaluation of Social Systems Scale) and the SPSS Scale to measure perceived social support were used. It turned out that a high-quality support network "colleagues" is able to buffer (moderate) the relationship between employee's "perceived supervisor support" and employee-burnout caused by poor supervisor support. The buffer function takes place via the quality dimension of the relationship exclusively, not via the dimension of "self-efficacy" from EVOS Scale. The quality of personal support networks from the secondary environment (work-colleagues) are rated higher than those of support networks in the primary environment.

Keywords: perceived supervisor support, burnout, support networks, personal networks

1. INTRODUCTION

This work is dedicated to representatives from the field of automotive industry in Germany (middle management) in which social contact with people is an everyday feature. In addition to the professional experience of support (employee's perceived supervisor support), the three burnout dimensions (emotional exhaustion, depersonalization & reduced personal accomplishment) as outcome variables should be investigated. It should be shown - as in other studies on main/direct effects - that employees who receive support and assistance from their superiors in their professional environment have less burnout symptoms. This results in the first Research-Question: *"Can previous findings on the positive effect of social support by the supervisor on burnout also be confirmed for the sample examined in this study?"*

In addition to social support by direct superiors, support networks in the work context but also in the private sphere must also be considered, since it can be assumed, that factors e.g. the quality of relationships, social support or emotional closeness in the private sphere can influence individual perceptions of supportive behaviour in the professional context to a not inconsiderable extent - or perceptions of supportive behaviour in the private sphere are possibly interrelated. Therefore, in addition to the quality of the "collegial" support network, the quality of "family" support network and the quality of the support network "friends" are also recorded empirically. The quality of the mentioned support networks includes the evaluation of the social system or multiperson system in the sense of "we - as a whole". Not only the social support of the networks is recorded, but two dimensions "quality of relationship"

(includes social support) and "collective efficacy" are evaluated, which as a whole represent the "quality of the support network". The dimensions cover both, affective and cognitive aspects of "system quality". This results in the following questions of this work:

"Is the quality of support networks, from the private or professional sector, able to buffer (moderate) the relationship between perceived social support from superiors and burnout of employees?"

and "which of the above-mentioned support networks do employees primarily access when needed (self rated quality), or which one buffers the relationship between social support from superiors and burnout most effectively?"

Social support networks provide the infrastructure for the production and distribution of a broad spectrum of social support benefits, which in turn represent the social resources of an employee - an important factor for the physical and mental health as well as for burnout. Social resources in the form of social support networks can help to cope with workloads and to better master challenges. In stressful situations, it is helpful to interact or to receive emotional or practical support from the support networks of the primary and secondary environment.[1]

Social support at the workplace, but also social relationships in the work context and their characteristics such as emotional attachment, cohesion, common goals, etc. play an important role in the examined outcome burnout and thus represent an important starting point in the field of workplace health promotion, as they represent a resource for employees to maintain or positively influence mental and physical health, as well as their work-related performance. Social relationships are also part and focus of organizational stress research with regard to psychosocial stress factors. Despite numerous empirical studies on the consequences of social support and stress at the workplace and on the derivation of health promotion measures, no theoretical conceptualization of the construct „personal support network quality" and their role in the process of coping with social support by superiors has yet been carried out.[1] The present study thus considers the burnout impact of social support by the supervisor, taking into account the quality of emotional and social resources resulting from interaction with members of predefined support networks.

1.1. Diagnostic Tools

The Maslach Burnout Inventory by MASLACH & JACKSON has been used as a diagnostic tool for the detection of burnout.[2] For this research, the German version of the Maslach Burnout Inventory (MBI-D) according to BÜSSING & PERRAR has been chosen.[3] The MBI-D closely follows Maslach & Jackson's item content and scaling and captures the components (according to the original MBI construct) "emotional exhaustion", "depersonalization" and "personal accomplishment". Important to notice is, that the scale of personal accomplishment has to be calculated vice versa. In this study, the scale has been renamed in "reduced personal accomplishment" to ease the scoring and interpretation of the findings. Higher reduced personal accomplishment scores refer to lower feelings of competence and successful achievement, whereas scoring high on this subscale indicates a higher attitude of inefficacy and reduced motivation. Scoring higher on the subscale emotional exhaustion indicates greater feelings of fatigue and being drained; a higher score on the subscale depersonalization denotes a greater tendency toward cynical, callous and uncaring attitudes against e. g. colleagues; The reliability was estimated for the subscale emotional exhaustion at .823, for the subscale depersonalization .811 and for the subscale reduced personal accomplishment .902.

To measure Perceived Supervisor Support, the SPSS scale from KOTTKE & SHARAFINSKI has been used. The SPSS scale is based on the Perceived Organizational Support Survey by EISENBERGER, HUNTINGTON, HUTCHINSON & SOWA [5] - with one difference - all items refer to the supervisor, not to the organization as a global entity. Given that the definitions of Perceived Organizational Support and Perceived Supervisor Support are practically identical in nature, their measurements have been adapted to accommodate these similarities. Higher scores indicate that participants perceived their supervisors to be more supportive. Cronbach's alpha in the present study was measured at .944.

The relatively unknown EVOS-scale [6] was used to assess "quality of relationships" and "collective efficacy" in multi-person systems. The EVOS therefore has two subscales, consisting of four and five items. Example of subscale "quality of relationship": „For me, the way we talk to each other, is…". Examples of subscale "collective efficacy": "For me, the way we decide what needs to be done, is…". Members of the social system answer the questionnaire

[1] Social support, in this case, has a negative connotation.

with help of a 4-point rating scale. The format is ranging from "very poor" (0) to "very good" (3). The consensus item „I think we will give similar answers to these questions" has been dropped. The consensus item is not an integral part of the scale and thus may be left out. In this study, it is looked at the two dimensions of EVOS separately. Both scales represent the quality of each support network. Cronbach's alphas for the subscales in the present study were measured at .811 for "quality of relationship", and .829 for "collective efficacy".

1.2. Sample

The target group of the main survey can be defined as follows: Office-based managers (middle management) from the producing automotive industry all over Germany. The focus is on medium-sized companies. Persons whose activities include more than 20% travel (field service), part-time employees and self-employed persons were not considered. The sample surveyed in this study consists of two sub-samples using different survey methods. Firstly, test persons were acquired via the XING network.[2] This network was deliberately chosen because the majority of its members are resident in Germany. The sample was explicitly surveyed in Germany to avoid cultural differences. Secondly, the link to the questionnaire was distributed among persons from the author's professional social network with the request to answer it themselves and also to forward it to other potential participants in their own company or beyond. Again, only persons from Germany were interviewed. The survey was conducted anonymously. The respondents did not receive any reward. The persons addressed expressed their consent to participate in the survey by filling out the online questionnaire, to which an explanatory cover letter with contact address and telephone number for further inquiries was attached. A total of 662 questionnaires were distributed or sent out online via the first access channel. The total response was N = 256 (38.67%). The second access method resulted in a total response of N = 84, whereby the number of respondents is unknown due to the corresponding distribution of the questionnaires (separate survey-link). It was necessary to exclude 2 individuals from the sample (0.59%) for error in the age indication, totaling 338 participants with data available for analysis. This sample size can be considered as very good when comparing the calculated minimum sample size in relation to the total number of all employees in the German automotive industry (n=384).

1.3. Hypotheses

In the first hypothesis, the aim is to test whether the frequently reported findings on the burn-out -reducing or -promoting effect of social support by superiors can also be confirmed on the samples examined in this study.

> *Hypothesis 1 - A high level of social support by the supervisor (perceived support of the employee) has a significantly negative correlation with employee burnout in all three operationalized dimensions.*

It is assumed that for all samples included, the relieving effect of a supporting supervisor can be proven in connection with the individual experience of burnout symptoms. Persons who feel supported by their supervisor to a high degree professionally should also feel better psychologically in this respect. It remains to be checked, however, whether the strength of the effect is similarly high for all the samples examined or whether there are differences in view of the demographic variables. In the first hypothesis, the interaction of different resources in the form of support networks and personality traits are not taken into account. The following hypotheses aim to clarify this in a more differentiated way.

In a next step, it is postulated that employees who perceive poor support from their supervisor, but who maintain a high-quality collegial support network, have fewer burnout symptoms than those who maintain a low-quality collegial support network. The latter have a higher stress perception and poorer health caused by poor perceived supervisor support.

However, it seems doubtful that a low level of social support by the supervisor combined with a high-quality collegial support network leads to the same result. Rather, it would be conceivable that the affected employees could fall back on colleagues who are available to help them in stressful situations and thus compensate for the deficit.

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[2] XING is a social network where members primarily manage their professional contacts. XING primarily offers a platform for business networks primarily in German-speaking countries, in contrast to globally oriented networks such as LinkedIn. URL: http://www.xing.com.

Hypothesis 2.1a - A high quality support network „colleagues" is able to buffer (moderate) the relationship between the social support by the superior (perceived supervisor support) and employee burnout.

With the help of this hypothesis, a contribution should be made to the clarification of moderating support networks. the further course of the project, it is to be examined whether employees who perceive a lack of support from their supervisor can compensate for this through a high-quality support network in the private sector. Interesting for the investigation of a relevant effect are employees, who feel supported by the superior only in small measure.

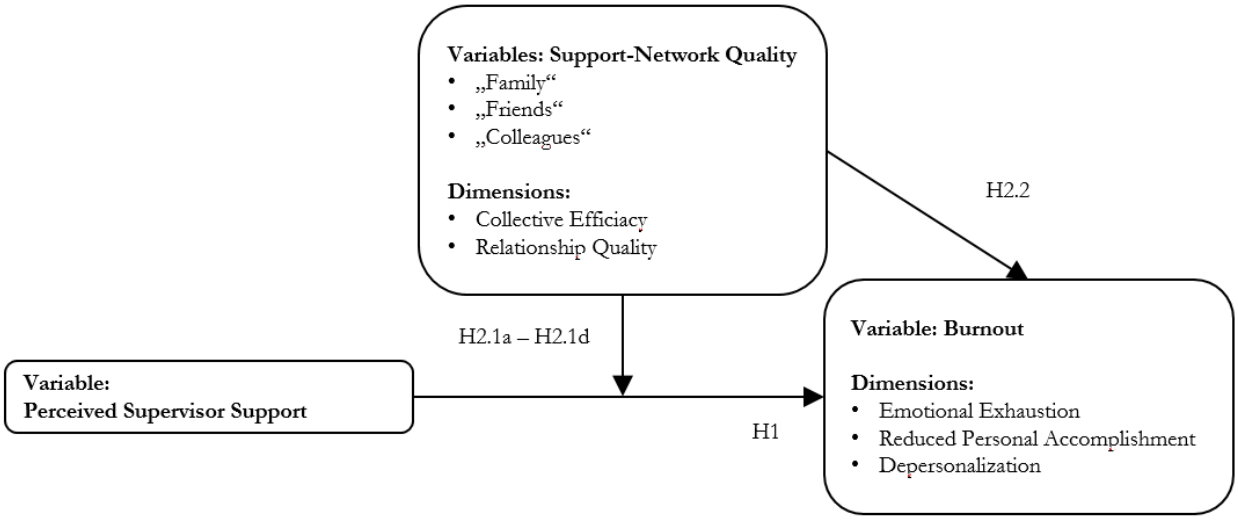

Figure 1. Conceptual Model and Visualization of the Hypotheses. Source: Authors' own Construction.

For this group of people, the influence of a high-quality support network in the private sphere (initially the focus should be on the support network „family") on burnout symptoms should be examined. In the sense of a compensatory (moderating) effect, it is to be expected that employees who perceive a higher quality of their family support network should distinguish themselves from those whose support network is of lower quality. They should therefore perceive poor supervisor support as less impairing and as a result of symptoms of the three burnout dimensions should evaluate themselves less strongly. Based on these considerations, the following hypothesis can be made:

Hypothesis 2.1b - A support network „family" in high quality is able to buffer (moderate) the relationship between the social support by the superior (perceived supervisor support) and employee burnout.

In terms of a further private resource, the next step is to consider the private support network „friends". It would be conceivable that employees who have a supportive inner circle of friends of high quality would have fewer burnout symptoms. The following hypothesis can therefore be formulated:

Hypothesis 2.1c - A high quality support network „friends" is able to buffer (moderate) the relationship between the social support by the superior (perceived supervisor support) and employee burnout.

In this study it is assumed that „professionals" and yet familiar, strong relationships in the work context are those who are first consulted in all matters related to the professional environment. Contrary to the assumption of CANTOR and LITWAK, which postulate that the preferred support persons are distinguished by their emotional and usually also spatial proximity - characteristics which in a way equate them as a quality feature of the relationship or that of the support network with the supporting person (group).[7] In this investigation, however, the context in which a support network exists should not be lost sight of. In this case the context is „work". It is therefore assumed that a support network from the private sphere, such as the family support network or the friends support network - even if they are characterised by high quality - are less well suited to moderating the relationship between perceived social support by the supervisor and the subjectively assessed mental and physical health of the employee.

Hypothesis 2.1d - A support network of high quality from the private near field (friends, family) has a weaker buffer function between the social support by the superior (perceived supervisor support) and employee burnout as the professional support network „colleagues".

The assumption is based on two reasons: a) Strong relationships ensure the integration into a social, professional core network, which gives the individual a stable social background (identity, sense of belonging, support) and fulfils basic support needs. In addition, close colleagues as communication channels ensure a rapid (informal) professional exchange of information. Furthermore, b) group dynamic processes play a role. In organizations, the phenomenon of „social contagion" is of particular importance. The term social contagion describes the phenomenon of a form of emotional transmission between people. Through social contagion, moods, feelings, etc. can spread in a society. Social contagion is explained by the same alignment of individual emotional energies. Self-organizing feedback mechanisms create resonance and reinforcement in the collective. And just as aspects conforming to affect in the individual combine to form a „conclusive affect logic", this also happens collectively. In the case of a social support by the superior that is perceived as insufficient, a collective „logic of fear" or „logic of anger" can develop.[8] So what people feel and how they behave is often not decided by them alone, because the psyche cannot escape the power of the social, although within internal networks of the organisation this effect can be strengthened and expanded - employees look for allies to support them. [9] [10]

For the reasons mentioned above, these allies are mainly found in the working environment. In this respect, the self-rated quality of support network „colleagues" should be higher. The following hypothesis can thus be made:

Hypothesis 2.2 – The self-rated quality of the support network „colleagues" is rated higher by the employee than the quality of support networks in the primary environment.

At this point, the work of HAGER & BRINK should be mentioned, which was carried out as part of a preliminary study for this dissertation.[1]

2. RESULTS

Testing Hypothesis H1

The results from the correlation analysis between "perceived supervisor support" and the three burnout dimensions "emotional exhaustion", "depersonalization" und "reduced personal accomplishment" are presented in Table 1. There was a significant correlation at the MBI dimension "emotional exhaustion" ($r = -.352$, $p < .01$) and "reduced personal accomplishment" ($r = -.322$, $p < .01$) found.

Table 1. Pearson Correlation

MBI Burnout - Dimensions	Perceived Supervisor Support
Emotional Exhaustion	-.352**
Depersonalization	-.149
Reduced Personal Accomplishment	-.322**

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

There are no significant interactions at between all three burnout-dimensions and "perceived supervisor support" at the same time. Hence, the first hypothesis (H1) is rejected. Accordingly, no significant correlation could be measured between "depersonalization" and "perceived supervisor support".

Next, a linear regression analysis was calculated for the two significant dimensions of burnout Table 1 and "perceived supervisor support" as the constant.

Table 2. Regression Analysis – Model Summary

MBI Burnout - Dimensions	R	R^2	Adj. R	Std. Error of the Estimate
Emotional Exhaustion	.352[a]	.124	.120	1.567
Reduced Personal Accomplishment	.292[a]	.104	.099	1.398

a. Predictors: (Constant) Perceived Supervisor Support

The determination coefficients "emotional exhaustion" and "reduced personal accomplishment" correspond to a medium effect. According to COHEN, there is a strong effect at $R^2 \geqslant .25$, a medium effect at $R^2 \geqslant .09$ and a weak effect at $R^2 \geqslant .01$. [11] 12,4% of the variance of the "emotional exhaustion" and 10,4% of the variance of "reduced personal accomplishment" can be predicted from "perceived supervisor support". According to ANOVA, the regression of the models makes a statistically significant prediction (Sig. .000≤.050).

Testing Hypothesis H2.2

Table 3 shows the results of the Pearson correlation between EVOS dimensions "quality of relationship" and "collective efficacy" and the three dimensions of burnout for all participants.

Table 3. Pearson Correlation

MBI Burnout - Dimensions	Quality of Relationship "Colleagues"	Collective Efficacy "Colleagues"	Quality of Relationship "Family"	Collective Efficacy "Family"	Quality of Relationship "Friends"	Collective Efficacy "Friends"
Emotional Exhaustion	-.366**	-.052	.026	.034	-.267*	.056
Depersonalization	-.091*	.014	-.063*	.090*	-.051	.076
Reduced Pers. Accomplishment	-.465**	-.453**	-.049	.091*	.035	-.124*

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

The hypothesis (H2.2) stating that burnout-preventing effects of personal support networks from the secondary environment can be rated higher than those of support networks in the primary environment was confirmed. The highest negative correlations have been found between the EVOS-dimension collective efficacy "colleagues" and the MBI-dimension "reduced personal accomplishment".

Furthermore, there were correlations between the EVOS-dimension quality of support network "colleagues" and the MBI-dimension "emotional exhaustion". There are only few and weak significant correlations with the support networks from the primary environment "friends" and "family". Worth mentioning is also a medium strong negative correlation between quality of support network "friends" and the MBI-dimension "emotional exhaustion".

A separate linear regression analysis was calculated for the two significant MBI-dimensions in Table 3 and the EVOS Subscales "quality of relationship" and "collective efficacy" for the three support-networks "colleagues", "family" and "friends". For reasons of space and clarity, Table 4 shows only the determination coefficients R^2 in the form of a matrix.

Table 4. Regression Analysis - R^2-values

Predictors / Outcome	Quality of Relationship "Colleagues"	Collective Efficacy "Colleagues"	Quality of Relationship "Family"	Collective Efficacy "Family"	Quality of Relationship "Friends"	Collective Efficacy "Friends"
Emotional Exhaustion	.134	.003	.001	.034	.071	.003
Reduced Pers. Accomplishment	.216	.205	.002	.008	.001	.015

In the regression analysis (Table 4), a medium effect was determined for the support network "colleagues" in its EVOS dimension "quality of relationship" for the outcome variables "emotional exhaustion" and "reduced personal accomplishment". 13,4% of the variance of the emotional exhaustion and 21,6% of the variance of reduced personal accomplishment can be predicted from Quality of Support Network "colleagues". Simultaneously, a medium effect (7,1%) was determined for the support network "colleagues" in its EVOS dimension "collective efficacy" for the outcome variable "reduced personal accomplishment". According to ANOVA, the regression of the models makes a statistically significant prediction (Sig. .000⩽.050).

Testing Hypotheses H2.1a-H2.1d

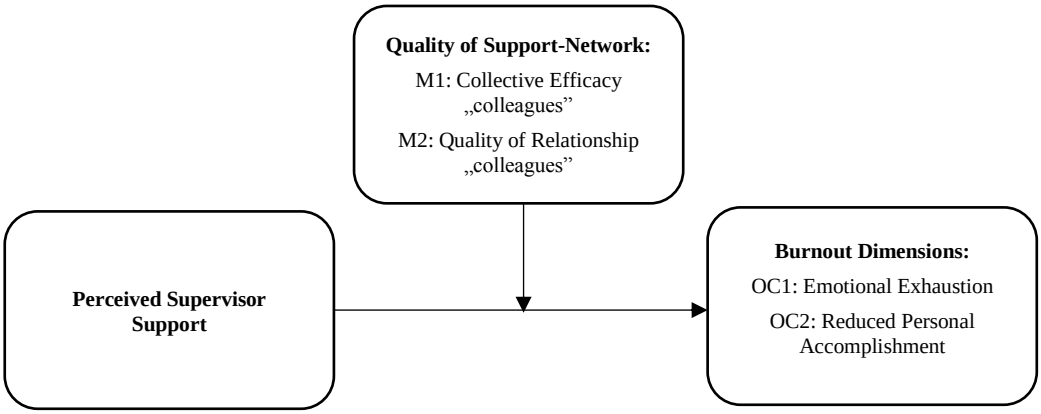

Fig. 2. Model of the Moderator Analysis. M=Moderator Variable, OC=Outcome Variable. Source: Authors' own Construction.

The prerequisite for the moderator analysis, the normal distribution of the dependent variable and the moderator variable, which is given. The previous correlation analysis in Table 1 shows, that perceived supervisor support has a significant influence on the burnout-dimensions "emotional exhaustion" and "reduced personal accomplishment"

Table 5. Results of the Moderator Analysis

	Quality of Relationship "Colleagues"	Collective Efficacy "Colleagues"
Relationship: Perceived Supervisor Support on Emotional Exhaustion	-,835/-1,256 p<,019	-
Relationship: Perceived Supervisor Support on Reduced Personal Accomplishment	-1.359/-,459 p<,001	-1.251/,342 p<,039

A moderator analysis should check the role of the Support Networks quality of relationship "colleagues" and collective efficacy "colleagues" as a possible moderator between "perceived supervisor support" and the MBI's significant two dimensions (Table 3). The reason for choosing support network "colleagues" solely, is the lower limit of the interval $R^2 \geq .09$ for a moderately strong correlation according to COHENS classification. All weak predictors have been dropped. Table 4 is showing the results.

As described by HAYES and already mentioned in the pre-research's moderator analysis, indirect effects are considered significant at $p < .05$ if zero is not included in the 95% confidence interval.[12] The results in Table 5 show a moderating effect of the EVOS dimensions "quality of relationship" of the support network "colleagues" on both MBI dimensions "emotional exhaustion" and "reduced personal accomplishment".

Therefore, Hypothesis 2.1a is rejected partly. A high-quality support network "colleagues" is able to buffer (moderate) the relationship between employee's "perceived supervisor support" and employee-burnout. However, the buffer function takes place via the quality dimension of the relationship exclusively, not via the dimension of "self-efficacy".

Hypotheses 2.1b and 2.1c are rejected. The support networks "family" and "friends" are not able to buffer (moderate) the relationship between employee's "perceived supervisor support" and employee burnout. The values from the regression analysis (Table 4) were negligible a priori. $R^2 \geq .09$. They were dropped according to COHENS classification.

Therefore hypothesis 2.1d is also rejected, as there is no moderating support network of high quality from the private sphere[3] between employee's "perceived supervisor support" and employee burnout.

3. DISCUSSION

In the following section, the results presented in the aforegoing section are discussed. Only significant values are interpreted.

3.1. Impact of Social Supervisor Support on MBI-Dimensions (H1)

In a first step, the aim of the study was to capture the „perceived supervisor support" that employees experience from their immediate supervisors and to investigate the extent to which this support predicts the development of burnout in its three dimensions. The theoretical starting point was that the positive effect of social support in connection with coping with stressful situations is transferable to dyadic supervisor-employee relationships of office-based managers - i. e. there is a connection between social supervisor support and the occurrence of burnout among the surveyed employees. A distinction of the three burnout dimensions according to MASLACH; JACKSON & LEITER made it possible to obtain a more precise description of the effect of supervisor support and to explain their specific connections.[7] The analyses on the prediction of burnout point to the special importance of the superior, since high levels of support are accompanied by lower levels of exhaustion. Social supervisor support can act as a psychosocial immune system. Granted or denied, social support can directly affect the mental state of individuals – both in a positive or negative sense. In a positive way, it promotes health and helps to overcome disease. Social support is thus a prerequisite for employee-oriented and health-oriented leadership. It can take the form of tips or work relief (instrumental) as well as encouragement, comfort and motivation (emotional). Less hierarchical leadership through emotional competence counteracts burnout among employees.[13] Hence, the more dissonant and dictatorial the leadership is, the more likely burnout will become noticeable among employees. Supervisor support is therefore strongly related to the emotional competence of the executive. Emotional Intelligence (EI), which became known through the psychologist and science journalist Daniel Goleman, describes the ability to perceive emotions appropriately, to use them in thought processes, and to control and understand them adequately. Goleman distinguishes between two components of Emotional Intelligence: On the one hand, social skills (in relation to oneself), which include self-perception and self-management. On the other hand, social competencies (in relation to dealing with other people), which include social awareness and relationship management. Emotional intelligence is a prerequisite for leaders to put themselves in the shoes of employees, to perceive complex situations and to be able to react with appropriate support.[14]

The influence on the burnout dimensions is made clear by the results of this work. In the study of HAGER & BRINK it was shown that perceived supervisor support has a medium strong, significant influence especially on the SF-36 factors „emotional well-being" ($r = .312$; $p < 0.01$) and „energy/fatigue" ($r = .344$; $p < 0.01$). „Emotional well-being" measures overall mental health, including depression, anxiety, emotional and behavioural control, and overall positive mood. „Energy/fatigue" measures whether the person is feeling energetic and full of energy or whether she/he is more tired and exhausted. This fact makes it clear that both SF-36 factors are relevant to burnout. The factor „emotional well-being" in a negative connotation shows parallels to the MBI dimension „emotional exhaustion". For the burnout dimension, a medium strong, significant influence of ($r = -.352$; $p < 0.01$) on the „perceived social support" could be determined in the main study. The SF-36 factor „energy/fatique" shows parallels to the burnout dimension „reduced personal accomplishment". It correlated medium-strong and significantly with the „perceived social support" and shows similar values ($r = -.322$; $p < 0.01$).[11] According to GOLEMAN, successful managers have a high emotional intelligence: *„Truly effective leaders are also distinguished by a high level of emotional intelligence"*.[15] Emotional intelligence is based on mutual understanding and trust, empathy, sociability and contributes to synergy effects in teamwork and group learning.[14] Thus, if a manager can recognize negative feelings and emotions, she/he has a decisive influence on stress and finally also on the perception of exhaustion and burnout-relevant factors of the employees. In this respect, coaching sessions for managers should focus on the feelings. Managers who understand

[3] Private sphere = "friends" and "family".

themselves and thus these inner mechanisms better have a clear psychological innovation advantage. And thus, also the teams, departments and companies they lead - not on the basis of a functional and therefore manipulative attitude, but on the basis of compassion, genuine empathy and sensitivity, following the principles of human dignity, respect and appreciation. Emotional intelligence should therefore not just be a catchphrase, but an important personality aspect of a successful entrepreneur and a health-oriented, supporting and burnout-preventing leadership.

3.2. The Role of Support Network Quality on the Relationship between social Supervisor Support and Burnout (H2.1a - 2.1d)

Another step and another question focused on the social environment and the social support network of the employees. Of particular interest was the self-rated quality of the individual support networks. Although the social environment has become an integral part of support networks, and has developed into a part of industrial and organizational psychology - against the background of socio-ecological considerations and the associated holistic principle, which empowers companies, teams, work groups and complex systems to take action - social support networks were only understood as a potential resource after the transformation from a deficit-oriented to a resource-oriented understanding of leadership. This empirical study attempted to close a gap in the research on this resource.

Social support in the work context is provided by an average of 11.31 people, with the personal support network consisting of roughly the same number of family members (3.98 people), friends (3.74 people) and work colleagues (3.59 people). The results of the moderator analysis show - also in the main research - that poor supervisor support can be better handled, to some extent, by employees, if they develop or maintain good quality support networks. The more a person is integrated into a diverse social network with important caregivers, supporters and advisors and accepts and values them as transaction partners, the better this person can deal with unfavorable social conditions, critical life events and ongoing stress. The burnout dimensions “emotional exhaustion” and “reduced personal accomplishment” are moderated by the subjectively assessed quality of the personal collegial support network. A high-quality support network of “colleagues” is thus able to buffer the relationship between the perceived social support by the superior and employee burnout. As has already been noted, the buffer function is performed exclusively by the quality dimension and not by the self-efficacy dimension. According to this study, the support networks “family” and “friends” are not able to moderate “emotional exhaustion” and “reduced personal accomplishment” due to poor social support by the supervisor. How could this be explained?

The question of the substitutability of individual relationships as well as the question of who can be considered as a supporting person can best be explained with the thesis of functional specificity according to LITWAK. LITWAK, does not focus on the persons in a social support network or their social positions, but on the nature of the support services. Since it is the subjectively perceived and not the actual support received, the approach needs to be slightly adapted: Let's suggest an employee who de facto needs specific support on a regular basis. From the employee's point of view, only the direct superior is initially considered as a theoretical support potential. The employee who is in fact in need of help must be able to turn to the potential helper, the superior, at any time. However, the superior must know that the employee needs support. The supervisor must therefore be prepared to help at any time. The fact that help can actually be provided is dependent on the concrete need for help and the actual availability of the superior and his or her competence to provide this help. These last selection steps, i. e. ultimately the fact that the superior can actually help, are, as already mentioned, placed in the foreground by LITWAK and treated by him under the keyword “optimal matching” of characteristics of the assistance and the relationship - in this research - between employee and superior.

In the special case of perceived support, the employee must feel or perceive the optimal matching. Why can the support network “colleagues” buffer the relationship between perceived supervisor support and burnout, while the other two support networks “family” and “friends” cannot? It is interesting to consider whether and for what reasons the employee in need of help contacts the colleagues, or why the employee believes that the colleagues are willing to help, or why the employee thinks the quality of the support network “colleagues” is higher.

This question is at the same time the question following CANTOR about the reasons for possible preferences for certain support persons or -networks. The interpretation of the present results is that the evaluation of the three support networks is not about individual preferences, since in this particular case, there are no suitable alternatives in the working context and the aspect of competence for the specific problem and the actual availability is the main focus. The question of CANTOR, to whom one would prefer to turn, is therefore not at issue. The next section makes it clear that support network quality also has a direct effect on burnout.

3.3. The direct Effect of personal Support Network Quality on Burnout (H2.2)

The effect of social support networks in the sense of a direct effect could also be determined via the support network „colleagues". The EVOS-factor quality of relationships „colleagues" correlates moderately and significantly with „reduced personal accomplishment" ($r = -.465$; $p < 0,01$), and equally significantly and moderately with „collective efficacy colleagues" ($r = -.453$; $p < 0,01$). A further significant and medium-strong correlation could be calculated between the EVOS-factor „quality of relationship colleagues" and the MBI-dimension „emotional exhaustion". With regard to the direct effect, it becomes clear that a collegial network helps to alleviate the burnout symptoms. The support and the quality of the network provides more work resources, a valuable tool for the employees for coping with stressful and complicated situations.

The support network, in which the affected employee can express emotions, deals with interpersonal relationships and offers the opportunity to express feelings and concerns. The primary support network used by the employees for coping with poor supervisor support can thus be identified as the collegial network. This goes in line with the results of the pre-research: The EVOS subscales „quality of relationship colleagues" and „collective efficacy colleagues" had the strongest and significant correlations and proved to be significant predictors, with the SF-36 dimensions „emotional well-being" and „energy/fatigue".

This suggested that - in the study - preferably colleagues have an influence on the mental well-being respectively on the burnout-symptoms of an employee. It is possible that for the employee the understanding of the supporter for the deficient work situation plays a decisive role in the selection of the primary support network. A good collegial support network could therefore be described as the most important „psychosocial immune system" in the work context.

4. CONCLUSION

In summary, it can be said that interesting findings are available after this research, which now need to be taken up in further work. In the debate on a personal support network, for example, it can be argued that it makes sense to differentiate between different support networks. For the further empirical examination of the construct, this could mean that the interaction of different support networks and the prerequisites for compensatory effects should be examined more broadly. Conditions should be investigated under which a lack of support by the supervisor can be compensated or under which a deficiency can be exacerbated. The central question was whether the quality of personal support networks is able to buffer the relationship between the perceived social support by the superior and employee burnout. It can be stated that the subjectively assessed quality of personal collegial support networks moderates the burnout dimensions "emotional exhaustion" and "reduced personal accomplishment". It is also clear with regard to the direct effect that a collegial network helps to alleviate the burnout symptoms. What can be concluded from this? First of all, that both aspects hardly contain redundant information. It can also be deduced from this that the perceived support is fed on the one hand by personality-specific characteristics, but on the other hand by the actual conditions of the professional support situation. In order to substantiate this thesis, the support network "colleagues" should be examined in addition to the analysis of the individual. Secondly, it can be deduced from the findings that although the personality has an influence on the experience of support, it is not sufficient to consider such variables alone. The differentiated recording of personal characteristics and situational conditions of the work context as well as their interaction would be promising in order to explain inconsistent results. In addition to the recording of concrete support services by colleagues and superiors, the examination of further work-related parameters would also be useful.

A logically significant situational factor would be, for example, the size of the working team. For the managers' population it is noticeable that the collegial support network is a relatively small group of people ($MD = 3.59$). It remains to be examined whether these effects are systematic or rather random. It would not be implausible, however, if the cooperation in a smaller team (or department) was more supportive and more facing than in a large one (and as a result the support network was correspondingly smaller). It would also be conceivable that a manager in a small circle would be more likely to respond to the individual and his or her needs and problems than if he or she had significantly more colleagues to lead. The connection between burnout and social support has been scientifically proven and the results of the present study further support this fact.

What steps can follow next? The focus should be extended to the organization. After all, by choosing their leadership style, supervisors make a lasting decision about the culture in the company. As already noted in the introduction to this dissertation, health-oriented leadership is not only characterized by social support, but also by appreciation and a health-promoting design of working conditions. The role model function of the superior as a motivator for health-

conscious behavior helps to reduce stress, motivate employees and promote sustainable corporate success. Due to the direct contact with employees, supervisors at lower and middle management levels in particular are predestined to take on the task of implementing health-oriented leadership.

LEITER & MASLACH see inefficient superiors as a possible cause of burnout: *„Instead of holding back and giving employees the freedom to follow their ability to judge at work, supervisors want to dictate the details. They face them - but not with stimulating leadership behavior, but with disturbing influence."*[16] The connection between social support and employee burnout, as well as the further influence of support networks and personality variables, presented in this paper offer initial starting points for recommendations for action and concrete measures for health-oriented leadership behavior. Nevertheless, it can also be seen that health-oriented leadership is not a completely new approach. Many existing management concepts, such as transformational or employee-oriented management, already have a positive effect on employee health. The question is whether health-oriented leadership really needs to be redesigned, or whether "good and correct" leadership does not also have the positive side effect of social support for employees. The possibilities for shaping a healthy management style are therefore nothing fundamentally new for managers, but it is assumed that these are generally perceived less consciously because the influence on the operational performance process and the performance of the employees was not considered to be significant. Accordingly, the company's goal must be to sensitize management levels to the connection between leadership and health. Only then can they initiate appropriate measures. A decisive starting point for this should be offers for managers at the level of personnel development. As an important source of impetus for the implementation of personnel development concepts, the human resources department must rethink the means by which the awareness of healthy supportive leadership can be strengthened and how existing deficits can be improved.

It is primarily a matter of integrating the health of employees into the organizational culture and anchoring it as a strategic goal in the operational management processes. The qualification of superiors can be the entry into a process that makes health promotion at all levels a central task of the company. If a healthier working environment and a higher level of mental well-being are to be achieved in the long term, a rethink must take place at all levels of the company and a healthy culture, especially a healthy management culture, must be created. The majority of German companies have not yet recognized the advantages of a healthy management culture. In practice, the problem of cost-benefit analysis often becomes apparent. As long as no clearly identifiable figures are available for the company that accurately describe the financial benefits of the measures for health-oriented leadership, this makes implementation more difficult. Clear advantages on the side of soft employee-related aspects, such as the working climate or the corporate culture, which are difficult to measure, are in many cases not sufficient for the management. The fact that the absenteeism rate alone provides information about a healthy organization is far from sufficient in view of the presenteeism phenomenon. In the future, it would be necessary to gain further business management insights in connection with management and the success of the company or the performance of the employees. In this way, business management could be convinced of the advantages of healthy leadership and would no longer act purely on the basis of the legal regulations on health management.

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Factors Influencing the Work-Life Balance and Job Satisfaction of Front-Line Employees by Means of a Qualitative Study

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Abstract

Purpose – The aim of this study is to analyse factors that have an impact on the work-life balance and job satisfaction of front-line employees in the hospitality industry.

Design/Methodology/Approach – A conceptual model was developed and proprietors of tourism businesses in Austria were asked in interviews about the job satisfaction and work-life balance of their employees.

Findings – The findings reveal that work-life balance stands in a relation with job satisfaction. Accordingly, the study clearly shows the benefit of having a committed front-line workforce. Furthermore, the results indicate that a certain factor is significantly related to predictors of work-life balance and job satisfaction.

Practical implications – The study has illustrated the importance for business owners working in the tourism and hospitality industry of having a satisfied workforce, who are able to benefit from a work-life balance. In particular, it is necessary for employers to realize that finding measures to help employees to maintain their work-life balance is an important factor for pursuing job satisfaction. Consequently, one practical implication in general from this study is the importance for business owners to find accordance with the working hours.

Keywords: Job satisfaction, work-life balance, tourism industry, front-line employees, working hours

1. INTRODUCTION

The topic of the work-life balance is especially for the tourism and hospitality industry an important issue. The tourism sector consists of labor-intensive and multi-faceted service organizations. Tourists spend a considerable amount of money and expend much effort in traveling. Especially front-line employees are of central importance for the guest experience in the hospitality industry [1], because employees in front-line and service jobs of the hotel and hospitality industry are often faced with stressful and demanding situations, such as low pay, long working hours, excessive job demands, aggressive customer behaviours, emotional dissonance and job insecurity[2]. Additionally, to ensure service quality, front-line staff has always to be friendly, hospitable and able to cope with pressure. The working environment within the hospitality and tourism industry generates irregular and unpredictable working hours, difficult demands, tension and often stress for the working personnel. For this reason, hospitality and tourism employees are often pressurised to ensure that tourists and guests are satisfied with their experience.

For some years now, a structural change has been taking place in the areas of economy, financial markets and trade, which can be described with catchphrases such as ‘opening up world markets’ or ‘globalization’. The recruitment, retention and motivation of the workforce will become more and more important for companies in the future. The prerequisite for this are motivated employees who support the company, who feel responsible and behave loyally, who, not least, see their own interests represented in the company. Conversely, if companies create conditions that meet the employees' interests in reconciling family and work, the willingness to adapt to company requirements and

flexibly divide working hours will also increase. This can be done by creating family-friendly measures that enable employees to meet professional and family requirements equally.

1.1. Review of Literature and definition of Job Satisfaction

The academic literature has a long history of investigating the job satisfaction of employees and has occupied a central place in research on employee attitudes over the past several decades. As job satisfaction is a complex and multifaceted concept, it can mean a variety of things to different people. Although most people are satisfied with their jobs as a whole, they are not necessarily happy and content with all aspects of their jobs. Previous research gave indication of the importance of job satisfaction at work, but not only for the well-being of employees, also for the purpose of organizational performance. A number of influencing factors like pay, working conditions, co-workers and managers, career opportunities, intrinsic and extrinsic aspects may influence the level of employee's satisfaction in the organization [3]. As every individual is different in their needs and expectations, employees tend to fulfil them in different ways. Needs and expectations are often considered of being internal or external to an individual. Indeed, jobs are more satisfying the extent to which it fulfils a person's wants, desires and expectations. Dawis & Lofquist [4] indicate that job satisfaction is the outcome of the worker's appraisal of extent to which the work environment fulfils the individuals' needs. Schneider and Snyder [5] describe job satisfaction as a personal evaluation of conditions present in the job, or outcomes that arise as a result from having a job. Job satisfaction is therefore related to individual's perceptions and evaluation of his or her job and this perception depends on the person's unique circumstances like needs, values and expectation. Table 1 [6] reflects a comparison of Maslow's needs and incentives in an organizational context. 'Physiological needs' and 'safety needs' are in industrial organizations mostly satisfied, because of the given situation that employees have a minimum income and the current standards of the external working conditions enabling largely a physically intact work performance. Likewise, mainly in most companies, general protection needs and security guarantees in the workplace take place by numerous regulations through accident prevention and occupational safety insurance. In terms of employment, Maslow's hierarchy of needs indicates that managers have the responsibility to make sure that the deficiency needs of their employees are met (e.g. a safe environment and proper wages). In a further consequence, it requires a proper climate in which employees can develop their fullest potential. In case of absence, employee frustration would increase and could result in poorer performance, lower job satisfaction, and increased withdrawal from the organization. The 'belongingness needs' are actually for employees at least partly to satisfy. There used to be starting points for a higher achievement motivation in the categories 'esteem needs' and 'needs for self-actualization'.

Table 1. Overview and comparison of Maslow's Needs and Incentives

Needs	Incentives
Physiological needs	e.g. payment, workplace design, shielding of harassment and disturbances, cheapened shopping and living possibilities, lunchroom, medical care
Safety needs	e.g. hope in the future of the company, health insurance, accident insurance, disability insurance, company pension scheme, job security
Belongingness needs	e.g. possibility of communication at work place, pleasant colleagues, superiors that are oriented towards their employees, meetings and talks about problem-solving issues
Esteem needs	e.g. career opportunities, more professional responsibilities, honorary title, size of salary, company car
Needs for self-actualization	e.g. delegation, participation in decision-making, participatory leadership-style, flexible working hours, varied job, training and advancement programs

Maslow considers the 'need for self-realization' as the goal of human ambitions. However, this is in industrial organizations only to a limited extent possible. The revealing advantages of Maslow's theory are primarily the plausibility and clarity as well as the consideration of the variety of motives. It is agreed upon that as long as basic needs are not satisfied, needs of higher category are not dominant. Moreover, besides the topic of the job satisfaction with the needs and incentives, employees' attitudes toward their organizations and life are also affected by work-life balance.

1.2. Work-Life Balance in the tourism and hospitality industry

To begin with, work-life balance is about managing the work life and family life [7]. The term work-life balance was put together, resulting from neglecting family and leisure in juggling the demands of workplace that caused work and life going 'off balance'[8]. Initially the studies focused on work-family balance and later on moved to work-life balance. Till now the work-life balance has been intensively studied in business, management and other disciplines. Few studies examined that what happened at the workplace has a significant impact on individuals and their families. Verma [9] describes work-life balance as adjusting the pattern of work so that the employees can benefit from a better fit between their work and areas of their personal life and in long run hope to achieve sustainable development and profitability.

Most people divide their daily life between work and family and both of these are difficult to separate. And if an organization wants better productivity and more commitment of the employees, then they have to be in fact happy and satisfied. Narenderanath [10] indicates that the balance is achieved if an individual's right to a fulfilled life inside and outside paid work is accepted and respected as a room, to the mutual benefit of the individual business and society.

So to say are for every human being, work as well as family of utmost importance. But often are work with family and family with work in conflict. This conflict arises oftentimes because of long working hours, reduced presence at home, missing social activities and because of child sicknesses [11]. For this reason and in order to avoid this conflict, the issue of the work-life balance become important for a number of perspectives. Work-life balance policies also affect the well-being of employees and contain[12]:

- Having flexi-time options
- Instituting job sharing
- Working from home
- Having parental paid leave

Especially the work-life balance in the tourism and hospitality management is strongly influenced by the interaction of both family and business systems. This blurring of both systems also causes that some employees feel disturbed in their privacy by this situation. They also see the need for the separation of the two areas, but often tend to have to be on-site at all times, or to be indispensable, and therefore face a certain pressure and often feel dissatisfied. Also the fact that in the hotel and hospitality industry, family members of family businesses are mostly tied to their business 24/7 operations. Irregular working hours, unhealthy eating habits, which often leads to an imbalance of private life and work, especially in tourist family businesses. The inner drive to be constantly and everywhere present, coupled with the high operational integration into the company, can be a health burden for the entrepreneurial family. In today's competitive world, organizations are spending lots of money on employee's job satisfaction in order to improve productivity of them. The existing literature mirrors number of studies that have addressed the importance of the work-life balance and job satisfaction of employees, because the ultimate performance of organizations depends on the performance of its employees.

2. METHODOLOGY

On basis of literature following model (Figure 1) has been proposed for the study. The object of the study is to analyze factors that influence the work-life balance of job satisfaction of front-line employees in the tourism and hospitality industry.

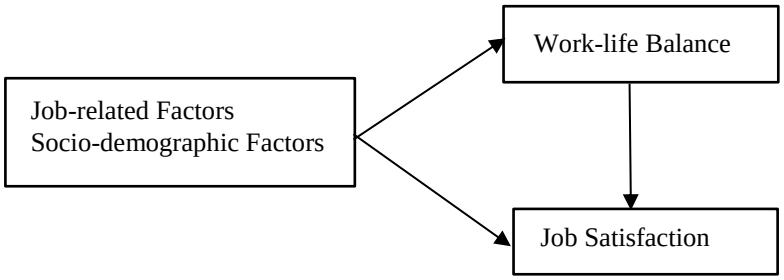

Figure 1. Conceptual model of Job-related Factors, Socio-demographic Factors in relation to Work-life Balance and Job Satisfaction.

The variables used in the study are job-related and socio-demographic factors in order to analyze their impact on the work-life balance and job satisfaction of the front-line employees. The target population for this study is defined as proprietors, who are active in the tourism and hospitality industry. They were asked about the work-life balance and job satisfaction of their employees.

2.1. Sample

A total of 11 guideline-based interviews were conducted with owners of tourism businesses in Tyrol. The respondents are entrepreneurs and run one or more businesses. The individual interviews were recorded and transcribed by using a recording device. The MAXQDA software was used for qualitative data analysis.

2.2. Data and methods

In order to conduct the study, the qualitative analysis was carried out with proprietaries of 21 companies in Tyrol. Unfortunately, only 11 of the 21 proprietaries wanted to conduct the interview, as the remaining 10 canceled due to illness, absenteeism, listlessness or simply no interest. Thus, 11 interview partners in the tourism and hospitality industry were selected who are active in this branch and who hold the position of the proprietor with a lot of customer contact. Since most studies on job satisfaction and work-life balance focus on younger people, especially mothers with young children, the choice of interview partners was deliberately made to include a broad selection. The youngest interview partner in this study is 27 years old and the oldest one is 84 years old.

Table 2. Overview of the interview partners

Name	**Gender**	**Position**	
Interviewpartner 1	Male	Proprietor	Hotel
Interviewpartner 2	Female	Proprietor	Hotel
Interviewpartner 3	Male	Proprietor	Boarding house
Interviewpartner 4	Male	Proprietor	Hotel
Interviewpartner 5	Male	Proprietor	Restaurant, Boarding house
Interviewpartner 6	Male	Proprietor	Hotel
Interviewpartner 7	Female	Proprietor	Hotel
Interviewpartner 8	Female	Proprietor	Restaurant, Boarding house
Interviewpartner 9	Male	Proprietor	Hotel
Interviewpartner 10	Male	Proprietor	Boarding house
Interviewpartner 11	Male	Proprietor	Restaurant, Boarding house

3. RESULTS AND DISCUSSION

As a result from the qualitative investigation it turned out that the working hours are decisive for the work-life balance and job satisfaction of the employees, as well as whether the employees are applying for a job in this branch. A major issue that concerns the proprietors is the intersection of the two areas of work and family. Karp et al. [13] and Gursoy et al. [14] state in their study that especially for the younger generation family, friends and free time are very important factors in order that both areas, work and family, can be brought into balance. Based on the conducted interviews, the business owners confirm that a company, taking team building measures into consideration and undertaking activities together outside of work has a positive impact on the work-life balance and strengthens the working atmosphere and team spirit. In a further distance an equalized work-life balance can certainly contribute to higher job satisfaction of employees. So that job satisfaction can be achieved, personal as well as external influences have to play a role. A harmonious interplay of family, company and external factors is certainly important to strengthen the work-life balance.

For this reason, it can be concluded that working hours is almost the most important factor. In practice, the form of flexibilisation supported and desired by companies does not necessarily coincide with the ideas of employees seeking a balance between work and non-work activities. In particular, if flexible forms of work are to be compatible with

family, this requires other flexibility criteria. A family-friendly employment exists when the scope and location of working time allows employees to combine their private life with work. Especially the work-life balance in tourism companies can be supported by special measures. Clear boundaries, consciously used recovery phases and honest and open communication help to create the necessary balance between company and private life in order to increase job satisfaction.

4. CONCLUSION

To conclude, work-life balance measures should be enforced in all businesses in order to motivate the employees and to avoid fluctuation. It needs a clear concept and a strategic approach to target work-life balance measures. Moreover, based on the conducted interviews, the proprietors confirm that measures that directly affect the employees are beneficial. These include measures that change aspects of working time, place of work, work processes, work content and work organization in the direction of work-life balance. Corresponding measures include job sharing, flexibilisation of working time models and places of work (teleworking and home work). Further measures include those attributed to employees' financial and social support, such as eg. child bonuses, child care facilities, health programs and household services. They do not directly affect the work of the employee, but have effects on the individually perceived work-life balance's goal as well as the company's information and communication policy, which informs about measures offered, or the corporate and management philosophy, which illustrates the basic attitude of the company towards work-life balance.

To sum up, the job satisfaction and well-being of front-life personnel is of utmost importance as they are the first point of contact for the guests. This is the only way for companies to keep qualified personnel in a competitive sector such as the tourism and hospitality industry. For this reason it is important for employers to enforce work-life balance measures in order to motivate the employees and avoid fluctuation.

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Development of a Strategic Competency Management with Regard to Preventive Work Design Using the Example of a German SME

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Abstract

The construction industry is a key sector of the German economy. 5.6 percent of all employees in Germany are employed in the construction industry. Especially older employees, have to give up their jobs prematurely due to illness. Physical demands typical for the industry are particularly work in standing jobs (92 percent) and carrying heavy loads (72 percent). Factors such as weather conditions (79 percent), noise (64 percent) and repetitive activities are involved. There are also differences in psychosomatic complaints compared to other sectors of the economy. For these reasons, the topic of preventive occupational health and safety is gaining in importance. New findings on the factors and processes that determine health care the basis for effective preventive occupational health and safety at the workplace, whereby this goes beyond the existing workplace health management (WHM). In this article, the findings from a research project conducted in Germany are presented. In the case of a medium-sized construction enterprise, the existing operational competency model was extended to include elements of preventive occupational health and safety. In addition, practical measures were developed to increase health competence in the company and thus achieve measurable improvements. Various tools (Online-Quick-Check, Vital-Wiki) for measuring the subjective state of health and health competence were developed and tested. In addition, the research partner established the position of a health coordinator for sustainable monitoring of the project goals.

Keywords: competency management, competency model, workplace health management, preventive work development, physical and psychological occupational strains

1. INTRODUCTION

The construction industry is a key sector of the German economy. In the year 2019 the construction industry contributed 5.5 percent to the overall economic gross value added for and 5.6 percent of all employees in Germany were in the construction industry (Richter 2012). Many people working in the construction industry, especially older employees, have to give up their jobs prematurely due to illness (German Federal Institute for Occupational Safety and Health 2014). Physical demands typical for the industry are especially the work in standing position (92 percent) and carrying heavy loads (72 percent). Factors such as weather conditions (79 percent), noise (64 percent) and repetitive activities are added. Also with the psychosomatic complaints show up differences to other economic sectors. For example, just under one in four of the construction professions (23 percent) without complaints. Against this backdrop, the topic of preventive work and health protection at national and European level. New findings about the health-determining factors and disease processes form the basis for an effective preventive occupational health and safety at work, whereby this goes beyond the previous workplace health management (WHM). The aim of the project

was to extend an existing competency model around the elements of preventive work and health protection, to increase health competency in the company and to achieve measurable improvements.

2. THEORY

2.1. Competencies and Competency management

Employee competencies are becoming a decisive competitive factor and must be recorded, aligned and managed just as professional as other production factors. Through strategic competency management, companies use these success potentials effectively and efficiently. (Bergmann & Daub 2006)

Erpenbeck and Rosenstiel (2007) determine four competency classes, in which in each case the self organization plays an important role. Apart from the technical-methodical, social-communicative and personal authority is to be held as innovation the focus on activity and conversion-oriented authority.

- Personal competencies: As the dispositions of a person to reflexively act in a self-organized manner, i.e. to assess oneself, to develop productive attitudes, values, motives and self-images, to unfold one's own talents, motivations, performance intentions, and to develop and learn creatively within and outside of work (Erpenbeck 2017, Sauter & Staudt 2016).
- Activity and implementation-oriented competencies: As the disposition of a person to act in an active and holistically self-organized manner and to direct this action towards the implementation of intentions, projects and plans - either for oneself or for others and with others, in a team, in the company, in the organization. These dispositions thus capture the ability to integrate one's own emotions, motivations, abilities and experiences and all other competencies - personal, professional-methodical and social-communicative - into one's own will drives and to successful realize actions (Erpenbeck 2017, Sauter & Staudt 2016).
- Technical-methodical competencies: As the dispositions of a person to act in a mentally and physically self-organized manner when solving objective problems, i.e. to use technical and instrumental knowledge, skills and abilities to solve problems creatively, to classify and evaluate knowledge in a meaningful way; this includes dispositions to design activities, tasks and solutions in a methodically self-organized manner, as well as to creatively develop the methods themselves (Erpenbeck 2017, Sauter & Staudt 2016).
- Social-communicative skills: As the disposition to act in a communicative and cooperative self-organized way, i.e. to deal with and interact creatively with others, to behave in a group and relationship-oriented manner and to develop new plans, tasks and goals (Erpenbeck 2017, Sauter & Staudt 2016).

Hamacher et al. (2012) point out that competences are to be considered in a situation-related way and can only be assessed in connection with the concrete challenges. In order to be able to look at concrete situations and areas in which competencies are manifested, Hamacher et al. among other things, the division of competencies according to fields of competence, fields of action (for example work or family) and content-related aspects (for example health or languages). In this paper, the focus is on individual health competencies. Health competencies are therefore action competencies and can described as

- Personal competencies
- Activity and implementation-oriented competencies
- Technical-methodical competencies
- Social-communicative competencies

be considered (Dierks 2017, Erpenbeck & Rosenstiel 2013, Hamacher et al. 2012, Kickbusch 2005).

Health competency is the totality of all cognitive and social skills that motivate and enable people to acquire, understand and use information to promote and maintain their health (Nutbeam, 1998). In concrete terms, this can mean the development and application of health-relevant knowledge, decision-making competence in health issues and the corresponding competence to act. In everyday life, comprehensive health competence of the individual has positive effects in both the private and professional sphere. Measures to build, maintain and promote health competency can have a positive influence on individual performance, well-being and quality of life. This in turn maintains and promotes work and employability, which is why working on individual health competency also benefits companies. Workplace-related and health-relevant knowledge is a necessary prerequisite for carrying out and

designing activities and work situations in a health-conscious manner in the long term (Dierks 2017, Ernstmann et al. 2019).

2.2. Competency management and competency modells

„Competency management is a management discipline with the task of describing competencies, making them transparent and ensuring the transfer, use and development of competencies, oriented towards the personal goals of the employee and the goals of the company" (North & Reinhardt 2005).

Models reduce confusing facts to the relevant aspects. Efficient competence management requires a competence model that concentrates the self-organization diversity of a company in networks, in organizational units or in teams on the ability of individual employees to act. (Erpenbeck 2013) This is intended to provide adequate forecasts of the future performance of individual employees (Sauter & Staudt 2016).

In company-specific competence models, however, there is rarely an explicit integration of "health competency". Instead, health competency is summarised as part of sub-competencies. However, "health competency" as a cross-cutting competence for action is regarded as the basis for vocational actionability (Tröller 2009) and therefore requires stronger emphasis and support. Promotion and investment in the health of the workforce is a success factor in economically challenging times. Against this background, only healthy, satisfied and therefore capable employees can represent a competitive advantage. If the corporate structure and culture support the health of the workforce, this can have a significant influence on the creativity and innovative ability of employees. The associated well-being and satisfaction of the employees awaken the intrinsic motivation valuable for innovation and increase the willingness to perform in the sense of achieving the company's goals.

3. METHOD

To achieve the above-mentioned goals, the joint project partners establish a common approach. After the analysis of the existing competency model an extended competency model has been established. Excerpts were prepared in accordance with the special circumstances of the construction industry and an Online-Quick-Check (OQC) was developed to measure and record the subjective state of health and health competency at employee and organizational level. In addition, the pilot company remaining in the project established the position of a health coordinator for sustainable monitoring of the project goals. Through employee-oriented discussion and the use of a Vital-Wiki, this newly created function had an impact on the health aspects of the practice partner's employees. In the following, the holistic approach, the instruments for achieving the goals, as well as the structure and intentions of the scientific accompanying study are presented.

3.1. Extended competency model

Values, norms and rules, which should be considered and lived by every employee in the company, formed the basis of the competence model of the participating practice partner. The competence model included health aspects in a comparatively general way and was to be adapted to the new requirements.

The first step in the further development of the competency model was the survey of the actual state. For this purpose, all relevant data available in the previous competence model were collected and stored centrally in order to make adjustments based on these data. These data mainly included the core competencies of the occupational groups employed, such as skilled building construction workers and bricklayers, but also of salaried employees and management. In a second step, a catalog of criteria was developed in order to determine the requirements for a model suitable for the participating practice partner. The necessary contents for the adaptation were defined and recorded in a criteria catalog. This process is displayed in Figure 1.

Figure 1: Procedure for expanding the competence model at the practice partner

As a result, four fields of competency of the inventory model were identified and named:

- personal competence,
- activity and action competence,
- social and communicative competence, and
- professional and methodological competence.

These fields of competency were then subordinated to the respective individual competences. The original formulations of the case studies for the individual competencies were revised so that all competencies were delimitable, measurable and observable (operationalized). This served primarily to make those competencies tangible, i.e. to transfer them to internal company processes and leave no room for leeway in how a competency is to be interpreted or understood.

After the existing competency model had been structured in the previous steps, it was extended to include the competence field of health competency. The "healthy employee" was then defined. Together, the concrete behavior of the "healthy employee" was described and operationalized. As with the other competence fields, the operationalizations were grouped into groups of three to achieve consistency with the existing competency model. They were then subordinated to the individual competencies of the competence field health competence. The core of the competency model, which has now been adapted and modelled, was then adapted to the appearance and internal style of the participating practice partner. For this purpose, the competence fields were indexed and a graphic representation of the model was designed, which also illustrates the value of the individual competency fields for the company. Finally, the individual competencies were classified into two classes. On the one hand in "Employee - Basically to be observed by all employees" and in "Management - To be observed by managers". This classification of the individual competencies mainly served to adapt to the existing employee assessment system, which was modified in parallel in such a way that the assessment criteria will be in line with the new competency model in the future. The competency model was integrated into the company's internal wiki after its expansion. The wiki mainly contains the management system of the participating practice partner with its associated elements. The competence model was presented at a meeting of the Health Circle.

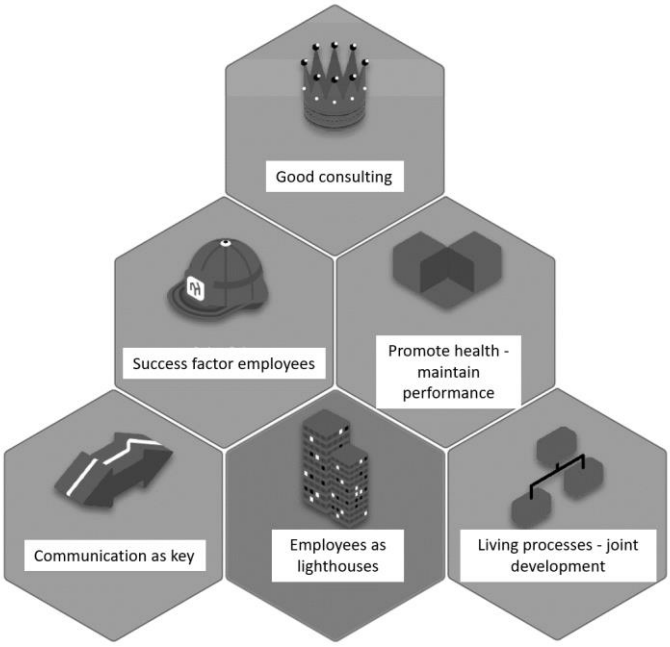

Figure 2: Mapping of the extended competence model at the practice partner (Source: Kemter et al. 2018)

3.2. Online-Quick-Check

The online quick check is the central instrument in the project. At the beginning of the project, the participating joint project partners agreed on the feasibility and other general conditions they considered important for successful implementation in the company. Subsequently, pre-tests of the OQC took place in October 2018. For this purpose, five managers and two commercial employees were selected who, after a brief introduction by the employee responsible for the project, underwent the test and passed on their feedback to him. The results of the pre-test were used to improve the final OQC.
In several subsequent workshops, members of the health circle were familiarized with the OQC and subsequently took part in the first implementation. For this purpose, four of the eight participants were asked to run the test in parallel. The authors accompanied the employees of the participating practice partner with questions or technical problems. In the follow-up to the meeting, the results were given out in the form of anonymous feedback forms.

3.3. Excerpts

Based on the preceding needs analysis, excerpts or information letters were developed. In these, essential information for preventive occupational health and safety was presented in an overview, easily understandable and graphically underlaid. The excerpts serve as information, education and internal communication in the pilot companies to increase health competence. In terms of content, these information letters dealt with topics typical for the industry, such as musculoskeletal disorders, seasonal illness and complaints, as well as psychological aspects, such as psychological occupational stress, and the private health behavior of the organization members.

These information letters were tested by the practice partner with regard to user-friendliness and practical relevance. On the basis of the testing in the pilot companies, the information letters were completed and finally distributed to the employees using the OQC feedback forms.

3.4. Health circle and health coordinator

In line with the development of the OQC, a group of ten employees, representing the average age and the activities and tasks in the company, was selected by the management and invited to an initial meeting invited. This round took

a practical approach to health promotion and provided impetus for further internal improvements. Another aspect was the importance of individual health for one's own (private) well-being and the resulting higher quality of life.

Due to the strongly increasing seasonal workload of the direct supervisors on the side of the practice partner, it was decided to assign a single person (SPoC - Single Point of Contact) centrally to conduct employee interviews and to train them further. This employee was appointed health coordinator and trained with regard to his work.

3.5. Employee appraisal interview and Vita- Wiki

A central point in the further course of the project was the application of Employee appraisal interview. These discussions were conducted by the health coordinator and each participating employee was invited by the health coordinator and asked to approve his or her OQC feedback sheet. The health coordinator used this as a guide for the employee interview and specified the overriding topics. The procedure is summarized in Figure 3.

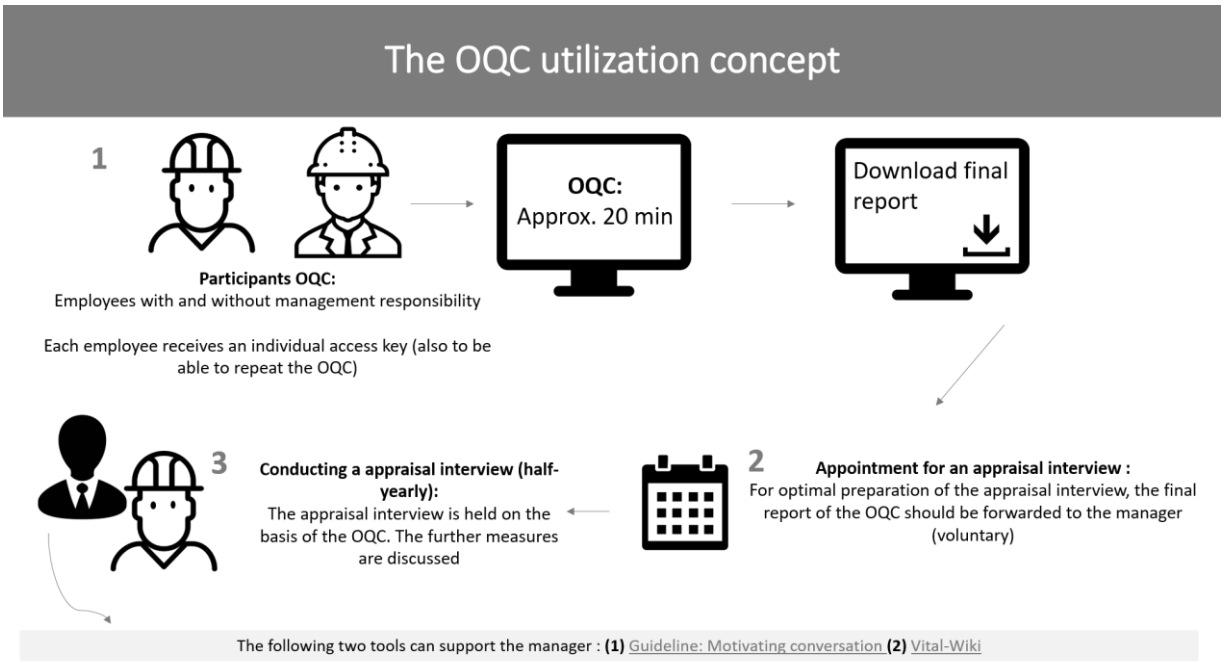

Figure 3: Procedure for conducting the employee appraisal interview (Source: Kemter et al. 2018)

A semi-structured guideline supported the health coordinator in planning and conducting the interviews. In all interviews, the health coordinator noted the content, procedure, comments and agreed-upon goals in key points and summarized them. At the end of the interview, the participating employees agreed on a health-oriented goal with the health coordinator that they would like to achieve by the next employee interview.

During the interview, it became apparent to some employees that they already had health restrictions due to lack of exercise or addictive behavior (e.g. nicotine). In a Vital-Wiki, further information and procedures for specific illnesses and advice on how to avoid them were summarized and prepared in advance. If the health coordinator identified health restrictions, he referred to this wiki during the discussions and recommended individual discussion.

3.6. Questionnaire

After the development of the competency model and before the implementation of measures on the employee side, an initial measurement by means of a questionnaire (t0) was performed. The corresponding indicators were determined by a preceding literature analysis as well as an analysis of the current situation at the participating pilot company. On the one hand, the status quo analysis was carried out by interviews with the members of the organization and their observation. Subsequently, 24 employees of the practice partner took part in the survey. After the employee-oriented interviews had been conducted after six months the second survey period (t1) took place where employees filled out the same questionnaire as for t0 and changes were recorded. The characteristic value was measured with a 5-step Likert scale. The questionnaire used specially developed scales to examine the subjective assessment of the organization members with regard to the levels of observation shown in Figure 4:

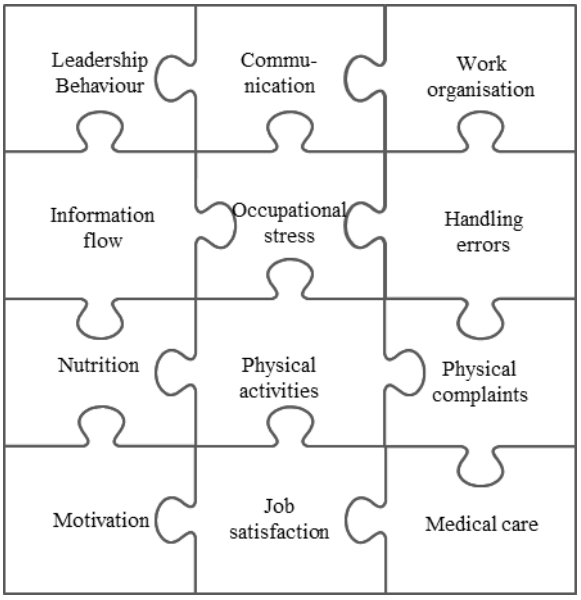

Figure 4: Dimensions of the questionnaire

3.7. Study

Within the framework of the research project, a detailed analysis of the health factors in the construction industry was carried out together with a partner from the practice, as well as an accompanying scientific study. The aim of this study was to identify driving and inhibiting factors of competency management in micro enterprises (ME) and small and medium-sized enterprises (SME) in general as well as in the extension of competency models to include health competency. Furthermore, preventive measures for the ME and SMEs in the construction industry were to be derived. More than 2,000 employees and managers at all levels from the construction industry in Germany were invited to participate in the study. Between 15.7.2019 and 15.10.2018, 150 participants accepted this invitation, with all hierarchical levels, from trainees to managing directors/company owners, taking part. The survey took place partly online and partly as a paper / pencil survey. The participants answered 84 questions on identical content. In order to ensure that the questions were understood by the participants, the wording of the questions changed according to

hierarchy level. A distinction was made between top management on the one hand and the employee level on the other. The employee level includes managers at lower and middle management levels. SPSS was used to evaluate the recorded data. The data were checked for bilateral correlation using Pearson's correlation coefficient and for normal distribution using Kolmogorov-Smirnov Test and Shapiro Test. The analysis and interpretation of the data allowed to draw conclusions for science and construction industry.

4. RESULTS

4.1. Study

Within the framework of the accompanying study on health competency, the survey of managers, employees and trainees identified factors that promote the implementation and establishment of an extended competency model in organizations. An open information transfer and defined responsibilities were identified as relevant, primarily on the part of employees and trainees. The managers named as a relevant factor that there is a clear organizational structure. It is known from the scientific community that available job descriptions, an organization chart and an existing company and employee-oriented personnel development strategy support this. Their implementations were not part of the project.

4.2. Extended competency model

The extension of the already existing competency model in the company by the level of preventive occupational safety and health protection could be integrated into the management system after analysis of the current status. The implementation of the new competency, both at management and employee level, was promoted by the development and application of the digital tools in the project framework and integrated into the organizational framework. The integration into management processes and workflows thus provided an important impetus for the further expansion of organizational and personnel development. The employee-oriented orientation was thus successfully ensured.
Nevertheless, the extended competence model in the company must be further adapted to meet the individual needs of the company and to be able to be used in an even more targeted manner in the future.

4.3. Tools

Both instruments, the employee appraisal interview, whose basis is the OQC, and the Vital-Wiki, which were developed in the project, were applied in the project and could be tested in the operational process. The goal of developing and testing digital tools to support occupational health management was thus achieved. The feedback from the employees who used them was positive in terms of application orientation and user-friendliness. In the employee appraisal interview conducted between the health coordinator and employees, pleasant conversational situations were created and individual stress and situations were addressed, which could be pre-structured by the previously conducted OQC. The guidelines prepared in advance by the health coordinator formed the decisive basis for this. These were designed in such a way that deviations were possible if necessary in order to maintain the individual course of the conversation. The Vital-Wiki could be used as a basis for health-promoting recommendations for action, even if there is potential for expansion at the content level. Thus, first stresses could be analyzed on an individual level. The goal of jointly agreeing on specific, measurable, accepted, realistic and scheduled (SMART) goals could not be realized comprehensively in the discussions.
The health circle established in the project at the pilot company had to be dissolved in the further course, due to time and personnel resources. For this reason, the tasks of the health circle were transferred to the position of health coordinator, who bundles the relevant competencies. This measure was perceived as beneficial by the employees.
The work carried out by the scientists The workshops on organizational health competency and the use of the tools in the project, which were conceived and carried out by the participants, were experienced positively and as good support by the participants.

4.4. Effects on employees

According to the health coordinator's subjective assessment, individual health competencies have increased as a result of the provision and use of information. This has increased both the managers' attentiveness to the health burdens of employees and the awareness of employees with regard to personal health. Overall, the extracts and the Vital-Wiki

increased employees' knowledge of health-related topics such as healthy eating, stress situations, disease patterns and health-promoting measures. Quantifiable effects on the individual health situation could not be determined in the before-and-after comparison, however. Through the direct involvement of the employees and an employee-oriented discussion, an open atmosphere was created and the first steps towards sustainable management and personnel development were taken.
An effect of the measures with regard to a lower sickness and accident rate as well as a stronger bond to the company due to lower fluctuation could not be identified. The aspects mentioned above can only be validly measured in the long term, in a period exceeding the project duration.

4.5. Project

The goal of extending the competency model to integrate preventive occupational health and safety into the company's mission statement and the implementation of digital tools for promotion was achieved in the project. In this way, the workplace health management of the participating practice partner was extended beyond the legal requirements in cooperation and anchored in the organization. The company thus makes a valuable contribution to the preventive health protection of its employees based on current scientific findings and methods.
The short-term goal of creating an overview of activity-related, health-related burdens and preventive measures was achieved. The goals set as medium-term were partially achieved. Thus, although individual burdens were identified in addition to the pure provision of information, no compensations, concrete changes in behaviour or adjustments of work processes could be achieved in the project. In particular, the obstacles of the feared encroachment on the private life of the employees by the company proved to be a hindrance. Since protective equipment already ensured a safety-oriented work design, no further adjustments were made to the work processes. The development of the organizational structure, by adjusting the competency model and personnel development measures, by greater participation and individual discussion, can be seen as a long-term effect. The effects of the implemented measures on the retention of older employees, through health prevention, and thus securing skilled workers and a better positioning of the company in the recruitment of new skilled workers, will be verifiable at a later date. At the end of the project no statements were possible in this regard.

5. DISCUSSION, CONCLUSION AND LESSONS LEARNED

5.1. Discussion and conclusion

The goals of the project, which were considered to be central, the expansion of the competency model with regard to preventive occupational health and safety, as well as the implementation of measures in organizational and personnel development in a company in the construction industry were achieved. In the course of the project a prototypical guideline for the extension and implementation of an extended competency model in companies of the construction industry was developed and important impulses for future projects were set. A generally valid applicability cannot be guaranteed from within the project framework, since the results are not representative. However, the procedure can be regarded as a guideline for further projects.
In the employee appraisal interview, individual burdens were identified and recommendations for action were made in order to promote precaution and prevention in the company. A learning process for the relevance of preventive measures was demonstrated by increasing mindfulness and creating awareness and sensitization of the workforce. However, continuous further development and application of the competency model, the instruments and measures as well as further additions are needed to generate a learning process that is geared towards sustainability.
The processes of organizational and personnel development to firmly anchor the topic of health in the corporate culture should be pursued further, since changing behavior is a continuous process and requires time that exceeds the project framework. The measures should be continued in an adapted form on an ongoing basis and firmly integrated into work processes in order to increase awareness. Adapting the organizational structure, creating clear responsibilities and training an internal, competent position of health coordinator can also promote the development process and create acceptance. The health coordinator was perceived by the employees as a person of trust and had good access to the participants within his role, which shows that the internal filling of the position was beneficial for the project.
These measures can have a lasting effect on the health condition of the employees and, through employee-oriented personnel management, on securing skilled workers and recruiting. Thus, especially SMEs can position themselves attractively on the market and face the demographic change. Furthermore, challenges were identified that were not

visible during the preparation of the project and learning effects are generated to drive future research projects. These aspects will be discussed in more detail in the following section.

The procedure sketched here forms a good action guideline for the application-oriented integration of a health-oriented authority model in enterprises. However, the instruments and the competency model should be individually adapted according to organizational requirements. A prototypical action guideline is illustrated in Figure 5:

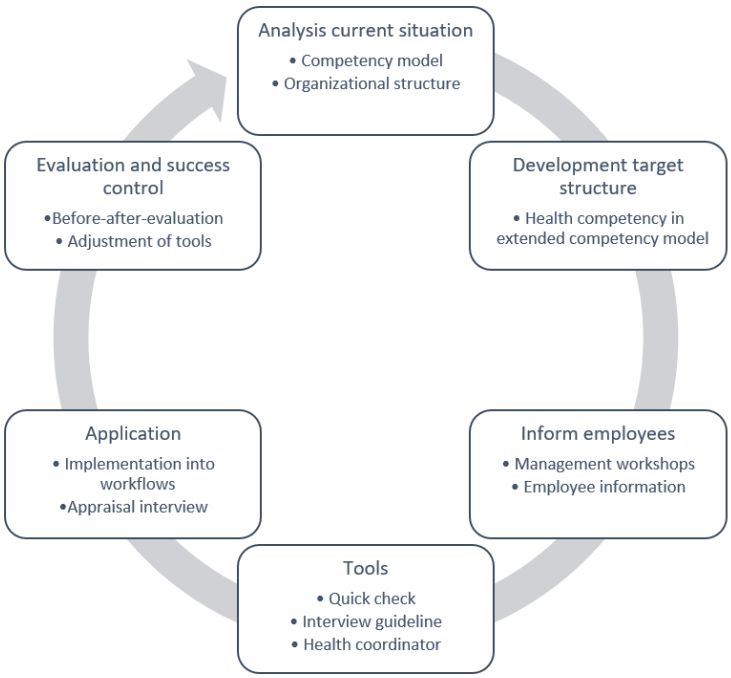

Figure 5: Guidelines and tools for the application-oriented integration of a health-oriented competence model in companies

In addition, the challenges mentioned in point 5.1 should be taken into account in planning and implementation in order to be able to counteract them with appropriate measures. It is recommended to extend the project duration to ensure sufficient evaluation of the process and its monitoring.

The participating project partners have jointly developed an implementation concept. The participating practice partner has transferred this concept into his quality management system from an entrepreneurial perspective. The authors has developed a transfer concept from this. In the course of the project, companies from other industries were offered presentations and lectures on competency model extension. In a final workshop, the concepts were presentedand the transferability to other construction companies was discussed.

There is no claim to general validity of the project. Nevertheless, the project meets the criterion of prototypical character and shows a potential procedure for the integration of preventive occupational health and safety in the construction industry.

This report on the project shows how the competency of preventive occupational health and safety can be transferred to the organizational competency model and how this can be integrated into the organizational structure by implementing appropriate instruments of human resources development. The accompanying study was able to demonstrate the usefulness of a clear company organization as well as of responsibilities and employee-oriented personnel development.

The health risks in the construction industry are and will remain high and there is a need for action in the future. In particular for SMEs in Germany, the recommendation can be made to become active in the area of organizational and personnel development and to integrate health protection into the organizational structure, beyond the legal

framework, in order to remain attractive and capable of action on the market. One possibility could be to form company-wide networks in order to use central competencies of an outsourced company unit, such as the human resources department. In this way, costs could be shared and the advantages of an innovative network could be used. Further application-oriented research projects are necessary to further concretize these needs and to develop solution offers. As could be shown, the employees in this process are not only the target of the measures, but also a decisive factor for success. The development towards an employee-oriented personnel management is a decisive driver. Especially SMEs with their more informal structures and flatter hierarchies have advantages in being able to map these measures individually.

6. FUNDING

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Factors Influencing the Success of "Agile Working" in Manufacturing Companies

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Abstract

In times of globalization and digitalization of the world, a good preparation for sustainability is necessary. Agile forms of organization as well as agile mindset are essential and serve as a foundation for a sustainable implementation. This scientific work examines the factors influencing the success of agile working. Four selected current studies on agile working were analyzed in order to gain first insights for the research regarding the current state of the success factors in agile working and the scaling possibilities. Central results of the research are that agile working is used to a large extent in software development or in software-related development. Agile working differs between industries, but there are many intersections and similarities in the application of agile working. The influencing factors are presented and thus an essential basis for the practical application of agile methods is created. Furthermore, the current state of research regarding agile methods will be presented and a possibility of transferability will be ensured.

Keywords: Agility, Globalization, Digitalization, Lean Management, Agile Management, Kanban

1 INTRODUCTION

Whereas originally corporations drove and initiated innovation in order to promote the economy, nowadays this is often and increasingly done by start-ups. These start-ups and the new market structures associated with them drastically modify the rules of the game. A good idea, which is scalable, is reason enough for investors to neglect the need for a business model and a business plan. In this context, the innovative start-up culture with special characteristics in corporations takes a back seat. Nowadays, there is no need for corporations to innovate, as this is possible with low personnel costs, which increases the pressure on corporations. Due to the broad-based nature of the economy, the consequences of this are quite bearable, but it makes the economy "more volatile, uncertain, complex and ambivalent". (Sauter, 2018) This phenomenon of changing drivers of the economy is called VUCA, the acronym for "volatility", "uncertainty", "complexity" and "ambiguity". (Sauter, 2018) These basic conditions in the economy bring challenges for all industries and thus all areas of society as well as people and employees are affected. In order to cope with this change, employees need skills and methods to react to the unplanned, with managers having less and less influence on the actual outcome.

The VUCA change: Many manufacturing industries are not exempt from having to govern the VUCA change within the economy. Nearly all manufacturing industries are facing major challenges and a major change. Megatrends such as digitization, which have fundamentally changed the economy and social life in recent years and will continue to influence it in the future, are forcing the industry to restructure. However, software-driven innovations have brought about a turning point. Within the unprecedented change towards the mobility industry, car manufacturers must accelerate product launches and respond much more strongly to the requirements of future customers. This particularly affects the digital functions and services within the vehicle. To remain competitive in this new environment, it is necessary to immerse oneself in and master the agile way of working. (Gauger, 2019) In the context of customer needs that are changing with increasing speed, digitization in conjunction with technical innovations is leading to ever new

possibilities and standards in automotive development. (Nuhn, 2016 / Verband der Automobilindustrie e.V., 2015) In this context, however, the requirements for environmental protection and quality are also increasing, whereby the available budget and development time have been drastically reduced. (Hab, 2017)

Innovation via agile methods: In the context of these conditions and the VUCA world in which the current economy finds itself, some companies try to meet this challenge with innovative management in the form of agile methods. (Weber, 2015) Agile management and agile development are particularly common in software development, although agile working within development has its origins in hardware development. (Takeuchi, 1986) Agile working pursues a variety of goals, such as reviewing and adapting workflows and products, and additionally focuses on the user. An additional goal is the shorter development time. Thus, agile management offers an optimal opportunity to react to the challenges mentioned above. (Highsmith, 2009) Since agile management offers a promising potential in terms of success, first attempts of its application are already taking place within the automotive industry. In this context, first studies have also been conducted, but these were often not specialized for the automotive industry. However, these have shown an industry average. (Highsmith, 2009)

Research gap: Although there are already studies on the subject, scientific research on the topic of agile work in automotive development still has gaps. In this case, the shift in the value chain must be considered, which may require additional roles and participants in automotive development compared to the original way of working with agile work. Furthermore, current studies do not consider the exact application and specialization of the respective type of company. This factor has an influence, since the literature often takes the view that agile methods are difficult or impossible to standardize and that individual adaptation is often necessary in order to do justice to the sector and the specific company situation in the respective industry. (Weber, 2015)

2 Basics of agile working

"Agility is the dexterity, agility or mobility of organizations and persons or in structures and processes. One reacts flexibly to unforeseen events and new requirements. One is not only reactive, but also proactive, for example in relation to changes". (Bendel, 2020)

Agility: The term agile can be described in many ways. In order to gain an even better understanding of the definition of the term agility, there are many explanations and definitions in the literature. In 2002, John Highsmith, one of the founders of the Agile Manifesto, established the following definition: "Agility is the ability to both create and respond to change in order to profit in a turbulent business environment. Agility is the ability to balance flexibility and stability". (Highsmith, 2009) Agile project management puts the emphasis and focus on people and communication between the parties, where the result is usually built together with the customer, with change being a high priority in this context. (Dechange, 2020) In order to explain the whole term Agile Project Management, the term project management is still missing in the following.

Project management: "Project management is understood as an umbrella term for all planning, monitoring, coordinating and controlling measures that are necessary for the redesign or reorganisation of systems or processes or problem solutions (...) in contrast to project management, line management is more concerned with the so-called ongoing business and the management of the organisation involved. (Kuster, 2019) Agile project management is becoming increasingly important in project management. This is mainly due to the many failed projects in the past. Out of these failures new approaches have been developed, which unite all common features of the agile character. Agile project management uses classical methods and approaches, but with the difference in the values and philosophy of agility. The differentiation from agile to classical project management is the different approach. In classical project management the procedure is planned from the beginning and attempts are made to adhere to this plan, whereas in agile project management an iterative approach is chosen. In this context planning plays a less important role and adaptive action is taken. So, the differences are mainly to be found in the values and principles of agility. (Dechange, 2020) In order to describe the principles and values that have significantly influenced agile project management, we refer to the agile manifesto, which is seen as the foundation of agile working. (Kent, 2001) The four principles of agile working are explained in the following.

Individuals and interactions are more important than processes and tools. In classic project management, the result is increasingly achieved by the same or a similar process to ensure consistent performance. In today's projects, the framework conditions are constantly changing, and a classic approach is no longer appropriate. (Highsmith, 2009) In this respect, the focus of agile working is not on processes and tools, but on individuals and the interactions between them. The greatest success factor is the human being as an individual in the implementation and application of agile

working methods. For a transition to agile working, employees who support the project are essential. This includes qualities such as motivation, teamwork and the willingness to drive change. (Kostron, 2016) The employees of a project within agile project management should work in a self-organized manner, which means that the employees allocate their resources independently and are responsible for the result and the path to the result (Preußig, 2018) In order to enable the employees to take on this responsibility, flat hierarchies and decentralized decisions are a basic requirement of agile project management, especially to enable fast action and reaction (see Joachim Pfeffer 2015: 4). Especially in time-critical situations, another feature - the simple structures, substantial. Often, official communication channels must be adhered to in classic project management, although there are simpler means of communication. (Prussian, 2018)

Functioning software is more important than comprehensive documentation. The Agile Manifesto and its properties were initially written for software only. In the meantime, the agile methods can be found in many more areas. Thus, "working software" today is to be a "working product". The classical project management deals to a large extent with documentation, whereby this is often not in any benefit/expense ratio. (Preußig, 2018) Agile project management is about creating a functioning product as early as possible, which initially should not symbolize a finished product, but rather a partial product, a so-called increment. This increment reflects a part of the functions of the product. The increment can be adjusted in the context of the feedback from the customer. (Prussian, 2018)

Cooperation with the customer is more important than contract negotiations. To be able to influence the result significantly, the feedback of the customer is indispensable. Regular communication and cooperation with the customer are fundamental for this. Within the scope of this communication, the customer can bring in his requirements and, later, his change requests. (Gessler, 2016) In classical project management, rigid and complex contracts are often used, which often lead to disputes at the end of the project. The main point of dispute is then whether and to what extent parts of the contract have been properly fulfilled. Within the scope of agile project management, the customer's requirements are in the foreground. Contracts are still necessary, but on a more flexible basis that adequately considers the costs of changes. (Prussian, 2018)

Responding to change is more important than following a plan. In classical project management, the emphasis is often placed on the initial project planning, but due to rapid technical changes and ever new innovations, changes often occur within the project process that were not originally planned. Agile project management sees this situation as a normal part and even an opportunity for the project result (Wolf, 2013) In agile product development, the product is constantly adaptable to the changing requirements of the market during production and afterwards. (Highsmith, 2009) The agile principles and principles according to the Agile Manifesto date back to the year 2001 (Beck, 2001) Since the year 2015 a similar simplified concept called Modern Agile exists, which is characterized by the following features (Kerievsky, 2015)

Makes people great: Companies have a duty to create good conditions for their employees, for their employees so that they can perform their tasks in the best possible way. This increases the intrinsic motivation of the employees and leads to a better team success.

Delivers continuously valuable: In order to enable a good cooperation with the customer, it is essential to deliver added value in a timely manner, for example in the form of a first increment. This promotes customer confidence and it is possible to incorporate customer feedback and satisfy the customer.

Makes security a basic requirement: The security within an organization is eminent, as this is where team strength is shown. A person who does not feel secure will not stand up for the organization or show his or her strengths to a client. About the error culture, the individual should be able to feel secure in the support of the team members.

Experiment and learn quickly: With increasing development speed are necessary to adapt to the changing environment faster and faster. In order to meet this change, it is necessary that employees have the freedom to experiment and to be able to continuously educate themselves within the scope of these experiments. Employees must also learn to deal flexibly with new challenges.

In terms of agile project management, "Modern" Agile is only one approach of many available approaches, but almost all approaches pursue the same goal. In this goal, people and communication are at the center of the action to enable the development of the individual and thus to react more flexibly to customer requirements with the goal of achieving the optimal result for the customer. (Sauter, 2018) In order to fully describe the characteristics of agile project management, it is also necessary to include its goals. In the literature there are many descriptions of agility. To ensure completeness of the description, the following additional goals of agility are listed: shorter time-to-market of the

product, reliable results, increased productivity and reduced risks, continuous innovation and adaptation to changing customer needs, cost savings when changes are made, better team motivation and communication, through personal responsibility. (Luczak, 2017) To further describe agile project management, the differences between agile project management and traditional project management are described below. Concerning the triangle of project management with the variables time, costs and the product, there are striking differences. In classical project management the product is fixed, whereby the time and the costs are estimated, whereas in agile project management the time and costs are fixed, but the product is variable. Here thus much more the question which the customer gets when for its money arises. Figure 1 explains this relationship. (Dechange, 2020)

3 Agile methods and frameworks

Well-known frameworks are for example Scrum, Kanban, Design Thinking and Lean-Start-up, as well as Pulse and Holocracy. More can be found in the literature, but in view of the scope of the work, only relevant and frequently used frameworks will be discussed below. Since Scrum and Lean-Start-up can be found in manufacturing industries, these approaches are explained in the following. (Achim, 2016) Kanban and Design Thinking will be explained in the following.

Scrum: The term Scrum comes from rugby and means "ordered scrum". Jeff Sutherland and Ken Schwaber designed Scrum as a way of project management for product development within teams. (ScrumGuides.org, 2020) Scrum is the most commonly used method, reasons for this are the clear roles and rules. Scrum combines and connects agile principles and concepts. (ScrumGuides.org, 2020) Originally it comes from software development and provides a framework for projects with few rules. In this case, however, self-organization of employees is very important, as well as flat hierarchies and quick feedback within the iterative approach. (Sauter, 2018) With the help of a process within the iterative development it is possible to approximate the result within the framework of continuous adaptation. (Gloger, 2016) In the area of the Scrum Framework there are defined roles with corresponding tasks. A Scrum Team consists of the Scrum Master, Product Owner and a team that implements the tasks. The team acts independently and is responsible for its own goals. The Scrum Master and Product Owner are not superior to the implementation team. The Product Owner is responsible for the success of the project, prioritizing and checking the requirements. Additionally, the Product Owner is responsible for the Product Backlog. The product backlog provides the team with an overview of the individual tasks and their status and priority in the respective sprint. A Sprint is an internal period within the project time. Often a Sprint has a duration of four weeks and after the Sprint a corresponding Sprint result is generated. The Scrum Master is not a direct member of the team but acts as a companion and coach. His task is to ensure that disruptions are resolved quickly, and conflicts are resolved. The Scrum Master also supervises the compliance of the Scrum processes. The last role in the Scrum Framework is the customer and employees, as well as management levels of the organization (Sauter, 2018). Within the Scrum Framework, different principles apply: Self-organization: Employees within the organization should work in a self-organized manner, Communication: Employees conduct daily consultations within the Daily Scrum and document the status of current tasks on a task board, Pull: The employees of the organization independently choose their tasks with the scope they can perform, Sprint: In the context of iterative work, a similar process is repeated until the desired approach to the goal is achieved, Timebox: A period of time in which the development team does its work before moving on to the presentation of the results After the presentation of the results, the planning phase of the next Sprint is started again, Daily Scrum: Daily meeting about the current status of the tasks, the next task and problems within a period of 15 minutes, Sprint Review: Direct feedback after the end of the sprint on the respective increment, i.e. the result of the sprint. All stakeholders are invited to participate. The result of the Sprint Review is the feedback of the stakeholders. The planned time frame for this is one hour, Sprint Retrospective: reflection of the result and disclosure of the potential of the next sprint. Time frame for this is 45 minutes. (ScrumGuides.org, 2020) Scrum enables company-wide agile working in iterative processes with a steep learning curve. Exactly this fact, the fast learning, is the big advantage of Scrum. Negatively noticeable are the delays that usually occur at the beginning or during the introduction of Scrum, because known processes are changed. Especially the values and principles of Scrum must be internalized by the employees of the organization. (Gloger, 2016)

Lean Start-up: Like Scrum, Lean-Start-up is based on a very solution-oriented idea. Here a product or service should be brought to the end user in the shortest possible time. In this case it is mainly about developing the customer's feedback around the product. The Lean-Start-up approach was developed by Eric Ries and Steve Blank. (Eckert, 2018) Lean Start-up is not based on concrete plans, but rather establishes contact with the customer at a particularly early stage. This contact is established early enough to get feedback from the customer. The process of Lean Start-up has the following three steps, which are sequential Build, Measure, Learn. Within the Lean-Start-up methodology it is possible to achieve a marketable product in the following five steps. Analysis of the customer's needs and the formulation of the task, development of the solution approach with the involvement of the customer, derivation of the

product vision and product development, iterative further development and evaluation of changes, end-customer capable product. Thereby the classical phases of product development, as well as the concretization of the business model are replaced by a recurring process. Within this cycle many agile methods find room for use. Above all, the focus is on the development of the organization's employees. Lean Start-up was characterized by start-ups with less formal structures. In order to carry this methodology into larger companies, adaptation measures are therefore indispensable. The culture and values of organizations at all levels are particularly affected by the changes. The advantage of Lean-Start-up is that it is a particularly efficient innovation method. (Sauter, 2018)

Kanban: Another agile framework is Kanban, where the focus is mainly on the optimization of work steps and communication. Kanban was developed in 1947 by Toyota Motors (Kanbantool.com, 2020). Afterwards the Kanban approach has been used by David J. Anderson among others in 2010. Kanban is based on four successive steps, which are explained in the following (Anderson, 2010)

Step 1: In this context the work processes are analyzed at the current point in time and then visualized. Within this framework, the individual process steps become visible. Frequently used in this case is the value stream analysis to improve the processes in the organization. In addition, discussions with employees can shed light on hidden potential.

Step 2: As a second step it is necessary to create a Kanban Board. The Kanban Board should have a column for each step. The first column should be used as a product backlog, where the tasks that still need to be done are listed. Column two is used to prioritize the tasks. It should be clear which task should be processed first. The other columns are used to list the next work process steps. This can be simplified by using only one in progress column. Finally, the column with the title Done should be added to list the completed tasks. Such a Kanban Board is part of the Daily Stand-up Meeting and should be available in digital or physical form.

Step 3: In the further procedure of Kanban, the individual work packages are visualized in the form of cards and then placed in the respective column. The cards contain all necessary information to complete the task. The following criteria are fundamental. Only the relevant information must be reflected on the cards. Title of the task and additional information, responsible employee and priority in the overall project, time start and end point of the task, degree of completion of the task, problems.

Step 4: The last step of Kanban is very similar to Scrum. This is about the prioritization of the work packages of the backlog by the product owner. The team can now independently process these packages and then confirm the completion. The cards are also useful at the Daily Stand-Up Meeting, where they are presented and possibly repositioned. The procedure here starts at the end of the process and continues right up to the start of the process. The employees select their work packages independently. This is another reason why Scrum can be combined particularly well with Kanban. In this environment it is also possible to promote further agile approaches. Here Kanban offers very simplified and flexible approaches that simplify working within an organization by visualizing the tasks and clearly showing not only the wrong prioritization but also the responsibility

Design Thinking: Design Thinking is a particularly customer-oriented method. Here the focus is first on the benefits for the customer and only then is the economic efficiency and general feasibility examined. (Übernickel, 2016) Within the framework of Design Thinking, creative processes are structured to provide orientation. Within the method it is about understanding the needs and wishes of the customer. The greatest benefit lies in validating the practical use of a new idea or product. A basic prerequisite for creativity within the team is the diversity of disciplines of the different members. It is only in this context that a creative environment exists in which new innovative ideas can emerge. In order to continue to carry out Design Thinking successfully it is necessary to establish a value system which should contain three main elements. Representative Teams: Teams must represent employees and managers in the organization. These teams can be moderated by a coach. Variable premises: Besides the availability of rooms, they should have innovative and versatile furniture. Iterative processes: An iterative process with many open solutions. Design Thinking has its roots in the iterative process and for this reason it is particularly important. The goal of Design Thinking is to focus on the needs and people. Within the development loops a useful solution should be created. This iterative process usually has different steps (see O A 2020). Within the methodology, six process steps have increasingly proven themselves, which are listed below: Understanding, observation, synthesis, developing ideas, creating a prototype, testing. (Kelley, 2001) In addition to the iterative process, it is essential that employees have the right mindset for the implementation. In this context, the following values are particularly important: openness, empathy, systematic thinking, communication. (Gerstbach, 2018) In addition to the existing value system, there are also factors within the organization and the environment that play a significant role in the application of Design Thinking within different projects. The main factors here are: Diversity in the team, flexible space, openness to method, clearly defined project mission. (Gerstbach, 2018)

Frameworks for scaling of agile methods: Within the agile methods and frameworks, there are strong limitations in terms of the number of employees within the organization or these respective projects. In the agile world, the

framework Scrum has spread particularly strongly, and many small and medium-sized companies have already been able to achieve advantages by using Scrum. Meanwhile, more and more larger companies and corporations are striving to counteract these advantages of Scrum, but Scrum is based on very small teams and does not offer a direct solution for an organization with a high number of employees or teams. (Daut, 2016) Due to this requirement, new approaches to scaling have been developed, most of which have their origin in Scrum. The similar origin does not mean that the scaling frameworks do not have different goals. The selection of the appropriate scaling framework will be discussed later in this paper. Since the basis of the scaling frameworks is Scrum, it is fundamental to have already internalized the principles and values of Scrum in the organization. In addition, an agile coach is often needed to support the scaling process. Using a scaling framework is a change in the organization and therefore not a short-term undertaking. (Korcok, 2019) In the following, the four most frequently used scaling frameworks, which also serve to understand this work, are presented.

Nexus: Ken Schwaber developed the Nexus Framework and released it in 2015. The basis of Nexus is Scrum. Nexus can be described as a process framework. Ken Schwaber himself describes it as an "exoskeleton" with a special focus on dependencies. The mindset for Nexus is both the agile manifesto and the agile principles. In the Nexus framework the Scrum principles are applied. Nexus can be used as a framework for up to nine cross-functional teams. In addition to the classic Scrum roles, a team that integrates Nexus is required. In addition to the classic Scrum events, there is also the "Refinement, Nexus Sprint Planning, Nexus Daily Scrum, Nexus Sprint Review, and Nexus Sprint Retrospective". (Halk, 2019) The sprint length is not changed. Customer integration can be sporadic and is not predetermined. The development and introduction of Nexus takes place team by team, whereby the knowledge carriers of one team are transferred to the next team. Nexus places particular emphasis on a simple procedure and transparency of implementation. (Halk, 2019)

Scaled Agile Framework (SAFe): The scaling framework SAFe was released in 2011 by Dean Leffingwell and is based on Scrum and Kanban. The optimization of the value flows lies within the organization and is particularly economically oriented. SAFe represents a holistic integration of agile working in a company. SAFe also pursues the goal of implementing agility throughout the entire organization. For this purpose, the SAFe Framework uses the Agile Manifesto, the Agile Principles and the House of Lean. Within the SAFe Framework, nine additional specific principles apply, which are to be observed as particularly detailed guidelines for the implementation procedure. Particularly if you have little experience with agile structures, SAFe thus offers a strong impression with easy-to-understand instructions for implementation. The nine principles are listed below: Economic Standpoint, System Thinking, Variability, Incremental Development, Milestone of Objective Evaluation, WIP Limit, Cadences and Synchronization, Intrinsic Motivation of Knowledge Work, Decentralized Decision Making. (Scaled Agile Inc., 2020) In addition, the SAFe Framework follows predefined values in which the description of the goal also plays a significant role. Transparency, delivery reliability and built-in quality are key values that should be observed within SAFe. It is possible to apply SAFe with up to 100 teams or even an entire organization. Thus, there is one Product Owner per team. In addition to the classic Scrum roles, there are other roles at various levels. The program level additionally has the Release Train Engineer, Product Manager and System Architect. The solution level also has the Solution Train Engineer, Solution Manager and Solution Architect. At the portfolio level, there is also the Lean Portfolio Manager. The event structure is also extended within the SAFe Framework at the respective levels. In addition to the classic Scrum Events, the program level includes the Program Increment (PI), the Preparation, the Agile Release Train Synchronization, System Demo and Inspect-and-Adapt. On the solution level there is also the Pre- and Post-PI-Planning, as well as the Solution Demo. The periods of the sprints are usually identical to Scrum. Additionally, there is a program increment, which has a duration of ten weeks. Within SAFe, customers are involved by the Business Owner and the Product Owner. The introduction of the SAFe Framework is based on the roadmap that SAFe provides. SAFe pays special attention to the value stream. Although the SAFe Framework has many new roles and events, it also has clear stages and procedures. These facts make the framework inflexible and slow, but easy to use. (Halk, 2019)

Large Scaled Scrum (LeSS): The LeSS framework was developed in 2013 by Craig Larman and Bas Vodde and is based on Scrum. Basically, LeSS only extends Scrum framework by the basis of scaling. In this case it is all about simplicity and clear principles. The focus is on the firmly defined structure and control of the processes. For the application of LeSS the mindset of Scrum is necessary, as well as two aspects of Lean - respect and continuous improvement. In addition, LeSS has ten further principles of its own, which are listed below: LeSS is Scrum, Transparency, More with LeSS, Holistic Product Focus, Customer Centered, Continuous Improvement, Lean Thinking, Systemic Thinking, Empirical Process Control, Queue Theory. (Halk, 2019) The LeSS framework allows for up to eight teams, then the framework expands to LeSS Huge. The teams are put together here on a long-term basis. There are no further roles within the classic LeSS framework, but there are with LeSS Huge. These roles would be the Area Product Owner and the Product Owner Team consisting of several Area Product Owners and Product Owners. In addition to the classic Scrum events, there are further events within the LeSS framework. In addition to

Sprint Planning One, Sprint Planning Two, as well as the Product Backlog Refinement and Sprint Review, as well as an overall retrospective should be planned. The time periods of the events are like those of Scrum. For the introduction of the framework there is a Practical Guide. The LeSS framework focuses on the product and is particularly customer-centric. The Large Scale Scrum Framework can be easily adapted to different circumstances, but also has particularly high demands on the teams.

Spotify-Model: The LeSS framework was developed in 2013 by Craig Larman and Bas Vodde and is based on Scrum. Basically, LeSS only extends Scrum framework by the basis of scaling. In this case it is all about simplicity and clear principles. The focus is on the firmly defined structure and control of the processes. For the application of LeSS the mindset of Scrum is necessary, as well as two aspects of Lean - respect and continuous improvement. In addition, LeSS has ten further principles of its own, which are listed below: LeSS is Scrum, Transparency, More with LeSS, Holistic Product Focus, Customer Centered, Continuous Improvement, Lean Thinking, Systemic Thinking, Empirical Process Control, Queue Theory. (Halk, 2019) The LeSS framework allows for up to eight teams, then the framework expands to LeSS Huge. The teams are put together here on a long-term basis. There are no further roles within the classic LeSS framework, but there are with LeSS Huge. These roles would be the Area Product Owner and the Product Owner Team consisting of several Area Product Owners and Product Owners. In addition to the classic Scrum events, there are further events within the LeSS framework. In addition to Sprint Planning One, Sprint Planning Two, as well as the Product Backlog Refinement and Sprint Review, as well as an overall retrospective should be planned. The time periods of the events are similar to those of Scrum. For the introduction of the framework there is a Practical Guide. The LeSS framework focuses on the product and is particularly customer-centric. The Large Scale Scrum Framework can be easily adapted to different circumstances, but also has particularly high demands on the teams.

4 Current state of research on the application of agile methods

In the following chapter the current state of research regarding agile methods in general shall be determined. The selection of the literature was made after appropriate literature research in the respective databases and fell on four studies, which deal with the part of the topic of the research project. It was especially important for the selection of the studies that they represent the focus of agile work regarding mindset and culture, as well as scaling methods. Due to the topic it was necessary to select current literature and to consider the industry. In the following, the four different studies will be presented and afterwards the results relevant for the research project will be presented.

BPM-Labor der Hochschule Koblenz - Status Quo Scaled Agile 2020: The fourth study by the Business Process Management Lab (BPM Lab) called Status Quo Scaled Agile was conducted in 2019 and published in 2020 by the BPM Lab of the University of Applied Sciences Koblenz. The new edition of the previous Status Quo Agile study questions how the use and distribution as well as the success of agile working looks like. It also questions how the collaboration of agile teams works in the context of scaling using methods such as SAFe, Spotify, Nexus and LeSS. In addition, it is also questioned which combination of classic and agile methods is used. The focus of the study is on the actual usage and success factors, as well as the scaling of agile methods within an organization. The study was conducted by Prof. Ayelt Komus together with GPM Deutsche Gesellschaft für Projektmanagement e.V. and IPMA - International Project Management Association. With 600 participants from more than 20 countries, the study of the University of Applied Sciences Koblenz by Prof. Ayelt Komus in cooperation with GPM Deutsche Gesellschaft für Projektmanagement forms a sound basis for the derivation of the hypotheses. This study was selected, since particularly the factors, which are intended in the research project were treated and relevant realizations in this area were pointed out. (Komus, 2020)

Capgemini Invent Change Management Study 2019: A further study for the investigation was published by the consulting firm Capgemini Invent. Title of the 2019 study is "Change Management". In this study, Capgemini deals with "Organizational Dexterity" within the agile transformation of an organization. Capgemini explored what Dexterity means for companies and what degree of dexterity they should aim for in order to keep up with the technological change in the context of digitalization. In this context, the question of how companies can succeed in becoming adaptable and which methods are necessary for this was posed. In particular, the mindset of the employees and the cultural change within the organization were discussed. Furthermore, the importance of leadership in this context was questioned. Over 1100 participants from eleven countries and 17 industries took part in the study. The study is particularly suitable for the research approach, as it deals with the mindset and the corporate culture, which are also part of the research project of this thesis and thus also serve to derive the hypotheses. (Bohn, 2019)

Lünendonk-Studie 2019: Scalable Agility – From agile to digital transformation: The Scalable Agility Study was published in 2019 by the market research company Lünendonk in cooperation with the company BridgingIT. In the context of the study, 26 companies were surveyed, whereby the participants were mainly executives who were connected to the agile transformation in their organization. The study covers a total of seven industries. Within the scope of the study, the participants were asked about the challenges of agile transformation in the age of digitalization.

The way the transformation was implemented was also part of the survey. This study is particularly well suited for deriving the theses because it includes the aspect of scaling within the agile methods in an organization. In addition, two of the 26 interviews were in the automotive industry and thus also aim at the research project of this thesis. (Zillmann, 2019)

Agile Pulse 2019 – the agility study from BearingPoint: In 2019, the management consultancy BearingPoint published the study Agile Pulse 2019 - the Agility Study. The following study was conducted online and 258 people participated. In addition to this, a series of interviews was conducted with managers in Germany and Austria. One focus of the study examined the extent to which agility has arrived in companies so far and a second focus was on the role agility will play in the future for different industries. Furthermore, the study should give an insight into the cultural change of the companies and additionally show how agile the mindset of the employees is. Within the study, the views of employees and managers were also specifically analyzed. The study is also suitable for the derivation of hypotheses as it considers the views of managers and employees about the degree of maturity and the agile mindset. (Spreckelsen, 2019)

Status Quo of the success factors of agility: In the study conducted by the BPM Laboratory of the University of Applied Sciences Koblenz, 11% of the respondents came from the automotive industry. This means that the second-largest participating industry within the study is represented by the automotive industry, which also means that a large part of the results shows the relevance for this industry. Most of the participants came from the IT and software sectors. (Komus, 2020) In the study by Capgemini Invent, 11.3% of the participants came from the automotive industry. This means that the automotive industry is only the fifth largest participant industry within the Capgemini Invent study. Most of the participants are also from the electronics and IT industry. (Bohn, 2019) In the Lünendonk study, the automotive industry came in fifth place with almost 8%. The banking sector dominates in the study with almost one third of the respondents. (Zillmann, 2019) In BearingPoint's Agile Pulse 2019 study, the automotive industry is ranked fifth within the industry sector with 9%. The main sector within the study is the IT and technology sector, alongside banking. (Spreckelsen, 2019) Overall, the four studies analyzed in this study only provide indirect information about the automotive industry. For this reason, although no direct statements can be made about the relationship between scalable agility and its success factors in the automotive industry, the statements and results of the studies can still be used to formulate the hypotheses. It should also be mentioned that although there are industry-specific differences, the application of agile methods in project management often shows great similarities between the different industries. For this reason, the success factors from the four available studies are presented in the following regarding the application of agile methods. The four studies agree that Scrum is the most frequently used methodology. This is followed by Kanban, Lean and Design Thinking (Bohn, 2019). Prof. Komus presents the following results in his study: As the most important success factor he names the internal processes as well as the attitude of top management towards agility. In particular, the part of the organization that supports and promotes the agile approaches stands out. It is interesting to note that the part of the organization that is concerned with agile topics is also concerned with classic project management. Professor Komus assumes that change will be an essential part of the agile culture within the organization. The results of the study also show that 80% of the participants find it difficult when teams are distributed locally. Professor Komus also proves in his study that two thirds of the participants see team size as an essential variable for successful cooperation. In addition to this, the participants find it particularly difficult to assess and evaluate upcoming tasks in terms of complexity. (Komus, 2020) The Capgemini Invent study identified a total of eight success factors, but these were not directly related to agile working, but to organizational dexterity. The change in the organization is directly related to the application of agile methods. Capgemini Invent assumes that the agile methods are only the first step and an organizational change within the company is necessary to be able to act flexibly and according to customer requirements in the future. In the study, Capgemini Invent found that corporate culture was the biggest success factor with 77%, followed by the role understanding in the area of Leadership & People with 64%. The third largest influencing factor on success is the processes with 45%. The five other success factors are, in descending order of importance, the ecosystem, data competence, the working environment, corporate management and the structure of the organization. The figures are based on the possibility of multiple answers. (Bohn, 2019) The Lünendonk study examines the process of introducing agile methods in organizations and has identified eight success factors. In this context, Zillmann was able to identify influencing factors from the organization of the HR department as a central control module in the study. The differences to classical project management were particularly striking. Dealing with mistakes has been classified as a further success factor, since this plays a significant role in agile and is different from classical project management. Cultural change and the understanding of roles for managers and teams was named as one of the main drivers for success. Here it may be necessary to create positions that promote communication and empowerment of employees. As Schiller shows in his study, physical proximity, non-existent frameworks and not clearly defined goals also play a direct role in success. The last success factor for agile methods is the networking of agile teams. (Zillmann, 2019) The study by the consulting firm BearingPoint identifies three major challenges that are directly related to the success of agile transformation within an organization. The first and most frequently mentioned is the corporate culture with 69%. The second most important factor, at 55%, was the

interaction between classic and agile projects. At 52%, interdepartmental cooperation was the third most important influencing factor. It was particularly revealing in this context that changing the culture and the employees was a greater challenge for larger companies than for small companies. In addition to the three main challenges, the behaviour of top management was also an influencing factor on the success of the application of agile methods. An essential part of the success for the agile methods is not only the changed organization but also the streamlining of processes as well as an optimization of the workflows in the organization and the promotion of employee competencies. The BearingPoint study also shows six basic factors influencing the efficiency and effectiveness of the introduction of agile methods. These are "structure, culture, processes, technology, methods and products". (Spreckelsen, 2019)

5 Discussion and conclusion

The analysis of literature and selected studies has shown that agility is an important component in the transformation of companies in the context of digitization but is only represented in specific industries and therefore only generally valid factors influencing the success of agile working could be concluded. These success factors reflect different levels within the organization. They show that the success of agile working requires a general and fundamental change in the company, which involves all employees of an organization from top management to the executive project team. Although all factors influencing success were eminent, the human being and his mindset were one of the biggest success factors. In this context, structure, culture, processes and methods were other areas with a high impact on success. In addition to the analysis of the influencing factors on success, this thesis offers approaches to solve problems and obstacles within agile working. In particular, the classification of the projects with the corresponding selection of an agile method and framework, as well as the selection, preparation and support of the employees in the projects by an agile coach had a clear influence on the success. The study also showed that the application of scaling frameworks is generally still in a very early stage and that there is little or no experience with their application. The examined studies came to the same conclusions. Especially precarious was the selection of a suitable framework for the respective project, in which scaling was necessary and desired. In this context, variables such as the project scope, the customer and the existing team had to be considered. In this context the scaling frameworks, as a rather long-term approach, show their weaknesses in the often-limited project business of automotive development at EDL. Consequently, the respective customer is to be an individual with individual requirements. This fact must be considered when selecting a suitable scaling framework for the EDL. Besides the mentioned influences the success of agile working depends on further factors. In this context the human being and his mindset are the main drivers for internal and external changes. An example for an external change with the goal to be more successful in agile working would be the corporate culture. It is mentioned as a success factor, but which changes in culture explicitly help to achieve success? Especially since the corporate culture is often very difficult to change and it can take years to substantially modify the culture of a company. However, the main characteristic for controlling this process would be the human being and his or her mindset. If we look at the internal success factors in the following, the framework used and especially the selection of a suitable framework for collaboration and further on also for scaling has become a clear influence on success.

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Theoretical Analyses of Management Attributes in Context with the Field of Automotive Industry

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Abstract

Leadership of automotive industries is facing complex changes and must react with fast, future-oriented decision-making related to new business models and based on sustainability. Currently the Covid 19 pandemic will push paradigm changes in this industry field which is one of the important economical driver in Europe. The actual body of knowledge offers opportunities for potential researches in the field of automotive industry. Hence the article deals with the interaction of leadership theories with organizational theories and decision making as leadership competence. The analyses will reference scientific theories valid in automotive industry leadership as well. The discussion in the theoretical analyses of the mentioned factors is part of an ongoing research project within a doctoral program.

Keywords: Organizational Theories, Leadership Theories, Decision Making, Automotive Industry

1. INTRODUCTION AND RELEVANCE

Environmental prospects influence organisations' behaviour and "…the formal structures of many organizations in post-industrial society […] dramatically reflects the myths of their institutional environments instead of the demands of their works activities", as noted by Meyer & Rowan.[1] Organisations are systems of individuals which operate and act to achieve formulated targets.[2] Petzold underlines that organisations are individual networks and added that organisations are groups or social entities, based on cooperation frameworks, which are aimed at reaching long-term goals to achieve organisational survival.[3] Therefore, organisations are patterns of relationships with common goals, and the organisational structure divides, organises, and coordinates organisational activities.[4] (Drumaux, 2007, p. 4). Due to the fact that automotive industries act internationally and globally leaders and their decision-making is connected with intercultural aspects. The culture of the organization itself and the culture of all related market members.

This article analyses which factors and organizational structures influence leaders in their decision making and which leadership roles and methods are appropriate to raise organizational performance and effectiveness in developing new business models. The following presented cause-effect-model describes the focus of this article.

[1] cf. Meyer & Rowan (1977), p. 341.
[2] cf. Schimak (2001), p. 200.
[3] cf. Petzold (1998), p. 399.
[4] cf. Drumaux (2007), p. 4.

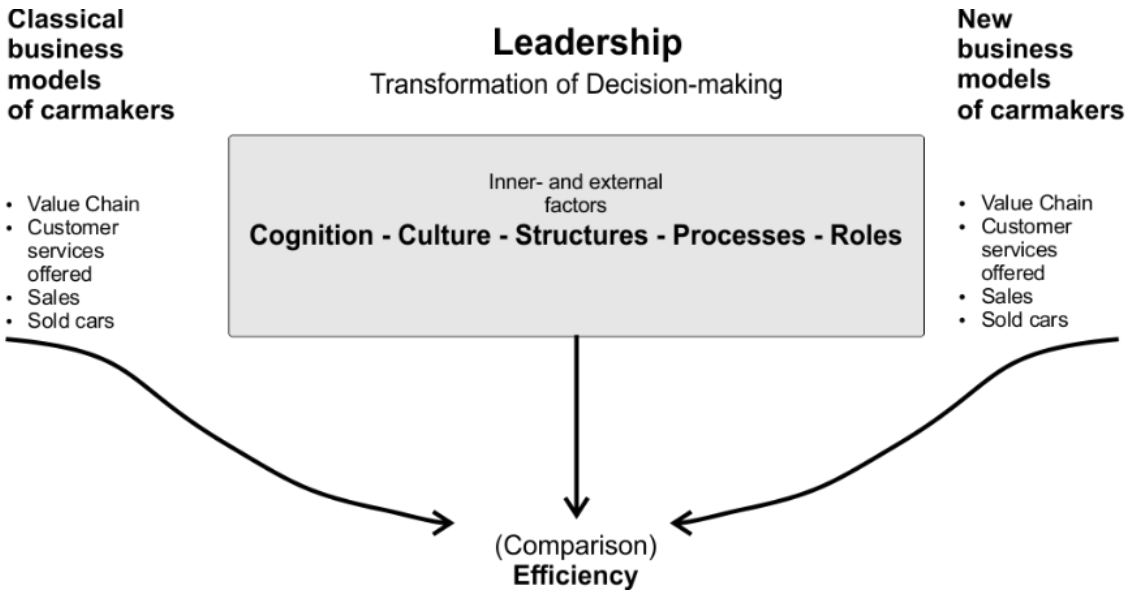

Fig. 1: Business models, Leadership, Organizational structure, influencing factors and organizational performance[5]

2. THEORETICAL ANALYSES

These chapter focusses the main theories of this article, organizational theories, leadership theories and decision making.

2.1 Organizational Theories

Organizational behaviors are influenced by environmental expectations "…the formal structures of many organizations in post-industrial society […] dramatically reflects the myths of their institutional environments instead of the demands of their works activities".[6] Schimak describes organizations as systems of individuals which are operating and acting to achieve formulated goals.[7] Another organizational definition is presented by Petzold, who describes organizations of individual networks, so that organizations are groups of social entities which are based on cooperation frameworks to achieve long-term goals and organizational survival.[8] Jepperson argues that institutionalization is created by culture, based on simple rules and processes within formal organization, if they are not monitored and sanctioned.[9]

2.1.1 Institutionalism

Institutions are broad and vague interpreted. Institutions can be seen as important cooperations or as environmental impacts, or they can be reduced to cultural and historical effects.[10] In contrast to its forerunner the new institutionalism is more focussing micro-economic argumentations and comprehension about the behavior of the agents.[11] Three forms of new institutionalism exist: the formal organization, the regime and the culture in contrast to forms of informal institutionalization.[12] A regime is described as "…explicitly codified rules and sanctions – without primary embodiment in a formal organizational apparatus".[13]

[5] Source: own illustration
[6] Meyer & Rowan (1977), p. 341.
[7] cf. Schimak (2001), p. 200.
[8] cf. Petzold (1998), p. 399.
[9] cf. Jepperson (2001), pp. 150 et seqq.
[10] cf. Jepperson (2001), p. 144.
[11] cf. Williamson (1975), w. p.
[12] cf. Jepperson (2001), p. 150.
[13] Jepperson (2001), p. 150.

Greenwood, Suddaby and Hinings postulated that institutionalism esteems from a radical change. The following illustration shows their sight of view:

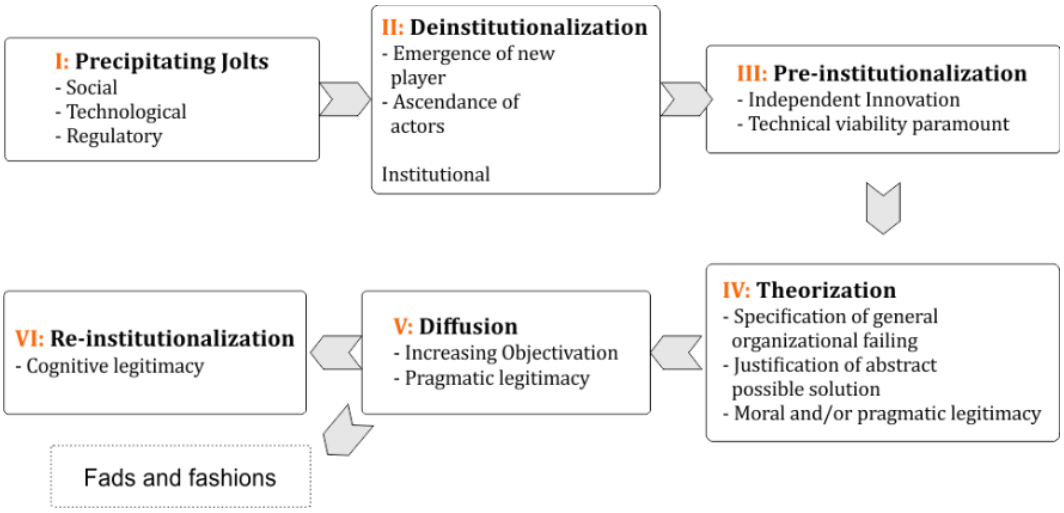

Fig. 2: Phases of institutional transformation[14]

In the primary phase radical events provoke a change from old premises, actions, rules, and actors. In phase two, additionally new actors with new solutions appear with divergent sight of views, and differential behavior, so that disturbance comes into the field. In the third phase organizations try to be appropriate to the challenges and they are testing different processes of adjustment. Phase four is described as theorization which leads to diffusion and to the next phase the re-institutionalization.[15]

Another process of institutionalization was presented by Tolbert and Zucker. They see organizations as initiators of institutionalism process and show a three-phase process of institutionalization:

Table 1: Phases of Institutionalization and compared dimensions[16]

Dimension	PRE-Institutionalization stage	SEMI-Institutionalization stage	FULL-Institutionalization stage
Processes	Habitualization	Objectivation	Sedimentation
Characteristics of adopters	Homogeneous	Heterogeneous	Heterogeneous
Impetus for diffusion	Imitation	Imitative/normative	Normative
Theorization activity	None	High	Low
Variance in implementation	High	Moderate	Low
Structure failure rate	High	Moderate	Low

Crises like changes in technology, legal foundations, or changing markets are seen as source of institutionalization. It then one or more organizations react independently their behaviors and practises than pre-institutionalization esteems.[17] Imitation process can possibly occur at this stage but its value and usability cannot be seen, so that the authors noticed that objective factors and efficiency lead to this problem solutions.[18] If value and usability are realized than a

[14] Source: Own illustration based on Greenwood, Suddaby & Hinings (2002), p. 60.
[15] cf. Greenwood, Suddaby & Hinings (2002), p. 60.
[16] Source: Own illustration based on Tolbert & Zucker (1996), p. 185.
[17] cf. Tolbert & Zucker (1996), pp. 175 et seqq.
[18] cf. Tolbert & Zucker (1996), pp. 175 et seqq.

social context is developed which is called objectivation.[19] Based on copying, imitation or mimetic processes organizations reproduce successful methods from competitors, which they get from monitoring the market or institutional organization foster the spread of new ideas.[20] If this solutions is used by mainly all organizations, so the new practices, methods and rules are anchoring for public. This process is called sedimentation. A characteristic of sedimentation is the transmission of these facts to new organizational generations.[21]

The new institutionalism postulates that social systems offer multiple self-logic operating functional systems to unity and therefore they are seen as a unity of diversity.[22] Because organizations are not monitoring their environment steadily they are described as self-absorbed.[23] According to Jepperson "the new institutionalism is a core concept of sociology"[24] whereas Durkheim argues that sociology is the science of institutions.[25] Therefore, institutionalism can be argued as a system-reflexivity and the system is driven to create decisions between itself and its environment accordingly.[26] Based on Scott who sees institutions as cognitive, normative, and regulative structures and activities which give stability and meaning of behaviors it can be concluded that institutions are cognitive constructions based on normative and regulative processes which esteem of social behaviours and impact of social behaviors.[27]

Hasse and Krücken give an example to demonstrate institutions, especially for education and meritocracy. Rules and succession transferred in former times status whereas todays status is given by exams and certificates. This leads to a new formulation of the social status of the new elites, based on education so that the education systems as strengthen the social society.[28] The stability and economically growth of social systems is based on formal and informal mechanisms and formal institutions and traditions are based on laws and rules and informal institutions.[29] Petzold concludes that institutions are summarized relationships for public and private affairs which are released and installed based on laws and rules which disburden the social life.[30]

Hasse and Krücken give a broader view of institutions and see them as large-scaled patterns and rules which enfold all actors.[31] According to Senge institutions are specific social rules and activities. A rule is an institution and an empirical phenomenon if the following conditions are fulfilled: over-time guilty, and binding actors within social affairs.[32] These conditions of Senge are related to Luhmann's spatial-temporal-social dimension.[33] The differences between old and new institutionalism are shown in the following table:

Table **Chyba! V dokumentu není žádný text v zadaném stylu.**: Comparision old vs. new institutionalism[34]

Focus	Old	New
Conflicts of interest	Central	Peripheral
Source of inertia	Vested interests	Legitimacy imperative
Structural emphasis	Informal structure	Symbolic role of formal structures
Organizations embedded in	Local community	Field, sector, or society
Nature of embeddedness	Co-optation	Constitutive
Locus of institutionalization	Organization	Field or society

[19] cf. Walgenbach & Meyer (2008), pp. 91 et seqq.; Berger & Luckmann (1967), w. p.
[20] cf. Walgenbach & Meyer (2008), pp. 91 et seqq.; Berger & Luckmann (1967), w. p.
[21] cf. Walgenbach & Meyer (2008), pp. 102 – 108.
[22] cf. Luhmann (1977), p. 134 et seqq.
[23] cf. Paetow (2004), p. 134.
[24] Jepperson (2001), p. 143.
[25] cf. Durkheim (1950), w. p. in Jepperson (2001), p. 143.
[26] cf. Schimak (1987), p. 62.
[27] cf. Scott (1995), pp. 33 et seqq.
[28] cf. Hasse & Krücken (1999), pp. 9 et. seqq.
[29] cf. North (2005), w. p.
[30] cf. Petzold (1998), p. 399.
[31] cf. Hasse & Krücken (1999), p. 8.
[32] cf. Senge (2004), p. 120.
[33] cf. Luhmann (1998), pp. 35 et seqq.
[34] Source: Own illustration based on Powell & DiMaggio (1991), p. 13.

Organizational dynamics	Change	Persistence
Basis of critique of utilitarianism	Unanticipated consequences	Theory of action
Key forms of cognition	Values, norms, attitudes	Classification, routines, scripts, schema
Social psychology	Socialization theory	Attribution theory
Cognitive basis of order	Commitment	Habit, practical action
Goals	Displaced	Ambiguous
Agenda	Policy relevance	Disciplinary

Institutionalism can esteem due to culture but furthermore based on simple rules and processes which are not monitored and sanctioned.[35] Based on the population ecology approach Hawley underlined that "…the diversity of organizational forms is isomorphic to the diversity of environments."[36] DiMaggio and Powell describe sociology new institutionalism as

> "the new institutionalism in organization theory and sociology comprises a rejection of rational actor models, an interest in institutions as independent variables, a turn toward cognitive and culture explanations, and an interest in properties of supraindividual units of analysis that cannot be reduced to aggregations or direct consequences of individuals' attributes or motives."[37]

2.1.2 Theories of Organizations

A broad spectrum of various phenomena tries to explain the variability and diversity of organizational theories.[38] The identity of groups and systems create borders for the collective, is argued by Hofstede,[39] whereas DiMaggio and Powell exclude the organizational variety and are focussing the adaptations of organizations within organizational fields. Organizational fields are described as enfolded differentiated organizational parts where all actors are embedded.[40] Based on new institutionalism organizations are embedded in environmental expectations. These expectations can be divided in technical and institutional environments. Technical environments are the rewards for the exchange of services and products for coordination and developing effectiveness and efficiency,[41] and underline

> "…that the formal structures of many organizations in post-industrial society […] dramatically reflects the myths of their institutional environments instead of the demands of their work activities."[42]

Organizations are systems of individuals which fulfil formulated goals based on their activities.[43] Another sight of view esteems from Petzold he defines organizations as systems of individuals, groups and social buildings which cooperate for work-sharing, long-term frame conditions, system-environmental-relations, with the goals to exist.[44] Petzolds definitions enables to differentiate between institutions and organizations:

- Organizations strive to exist self-oriented
- Institutions exist within society, independent it they generate or not generate profits.

Jepperson developed an organizational-theoretic model which is based on two dimensions and differs between the grade of social construction and the deepness of research. The social constructs are divided in high (phenomenology)

[35] cf. Jepperson (2001), pp. 144 et seqq.
[36] cf. Hawley (1968), pp. 328-
[37] cf. DiMaggio & Powell (1991), p. 8.
[38] cf. Kieser (1995), w. p.
[39] cf. Hofstede (2001), p. 213.
[40] cf. DiMaggio & Powell (2000), pp. 148 et seqq.
[41] cf. Meyer & Rowan (1977), pp. 340 et seqq.
[42] Meyer & Rowan (1977), p. 341.
[43] cf. Schimak (2001), pp. 200 et seqq.
[44] cf. Petzold (1998), p. 399.

and deep (realistic) and the deepness of analysis is differentiated in low (individualism) and high (structuralism).[45] The following table shows Jeppersons model:

Table 1: Organizational Theories[46]

Degree to which units socially constructed	Featured Levels of Analysis	
	Low-Order (Individualist)	High Order (Structuralist)
High Construction (Phenomenological)	1 • "Organizational culture" • symbolic interaction	2 • Institutionalism
Low Construction (Realist)	3 • Actor &/or functional reduction attempts • Neoclassical economics • Behavioral psychology • Most new institutional economics • Network theories	4 • Social ecology • Resource dependence • Some network theory

2.2 Leadership Theories

Due to change based on digitalization the complexity for organizations arises more and more so that organizations are faced with deep transformational processes.[47] Globalization, shortened product life-cycles, technology changes and more flexible organizational structures demand for more qualified and highly motivated staff, as success factors.[48] Several definitions and conceptions are describing leadership. Leadership can be seen as a response to challenges and opportunities and definitions of leadership are many and varied. [49] Most influential general theories of leadership "reflect the ideas of an underlying theory or school of leadership."[50] Main theories are briefly introduced in the following table.

Table 3: General theories of leadership[51]

Theory or School	Description	References
Great Man or Trait School	Celebrates outstanding individual leaders (in the heroic tradition) and studies their traits or characteristics to understand their accomplishments as leaders	Stogdill 1948; Tannenbaum & Schmidt 1973; Harter 2008
Behavioural or Styles School	Describes leadership in terms of people- and task-orientation, suggesting that different combinations of these produce different styles of leadership	Lewin et al. 1939; Blake & Mouton 1964; 1985; Kouzes & Postner 1995
Situational or Context School	Emphasises the importance of context in shaping leaders' responses to be more relationship or task motivated, or more authoritative or participative	Hersey & Blanchard 1969; 1974; Vroom & Yetton 1973; Graeff 1983

[45] cf. Jepperson (2001), p. 154.
[46] Source: Own illustration based on Jepperson (2001), p. 154.
[47] cf. Walenta & Kirchler (2011), p. 75.
[48] cf. Wischer (2005), p. 405.
[49] cf. University of Cambridge Institute for Sustainability Leadership (2017), p. 4.
[50] University of Cambridge Institute for Sustainability Leadership 2017, p. 4.
[51] Source: own illustration based on University of Cambridge Institute for Sustainability Leadership 2017, p. 5.

Contingency of Interactionist School	Proposes that leaders' influence is contingent on various factors (like positional power), which in turn determines appropriate leadership styles	Fiedler 1967; House & Mitchell 1974; Barbour 2008
Transactional or transformational School	Contrasts leadership as a negotiated cost-benefit exchange and as an appeal to self-transcendent values of pursuing shared goals for the common good.	Bass 1974; Burns 1978; Price 2003

Research results reveal that decision making is influenced by emotions.[52] The behavior oriented theories underline that the cognitive and motivational capacities are limited.[53] Management and leadership are analysed by differential disciplines like psychology, sociology, philosophy, political and economic sciences.[54] Classical management conception are not appropriate for future conditions, because of organizational influencing factors.[55] Societal frameworks are subject of incalculably environment, the competitive values of figures, CSR-activities, which often play a fig leaf function.

Moreover, guilty structures are dissolving and democratic knowledge of network societies, pressure for flexibilization, and the development of new business models based on new value understanding.[56] These transformations lead to

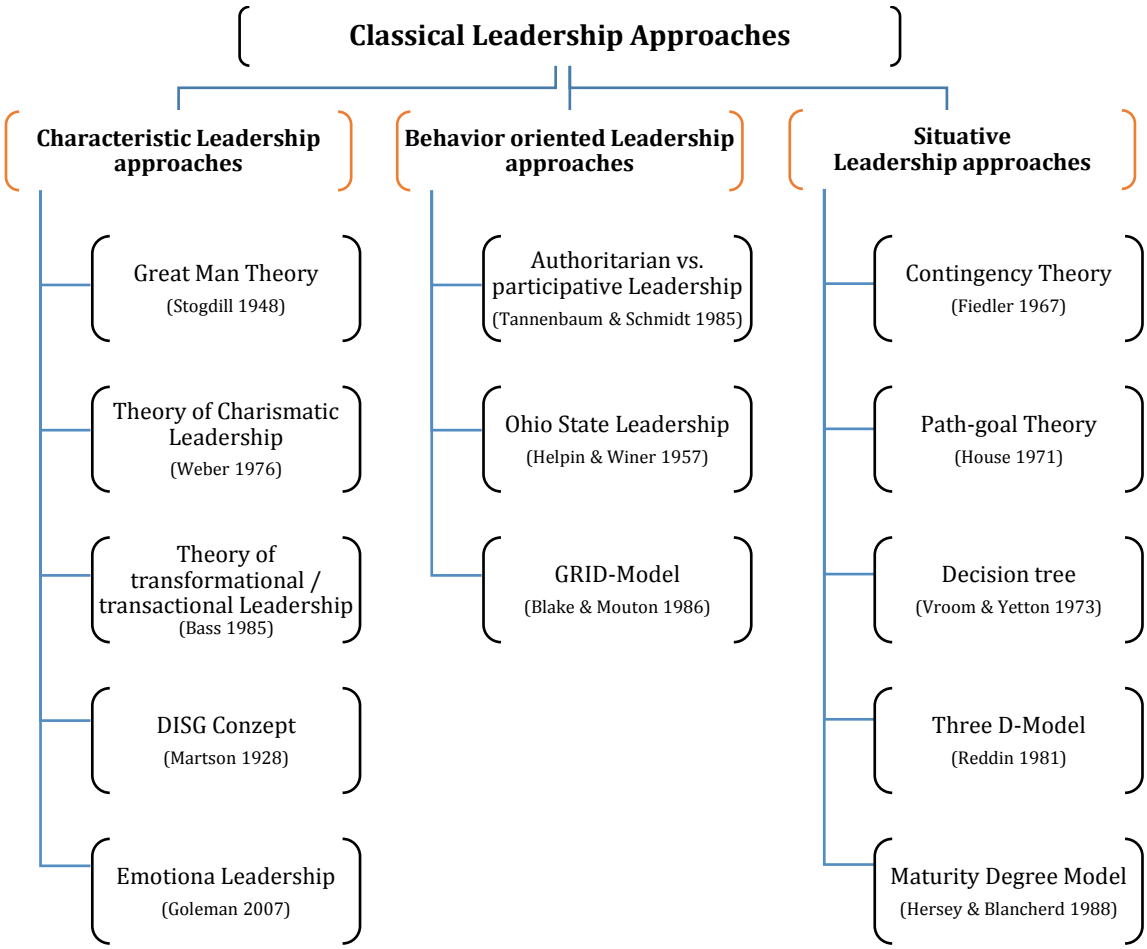

Fig. 3: Classical Approaches of Leadership Research[57]

[52] cf. Bechara et al. (1997), p. 1.292-1293.
[53] cf. Berger & Bernhard-Mehlich (2006), p. 169.
[54] cf. Walenta (2012), p. 496.
[55] cf. Gebhardt et al. (2015), p. 5 et seqq.
[56] cf. Gebhardt et al. (2015), pp. 5 et seqq.
[57] Source: Own Illustration based on Lippold (2015), p. 25.

2.2.1 Definitions of Leadership

Cultural or value context influence the leaders, therefore leadership is often clustered into geographical groups and leadership behaviors or approaches are influenced my cross-cultural appeals. General leadership theories are focussing leadership on behaviours, based on relevant insights from transformational, servant, situational and ethical schools.[58]

Table 4: Leadership Definitions[59]

Year	Author(s)	Definition
1974	Stogdill	"[There are] almost as many definitions of leadership as there are persons who have attempted to define the concept."60
2004	Northouse	"Leadership is a process whereby an individual influences a group of individuals to achieve a common goal."61
1985	Donelly, Ivancevich & Gibson	"Leadership is an attempt at influencing the activities of followers through the communication process and toward the attainment of some goal or goals."62
1995	Kouzes & Posner	"Leadership is the art of mobilizing others to want to struggle for shared aspirations."63
1986	Bryman	"Leadership is the creation of a vision about a desired future state which seeks to enmesh all members of an organisation in its net."64
1992	Zalenik	"Leadership requires using power to influence the thoughts and actions of other people."65
1994	Jaques & Clement	"Leadership is that process in which one person sets the purpose or direction for one or more other persons and gets them to move along together with him or her and with each other in that direction with competence and full commitment."66
1961	Prentice	"Leadership is the accomplishment of a goal through the direction of human assistants. A leader is one who successfully marshals his human collaborators to achieve particular ends."67
1990	Cohen	"Leadership is the art of influencing others to their maximum performance to accomplish any task, objective or project."68
1978	Katz & Kahn	"Leadership is the influential increment over and above mechanical compliance with the routine directives of the organization."69
1988	Hersey & Blanchard	"Leadership is the process of influencing the activities of an individual or a group in efforts toward goal achievement in a given situation."70

Leadership can be categorized in factors which are associated with leadership. The next table gives an overview:

[58] cf. University of Cambridge Institute for Sustainability (2017), p. 10.
[59] Source: own illustration
[60] Stogdill (1974), p. 259.
[61] Northouse (2004), p. 3.
[62] Donelly, Ivancevich & Gibson (1985), p. 362.
[63] Kouzes & Posner (1995), p. 30.
[64] Bryman (1986), p. 6.
[65] Zalenik (1992), p. 126.
[66] Jaques & Clement (1994), p. 4.
[67] Prentice (1961), p. 143.
[68] Cohen (1990), p. 9.
[69] Katz & Kahn (1978), p. 528.
[70] Hersey & Blanchard (1988), p. 86.

Table 5: Categorization of factors associated with leadership[71]

Primary factor	Associated leadership traits
Capacity	Intelligence, alertness, verbal facility, originality, judgement
Achievement	Scholarship, knowledge, athletic accomplishment
Responsibility	Dependability, initiative, persistence, aggressiveness, self-confidence, desire to excel
Participation	Activity, sociability, co-operation, adaptability, humour
Status	Socio-economic position, popularity
Situation	Status, skills, needs and interests of followers, objectives to be achieved

2.3 Decision making

Leaders and organizations are faced with huge data and facts and should comply many expectations. Therefore, leaders are under pressure and should be equipped with appropriate tools and decision-making methods.

Fig. 4: Factors of Effective Decision Making[72]

Wrong decisions lead to many projects' loss. Harbinson and Pekar showed in their study, which was based on 5.500 international cooperation projects that 40 percent of these cooperation failed[73], and Murphy and Kok presented the results of their study which showed that 70 percent of projects failed.[74] O' Grady and Lane underline that the main

[71] Source: own illustration based on University of Cambridge Institute for Sustainability Leadership (2017), p. 6.
[72] Source: own illustration based on Verma (2014), p. 175.
[73] cf. Harbinson & Pekar (1997), w. p.
[74] cf. Murphy & Kok (2002), p. 4.

factors of decision making processes are the precision of perception of the leaders,[75] and Stimpert and Duhaime stated that the knowledge structures of managers influence their decision-making.[76] Staehle argues that people act according to their perception and not based on reality.[77] This subjective reality is close-knitted with the paradigm of reception and converting information. Individually and personally attitudes, and values are influencing the selection of information. Perception, education, and experiences form individual and unconscious patterns which are steering action and behaviour.[78]

The individual knowledge of people determines perception, decision-making in its kind of thinking and acting.[79] This process of intermediation between situative pictures and knowledge structures is called as understanding.[80]

There are existing various decision-making models, the administrative model, the political model, the ethical model, the rational model, and the normative model.[81] These models are discussed in short.

The rational decision-making model focusses to maximize the value and profitability of the organization. Thus, managers follow a rational method in respect to these sequences:[82]

- Problem identification
- Generation of solutions and possible alternatives
- Selection of the best alternative
- Implementation of the desired problem solution

The normative decision-making model assumes that managers and leaders are faced with constraint sets and obstacles during decision-making. Personal or environmental factors like time, complexity, uncertainty, risk, limited availability of resources can reduce this model rationality. Therefore, decision-making is depicted by the following factors:[83]

- Limited processing of information because a boundary or threshold limit exist which manages to extend information which can be handled and processed by a person.
- Judging strategies (many shortcuts) can be used while decision-making.
- The chose those solutions or alternatives requires a minimum of inputs and resources.

CONCLUSION: RESULTS AND CRITICAL DISCUSSION

Bass described leadership as "influencing the attitudes and behaviors of individuals and the interaction within and between groups for the purpose of achieving goals."[84] The results of the study of Chesbrough & Brunswicker show that 78 percent companies are practicing open innovation and that inbound innovation practices are more preferred than outbound practices. To foster innovation customer co-creation, informal networking, and university grant are used in practice. Outbound practices are joint ventures, donations, and spin-offs.[85]

Another study, conducted by Abdolmaleki, Ashloublagh, Shahrabi, Ashlaghi, & Safdari (2013, p. 1981) revealed the effects of leadership styles (intercept, transformational style/convertible, light situational/contingency, democratic/participative style and light servant) on innovation.[86] Their results revealed that "innovation is a function of leadership components".[87]

[75] cf. O'Grady & Lane (1996), p. 318.
[76] cf. Stimpert & Duheim (2008), w. p.
[77] cf. Staehle (1999), p. 197.
[78] cf. Ackerschott (2001), p. 13.
[79] cf. Ackerschott (2001), p. 25.
[80] cf. Wessells (1984), p. 343 et seqq.
[81] cf. Verma (2014), pp. 172-173.
[82] cf. Verma (2014), pp. 172.
[83] cf. Velma (2014), p. 172.
[84] Bass (1990), p. 19.
[85] cf. Chesbrough & Brunswicker (2013), p. 1.
[86] cf. Abdolmaleki, Ashloublagh, Shahrabi, Ashlaghi, & Safdari (2013,), p. 1981.
[87] Abdolmaleki, Ashloublagh, Shahrabi, Ashlaghi, & Safdari (2013) p. 1981.

Australian Researchers analysed leadership styles and innovation and revealed two leadership styles which develop innovations: transformational leadership and consideration leadership.[88] According to Zuraik "innovation management is a systematic, holistic approach"[89] and, therefore, innovation leadership must look beyond the boundaries of conventional leadership styles. The choice of the appropriate leadership style is related to innovation stages and types. Thus, there is no clear answer as to which leadership style leads to innovation, as argued by Kesting, Ulhoi, Song & Niu.[90]

Kienbaum/StepStone focused leadership in combination with digitalisation and the results show that self-confidence, trust, and continuous feedback are the main drivers for team innovation processes. However, they also noticed that clear role and function allocations are beneficial for innovation. The laissez-faire leadership style does not directly improve team innovation. Summarising, Kienbaum/StepStone showed that the following three leadership styles foster innovation: ethical leadership, strategic management, and transformational leadership.[91]

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[88] cf. Wipulanusat, Panuwatwanich, & Stewart (2017), p. 15.
[89] Zuraik (2016) p. 17.
[90] cf. Kesting, Ulhoi, Song & Niu (2015) p. 34.
[91] cf. Kienbaum & StepStone, 2018, p. 20.

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Experiences Inclusion of Special Education Teachers

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Abstract

Despite the social, legislative and educational changes that have occurred in recent years in education and the fact that the discourses of inclusion is more than settled on the international panorama, the reality of the school in many occasions is different. Based on individual interviews and discussion groups, we approach the teaching experience of fourteen special education teachers in the autonomous community of Andalusia (Spain) in public schools. Their expiriencies show us educational segregation discourses and practices that are hidden behind macro and micro educational discourses and actions that have an impact on the development of inclusive practices, and therefore, on the learning, development, well-being and identity construction of students with special educational needs. Teacher training, reflections and commitment to inclusive school practices are positioned as strategies that allow the transformation of the school culture and the discourses that promote school segregation.

Keywords: Inclusive school; special education teacher; school traditions.

1. INTRODUCTION

In recent years, the Spanish Educational system, as has occurred in many other countries, has experienced organisational, educational, social and legislative changes that have contributed to the construction of an inclusive school that specialises in diversity (Arnaiz, 2012)[1]. These transformations, promoted internationally by organisations such as UNESCO (2005)[2], OECD (2008)[3], OEI (2010)[4] and by authors such as Ainscow, Echeita, Florian, Fernández Enguita or Dyson, among others, have made it possible to overcome segregating practices and discourses.

However, the reality of shoool is quite different, becouse currently there are many students with special education needs who experience school segregation whilst at school. This panorama, undoubtedly worrisome, encourages us to find so-called inclusive school practices that are based on the deficit paradigm, teachers opposed to inclusion and teachers who delegate all responsibility of the special education teacher.

In order to understand this further, we have approached several special education teachers. They have shared with us a variety of different situations and experiences that have happened within their school, that has allowed us to question the weaknesses, strengths and consequences –personal, social and educational– of a parallel educational model immersed in the ordinary school and which is hidden behind the discourse of inclusion.

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1.1. School inclusion

Inclusive education has been a challenge and a conceptual, philosophical, methodological and organizational evolution with respect to the concept of integration (Stainback and Stainback, 1999)[5]. As a complex, transformative and committed process, inclusion seeks to expand the presence, participation and success of all students in educational contexts, mainly students who, for personal, social and/or economic reasons, present any situation of vulnerability –marginalization, exclusion, school failure– (Echeita & Ainscow, 2011)[6].

Inclusive education guarantees the right of students to learn from a common curricular framework (Moriña, 2010)[7] that respects the various forms and rhythms of learning, of being at school (Duk & Murillo, 2016)[8]. As a collaborative and systemic task (Echeita, 2013)[9], inclusion ables the identification and elimination of barriers –beliefs, attitudes, educational practices...– (Ainscow, Booth & Dyson, 2006)[10] and the commitment of the entire educational community (Lledó & Arnaiz, 2010)[11].

However, the reality of the school is far from the principles of inclusive education, as we continue to attend educational practices linked to the paradigm of deficit and school exclusion (Moriña, 2008; Portela, Nieto & Toro, 2009)[12,13] as a result of poor teacher training in relation to attention to diversity. In this sense, the European Agency for the Development of the Education of Students with Special Educational Needs –EADSNE– (2011)[14] points out that the ability to assess and support the progress of all students, work as a team, use various teaching methods, promote active and participatory learning experiences and diversifying teaching content and evaluation methods are the competencies that teachers have to develop to promote inclusive education.

However, we find a large part of the teaching staff who continue to be anchored in traditional and transmitting educational practices. Aware of this situation, many teachers, mainly special education teachers, demands real didactic, methodological and organisational transformations (Stainback & Stainback, 1999)[5] that reconfigure educational decision-making and the relationships between the different school agents (González, Cortés & Rivas, 2020)[15], since the discourses relating to school inclusion have evolved at a higher speed than inclusive educational practices (Arnaiz & Guirao, 2015)[16].

1.2. Special education teachers

The promulgation of Law 1/1990, of October 3, on the General Organisation of the Educational System, LOGSE[17], regulates for the first time in Spain the functions of the Special education teachers considers them to be part of the ordinary educational centers with functions of support to the integration of students with specific and special needs. The approval of this law and other more specific regulations (Law 2/2006, of May 3, Education –LOE–[18]; Law 8/2013, of December 9, for the Improvement of Educational Quality –LOMCE–[19]; Order of August 20, 2010; Decree 147/2002, of May 14[20]; Instructions of March 8, 2017[21]) have regulated over the last two decades the competences of special need teachers. More specifically, article 19 of the Order of august 20[22], 2010 states that the functions of the special education teachers in Andalusia (Spain) are:

- The attention and provision of direct teaching for the development of the curriculum to students with educational needs.
- The realisation of the adaptation of the curriculum of these students.
- The preparation and adaptation of teaching material.
- Tutoring and/or co-tutoring of students with educational needs.
- Coordination with other professionals.

Likewise, the Order of July 25, 2008[23], states that special needs teachers will provide educational attention to students with needs "preferably within the class group and, in those cases where it is required, outside of it, in accordance with the human resources assigned to the center ", because special needs teachers are a resource available to the educational system that aims to respond to the needs of students with needs (Moriña, 2002)[24], collaborate with the rest of the teachers, with other specialist professionals (both external and internal to the school) and with the family.

However, and despite the enormous effort and commitment of special education teachers to promoting inclusive practices in educational centers, aspects such as the ratio of students with educational needs/special education teachers (González-Alba, Cortés-González & Mañas-Olmo, 2020)[25] or the performance of substitute functions for other teachers (Rodríguez González, 2018)[26] are situations experienced by special education teachers that limit or prevent students with educational needs from being cared for in their ordinary classroom.

2. Methodology

From an epistemological perspective, we consider the school experience a source of knowledge that allows us to understand the reality experienced by teachers (Rivas, Leite, Cortés, Márquez & Padua, 2010)[27]. The methodology used is framed within a qualitative perspective (Pérez Serrano, 2007; Sandín, 2003)[28,29] and has allowed us to generate a collaborative and horizontal research process (González-Alba, 2018)[30]. In a more specific way, we have made use of in-depth interviews (Ruiz Olabuénaga, 1999)[31] and discussion groups (Del Rincón, Arnal, Latorre & Sans, 1995)[32] with the aim of knowing how a series of teachers perceive special education teachers experiences of integration and inclusion of students diagnosed with specific needs for educational support.

Fourteen special education teachers of at least three years of experience have participated in the research and who teach or have taught in a specific classroom and integration support classroom, both in public primary and secondary education centers in the provinces of Malaga, Seville and Cordoba (Andalusia, Spain). Due to the employment situation of many of the teachers, the fourteen reports show us their professional experience in more than 50 educational centers in the autonomous community of Andalusia, as some of the participating teachers have taught in 3 or 4 educational centers during the same school year.

The investigation has been developed in two phases. During the first, fourteen individual interviews (lasting approximately 50 minutes) were carried out with their respective transcripts and personal returns; in a later phase, two groups for discussion and reflection (of an average duration of 75 minutes) have been carried out with a part of the participating teachers.

The analytical process has been developed in two phases, one of "Open Coding" and the other of "Axial Coding" (Strauss & Corbin, 2002)[33]. During the first analytical stage (September/October 2019) the research team carried out an analysis of the content, coding of the information and a preliminary list of emerging categories –descriptive and interpretive students diagnosed with specific needs– of the interviews and discussion groups.

In a second analytical phase (January/February 2020), what Strauss and Corbin (2002)[33] call “axial coding” has been carried out, that is, the categories have been related to subcategories. Two axes of analysis have emerged from this analytical process.

School identity and segregation. The school experiences have their resonance in the identity construction of the students, mainly the segregating and deficit-based practices that promote an identity of difference (in a negative sense) with respect to their peers.

Lack of resources and school traditions. Inclusion, as a complex process that involves the entire educational community, requires greater resources and internal and external educational transformations that are capable of eliminating discourses and practices that permeate the culture of many educational centers.

3. Presentation and discussion of results

School identity and segregation.

The personal and school experiences experienced by the students in the educational context will be a determining factor in their identity configuration, since “each subject is developing their identity in a process of individual reconstruction of the conditions of the context in which they develop” (Rivas, 2007, p.124)[34]. The activities and personal and school relationships that are established in the classrooms have their effect on the students, especially the educational actions that provoke significant emotional states in the students. In this sense, and as some teachers point out, the educational attention of students with educational needs outside of their ordinary classroom has

promoted the construction of an identity of difference (González-Alba, 2018; González, Cortés & Rivas, 2020)[30,15] in their students with respect to their peers, since identity is a process that is socially constructed and is configured in the relationship established between the individual and the group (Mijangos, 2015)[35].

> I have many students who have told me that they do not like working with me outside of their class, I think it is because this makes them feel different from their classmates (AGM interview).

> Normally students do not have a problem with going out of the class with me, when I have worked in high schools some students did not want to come to my class because they did not feel judged (MAS interview).

These segregating educational experiences have configured in students an identity of difference built from a cognitive (thought) and affective (feelings) process, promoting, in turn, an attitude of rejection towards working outside the ordinary classroom. We find segregating practices that act as "didactic barriers" (Orozco & Moriña, 2020)[36], which lead to self-questioning and school displacement and that in some way will configure in students with educational needs a particular personal and school identity.

To this perception of difference experienced by students when leaving class to receive educational attention are added school experiences in which teachers have promoted the construction in the classroom of two groups, (1) an endogroup, formed by those students to whom the teacher attributes positive values, and (2) an outgroup of which those students cataloged with negative values, attitudes and aptitudes are part (Jiménez & Aguado, 2002)[37] according to the teachers' criteria. This is how some teachers explain it:

> As a general rule, the teachers explained the activity to these students and gave them a file, until I arrived, many doubts were not resolved or their work was not corrected (interview, PLF).

> I have felt many times that my students were not attended by the teachers, they gave them the same activity over and over again or they had them drawing pictures (interview, AGM).

We are witnessing a process of dehumanization (Freire, 1970)[38] and reification towards the students that materializes in school decisions –curricular, organisational, educational– that affect their training process and that configure an identity of difference. As the teachers point out, we are witnessing school situations that have contribuited to the construction of segregating school settings, that is, practices that promote the attention and educational distribution of students based on some of their characteristics (Murillo & Martínez-Garrido, 2018) and teachers who consider that the attention of students with educational needs is not their responsibility (Sandoval, Simón & Echeita, 2012)[39].

These segregating practices have promoted in the students the construction of a personal and school identity linked to the difference, generating inequalities among the students; and in the teaching staff an evaluative, limiting and compensating perception of diversity, an attitude that reinforces an organisational approach that transcends the curricular and pedagogical aspects and that reinforces the idea that attention to diversity is based on the special education teacher/students with special needs binomial.

Resources and school traditions

The school context is a plural, multicultural and complex scenario subordinated to a series of macro and micro-school educational practices and traditions –educational laws and regulations; relationships; teaching culture, methodology, didactics and evaluation; social and cultural values– (Ball, 1997)[40], which in many cases limit school inclusion.

Considering Ball's contributions and the teaching reports, we find, on the one hand, a dimension external to the center –macropolitical– and linked to a limited allocation of specialised human resources to serve students with special

needs. As the teachers points out, a special education teacher/student with special needs ratio forces teachers to have to work with students outside of their ordinary group, and therefore, not be able to carry out inclusive practices.

> That year I had to work in the integration support classroom because I had so many students assigned that I could not attend to all of them in the class-group (PLF, discussion group).

> Every year I serve an average of 20 students, with that number of students and with the very specific needs that some have, it is impossible to work on inclusion (AGM, interview).

On the other hand, and despite the fact that there are various studies in which special education teachers expose the need and the virtues of actively collaborating with others teachers (Lledó & Arnaiz, 2010; Vlachou, 2006)[11,41] as a key strategy in promoting the inclusion, we continue to find traditional school discourses and practices linked to the paradigm of school deficit and segregation. In other words, we are witnessing a school setting anchored in the deficit paradigm and in school traditions that permeate a culture of the center –micropolitical– contrary to the promotion of inclusive practices.

> I started 30 years ago, and the special education teachers were the teachers' relief in the classes, the discharge of the class, so the children always came out of class to come with us, the longer hours the better, we were there to unload the students. Tutors of children who had difficulties, the more children we had the better for them (interview, IGM).

> When I started at the center they told me that the previous special education teacher normally worked in another classroom (interview, JMD).

> When you arrive at the center there is a kind of internal experience that is transmitted year after year and that may or may not be positive (interview, NNM).

We attend two speeches that are thirty years apart in time but that show us a school that promotes segregating school practices that have been legitimized. This practiques are perpetuated as a consequence of a school tradition inherited and maintained over the years by the teachers and by the management team. We find a teaching school discourse built historically and supported by segregating school traditions, and actions –macro and microeducational, which, like so many others, have been built in, by and for the school and which are noticed by special needs teachers.

4. Conclusions

As can be seen from both the interviews and the discussion and reflection groups, we are witnessing a school setting in which a series of external dimensions (limitations of human resources assigned by educational administrations) and internal (educational tradition inherent in each school center) that promote a consolidated, parallel, limited school model, hidden behind the discourse of inclusion and that in practice is inclusive, not inclusive, which requires, according to Booth and Ainscow (2011)[42], the modification of school cultures, of their educational practices and educational policies.

Regarding a macro educational dimension (external to schools), we must consider that any activity that seeks to increase the capacity of schools to respond to diversity and promote inclusive practices requires external support (Booth & Ainscow, 2002)[43], of a legislative and human resources framework (Boer, Pijl & Minnaert, 2011)[44]. In this sense, and despite the fact that the Spanish educational system has a legislative and regulatory framework that promotes equity and inclusion, as has been evidenced in this research and from an external perspective to schools, the shortage of special needs teachers makes it difficult to effectively apply its backbone principles.

Regarding the internal dimensions analysed (educational micro), a large number of cases can be seen (1) a culture of the center based on segregating practices, and (2) teachers that promote educational attention to students with educational needs outside of the classroom. In this sense, Boer, Pijl, and Minnaert (2011)[44], Sánchez Palomino

(2007)[45] or Mosia (2014)[46] remind us that low rates of teacher training in attention to diversity can lead to negative beliefs and attitudes or rejection towards inclusive practices.

As we have previously indicated, we know that educational inclusion is a complex, transformative and committed process that is the responsibility of the entire educational community, and that, therefore, requires teacher training strategies that allow us to rethink inclusive education from a shared logic (Blanco, 2006; Valcárcel, 2011)[47,48], voluntary, reflective (Tedesco, 2011)[49], committed (Echeita et al., 2008)[50] and multidimensional.

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Paradoxes of Education and Their Effect on Media Education and Practical Applications

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Abstract

The aim of the paper is to outline the issue of media education in the current educational process. It also emphasises the importance of media education and its inclusion in the process of education. The whole issue is analysed from the perspective of paradoxes of education, which are an integral part of the educational process.

Keywords: didactics, media education, paradoxes of education, civics

1. INTRODUCTION

Today's generation is said to be born with a smartphone in the hand in an era that is very simple. We have possibilities that previous generations could not dream of. Quite literally. Despite this fact, it turns out that it is increasingly difficult for us to succeed in this media world. Ideally without a harm. The modern era places considerable demands on us. Not only on teachers who have to quickly adapt to modern and technical progress. But also on pupils. They have to learn new things and although they are more adaptable and it is easy for them to learn many things, their ability of critical thinking is becoming increasingly problematic.

The technical, media and communication environment that surrounds us is changing so fast that it is very difficult for us to be aware of, respond to and cope with the changes. The current media pressure and the need to control technical devices or search for information on the internet requires a degree of knowledge. It is important to know where to find the information, how to work with it, how to sort it and primarily be able to think about it in a critical way.

The world of the internet affects all spheres of our society. Social networks are no longer a means of communicating experiences and impressions but have become a misleading environment that affects almost all individuals and especially the youngest population. The question that arises is to what extent technological progress is useful. We can also ask questions about its advantages.

The role of the school as an educational institution is to teach pupils to think critically and sort information. Is this really achieved? Media education could teach children, pupils and students work with information. Media education is included in the category of cross-curricular topics. Therefore, it should be included in the curriculum according to the possibilities of every school. However, the delivery of media education is currently insufficient.

2. CROSS-CURRICULAR TOPICS

The Framework educational programme for elementary education and the Framework educational programme for grammar schools define the concept of cross-curricular topics. These topics focus on the current challenges of the modern world and form an integral part of elementary education. They represent an important part of elementary

education, provide the opportunity for individual engagement of every pupil as well as mutual cooperation and contribute to the development of pupils' character, primarily in the area of attitudes and values. [19] [20]

As has already been mentioned, cross-curricular topics are mandatory for elementary as well as grammar schools. However, their implementation in the educational process is the responsibility of every school. Not all cross-curricular topics need to be necessarily included in every grade. However, it is important to gradually cover all cross-curricular topics. However, their extent and method of implementation is defined by the school educational programme of every school. The cross-curricular topics can be integrated in various subjects or can be implemented by means of projects, seminars, courses, or as an independent subject. The cross-curricular topics must be linked to the educational content of specific subjects and to the content of other pupils' activities inside and outside school.[18] The cross-curricular topics are as follows:[17]

- Personality and social education;
- Civic education for democracy;
- Education towards thinking in European and global contexts;
- Multicultural education;
- Environmental education;
- Media education.

The present paper focuses on the cross-curricular topic of media education. This topic can be implemented in all educational areas. These areas include the following: Language and language communication, Mathematics and its applications, Information and communication technology, Man and his world, Man and society, Man and nature, Arts and culture, Man and health, Man and the world of work.

3. MEDIA EDUCATION

Media education covers the basic knowledge and skills related to media communication and media use. The role of the media is to present knowledge from the outside world and experience of other people. They are also a means of sharing our own experience, as has already been mentioned. Through media education, individuals should learn to work with information presented through the media. A very frequent phenomenon is media manipulation or the so-called fake news. The objective of media education is to teach individuals to work with the media and their content in a critical way. Critical thinking is defined as follows: *"Critical thinking is an intellectually disciplined process of active and skilful conceptualization, application, analysis, synthesis or evaluation of information obtained or generated by means of observation, experience, reflection, thinking and communication as a guide to conviction and action. In its basic form it is based on universal values such as clarity, precision, consistency, relevance, persuasion, depth, width and equity of thought."* [10]

Media education should provide every pupil with the basic level of media literacy. It also focuses on a systematic development of a critical distance from media communications and on the ability to interpret media communications in terms of their information quality (news coverage in terms of its relevance and credibility of news and events, advertising in terms of the efficiency of the information offered, etc.) [18]

3.1. Media education in practice

As has already been mentioned, media education is delivered in compliance with the Framework educational programme for elementary education and Framework educational programme for grammar schools. Media education is delivered in almost all of the educational areas. In practice, media education is mostly included in Language and language communication (Czech language and foreign language), Man and society (citizenship education), Arts and culture (music and visual arts). This cross-curricular topic should be included in every school educational plan and every school should include it in the process of education. The specific form of inclusion depends on every school.

Looking at this from a practical perspective, media education to a large extent depends on the technical equipment of every school. If a school has a variety of technical resources, media education is easy to teach. Another important pillar is the human factor.

We are aware that in the present era, and especially with respect to the coronavirus pandemic, the technical infrastructure in schools is largely supported. However, there is not much time left for projects, teaching of the subject itself or development of media literacy. Of course, teachers are not to blame. Perhaps for this reason they are under increased pressure and are affected by the paradox of education associated with online education.

Leaving out of account the coronavirus pandemic, although many schools have the possibility of using media education as a separate subject, they opt for projects or inclusion of the issue in the different educational areas. Although the variability of media education and ways of its inclusion in educational areas are almost endless, as a separate subject there would be much more space for media education and pupils would have many more opportunities to work with media and information. On the other hand, the attractiveness of the subject could decrease and pupils could lose their interest.

Despite all the advantages of media education, there are also many negatives. They include primarily the unwillingness of many teachers to learn new things—quite paradoxically. Taking into account the educational process alone, many older teachers are not willing and able to understand the importance of social networks, discuss with pupils why it is not a good idea to use a single website as a reference or why it is not a good idea to share private matters on social networks. In our opinion, it is not enough to tell children that this is bad. It should always be explained to them.

The authors believe that this paradox is evident today. Moving away a bit from media education and turning to the form of education, it is shifting towards the online environment. Teachers (logically) not only inveigh against online education but especially fight for traditional face-to-face education, which has clear benefits. But the question is whether their unwillingness or perhaps fear from using new technical platforms in education stems from their reluctance to learn new things or whether it is completely legitimate and traditional education is simply irreplaceable. So what exactly does technical progress bring?

4. PARADOXES OF EDUCATION

One of the first authors to address educational antinomies was for example Eugen Fink. In the Czech Republic this issue was addressed by Radim Palouš in his book *Paradoxes of Education*. In this work he describes the pitfalls that teachers encounter in the process of education. The main focus is on how to ensure a successful course of education. According to Palouš, it is very difficult. *"The activities of a single teacher often bring completely different results."* [17]

Antinomies (paradoxes) of education are concepts that refer to non-standard situations that teachers may encounter in the process of education without being fully prepared. In many cases theory contradicts practice. *"The difficulty of the teaching profession is that the teacher must get the pupils to work even if they are reluctant and try out various methods to avoid learning... Yet, this situation may surprise even an experienced teacher who is unable to resolve it at once"* [21] This is a contradiction between theory and practice or beliefs and reality as experienced by the teacher.

It should be noted that the educational process involves not only the teacher but also the pupils. However, the course of the process is not dependent just on the teacher's competences but also the overall climate and classroom atmosphere. What works with one pupil may not work with another pupil. An excellent teaching method in one class may not be good at all in a different class. How can especially young teachers avoid these paradoxical situations? Or to put it differently, is an experienced teacher able to learn to resolve these problematic situations?

The authors of the present paper believe that the most apt antinomy is that defined by Rebolul. [17] In his work, this French author defined a total of five antinomies. In the context of the present paper the most important antinomy is the fourth one—uncertainty and ("technically" obtainable) expertise of the teacher. According to Strouhal, the current era provides us with very sophisticated technical instruments to ensure the teaching process and support education. *"In the context of technically supported education, teaching activity appears as a process of achieving operational and later well-defined general objectives and as a process which is open to objective evaluation methods."* [16] A great emphasis should be placed on the significance of objectives because education should form individuals who are capable of free and critical thought and judgement. At the same time however, Strouhal claims that the capability of free and critical thought is not measurable or technically verifiable. So, how can we address the objectives of education and the pressure on teachers in terms of educating a competent and critically thinking individual?

On the other hand, Staněk [14] defines the paradox as an accelerating quantity. The development of information technology and technical progress has affected not only our everyday lives but also education: on the one hand it has increased the speed of gaining knowledge and learning, but on the other hand education has become divided. This includes generation gap, differences in material equipment of pupils, teachers and schools and also a social division.

5. CONCLUSION

The paper outlines the issue of media education in the educational process and its link to the paradoxes of education as defined by several authors. The paper provides a theoretical insight into the issue and suggests ideas for further empirical research.

Currently, the demand for media education among pupils is increasing. But we believe that the issue of media education is also reflected in teachers' behaviour and their needs. The link to the paradoxes of education is absolutely clear. Especially today when the majority of education has moved online and there is an obvious need for the knowledge of technical subjects, especially in terms of critical thinking. Through the media pupils learn a lot of information but are unable to sort it due to its unilateral content. Whether it be the pandemic or elections.

The issue of the paradoxes of education is quite broad and includes many areas, especially the process of education. We are aware of the fact that the text describes only one of the sections of the issue and cannot provide a comprehensive overview. This paper is rather a reflection on the paradoxes of education, media education and especially the need for its adequate inclusion in the educational process.

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The Importance of Lifelong Learning during the Pandemic Period

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Abstract

The COVID-19 pandemic has suddenly accelerated the transition to distance learning, education and e-learning. Due to the crisis, there has been a massive shift to online platforms and tools that make learning and skills development continuous. These tools, on the one hand, promise a future, on the other hand, they give worrying signs. With lifelong learning, equality of opportunity is offered to individuals who both continue their formal education and have lost their education, while at the same time, individuals are given the opportunity to complete their personal development, integrate with the society and increase their productivity. In lifelong learning, rather than transferring information to the learner, roles such as increasing the learning capacity of the individual, making them aware of their abilities and skills and guiding them to make choices in line with these skills, self-learning, learning and developing to learn are at the forefront. During the pandemic period in Turkey, education is carried out remotely and using technological facilities such as TV or internet. The state and all educational institutions / organizations have put forward their opportunities in order to provide individuals with access to these opportunities. While these changes previously caused discomfort in individuals to some extent, these new solutions brought to education over time during the pandemic period showed us once again the contribution and importance of the much-needed concept of lifelong learning to education. Although it is known until now, COVID-19 has been a relatively catalyst in the worldwide use of lifelong learning to seek innovative solutions in a short period of time, making change in education mandatory, albeit temporarily.

Keywords: Lifelong learning, Virtual learning, Pandemic period, Covid-19, Educational management

1. INTRODUCTION

With the start of the pandemic process, the foundations of the distance education system were laid and a new education system was created. Students, parents and teachers found themselves in a situation they were not used to before. In a sense, a digital transformation began with the start of this process.

Upon examining the relationship between economic and educational parameters and the effect of Covid-19 on education system in Turkey, we can talk about the existence of a strong bond. Distance education has led to the prominence of socio-economic inequality. That is, the right to education and access to education is significantly affected by COVID-19. If we look at the overall picture, we can say that the pandemic will cause above-average damage to education.

The pandemic process has also led to changes in education. In this article, the effects of the pandemic process on education and students will be discussed and the parameters that can affect the new system to be implemented will be presented. Nowadays, the concept of "21st century digital literacy" has emerged. Digital Literacy is defined as the skills that must be possessed in order to live, learn and work in a society where access to information is provided through digital technologies such as internet platforms, social media and mobile devices. In fact, reforms in the field of education had begun before the pandemic process, but the pandemic process accelerated and made these reforms mandatory. The education area has begun to be built to adapt to the 21st century skills.

1.1. Lifelong Learning

Lifelong Learning covers all kinds of learning activities that an individual participates throughout his life in order to improve his knowledge and skills. Lifelong learning is not limited to schools; can happen at home, at work, in all areas of life; It is one of the basic concepts that shows that learning can be sustained without any obstacles, regardless of age, social, economic status and education level.

The concept of lifelong learning has emerged in line with the needs of the age, in order to keep up with the rapidly developing and changing social and cultural life, and has become an important indicator in terms of education level and employment conditions in developed and developing countries.

With the development and gaining importance of lifelong learning, education has emerged as the basic component of all educational activities including both school education and out-of-school education, regardless of time and place. In the Lifelong Learning Memorandum announced by the European Union Commission in 2000, it was mentioned that the following six basic strategies are necessary for the definition and dissemination of lifelong learning, and the general framework of lifelong learning in the 21st century was determined:

- New basic skills for all,
- More investment in human resources,
- Development of innovations and new methods in education,
- Appreciating and certifying all kinds of education,
- Reviewing the guidance and counseling services
- It has been determined as bringing education closer to the learners as much as possible, using information communication technology to reach those with difficulty in access, lifelong learning approach for local and regional-based initiatives, multi-purpose learning centers, and utilizing information networks for the learning society.

The lifelong learning system, which started to be established with the Lifelong Learning Strategy Document for the period of 2009-2013, is aimed to have a more systematic structure in line with national and international approaches with the Lifelong Learning Strategy Document and Action Plan for the 2014-2018 period. The National Lifelong Learning Strategy Document for the Period of 2014-2018, prepared to increase the effectiveness and efficiency of the lifelong learning system, includes:

- Creating lifelong learning culture and awareness in the society,
- Increasing lifelong learning opportunities and presentation,
- Increasing access to lifelong learning opportunities,
- Development of lifelong guidance and counseling system,
- Developing a system for the recognition of prior learning,
- Development of lifelong learning monitoring and evaluation system

1.2. The effect of Pandemic on Lifelong Learning

The Covid-19 outbreak continues to adversely affect all aspects of life in the world. In this context, it was the first time that education was affected on such a global scale for the first time, and education institutions at all levels from pre-school to higher education were rapidly closed in most countries. It is now known that over a billion students at all levels worldwide are moving away from traditional educational settings (Bozkurt, 2020; Kayalar, 2020).

In Article 42 of the Constitution of the Republic of Turkey, the statement of "No one shall be deprived of education and training" is made emphasis on the right to education. During the pandemic process, some groups, most of whom were disabled children and refugee children, could not benefit from these rights. The most important reason for this was that educational services for disabled and refugee students were different. Students with disabilities are offered the choice to attend either special education schools or public schools as mainstreaming students. There are two options for refugee students: temporary schools and public schools (Yıldız and Vural, 2020; Çelik and İçduygu, 2018; Yamamoto and Altun, 2020)).

During the pandemic process in Turkey, while continuing education with the EBA and TRT channels, it is seen that these two groups are at a disadvantage in addition to the negatively affected students. After all, distance or digital education was not considered for special education schools and temporary education schools, so these students were deprived of their educational rights, while students attending private schools received different

education from public school students in this process. These students, whose numbers are quite high, were able to access education through some platforms. In addition, the inadequacy of the courses on the EBA and TRT channels will create an educational difference between the two student groups because this three-month process has an important place in the education life of students.

1.3. Measures Taken Against Adverse Effects of Covid-19 on Lifelong Learning

Especially university and vocational high school students have compulsory practical courses and internships. Even if distance education continues, if no alternative is developed for this group of students, they will not be able to complete their education or have to take a break. However, a system can be developed to eliminate such training problems. Simulations can also enter the artificial intelligence education life, and thus practical courses and internships can be done through simulations. In addition to these, digital systems such as platforms, channels, websites can be developed and integrated into education.

Education in Turkey during Pandemic is now carried out using technological means such as remote and the TV or the internet. The state and all educational institutions and organizations have put forward their opportunities in order to provide individuals with access to these opportunities. While these changes previously caused discomfort in individuals to some extent, these new solutions brought to education over time during the pandemic period showed us once again the contribution and importance of the much-needed concept of lifelong learning to education. Although it is known until now, COVID-19 has been a relatively catalyst in the worldwide use of lifelong learning to seek innovative solutions in a short period of time, making change in education mandatory, albeit temporarily (Göral, 2020).

In this temporary education process, individuals, while staying at their homes, left aside the limiting views such as education in the classroom, active teacher, and passive student, which are seen in traditional education methods, and entered the process of getting to know themselves (Wiederhold, 2020; Williamson et al, 2020; Zhu and Liu, 2020). Now, all individuals can experience an active and independent learning process by determining what, when and how they will receive education from their homes, and on the other hand, they have started to benefit from equality of opportunity in education thanks to access to countless resources available in this critical period. Again, in this period, we see that learners and solution providers really experience the concept of "learning anywhere, anytime" in digital format. Traditional face-to-face learning is complemented by new learning methods, from live broadcasts to educational influencers and virtual reality experiences, and learning for both tutors and learners is supported by technological resources. Not only that, but these days when it is compulsory to stay at home, learning is being tried to become a habit integrated into daily routines. Especially adults who try to keep their children at home either create educational activities for their children or involve their children in the jobs they do or have to do sometimes housework and sometimes professional activities. For this reason, both adults and children can experience learning as a true lifestyle in this process. Just like lifelong learning aims.

In this period, we also see public-private sector training partnerships that are the basis of lifelong learning approach. While the role of states in education is decreasing, the roles of relevant social partners are increasing. Over the past few weeks, various stakeholders, including governments, publishers, education professionals, technology providers, and network operators, have been coming together to form learning consortia and coalitions as a workaround to the crisis. In China, the Ministry of Education has set up a group of various components to develop a new cloud-based, online learning and publishing platform and to develop an educational infrastructure led by the Ministry of Education and the Ministry of Industry and Information Technology. With examples like these, it is clear that educational innovation is gaining attention beyond typical state-funded or non-profit social projects.

RESULT AND SUGGESTIONS

In recent years, much more interest and investment in education solutions and innovation from the private sector has provided huge resources for lifelong learning. On the other hand, it should not be forgotten that lifelong learning uses technological resources as a tool and aims to adapt the service to the learner in a random manner. Although most of the lifelong learning initiatives undertaken to date are limited in scope and relatively isolated, the pandemic may pave the way for larger cross-sectoral coalitions to form around a common educational goal. Otherwise, socioeconomic inequality will unfortunately manifest itself in education, as long as access costs do not decrease and access quality increases today. The digital divide among learners will widen further if education is determined by those who access the latest technologies. In this regard, the lifelong learning approach following technology but not

dependent on technology should be adopted and should not be seen as an alternative or temporary plan only in critical periods, but should be given great places in the foundation of the education system.

The basic starting point of lifelong learning for social transformation is the need for individuals to reach awareness that will develop their skills to plan deeper, more realistic and suitable for their personal realities. For this, they need to ask in-depth questions, work to improve their self-awareness, rediscover career goals and objectives, and shape their visual, verbal and virtual presence according to the sector.

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Determining Statistical Relations between Quantitative Demographic Indicators in Rural Areas

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Abstract

Rural areas in the Dalmatian hinterland are marginalized in terms of traffic. When analysing the Dalmatian hinterland where the town of Drniš is the centre of the rural area, it is evident that passenger cars are the only possible form of transport. The realized trips will be analysed in the context of demographic indicators. In order to determine the dependence of the number of total daily migrations in the selected rural area, the relevant independent variables will be determined and will be statistically analysed. As the impact of depopulation is substantial in rural areas and economic activities have been transferred to urban areas, research faces challenges regarding the limited amount of data that can be used in statistical analysis.

Keywords: rural area, daily migrations, demographic indicators, public passenger transport

1. INTRODUCTION

Drniš is a town in the heart of the Dalmatian hinterland, halfway between Šibenik and Knin. It is surrounded by the mountains Promina and Moseć, which form a passage to Petrovo polje called Drniška vrata. The river Čikola runs near the town (Marin, 2008). The town of Drniš is an integral part of the rural area of the Dalmatian hinterland (Lukić, 2013). Drniš occupies an area of 351.75 km2 (Radeljak, 2015). Administratively, Drniš is one of 20 local self-government units in the Šibenik-Knin County, and includes 27 settlements: Badanj, Biočić, Bogatić, Brištane, Drinovci, Drniš, Kadina Glavica, Kanjane, Kaočine, Karalić, Ključ, Kričke, Lišnjak, Miočić, Nos Kalik, Pakovo Selo, Parčić, Pokrovnik, Radonić, Sedramić, Siverić, Širitovci, Štikovo, Tepljuh, Trbounje, Velušić, Žitnić (Ministarstvo uprave, 2020). Near the town of Drniš, there are several municipalities to which it is connected by economic, transport and demographic factors (Radeljak, 2014). In Figure 1 Biskupija, Ervenik, Unešić, Promina, Ružić, Kijevo and Kistanje are pointed out. As the mentioned municipalities do not have facilities such as primary schools, doctor`s offices, post offices and other facilities, they are forced to communicate with Drniš on a daily basis. The town of Drniš offers a variety of opportunities for tourists. Firstly, the Krka National Park, which is located nearby, is visited by an increasing number of tourists every year (Turizam u brojkama, 2012-2018). Another possibility is rural tourism due to a large number of rural households, hiking and hunting opportunities, and cycling tourism, which is becoming increasingly popular (Strategija razvoja grada Drniša do 2020. godine, 2015). The aim of this paper is to examine the correlation between the number of daily migrations of the residents of Drniš and different demographic indicators.

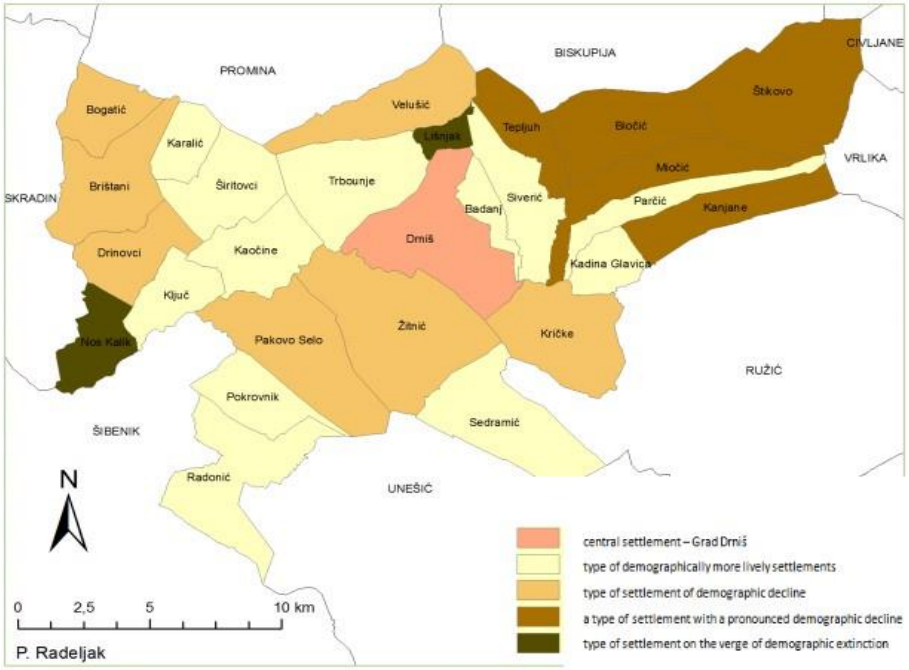

Figure 1. The area of Drniš and the surrounding municipalities
Source: Case study - The town of Drniš, Petra Radeljak Kaufmann

2. The analysis of the demografic indicators of the town of Drniš

The traffic position of the town of Drniš is favourable at both the local and county level. Considering the local level, rural areas are well connected with the town of Drniš in terms of infrastructure, but not when it comes to public passenger transport. The lack of public passenger transport does not help the development of rural settlements outside the town of Drniš because only a select, working group of residents, who own and use a personal car, is mobile. Groups of residents such as pensioners, students and pupils cannot travel independently to the town of Drniš. As for the county level, the town of Drniš is located at the intersection of important road and rail routes. A ride from Šibenik to Knin lasts 30 minutes, and it takes 1 hour and 30 minutes from Zadar or Split when travelling by car. Public transport at the county level exists, but it is unintegrated and unreliable (Maretić & Abramović, 2019). When travelling by bus, it takes about 40 minutes from Šibenik to the town of Drniš, and from Knin to the town of Drniš passengers need around 25 minutes (Županijski red vožnje Autotransport Šibenik, 2019). When travelling by train, passengers need around 1 hour and 15 minutes from Šibenik, and about 25 minutes from Knin (Vozni red HŽPP, 2020). The town of Drniš does not have a train station (Maretić & Abramović, 2020), but one is located in Badanj, a peripheral settlement, which is an integral part of the administrative area of the town of Drniš, i.e. it forms the rural area of the administrative area of the town of Drniš.

Emigration has had the greatest demographic influence on the town of Drniš and it began at the end of the 19th and the beginning of the 20th century. However, its impact was not significantly felt because it took place along with the demographic transition, which resulted in an increase in population due to a high birth rate (Bralić and Radeljak, 2011). The population numbers reached their peak in 1961 with 19,538 residents, after which there was strong depopulation, both in the area of the town of Drniš and in the surrounding areas (Radeljak, 2015). In the last inter-census period, the town of Drniš lost about 1,100 residents. In 2011, there were 7,500 residents in the town, 3,144 of which lived in the settlement of Drniš. All of the settlements in the area of Drniš had fewer residents in 2011 in comparison to 1857, as well as all of the surrounding municipal settlements (Radeljak, 2015). The data collected during the last census related to the number of residents, the number of daily migrations and the number of working-age population is shown in Table 1.

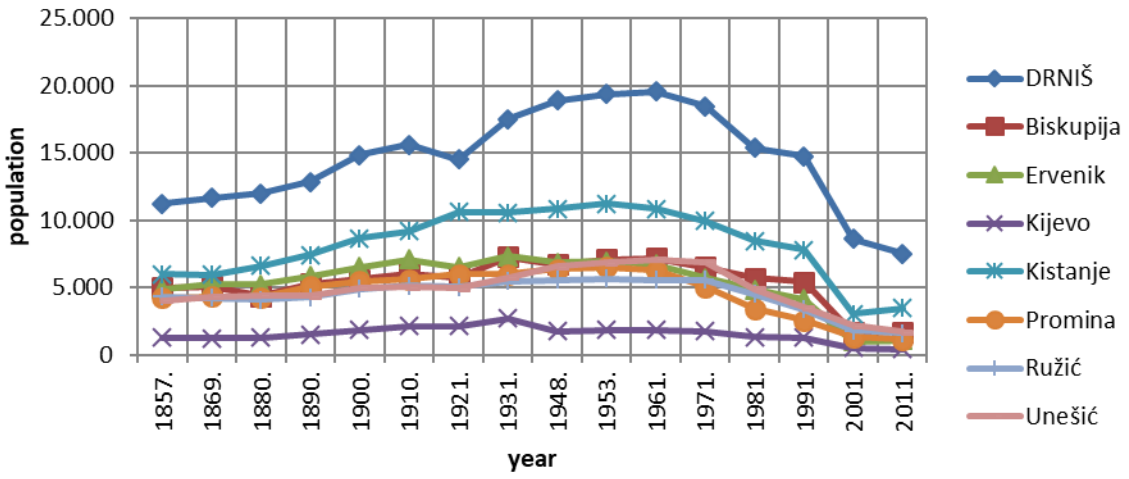

Figure 2. Demographic trends of the town of Drniš and the surrounding municipalities
Source: Compiled by the author according to the data of the Croatian Bureau of Statistics

Table 1. Number of residents and daily migrations

Town/Municipality	Total population	Daily migrations	Working-age population	Share of daily migrations [%]	Share of working-age population [%]
Drniš	7.498	1.615	4.523	21,54	60,32
Biskupija	1.699	181	847	10,65	49,85
Ervenik	1.105	42	576	3,80	52,13
Kijevo	417	82	233	19,66	55,88
Kistanje	3.481	164	1.873	4,71	53,81
Promina	1.136	218	551	19,19	48,50
Ružić	1.591	352	901	22,12	56,63
Unešić	1.686	381	886	22,60	52,55

Source: Compiled by the author according to the data of the Croatian Bureau of Statistics

The employment rate is the highest among the residents who migrate daily as is shown in Figure 3.

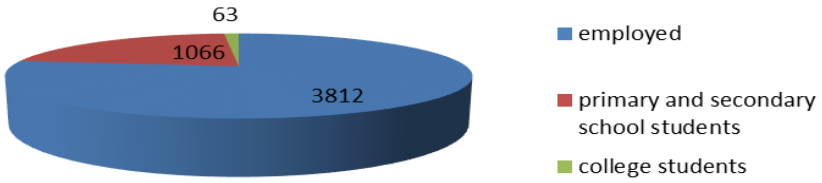

Figure 3. The structure of daily migrations in Drniš
Source: Compiled by the author according to the data of the Croatian Bureau of Statistics

By analysing and processing the data from Table 1, Figure 3 shows the shares of individual population groups when it comes to the number of daily migrations. The unemployment rate and population density are shown in Table 3 according to the calculations (Šipuš et al., 2019). The unemployment rate is defined as a criterion of economic development, while population density is defined as a criterion of demographic development.

Table 2. Unemployment rate and population density

Town/Municipality	Unemployment rate [%]	Population density [people/km^2]
Drniš	54	21,1
Biskupija	77	12,74
Ervenik	78	5,18
Kijevo	65	5,6
Kistanje	83	14,25
Promina	59	8,15
Ružić	60	9,93
Unešić	55	8,99

Source: Compiled by the author according to the data of the Croatian Bureau of Statistics and the collected data from sources [15-21]

The chosen independent variables for analysis are:

• employed residents,

• total population,

• number of working-age residents,

• unemployment rate and

• population density.

3. Coorelation analysis

Correlation analysis is a statistical method used to examine the strength of the relationship between two variables and it provides a mathematical framework that expresses the statistical correlation between traits. Correlation can determine the variations of characteristics between two data ranges. The essential properties of the correlation coefficient are that it can be: $-1 \leq r \leq 1$ and if the value of the correlation coefficient r is close to zero or equal to zero, it means that the linear relationship between the variables is weak or non-existent. On the other hand, the closer the value of the correlation coefficient is to 1 or -1, the stronger the relationship between the variables. Pearson's and Spearman's correlation coefficients are used most often. The interpretation of correlation is performed according to intervals (Petz, 2004):

- r from 0,00 do ± 0,20 means no correlation or insignificant correlation,
- r from 0,20 do ± 0,40 means small correlation,
- r from 0,40 do ± 0,70 means real, significant correlation,
- r from 0,70 do ± 1,00 means high or very high correlation.

The Pearson correlation coefficient indicates how well we can describe the relationship between our data sets through linear dependence.

The total number of daily migrants is analysed as a dependent variable, and the selected variables from Chapter 2 are analysed as independent variables. The null hypothesis is set as follows: “"The correlation between the individual analysed independent variables and the dependent variable is not statistically significant." Pearson`s correlation coefficients were calculated for all the variables, and the probability of the hypothesis correctness is shown below the coefficients, as can be seen in Table 3.

Table 3. The Pearson correlation coefficient

Pearson Correlation Coefficients, N = 8 Prob > |r| under H0: Rho=0					
	Employed residents	Working- age population	Total population	Population density	Unemployment rate
Total number of daily migrants	0.99418	0.93175	0.91613	0.82504	-0.55828
	<.0001	0.0008	0.0014	0.0117	0.1504

Source: Calculated by the author with the SAS software tool

The scatter plot analyses the data displaying the relation between two sets of data (Pavlović, 2016). Figure 4 shows the relation between the set of data that consists of the total number of daily migrants and the set of data for all variables that are the subject of analysis. Regarding the fact that Pearson's correlation coefficient is around -0.55828 for the variable for the unemployment rate (Table 4) and that the data is scattered without indicating any regularity (Figure 4), linearity is not statistically relevant and liner regression will not be calculated for this variable.

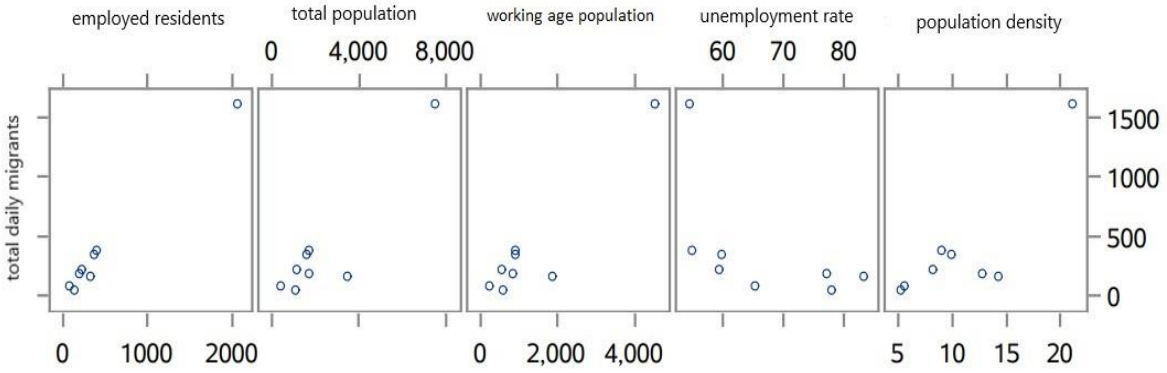

Figure 4. The scatter plot
Source: Analysis with the SAS software tool

By comparing the data from Table 4 and the scale for interpretation that is described at the beginning of this chapter, the correlation for all independent variables can be characterized as a correlation with a very high level of connection. In order to analyse in more detail and to simplify the problem, linear regression will be applied. Linear regression will be used to construct a model that describes the interdependence of the dependant and independent variables.

4. Regression analysis

Regression analysis is used when there are two or more variables that are inherently connected, i.e. when there is some dependence (of correlations) between them that we want to explore. Regression techniques allow us to quantitatively express that dependence (correlation) and use the obtained model for (1) predicting some data for which we have no measurements or use it to arrive to some (2) constants that describe that dependence. Linear dependence is the simplest non-trivial dependence that can be imagined and therefore tends to transform into this kind of dependence (Bertoša, 2020).

Linear regression will be analysed in such a way that the dependant variable will be presented by the total number of daily migrants and the independent one will be the number of employed residents, the number of working-age residents, the total number of residents and population density. The level of reliability, determined during the analysis, is 95%. The dependence of linear regression implies that the dependant variable Y linearly depends on the independent variable X in such a way that:

$$Y = l + kX$$

where:

l – represents a section on the Y-axis,

k – represents the slope of the linear regression line.

The variable X will be represented as a vector:

$$X = \begin{pmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{pmatrix}$$

X_1, X_2, …, X_n are different measurements of the variable X that represent the total number of residents, population density, the level of unemployment, the number of employed residents and the number of working-age residents. In an analogous manner, the variable Y is a vector whose elements are different measurements of the variable Y that (in corresponding linear regressions) represents the total number of daily migrants.

By including any value of the independent variable X, the dependant variable can be calculated. The calculated number will represent a prediction obtained with the model of linear regression. In order to determine the accuracy of measurement, the procedure of calculating the relative error will be conducted. The calculated parameters from the model will be rounded down to the first significant digit and the relative error on the section of the Y-axis will be calculated with the standard error.

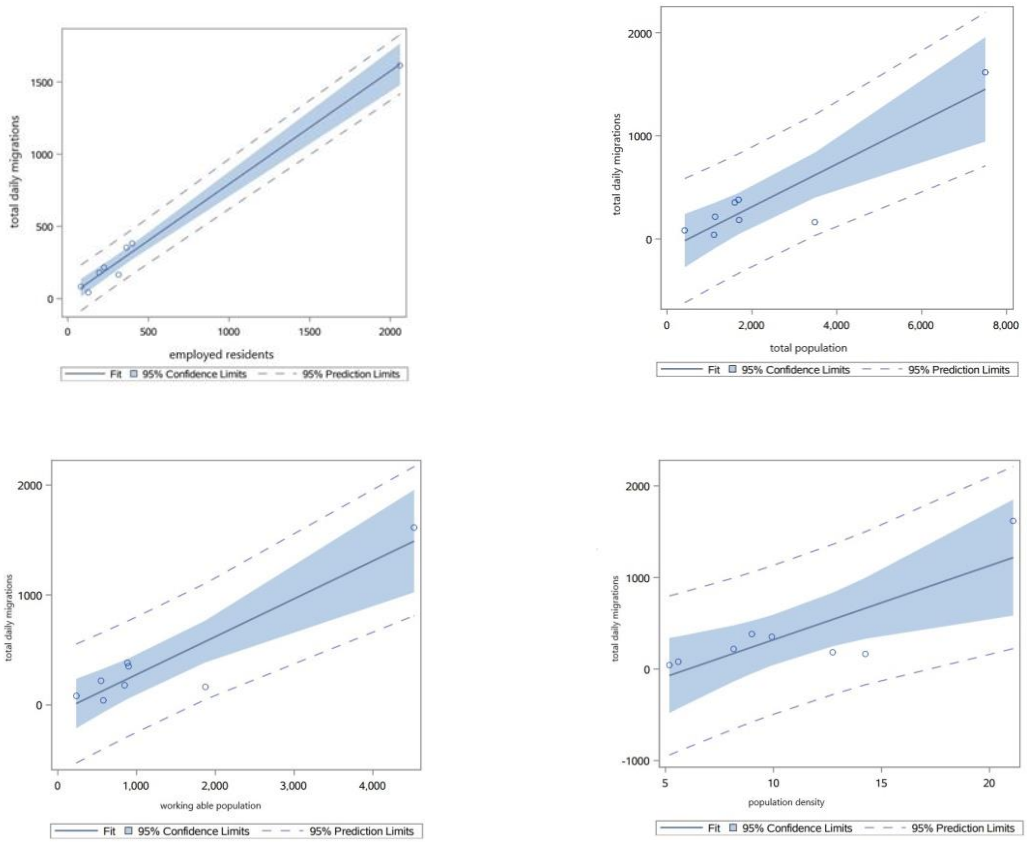

Figure 5. Lines of the linear regression
Source: Analysis with the SAS software tool

The calculated values of the linear regression model for the independent variable of the number of employed residents are:

$$Y = 11.29882 + 0.78231\ X$$

The line of the linear regression for the mentioned model is shown in Figure 5.

The calculation in the software tool generated a standard error 26.64912. The relative error of the calculated section on the Y-axis is:

$$(0.1 \pm 0.3) \times 10^2 = 10 \pm 30$$

The relative error is 300%.

The same procedure will be conducted for calculating the relative error for the linear regression slope. The standard error for the slope is 0.03460, and the relative error is:

$$0.78 \pm 0.03$$

The relative error is 3.85%.

The calculated values of the linear regression model for the independent variable of the number of residents (Figure 5), are:

$$Y = -102.85818 + 0.20727\ X$$

The calculation in the software tool generated the standard error 116.56546. The relative error of the calculated section on the Y-axis is:

$$(-0.1 \pm 0.1) \times 10^3 = -100 \pm 100$$

The relative error is 100%.

The same procedure will be conducted for calculating the relative error for the linear regression slope. The standard error for the slope is 0.03703, and the relative error is:

$$0.21 \pm 0.04$$

The relative error is 19.05%.

The calculated values of the linear regression model for the independent variable of the number of the working-age residents (Figure 5) are:

$$Y = -67.97074 + 0.34444\ X$$

The calculation in the software tool generated a standard error 100.61707. The relative error of the calculated section on the Y-axis is:

$$(0 \pm 0.1) \times 10^3 = 0 \pm 100$$

The result is from -100 to +100

The same procedure will be conducted for calculating the relative error for the linear regression slope. The standard error for the slope is 0.05480 and the relative error is:

$$0.34 \pm 0.05$$

The relative error is 14.71%.

The calculated values of the linear regression model for the independent variable of the population density (Figure 5) are:

$$Y = -489.96993 + 80.92576\ X$$

The calculation in the software tool generated the standard error 267.08940. The relative error of the calculated section on the Y-axis is:

$$(-0.5 \pm 0.3) \times 10^3 = -500 \pm 300$$

The relative error is 60%.

The same procedure will be conducted for calculating the relative error for the linear regression slope. The standard error for the slope is 22.62759 and the relative error is:

$$(0.8 \pm 0.2) \times 10^3 = 800 \pm 200$$

The relative error is 25%.

5. Conclusion and discussion

The town of Drniš has no established public transport in its administrative area, nor in the wider gravity area. Therefore, the residents of the settlements and municipalities that are dislocated from the city can only travel by car. In this paper, the author examines the correlation between the daily migrations of residents and independent

variables that include the number of residents, the number of employed residents, the number of working-age residents, the total number of residents, the level of unemployment and population density.

In order to correctly draw conclusions from the before mentioned analyses, it is necessary to explain the context of the analysed situation. The starting point is to consider all of the analyses in the context of the rurality of the coverage area. Rural areas are sparsely populated areas; they are areas without strong economic activities, as well as without strong state and local institutions. Since there is no trip generation, there is a lack of data that could be analysed. The population is declining, and rural areas are not attracting young people, so the population largely consists of retired people. The correlation analysis for the selected independent variables showed some specific results. Therefore, the employed residents with small differences and the total number of migrants have very strong correlation, but because of the constraints set due to the rurality of the area, the statistical relation cannot be examined with the increase of numerical differences of these variables. The correlation between the total number of daily migrants and the total population is also linearly grouped at small numerical differences and there is also the same limitation for examining the increase in differences as for the previous independent variable. The number of working-age residents also outlines the linear correlation with the total of daily migrations, and it is clearly represented when grouping the data with small differences. The same limitation for the increase in differences is evident as with the previous variables. The unemployment rate in relation to the total number of daily migrants is too dispersed. The reason is the small amount of data, but sociological differences in areas where there are smaller and larger differences in the unemployment rate in relation to the total number of daily migrants also contribute to this. Accordingly, the municipalities of Biskupija, Ervenik and Kistanje have larger differences and others have smaller ones, except for the town of Drniš. Due to the large scattering and no observed linearity, these independent variables will be omitted from the linear regression. Population density is on the edge of a very high correlation with the total number of daily migrants. At the lowest differences in the data collected for the total number of daily migrants and population density, the linearity is clear, but as the difference increases, the data disperse significantly and the correlation decreases. Linear regression constructs a model that will allow predicting the total number of migrants for each independent variable. The results for all independent variables calculated with the model have a high relative error for the section on the Y-axis, and an acceptable one for the slope of the line. As for the relative error on the Y-axis, this shows how much oscillation there can be for the initial prediction of the total number of daily migrants relative to the independent variables. The slope is acceptable and indicates an inclination or a gap in the increase of the total number of migrants for two consecutive independent variables. Therefore, for the same increase of the employed population, the total number of daily migrants will increase faster than for other independent variables. In the correlation analysis for all indicators, the town of Drniš is more dispersed than the municipalities and in the case of linear regression, the town of Drniš has the largest deviation from the line of regression.

Future research should focus on examining new statistical methods for establishing statistical relations between indicators. The disadvantage of applying linear regression to data in rural areas is the low reliability due to the small data set. Regardless, linear regression provides good results at low differences between the dependent and independent variables, while differences in high data values in rural areas are still insufficiently explored when applying this method. The reason for this may be the definition of rural space with which small towns form an integral part of rural areas. The applicability of linear regression in a rural area may be limited by the low number of small towns in the coverage area. Also, if the number of small towns in the coverage area is low, and a larger data set with larger cities or municipalities is analysed, the number of smaller towns can be ignored.

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Usage of Speech Recognition Systems in Intelligent Industrial Automation

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Abstract

In the field of industrial automation, the use of voice and speech recognition systems is less common, although it can offer many possibilities. This article presents the basic operation of speech recognition systems and the possible resulting errors in industrial use. We provide insights into applications that are already available for use in this area and thus provide inspiration for the use of speech recognition systems in "dirty" environments, such as industrial automation. Although the use of speech recognition in industrial automation is fairly new, its application is gaining ground. We can see some examples of these solutions like the usage of a speech recognition system in a cell of a robotic arm or in a modern storage system.

Keywords: Speech recognition, Human-machine interface, Robotics, Industrial automation, Industry 4.0

1. INTRODUCTION

A possible way to increase production capacity to meet the ever-increasing market demands is industrial automation, for which modern technologies such as industry 4.0, robotics and artificial intelligence offer many opportunities. These modern technologies include voice controlled and speech recognition systems, which are used daily in the world of mobile phones and globalization. The language barriers among cultures can be bridged using real-time translation applications, without having to learn the actual language, although these systems may not always give reliable results because of the complexity and dissimilarity of languages. Nevertheless, we can say that speech recognition technology is becoming more sophisticated and gaining more and more ground in our everyday lives.

Speech is one of the most important forms of communication created in the history of humanity. This primary form of communication has many advantages. Speech can be used at a greater distance, does not require any objects to transmit, and most importantly, it is the fastest available form of human communication [1, 2]. Writing as a form of communication is slower and processing it is more time-consuming. Meanwhile, human-machine communication has become faster and faster, but the keyboard [3], which has become commonplace in today's world as a data input device, is still a slower solution than voice recognition systems.

Industrial and manufacturing technologies prefer to use ready solutions, which is why speech recognition systems are not yet used widely in industrial automation, even though these systems are increasingly reliable and have many applications. Using automatic speech recognition (ASR) systems in the industry can make the work easier and faster, by allowing human operators using both of their hands as their voice as if it was a third hand [2].

This article provides a review of recent literature on the applications of automated speech recognition and voice control systems in the field of industrial automation and thus provides knowledge and motivation for wider application of such technology.

2. Methods

The purpose of this study was to collect and present various voice and speech recognition applications from literature sources that are currently used in industrial automation. The search period applied to peer-reviewed journal publications between 2000 and 2020. We searched for articles in the mdpi, Web of Science and researchgate databases using the following keywords: speech recognition, robotic arm, human-machine interface, and industrial automation. As shown in Figure 1, the number of obtained articles was 743. We excluded those that were not open access, which reduced the number of articles to 503.

After filtering by title and abstract, only 47 articles left. Articles that focused on speech recognition itself and not on the application possibilities, and those unrelated to industrial automation were removed. The result of robotic arms and industrial automation keywords were more about different control method of robots, or about the widespread technologies in industrial automation, which were also not related to speech recognition.

Furthermore, 18 of 47 articles were discarded for other reasons. Although the content of these articles was related to the topic based on the abstract, their detailed content differed or were very similar to the other articles. The number of articles thus left for in depth article review was 29.

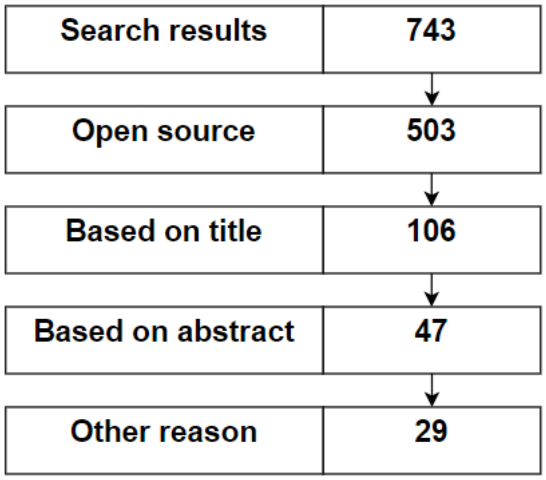

Fig. 1. Article selection

3. Results

3.1. ASR Systems

The four main components of ASR systems are pre-processing stage, feature extraction stage, a language model, and classification stage as shown in Figure 2. The purpose of the pre-processing stage is to transform the speech signal before any information is extracted, commonly by using functions such as noise removal, endpoint detection, pre-emphasis, framing, and normalization [4-6]. These functions are also dependent on the approach that will be employed at the feature extraction stage.

The feature extraction stage extracts a number of predefined features from the processed speech signal. These extracted features must be able to recognize distinct classes while being robust to any external conditions, such as noise. Some of the extraction features proposed in recent years are mel-frequency cepstral coefficients (MFCCs), discrete wavelet transform (DWTs), and linear predictive coding (LPC) [1, 7]. The classification stage will have to efficiently classify the input speech signals according to these extracted features [8-10].

The next stage is the language model, which consists of the syntax and semantics of the language, as well as any additional knowledge related to it [11]. This is necessary to recognize trigram, words or even sentences in the input speech signal, instead of only the phonemes it consists of. Thus, in order to produce meaningful representations of the speech signal, knowledge of a language is required [12].

Finally, a classification stage uses the extracted features and the language model to recognize the speech signal. The classification stage can be tackled in two different ways: the first approach uses the joint probability distribution over the given observations and class labels. This is called a generative approach. The second approach is not discussed in this study.

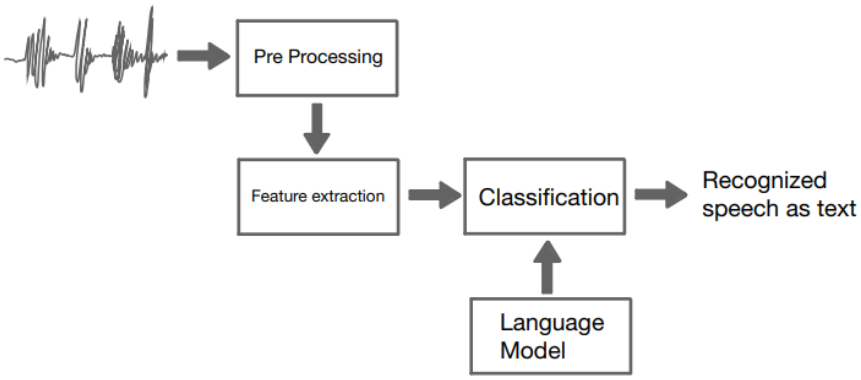

Fig. 2. Basic block diagram of an ASR system

3.2. Speech recognition chain

Humans make sound in normal environment which is an analog environment. A computer cannot work with analog data. It needs digital data to be able to work with. So, the first thing what we need to do is an analog to digital conversion. The microphones are basically analog-digital converts.

1. Capture some wave on the graph as amplitude over time - with a microphone

2. Digitalize this wave - analog to digital conversation

3. Create spectrogram – by Fast Fourier Transform

3.2.1. Microphones

When someone speaks, sound waves are created by their voice and the energy is carried toward the microphone. This sound is energy carried by vibration in the air. Inside the microphone, the diaphragm moves back and forth when the sound waves hit it. The coil, attached to the diaphragm, moves back and forth as well. A permanent magnet produces a magnetic field that cuts through the coil. As the coil moves back and forth through the magnetic field, an electric current flows through it. The electric current flows out from the microphone to an amplifier or sound recording device.

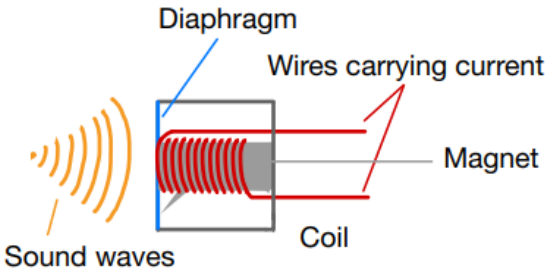

Fig. 3. Microphone

3.2.2. Spectrogram

A spectrogram visually represents the spectrum of frequencies of the signal as it varies over time. In the case of audio signals, spectrograms are referred to as sonographs, voiceprints, or voicegrams. A 3D plot representation of the data may be called a waterfall. Spectrograms are used extensively in fields such as music, linguistics, sonar, radar, speech process, and seismology [2]. Audio spectrograms are used for the phonetical identification of spoken word and for analyzing various animal calls. A spectrogram can be generated by an optical spectrometer, a bank of band-pass filters, by Fourier transform or by a wavelet transform [13].

3.2.3. Linguistics

Linguistics is the scientific study of languages. It analyzes the form and meaning of language, as well as its usage of context. Linguists traditionally analyze human language through observation of connections between sound and meaning. It also deals with outside factors that can influence language, such as culture, which often determines the language-based context. [7, 14-16] The sub-branches of historical and evolutionary linguistics research the change and growth of languages, particularly over an extended period of time.

3.2.4. Phonemes and allophones

A phoneme is a unit of sound that distinguishes words from one another in languages. A pair of words where the difference in meaning is represented by the difference in a single phoneme is called a minimal pair. For example, the sound patterns /sɪn/ (sin) and /sɪŋ/ (sing) are two separate words that are distinguished by the substitution of one phoneme, /n/, for another phoneme, /ŋ/ in most dialects of English, except in the dialects of the west midlands and the north-west of England [17].

Although there are differing views within linguistics in exactly what phonemes are and how a given language should be analyzed in phonemic (or phonematic) terms, the general definition of a phoneme is an abstraction of a set (or equivalence class) of speech sounds (phones) that are considered equivalent in a given language. For example, in English, the k sounds in the words kill and skill are not identical, but they are distributional variants of the phoneme /k/. Allophones are sounds in speech that are different but do not change the meaning of a word. These can be spoken differently by different people but it is always the same phoneme that is meant. In phonology, they are defined as one of a set of multiple possible spoken sounds or signs used to pronounce a single phoneme in a particular language. [4] Replacing a sound by another allophone of the same phoneme usually does not change the meaning of a word, but the result may sound non-native or even unintelligible. Native speakers of a given language perceive one phoneme in the language as a single distinctive sound and are "both unaware of and even shocked by" the allophone variations that are used to pronounce single phonemes. [18,19]

The reason for allophones are the position of the phonemes within the word and the person's accent, age, gender, and emotional status.

These phonemes are the basic building blocks that the speech recognition software can use to put them in the right order to first form a word, then afterwards a sentence and so on. A speech recognition software does that by using two techniques: Hidden Markov Models (HMMs) and Artificial Neural Networks (ANNs).

3.3. Used methods at the classification stage of an ASR system

3.3.1. Hidden Markov models

HMMs are used to reconstruct the phrase that has just been said by putting the right phonemes after one another. For this, HMM is using probability values.

The most successful and most commonly used method for the classification stage of an ASR system is the HMM, because of its ability to model the time distribution of speech signals. HMMs are based on a flexible model, which allows them to adapt to the required architecture, and to easily execute both the training procedure and the recognition process. Because of this, the approach is both efficient and highly practical to implement. HMMs can find the probability of the phoneme or word generating a speech sequence, and evaluate its most probable representation from a number of possibilities.

HMMs consist of three primary parameters. The first is the list of possible state transitions, depicted by aij, which is the probability of being in state Sj, given that the previous state was Si. These state transitions are represented by the flow of arrows between the given states.

The second is the list of possible observations visible at the output, which are the possible sounds at each state, represented by the variable bj(Ot), which is the probability of the observation at time t, for state Sj. These observations can be also represented by a probabilistic function, because the speech signals can be produced in different ways.

The final parameter is the initial state probability distribution.

The three fundamental components of an HMM process are: evaluating the probability of a sequence of utterances for a given HMM, selecting the best sequence of model states, and modifying the corresponding winning model parameters to better represent the speech utterances presented.

3.3.2. Artificial neural networks

The second most widespread classification method in ASR systems is ANNs. These are most commonly used together with HMMs to combine the advantages of both methods but are used independently as well.

ANNs can organize and learn according to datasets inputted during the training phase. They can adapt when unknown data are presented. These make them excellent for pattern recognition applications. The main disadvantage of ANNs is that they are prone to overtraining and local minima problems, because of their basis in Empirical Risk Minimization (ERM). Additionally, they are unable to represent the time variability of a speech signal, which can be solved by using a hybrid model that combines ANNs and HMMs.

The most common architectures of ANNs are multilayer perceptron (MLP), recurrent neural network (RNN), and fuzzy neural network (FNN).

3.3.2.1. Multiplayer perception

In ASR systems the most successful and most commonly used ANN architecture is the MLP. It is a feed-forward network that consists of at least three layers: the input layer, the hidden layer, and the output layer.

The training process uses a learning algorithm based on the conventional backpropagation approach and the concept of lateral inhibition. Afterward, the network determines the resultant output based on the representation corresponding to the output neuron, which results in the highest activation. However, an MLP is unable to handle the dynamicity of speech signals, so it needs to be given inputs with a fixed length. Additionally, MLPs are better at recognizing phonemes than words, as they are unable to deal with large vocabularies. [20]

3.3.2.2. Recurrent neutral network

RNNs consists of three layers: an input layer, a hidden layer, and an output layer, and use feedback connections, either at the hidden or output layer. The output of each node is multiplied by a corresponding weight, and fed back to the node itself, making its state dependent on both the current input and its previous state. The results of an RNN can be better than that of an MLP, but their training algorithms are more complex and are sensitive to changes.

3.3.2.3. Fuzzy neutral network

FNNs are based on a combination of fuzzy systems and neural networks. Fuzzy systems use membership functions, which map each element to a degree of membership. Because there are no clear boundaries for sounds in a speech signal, membership functions are optimal for speech recognition applications. Additionally, if the amount of training data available is not enough to properly train the ANN, it may not be adequate for classification. However, FNNs are able to converge during the learning process, which results in better performance. Like other neural networks, FNNs can be used independently or combined with another method. The proposed example is a hybrid system consisting of a wavelet transform, a Continuous Density Hidden Markov Model (CDHMM), and finally an FNN.

Ling et al. [21] gives a systematic review of existing techniques and future trends in the topic of deep learning for acoustic modeling in parametric speech generation. Kongs et al. [22] describes methods for evaluating automatic speech recognition (ASR) systems in comparison with human perception results, using measures derived from linguistic distinctive features.

3.4. Usage of ASRs

In this section, we discuss two major applications of ASRs. Although these are not for industrial automation, we consider important to mention them due to their potential future implications and applications..

Medical assistance applications include automated speech recognition system in medical equipment. These are both easy to use and allows instrument control in environments where the hands of the doctor or healthcare worker are busy. These applications are primarily used in dictation systems for the development of reports in areas like radiology, pathology, and endoscopy. This eliminates the need for transcription services and decreases time in situations where the existing interaction is already with a computer. Automatic speech recognition techniques have also been successfully used to help patients with speech and voice disorders [6].

The second major application territory is home automation and security access control. Automation industry applies ASR systems in various sectors, from household appliances to automobiles. ASR systems have been installed in various cars for controlling driving actions, improving driver safety by minimizing visual and manual demands of performing current in-vehicle tasks. Speech can provide a more secure means of authorization without any need of remembering passwords or using keys. Acoustical systems have great advantages if the perception of visual information is impaired (e.g. darkness, too much light, vibration). Interfaces based on gestures or voices have been widely used for home automation. Powered wheelchairs help with mobility for the disabled and elderly with motor impairments [8-10].

3.5. Robotics

One of the most common ways of increasing production capacity is the use of automated systems and robotic arms. The robotic arm has several advantages: it is able to perform high-quality, monotony-tolerant work at a low cost [11]. This can also be an advantage for the workers, as they can be used optimally even in hazardous work environments.

There are many types of robotic arms depending on whether they specialize in accomplishing one particular task or performing universal tasks. The most commonly used robots are serial manipulators, in which each rigid body element is connected by so-called joints. We can group the robot arms according to the number of these joints, but also according to speed, accuracy, power, or the type of motors controlled [12].

Despite the diversity of robotic arms, all of their basic operations are illustrated in Figure 4. It is apparent that every robot has a predefined program that follows a series of defined coordinate points. To follow these sequences, some kind of control system is required with which the robotic arm communicates. On this channel, the control system can send instructions to the robot arm, and the robot arm can also provide status information and events.

As a result of external instructions, the motor control system puts the robotic arm motors in motion, the position of the end tool changes. The extent of the change must be measured back by the engine control system so that the system receives feedback on the extent of the change and results in the most accurate positioning possible [23].

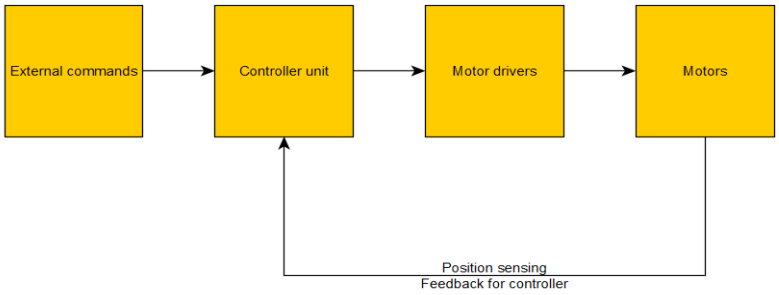

Fig. 4. Typical robotic arm driver with ASR system

The control of robotic arms used in the field of industrial automation is usually programmed with special software for the given device or with some external controller, the programming of which requires professional knowledge. These complex and slow systems could be replaced by voice-controlled robotic control systems, which could simplify programming for the target task and limit the required expertise to the knowledge of keywords.

The possibility of implementing a robotic arm with voice control has been shown in several studies. Article [24] is about a person with missing arms who is helped by such a system in daily activities. The aim of this paper is the development and testing of a voice control system for a robot usable by disabled subjects in daily activities. The system consists of a 6 degree of freedom robot, a PC, a wireless microphone and a speaker. Figure 5 illustrates the configuration of the system. Other applications are written in [25,26].

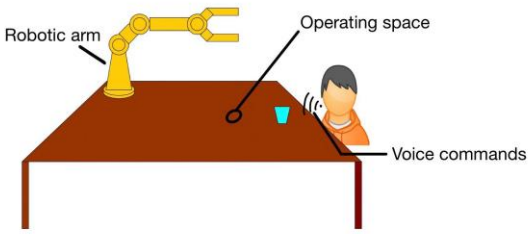

Fig. 5. The configuration of the system

In article [27], the JACO robotic arm is controlled by a semi-autonomous Assistive Robotic Manipulation Assistance (ARoMA-V) based on computer vision and voice recognition. The subjects who were unable to use the joystick for robot control found this platform useful. It then received a subsequent improvement (ARoMA-V2, Ka et al. [28]). The system was operated by two sets of user commands: 1) direction-based commands (e.g. move up, move

down, move left, move right) and 2) task-based commands (e.g. open hand, close hand) as shown in Table 1. The testing of its ability to recognize the vocal commands and identify objects was successful. However, neither application was evaluated using a validated usability scale by the subjects with disabilities.

Table 1: Direct-based and task based-commands

Direction-based commands	
Moving the robotic arm's endpoint	"up" "down" "left" "right" "front" "back"
Task based commands	
Giving task specified command to the robotic arm	"move home" "shake" "go to position one" "open the juice"

The versatility of applications for voice-controlled robotic arms is clear from article [28]. These voice commands could also be used to program a robotic arm in an industrial automated system by teaching commands such as "go to position 34.56, 112.222, 56.1" or "save position as start position" but many other fine-tuned voice commands can also be taught to the system. Article [29] mentions a solution that illustrates a voice-activated robot based on speech recognition with the ability to move to any point within its reach. The robotic arm identifies the current state of the block, the position of which it needs to change. It is also capable of recognizing 256 words or commands and respond within a time comparable to human reaction time.

In addition, the paper addresses the "BLOCKS'WORLD" problem in the field of AI, which is similar to a set of wooden blocks of various shapes and colors sitting on a table, where the goal is to build one or more vertical stacks of blocks. Only one block may be moved at a time: it may either be placed on the table or placed atop another block. Because of this, any blocks that are, at a given time, under another block cannot be moved.

The 256 words or commands in the article include the command set of a complex system. This is mainly because the commands used, in which the subcommands can be recognized separately [29]. For example, the commands "move up position" or "move down setpoint" can be each broken down into 3-3 subcommands. If these subcommands are used in multiple places, the number of applicable commands is also increased.

Article [30] talks about another voice command management integrated circuit, which can be found with the following identification number: SR-07. The speech recognition kit is a complete and easy to build programmable speech recognition circuit, as the module can be trained to recognize words. This kit allows experimentation with many aspects of speech recognition technology.

The above articles showed examples for how voice-controlled robotic systems can be implemented relatively easily in serious industrial systems. This can have additional advantages in the industry, as the programmed robot cells are program-specific, they only repeat the given sequence of operations that they were initially programmed to. A robotic cell with voice control can perform up to several processes depending on what task the operator supervising the operation instructs. If switching between programs with voice control was possible, the number of robot cells could be reduced and the capacity increased.

In the field of industrial automation, we can find such intelligent robots in the portfolios of several companies, which help the work of operators [31]. The robot checks the status of the given workflow through some image processing system and helps the operator to master the next step. Not only can the robot instruct the operator, but the operator can also ask the robot to repeat the instructions or subtasks for that particular workflow. This creates a cooperative work between man and machine, with which, in addition to increasing efficiency, it is also possible to improve the quality parameters, as the steps are constantly monitored by the robot. This minimizes the risk of accidental omission of individual sub-processes.

3.6. Speech recognition in noisy environment

One of the reasons for the lack of speech recognition systems in industrial automation stems from the noisy environment. Due to various background sources, the system may recognize instructions that have not actually been issued. These noise effects may have been a serious problem in the past, but now with a number of noise filtering technologies and adjustable microphone sensitivity, the resulting problems can be avoided. Some articles present a special headset that was worn by operators and performed only instructions sent by its user.

Many different types of noise can be found in the industry, such as noise made by machines, engines or tools, tapping, buzzing, clicking or humming, amongst many additional types. These types are mainly found in assembly plants, near production lines or tooling plants. In all noisy environments, the possibility of using speech recognition systems may decrease depending on the frequency, type and intensity of noise effects. For example, a 1000kW motor at 3600 rpm can generate up to 106dB of noise. Depending on the set intensity of the microphones used in speech recognition systems, such noises can suppress the human voice, making speech recognition systems impossible.

Human speech consists of complex sounds. The frequency range of the base tones is approximately between 80Hz and 1000Hz, but with overtones it can reach 8000Hz, where the components above 4000Hz are very weak. Speech that carries information is in the frequency range within 800Hz and 3500 Hz, the ranges outside of this give the natural fidelity of the speech instead [32]. This frequency range can be further reduced by measuring the speech spectrum of the person using the speech recognition system with the help of a training set, further increasing the efficiency of filtering ambient noises. Figures 6 and 7 show the voice spectra of a man and a woman.

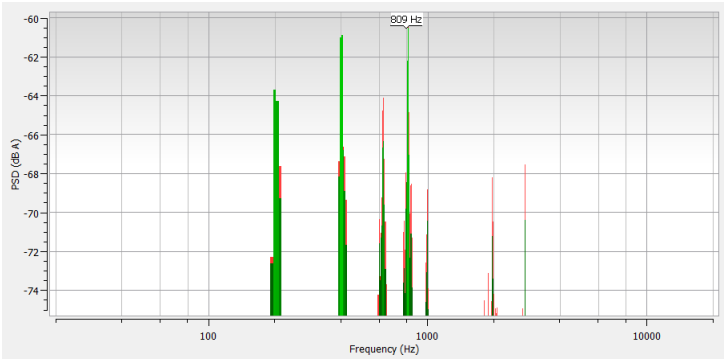

Fig. 6. Spectrum of a male voice

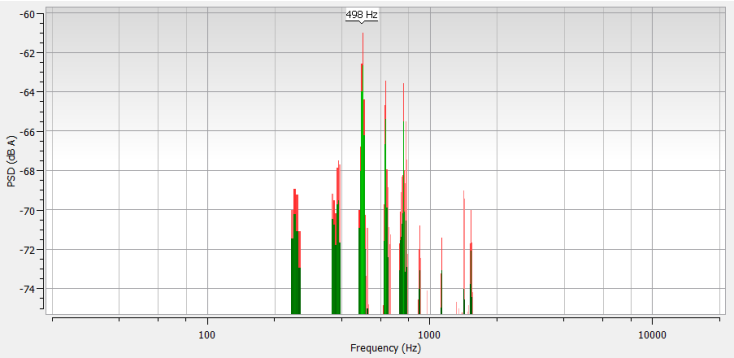

Fig. 7. Spectrum of a female voice

The following figures show a few spectra of industrial workstations, taken next to various machines or during various operations.

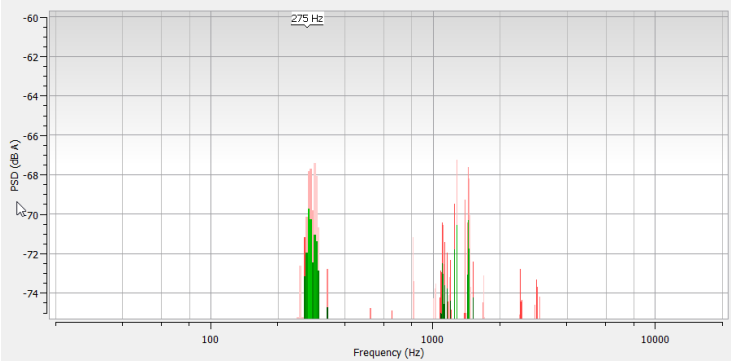

Fig. 8. Workstation 1

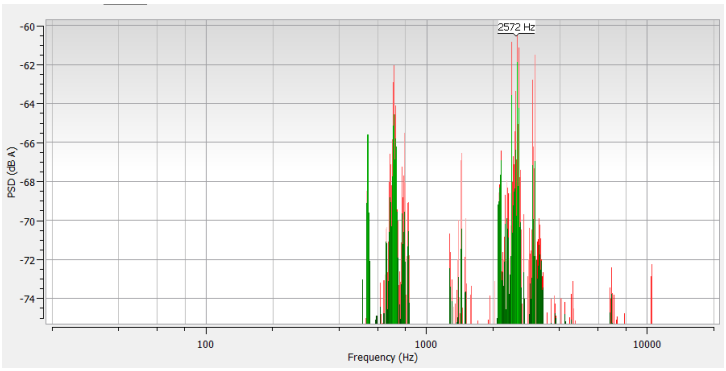

Figure 9: Workstation 2

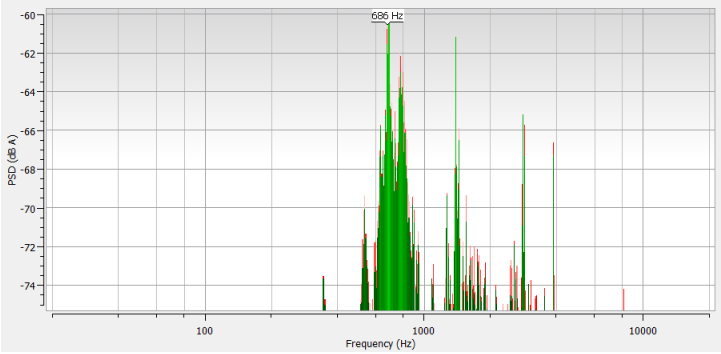

Fig. 10. Workstation 3

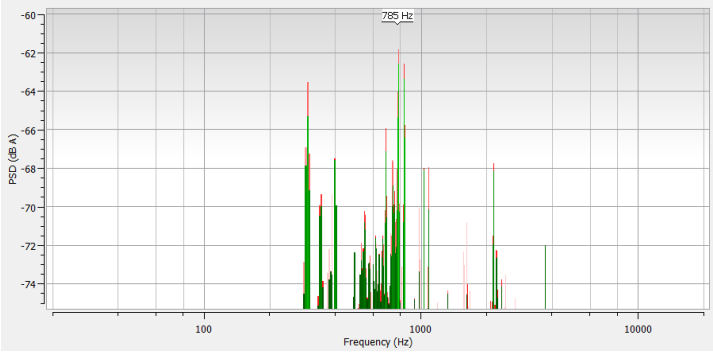

Fig. 11. Workstation 4

The figures above show that the noises made by the various workstations fall within the spectrum of human speech, but by knowing the spectrum of the individual's speech, the various bands can be filtered out [33,34], providing greater accuracy for the industrial operation of voice recognition systems.

Noise can be reduced not only by filtering out the effects entering the microphone, but also by reducing the noise generated by the devices themselves, for example by placing and separating the machines correctly [35].

Another possible cause of the error is that the instructions received can be misinterpreted by the speech recognition system, which is only revealed at the end of the workflows. These errors can also be prevented by a system communicating in two directions and providing feedback to the operator by repeating the instruction.

3.7. Modern warehousing

The next application is more widespread in the field of home practices, but we mention it, as it may provide many opportunities for the development of future storage systems [36]. The application is called findybot300. Here, a system is presented to increase the efficiency of storage processes. Figure 12. shows an organizer cabinet that has been supplemented with simple rows of LEDs in the application. Under the racks of the control cabinet are the corresponding LEDs.

Fig. 12. Self-made picture about an organizer cabinet

The user can use a voice command to request the cabinet to show where the part, object, or device that matches the particular search criteria is located in the cabinet. If the system finds a match, the RGB LED line below the rack lights up green. This technology could be envisioned in a system where warehousing is not done automatically and parts are collected by warehouse workers. This reduces and optimizes the search time for parts.

Not only we can specify a search for specific things, but also we can enter partially specified data such as "yellow devices" and the system then scans the contents of the entire storage cabinet and selects the stacks that may match that particular search term. The coloring is adjusted so that what it thinks is the closest match is shown in different shades of green, while results less relevant, but still related to the search criteria, are shown in yellow or red.

Of course, the application of the system can also be used in the case of automated warehousing systems, in which case it is not necessary to use the LED line used as the human-machine interface, and the search results are communicated to the machine in another way.

The industrial application of the system described in the previous article [36] is not known or is not published, but similar voice recognition systems are used in an industrial environment to increase efficiency. Several companies have portfolios featuring voice-guided technologies and software that help with logistics. Warehouses using such technology are known as Voice Directed Warehouse (VDW) [37-39]. This technology specifically corrects the disadvantages that are pivotal points of traditional logistics.

Table 2: Original vs. Voice-directed warehousing [37]

Efficiency of the original warehousing	
Effective work	10%
Ineffective work (traveling, searching, administrative work)	90%
Efficiency of the voice-directed warehousing	
Effective work	80%
Ineffective work (traveling, searching, administrative work)	20%

The efficiency of a conventionally prepared package is very low. Effective work accounts for only 10% of the total time, with the remaining 90% covered by searching, traveling and various paperwork [37]. The rate of efficient work

can be significantly increased if the goods are optimized according to their demand during storage, and the searched items can be reached in a short route. Furthermore, such a system can optimize the route and guide the worker with voice instructions, and human-machine interaction provides the opportunity to further reduce paperwork through voice control and automation.

4. Conclusion

Based on the industrial applications of ASR found during our research, we can say that the use of speech recognition systems is not widespread in the field of industrial automation. Nevertheless, it has many possibilities. In order to increase production capacity to meet the growing market demands, it may be worthwhile to use speech recognition systems, as we have seen from the literature that is the subject of this article.

It is possible to use ASR systems in the industrial environment. In each industry, a given work process can be performed by several people in a shift. In such cases the voice templates may be specific to a user in speaker-dependent recognition systems. Alternatively, the voice templates may be for all users. Since everyone's speech may be different, custom voice templates may be created. It is common to require workers new to a voice directed workflow system to train the system for their voice by creating voice templates for a variety of words and/or sounds.

Due to the uniqueness of the production lines, individual research and development activities are required to learn about the efficiency of the systems. We also can't say for certain, whether these systems are a good investment for companies, however in some cases they could save a significant amount of time and money for them. Looking at the examples above, we can summarize that the use of the technology can be applicable for individual cases. Overall, voice controlled robots are potentially applicable to all industries where physical movement of objects is required by human operators and robots.

Acknowledgements

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Object Recognition Tool for "Smart Nest Boxes"

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Abstract

This paper deals with presenting the "Smart Nest Boxes" research with the help of Artificial Intelligence. The first main task was to apply a Convolutional Neural Network (YOLOv2) for automatic real-time recognition of objects from "Smart Nest Boxes", which are part of the ornithological project Ptáci Online (Birds Online), the second one was rating the algorithms of the trained Artificial Neural Networks by using the standard methodology (e.g. precision, recall). This research greatly contributes to the project by automation of tasks that would have to be performed by people and simplifies bird watching for researchers in order to gain statistical data such as feeding, bird arrivals and departures.

Keywords: Convolutional Neural Network, DeepLearning4J, Object Detection, Ornithology, Artificial Intelligence

1. INTRODUCTION

Artificial Neural Networks have been, since they began in 1989 in Bell Labs, a very dynamic field. Although Computer Vision has not been successfully used before 2011, it has been winning contests in object detection and classification afterwards, and since 2015, the object classification problem with the help of Convolutional Neural Networks has been considered successfully finished. [14]

In some cases, Computer Vision algorithms are essential to use for interdisciplinary cooperation. In recent years, many biological projects such as mapping the movement of forest game [3][5], cattle [6] or birds [2] have expressed the need to work with a large number of scientific data and it would be inefficient and very time demanding to process them manually. With the help of object recognition, such tasks can be automated, and the researchers can work directly with the statistical data generated by the machine.

The ornithological project "Ptáci Online (Birds Online)" has expressed the need to use CNN for classification of birds, carried food, eggs, beaks, adult birds and related objects in pictures and videos taken by cameras placed in so called "Smart Nest Boxes," which are installed in many places across the Czech republic and their locations can be found on an interactive map available on the website Ptaci Online [18]. With the help of Artificial Intelligence, all the desired models can be trained, and the output data can be stored on the servers for further processing. This way, the researchers can map how often the birds fly in and out, how often they feed the hatchlings and the models are able to help them with many other tasks that would otherwise need someone to look at all the videos.

2. THEORETICAL OVERVIEW

Artificial Neural Networks are using artificial neurons to transfer information in a similar way like biological neurons do. They communicate in layers and each neuron in one layer is connected to each neuron in the neighboring layers. The value of activation function determines whether the neuron is going to be excited or not. There are several methods divided into two categories (with and without teacher) to create the Artificial Neural Network. One of them, used for this type of task, is called Back Propagation. Convolutional Neural Networks are the type of Artificial Neural Networks, which are used for classification objects in pictures and videos. [14]

There are many types of CNN, such as R-CNN [7], YOLO [8], SSD [9] and more. In order to be able to analyze video in real time, it is necessary to pick an architecture, which is not too time and computational capacity demanding. One of the possible architectures is YOLO (You Only Look Once), which was presented in 2016 and presents "*object detection as a regression problem to spatially separated bounding boxes and associated class probabilities*". [11] The principle of this architecture is, as the name suggests, that the machine only looks at the input picture once. The system "*resizes the input image to a square, runs a single convolutional network on the image, and thresholds the resulting detections by the model's confidence*". During the process it is pixelated, and each pixel counts as one artificial neuron. The machine is looking for dependencies to classify, whether the desired object is located in the picture or not, where it is and how many percent sure the machine is whether it is the object. [11]

In the past, several similar applications have been published. One of them analyzed satellite pictures to identify if there are any forest game in the picture [5] and statistical calculations could be furtherly executed. This method is not new and has already been published multiple times. [2]

3. OBJECTIVE

The objective of the research is to automatically map the behavior of all the birds, that have been nesting in the "Smart Nest Boxes", by using CNN to detect the carried food and adult birds (plus eggs and beaks of the hatchlings in the future) and put the models in context (for example, if the bird has not been detected at the start of the stream and it is detected a few seconds after, it means the bird has arrived, on the contrary if it is detected at the start and disappears, it means it has left the nest).

This task is very complex and time demanding, because it requires a large number of manually labelled input images in order to train high quality models. The recommended number of pictures for each class is about 1000. [13] However, if the models are going to work as predicted, they will be a great time-saver for further phases of the research and will eliminate the need to look at the videos in order to find out what is going on in them.

It is necessary to describe how the camera stream is activated. The "Smart Nest Boxes" have a turnpike in front of the entrance light. If the bird enters or leaves the nest, the light door activates the central computer system. The computer turns on the cameras (with night light source, if it is necessary), and the recording process is started. The recorded data is uploaded to the central server. The data is saved in the form of video sequences and the sequences are split into separate pictures, which are saved in separate folders named by date and an automatically generated identification.

In order to find out what is happening in each sequence, a certain number of object classes need to be specified. It is possible to train either one model capable of identifying and classifying multiple objects, or a specified number of separate models, each capable of identifying one class. For simplification, more single-class models were chosen.

4. METHODOLOGY

There is a standard 10-step procedure used to train the CNN network. The steps are following [16]:

1. Getting a sufficient set of labelled data

2. Data normalization

3. Setting learning parameters (learning rate, batch size, iterations)
4. Initialization of variables and placeholders
5. Defining model structure
6. Declaration loss function
7. Initialization and training the model
8. Model evaluation
9. Hyperparameter tuning
10. Putting model to practice

For model evaluation, the following standard measures are used [17]:

- Precision (p)
- $p = TP / (TP+FP)$ (*1*)
- Recall (*s*)
- $s = TP / (TP+FN)$ (*2*)
- Quality of algorithm (*F*-measure)
- $F = 2 \cdot (s \cdot p) / (s+p)$ (*3*)

where
TP = true positives, the number of correctly classified objects as positive
FP = false positives, the number of incorrectly classified objects as positive
FN = false negatives, the number of incorrectly classified objects as negative

The threshold for rating the model as successful was set for F-measure minimum of 0.8, as the quality of photos was not very high.

5. RESULTS

The network was trained in the framework DeepLearning4J without CUDA architecture on a ImageNET and Pascal VOC pretrained network. Training/Validation Split was set for 80/20, training parameters were following:

- learning Rate: 10^{-3}
- momentum: 0.9
- total training time: 45 hours
- loss in the final iteration: 0.5928.

Results of both trained models are stating in the following tables:

Table 1. Carried food classifier results

Threshold	Precision (*p*)	Recall (*s*)	F-measure (*F*)
0.3	0.99	0.55	0.71
0.1	0.93	0.75	0.83
0.05	0.84	0.86	0.85

Table 2. Adult Great Tits classifier results

Threshold	Precision (*p*)	Recall (s)	F-measure (*F*)
0.3	0.99	0.56	0.72
0.1	0.94	0.76	0.84
0.05	0.80	0.88	0.84

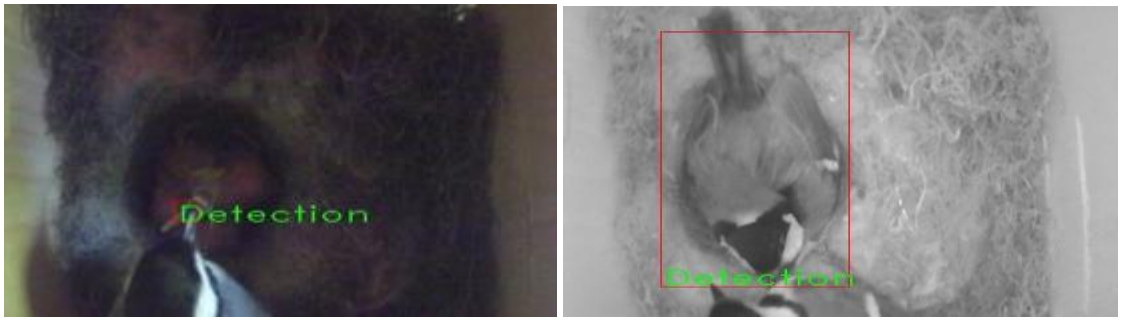

Fig. 1. (a) Carried food classifier example; (b) Adult Great Tits classifier example

6. DISCUSSION

As visible in the tables 1 and 2, both the model for recognizing carried food and the model recognizing adult Great Tits had the best results according to standard coefficients Precision, Recall, and *F*-Measure if the threshold for object recognition was 0.1 or less. However, with lowering threshold value, the precision fell, and recall was raised. The models can be used in practice under such specified thresholds.

A significant problem is the detected object's precise definition of the occurrence in recognizing. The CNNs often hallucinate or recognize a single object several times. A typical hallucination is the detection of two overlapping objects. In practice, this means that one bird is seen more than once in one place. This error is probably caused by training different tensors that do not share information about mutual detection.

The problem of finding more objects of interest and thus entering an error in the measurement can be eliminated in several ways. The easiest option is to remember the occurrence of the first tensor, and if the second tensor overlaps it with a large proportion, it is probably the same object detected by different parts of the CNN.

This method can be used successfully if there are only a small number (parents) of adult birds in the nest. However, it is difficult to recognize in young birds. The young can overlap in different positions. Therefore, it is necessary to use other methods to recognize them.

The method we found to be useful in this case is, for example, localization according to open beaks. Apparently, even parents carrying food according to their beaks perfectly locate the young. It is therefore clear that simply entrusting the task to artificial intelligence does not lead to the goal. It is also necessary to combine statistical and other mathematical methods for targeted and high-quality identification.

In order to automate more tasks, it is most advised to train more models automating counting eggs, beaks of hatchlings and other birds. Further research and optimization of used CNN architecture is also advised, experiments

on R-CNN, other YOLO, SSD, ResNet compared in literature [1] and adaptive anchor box mechanism [4] or new architectures is planned. Experiments will be conducted in Tensorflow [12] and Theano [10] frameworks.

7. CONCLUSION

In this paper, a brief review of creating and evaluation of two main models helping to automate gaining statistical data for the project Birds Online has been presented, one of the models serves to recognize adult Great Tits, one for carried food. Both models have reached the desired F-measure above 0.8 if threshold is set to 0.1 or less, so they both have been put into practice and help mapping number of daily arrivals, departures, and feedings.

Although much progress has been made, further research is planned to expand the application for more objects in the "Smart Nest Boxes" such as eggs, beaks, more types of adult birds etc., and to improve the neural network from YOLOv2 to a more optimally performing architecture. It may be also advisable to create one multi-class model instead of separate single-class models. [15]

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Evaluation of Humanitarian Logistics Strategies with Fuzzy SAW-EDAS Methods

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Abstract

Humanitarian crises cause thousands of people to be injured and sick every year and to lose their lives. Moreover, they cause severe economic instability in the regions where they arise. To prevent these global disasters and reduce the pain, thousands of humanitarian organizations carry out humanitarian aid activities. Humanitarian logistics (HL) is defined as the process of planning, implementing, and controlling inefficiencies, the storage of goods and material, from the point of origin to the disaster area, to alleviate the suffering of a disaster victim. Many factors must come together in the HL concept to be successful in these processes. Moreover, to manage these processes efficiently, it is crucial to implement the right strategy for HL. Therefore, it is structured as a fuzzy Multi-Criteria Decision Making (MCDM) problem. To overcome the uncertainty in the decision-making, fuzzy logic is utilized. In this context, the study aims to propose an evaluation framework for HL strategies with fuzzy MCDM methods. The importance degrees of challenges in HL are calculated with the fuzzy SAW method. The HL strategies are evaluated with the fuzzy EDAS method. A case study of HL strategies is provided to demonstrate the potential of the proposed methodology. At the end of the study, the results are presented, and future perspectives are provided.

Keywords: EDAS, fuzzy sets, humanitarian logistics, MCDM, SAW.

1. Introduction

According to the World Health Organization (WHO), natural disasters kill around 90 thousand people and affect close to 160 million people worldwide every year [1]. In the World Risk Report 2019 [2], it is stated that we were confronted with a series of crises and disasters because of extreme natural events in 2019. In this context, effective management of these disasters has become even more critical than in the past. Disaster management includes a systematic approach to handle natural and human-made disasters [3]. If significant disasters strike a country that is overwhelmed by the consequences, help is requested from the rest of the world [4]. To reduce pain, thousands of humanitarian organizations carry out humanitarian aid activities. Humanitarian logistics (HL) directly focuses on helping sufferers and injured people in disaster areas [5]. Therefore, it is vital to implement the right strategy for HL.

Recently, several studies have been dedicated to investigating the HL subject [3-11]. Some of these studies are research papers [3,4,5,6,8,11], while other studies re-view the issue [7,9,10]. In research papers, only three studies

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integrate HL subject with Multi-Criteria Decision Making (MCDM) approach [4,5,11]. Therefore, there is a research gap in this area. This study aims to propose an evaluation framework by implementing fuzzy MCDM techniques for HL strategies.

The evaluation framework is developed by analyzing the industry reports, examining the research papers, and consulting the experts. Our research methodology is based on a fuzzy MCDM approach. Zadeh [12] proposed the fuzzy sets to overcome the uncertainty in decision-making. The weights of challenges in HL are calculated by using the fuzzy Simple Additive Weighting (SAW) method. The HL strategies are ranked with fuzzy Evaluation based on the Distance from the Average Solution (EDAS) method.

The remaining of the study is structured as follows. In Section 2, the concept of HL is provided. The research methodology is provided in detail in Section 3. In Section 4, the application of the methodology is presented. In Section 5, the concluding remarks and the suggestions for future work are given.

2. Humanitarian logistics

The HL emphasis on aiding the sufferers of disasters in affected areas. The main objective is saving the lives of people and consequently declining the death rate. In HL, the initial response should be received in the first 72 hours and the early 12 hours are critical. The organizations should rapidly evaluate the state and start sending relief goods within this time limit [5].

In an effective HL system, the human losses must be minimized by shipping and transporting relief goods (food, water, medical supplies, etc.) to affected fields. In addition, a specific amount of relief goods needed for every person should be delivered [3].

Governments, local and regional humanitarian relief organizations, and private sector enterprises can have various mandates, interests, capacity, and logistics expertise. These actors have to improve their performance to respond effectively to a disaster [5]. Moreover, humanitarian organizations will collaborate with donors to gather relief materials, such as tents and clothing. These collaborations can be handled under an operating framework agreement necessitating effective coordination mechanisms with their stakeholders. Such continuous-aid actions have encouraged organizations to apply scientific methods for their activities around sourcing, distribution, and logistics [11].

3. Research methodology

The research methodology of the study involves three main stages. In the first stage, the HL evaluation model is constructed with the help of a literature review, industry reports, and experts. The evaluation model consists of sixteen HL challenges and five HL strategies. Secondly, the experts evaluated these challenges, and the fuzzy SAW technique computes the weights of HL challenges. Finally, experts evaluated HL strategy alternatives, and the fuzzy EDAS technique determines the most appropriate alternative. Fig. 1 illustrates the research methodology

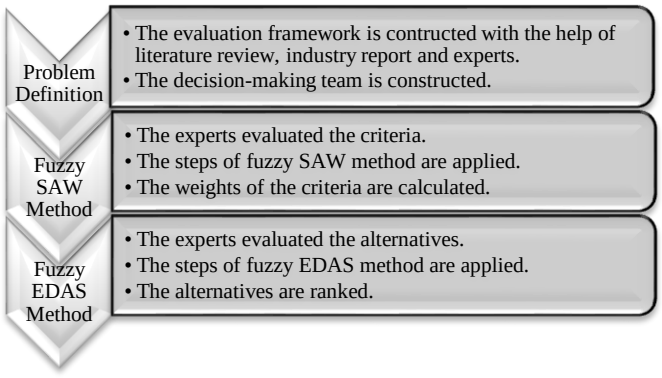

Fig. 1. The stages of the research methodology.

3.1. Fuzzy SAW method

The SAW method, also known as the weighted sum method, is the most widely used MCDM method [13]. The basic principle of SAW is to obtain a weighted sum of the performance ratings of each alternative. An evaluation score is calculated for each alternative. This method's advantage is that there is a proportional linear transformation of raw data; this means that the relative order of the sizes in the standardized points remains the same [14].

Chou et al. [15] proposed the fuzzy SAW method to solve problems under an imprecise environment. The steps of the fuzzy SAW method are as follows:

Step 1. Decision-makers (DM) evaluate criteria using linguistic terms in Table 1.

Step 2. Let $Dt = \{d_1,d_2,...,d_k\}$ be a committee of k DMs, $Ai = \{a_1,a_2,...,a_I\}$ be a discrete set with *I* member alternatives, $Cj = \{c_1,c_2,...,c_J\}$ be a set consisting of the decision criteria, be the degree of importance of each DM, where $0 \leq I_t \leq 1,\ t = 1,2,...,k$, and $\sum_{t=1}^{k} I_t = 1$, $\widetilde{\omega t}$ be the fuzzy weight of the DMs. The degree of importance I_t is computed as:

$$I_t = \frac{d(\widetilde{w_t})}{\sum_{t=1}^{k} d(\widetilde{w_t})}, t = 1,2,\dots,k \qquad (1)$$

where $d(\widetilde{w_t})$ gives the defuzzified value of the fuzzy weight by using the signed distance.

Table 1. Linguistic Scale for fuzzy SAW [16]

Linguistic term	Abb.	Fuzzy Numbers
None	N	(0,0,0.17)
Very Low	VL	(0,0.17,0.33)
Low	L	(0.17,0.33,0.5)
Medium	M	(0.33,0.5,0.67)
High	H	(0.5,0.67,0.83)
Very High	VH	(0.67,0.83,1)
Perfect	P	(0.83,1,1)

Step 3. Aggregated fuzzy weights of individual attributes ($\widetilde{W_j}$) are computed. The aggregated fuzzy attribute weight, $\widetilde{W_j} = (a_j, b_j, c_j)$ of criterion *Cj* assessed by the committee of *k* DMs is computed as:

$$\widetilde{W_j} = (I_1 \otimes \widetilde{W_{j1}}) \oplus (I_2 \otimes \widetilde{W_{j2}}) \oplus \dots \oplus (I_k \otimes \widetilde{W_{k1}}) \qquad (2)$$

where $a_j = \sum_{t=1}^{k} I_t a_{jt}$, $b_j = \sum_{t=1}^{k} I_t b_{jt}$, $c_j = \sum_{t=1}^{k} I_t c_{jt}$.

Step 4. The fuzzy weights of criteria are defuzified. The defuzzification of $\widetilde{W_j}$ is denoted as $d(\widetilde{W_j})$ and computed as:

$$d(\widetilde{W_j}) = \frac{1}{3}\left(a_j + b_j + c_j\right), j = 1,2,\dots,n \qquad (3)$$

Step 5. The normalized weight of criterion *Cj* is denoted as W_j and computed as:

$$W_j = \frac{d(\widetilde{W_j})}{\sum_{j=1}^{n} d(\widetilde{W_j})}, j = 1,2,\dots,n \qquad (4)$$

where $\sum_{j=1}^{n} W_j = 1$ and the weight vector $W=(W_1, W_2, \dots, W_n)$ is constructed.

3.2. Fuzzy EDAS method

EDAS method is introduced by Ghorabaee et al. [17] tested the validity of this method. This method considers the average solution for the evaluation of alternatives. It is also a distance-based method.

In literature, the EDAS method with fuzzy logic is proposed by Ghorabaee et al. [18] for supplier selection. The EDAS method was also combined with the advanced techniques in the literature. Besides, hesitant fuzzy EDAS is

proposed with different aggregation operators with defuzzification and without-defuzzification processes for hospital selection [19].

The steps of the fuzzy EDAS method are presented as follows [18]:

Step 1: The matrix between criteria and alternatives is constructed using a fuzzy scale in Table 2.

Table 2.The Fuzzy Scale [18]

Linguistic expression	Abb.	Fuzzy Scale
Very Good	VG	(8, 9, 10)
Good	G	(6, 7, 8)
Fair	F	(4, 5, 6)
Poor	P	(2, 3, 4)
Very Poor	VP	(1, 1, 2)

Step 2: The matrices of positive distance from average (PDA) and negative distance from average (NDA) are calculated. *B* is the set of beneficial criteria, and *N* is the set of non-beneficial criteria.

$$\widetilde{pda}_{ij} = \begin{cases} \frac{\psi(\tilde{x}_{ij} \ominus \widetilde{av}_j)}{\kappa(\widetilde{av}_j)} & if\ j \in B \\ \frac{\psi(\widetilde{av}_j \ominus \tilde{x}_{ij})}{\kappa(\widetilde{av}_j)} & if\ j \in N \end{cases} \quad (5)$$

$$\widetilde{nda}_{ij} = \begin{cases} \frac{\psi(\widetilde{av}_j \ominus \tilde{x}_{ij})}{\kappa(\widetilde{av}_j)} & if\ j \in B \\ \frac{\psi(\tilde{x}_{ij} \ominus \widetilde{av}_j)}{\kappa(\widetilde{av}_j)} & if\ j \in N \end{cases} \quad (6)$$

where $\widetilde{av}_j$ represents the average solutions matrix and $\kappa(\widetilde{av}_j)$ represents the defuzzified number.

Step 3: Calculate the weighted sum of positive and negative distances.

$$\widetilde{sp}_i = \oplus_{j=1}^{m}(\tilde{w}_j \otimes \widetilde{pda}_{ij}) \quad (7)$$

$$\widetilde{sn}_i = \oplus_{j=1}^{m}(\tilde{w}_j \otimes \widetilde{nda}_{ij}) \quad (8)$$

Step 4: Normalize the values for all alternatives.

$$\widetilde{nsp}_i = \frac{\widetilde{sp}_i}{max_i(\kappa(\widetilde{sp}_i))} \quad (9)$$

$$\widetilde{nsn}_i = 1 - \frac{\widetilde{sn}_i}{max_i(\kappa(\widetilde{sn}_i))} \quad (10)$$

Step 5: Calculate the appraisal score ($\widetilde{as}_i$) for all alternatives.

$$\widetilde{as}_i = \frac{1}{2}(\widetilde{nsp}_i \oplus \widetilde{nsn}_i) \quad (11)$$

Step 6: Rank the alternatives according to the appraisal values.

4. Application of the research methodology

An application illustrating the proposed methodology is realized for a company named XYZ. The subsequent sections give the details of the application. XYZ company seeks to develop its strategy to overcome HL challenges.

There are five possible alternative strategies. The company must decide according to the four main criteria and sixteen sub-criteria.

4.1. Humanitarian Logistics Evaluation Model

The HL evaluation model is constructed by examining industry reports and academic papers. Moreover, experts are consulted to finalize the model. As a result, four main factors and sixteen sub-factors take part in our evaluation model. Table 3 provides the model.

Table 3. The HL challenges [20]

Main Challenges	Challenges (Causes)
C1. Poor quality/ Inappropriate supplies	C11. Not following agreed standards/specifications for procurement, products, or services
	C12.Risks from wrong/expired medicines
	C13.Limited/no choice of relief goods for the affected population
	C14.Donation of goods that are irrelevant to the affected population
C2. Inefficiency – gaps, duplication	C21.Inadequate mapping of needs
	C22.Poor management of logistics by humanitarian agencies – Ineffective/inadequate collaboration with the private sector
	C23.Poor strategic coordination of HL activities
	C24.The insecure working environment for suppliers/transporters/aid workers
C3. Slow/delayed response	C31.Inadequate prepositioning and preparedness at global, regional, and national levels
	C32.Lack of urgency on behalf of the donor and affected governments/agencies
	C33.Poorly coordinated rapid needs assessments
	C34.Bureaucracy within humanitarian agencies and donors
C4. Restricted access	C41.Poor infrastructure
	C42.The low-risk security regime of humanitarian organizations limits the reach of humanitarian workers
	C43.Insecurity limits movement
	C44.Seasonal factors, especially flooding

The HL strategies are determined as [21]:

A1. Creating a professional logistics community: It enables humanitarian logisticians to share knowledge and experience on common issues and create a consistent, powerful voice with all the sector stakeholders.

A2. Investing in standardized training and certification: It will help build a pool of logistics professionals that share standard processes and vocabulary, promoting professionalism and collaboration.

A3. Focusing on metrics and performance measurement: It will empower logisticians to demonstrate and improve the humanitarian supply chains' effectiveness.

A4. Communicating the strategic importance of logistics: It will enable logisticians to create awareness of logistics' contribution and obtain needed funding and resources.

A5. Developing flexible technology solutions: It will improve responsiveness by creating visibility of the materials pipeline and increasing people's and processes' effectiveness. Furthermore, advanced information systems will create the infrastructure for knowledge management, performance measurement, and learning.

4.2. Criteria weight calculation with fuzzy SAW method

DMs evaluated criteria using linguistic terms in Table 1 to calculate weights. These evaluations with linguistic expressions are shown in Table 4.

Table 4. DMs evaluation of criteria

	C11	C12	C13	C14	C21	C22	C23	C24	C31	C32	C33	C34	C41	C42	C43	C44
DM1	M	VH	L	VL	L	H	M	VL	L	M	H	L	VH	H	H	L
DM2	H	VH	L	L	H	H	L	L	N	L	H	VL	P	M	VH	VL
DM3	M	H	M	M	M	VH	M	M	M	L	H	M	P	M	H	L

The equations (1) – (4) are applied, and the weights of customer requirements are calculated as shown in Table 5.

Table 5. The weights of the criteria

Criteria	Defuzzified Weights	Normalized Weights	Rank	Criteria	Defuzzified Weights	Normalized Weights	Rank
C11	0.556	0.068	6	C31	0.297	0.036	15
C12	0.778	0.095	2	C32	0.389	0.047	10
C13	0.389	0.047	10	C33	0.667	0.081	5
C14	0.333	0.041	12	C34	0.333	0.041	12
C21	0.500	0.061	8	C41	0.907	0.111	1
C22	0.722	0.088	3	C42	0.556	0.068	6
C23	0.444	0.054	9	C43	0.722	0.088	3
C24	0.333	0.041	12	C44	0.278	0.034	16

At the end of the fuzzy SAW method, the most crucial criterion is determined as C41. Poor infrastructure; the second one is C12. Risks from wrong/expired medicines, and the third one is C43. Insecurity limits movement.

4.3. Ranking of alternatives with fuzzy EDAS method

The matrix between criteria and alternatives are constructed by using a fuzzy scale in Table 1.

The PDA and NDA matrices are constructed by using (5) and (6) and $\widetilde{sp}_i$ and $\widetilde{sn}_i$ values are computed with (7) and (8).

$\widetilde{nsp}_i$, $\widetilde{nsn}_i$ and $\widetilde{as}_i$ values are calculated by using (9)-(11). The final ranking is shown in Table 6.

Table 6.The final ranking

	NSP	NSN	AS	Defuzz. Value	Ranking
A1	(0.501,0.596,0.670)	(0.748,0.906,1.199)	(0.624,0.751,0.934)	0.7698	4
A2	(0.283,0.335,0.412)	(1.155,1.430,1.442)	(0.719,0.882,0.927)	0.8428	3
A3	(0.208,0.243,0.292)	(1.248,1.531,1.903)	(0.728,0.887,1.098)	0.9044	2
A4	(0.484,0.574,0.708)	(0.513,0.644,0.786)	(0.499,0.609,0.747)	0.6183	5
A5	(0.792,1.015,1.193)	(0.842,0.981,1.177)	(0.817,0.998,1.185)	1.0000	1

At the end of the fuzzy EDAS method, the most appropriate alternative for XYZ is developing flexible technology solutions (A5).

5. Conclusion

This paper aims to propose an evaluation framework by implementing fuzzy MCDM techniques for HL strategies. In this context, a novel HL evaluation model was presented. Then, a research methodology for selecting the most appropriate HL strategy was provided. In the research methodology, the fuzzy SAW technique was used for the criteria weight calculation. The fuzzy EDAS technique was used to rank the HL strategies. Fuzzy logic was implemented to

overcome uncertainty in the decision-making process. Besides, the experts' evaluation phase was facilitated with the utilization of linguistic expressions. The proposed methodology was verified through an application on a logistics company.

Future research can be interesting to consider the interactions and dependency between criteria and calculate the factors' weights by utilizing the fuzzy Analytic Network Process (ANP) method. Additionally, the problem can be solved using aggregation operators for the group decision-making process.

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Digital Technology Assessment for Healthcare Logistics with Fuzzy MCDM Methods

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Abstract

Nowadays, with the new medical device materials and digital technologies, diagnosis and treatment methods have become more effective in the health sector. Logistics enterprises play an active role in the transportation, storage, and shipment of products in this sector. Healthcare logistics involves susceptible situations with specific rules and procedures; it necessitates separate heat, humidity, and transport conditions at every phase, from raw material supply to product distribution. To keep the integrity of the transported materials, provide a high level of hygiene, and guarantee patients' health, the quality of transportation in the health sector is more important than other sectors. Therefore, healthcare logistics must be combined with the right digital technologies to meet the increasing demand more efficiently, safely, and ecologically. In this paper, the assessment of digital technologies for healthcare logistics that contain many components is considered as a multi-criteria decision-making (MCDM) problem. Viewing the complex profile of this problem, there is a need for a methodology to select the most suitable solution. However, it is challenging to decide on the most appropriate alternative when information is in an uncertain nature. In this context, the study aims to propose an evaluation framework of digital technologies for healthcare logistics with fuzzy MCDM methods. An application about healthcare logistics is given to illustrate the potential of the proposed approach. Finally, the application results are provided, and the concluding remarks and future perspectives are presented.

Keywords: digital technologies, fuzzy logic, healthcare logistics, MCDM methods

1. Introduction

Health logistics is a compassionate and vital issue where all operations are carried out under certain rules and procedures under the Ministry of Health's supervision. All value-added operations are controlled by regulations and audits, starting from importing raw materials to production, storage, and distribution [1].

The areas where the products will be stored must comply with the hygiene rules, pay attention to the required temperature and humidity levels, minimize contact with air, regularly control pests, and monitor the control elements at the highest level. When transporting medicines, smelly, fragile, or harmful products should not be carried in the same vehicle. Depending on the necessity, the vehicles may need to be temperature-controlled vehicles with limited

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contact with air. The assigned personnel must be trained, especially dressed, and pay attention to hygiene rules to deliver these products. This type of transportation should be controlled carefully and meticulously [2, 3].

Logistics companies play an active role in the transportation, storage, and shipment of products in the highly sensitive healthcare sector. The ability to produce healthcare services insufficient, high quality, efficient, economically, and medically effective and sensitive to user expectations and increase the health status of society depends on the used technology. For these applications' implementations, health logistics must be integrated with the right digital technologies in order to meet the increasing demand more effectively, safely, and environmentally [4]. In this study, a digital technology evaluation problem for healthcare logistics is considered as a fuzzy multi-criteria decision-making (MCDM) problem.

MCDM is a powerful tool widely used for evaluating problems containing multiple, usually conflicting criteria. It refers to find the best opinion from all of the feasible alternatives. Priority-based, outranking, distance-based, and mixed methods could be considered primary classes of the current methods [5].

The composite structure of the evaluation of digital technologies for healthcare logistics involves many various and contradictory criteria. However, it is challenging to decide on and rank alternatives when information is in an uncertain nature. Sometimes decision-makers (DMs) have difficulties in expressing their thoughts by crisp numbers. Furthermore, DMs can express their opinions more comfortably with fuzzy numbers. It overcomes the uncertainty of this MCDM problem.

In this study, firstly, the evaluation criteria are determined with literature review and expert opinions. These criteria are weighted by using the fuzzy Analytic Hierarchy Process (AHP) method. After that, digital technologies are identified with literature review and expert opinions. The most appropriate digital technology is determined by using the fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method. The study aims to propose a model for evaluating digital technologies for healthcare logistics and presenting an integrated fuzzy AHP-fuzzy TOPSIS methodology in this area.

The paper's structure is as follows: The concept of healthcare logistics is summarized in the next section. Section 3 presents the research methodology. Application is given in Section 4, and finally, the last section concludes the study.

2. Healthcare Logistics

The automation of material handling in healthcare facilities not only optimizes delivery times but also allows hospital staff to spend more time on patient care. To maintain the integrity of the transported materials, ensure a high level of hygiene, and guarantee patients' health, the quality of transportation in the health sector is more important than other sectors. In cases requiring urgent transfer, transportation automation can significantly reduce delivery times while ensuring high safety standards [6, 7].

The use of automated warehouses makes storage areas most useful by reducing idle stock, preventing supply errors, providing safe and controlled access to medicines, and providing high storage capacity. The automation of logistic flows significantly contributes to the best use of resources, increasing patient care efficiency, safety, and quality.

There are two basic principles of logistics management in healthcare institutions [8]:

- Effectiveness principle: the required material is delivered in the desired quality, in the desired amount, at the desired place and time, securely and easily.
- The principle of the economy: the cost of the material to be supplied is less compared to other materials provided under the same quality conditions.

The variety of devices and materials used in the healthcare industry affects logistics costs. Timely procurement, transportation, storage, stock management, maintenance, and repair of devices and materials are essential. Therefore, the importance of logistics and supply chain management in hospitals is increasing day by day. The functions of healthcare logistics are [9, 10]:

- stocking and distribution of medicines and other consumables
- transport/delivery from suppliers to hospital warehouses
- transport/delivery from suppliers to drug stores
- transport/delivery from warehouses to hospitals
- handling and repackaging products according to the requirements of the sector
- managing, controlling, and monitoring with technology and up-to-date systems, stacking equipment, and automation software
- storage and distribution of imported drugs brought from abroad against prescription or special permission

3. Research Methodology

In this paper, the proposed methodology consists of three steps:

Step 1. Determination of the proposed model with literature review and expert opinions.

Step 2. Calculation of the evaluation criteria weights with the fuzzy AHP method.

Step 3. Evaluation of alternatives and selection of the most appropriate digital technology with fuzzy TOPSIS.

3.1. Evaluation model and alternatives

As a result of the literature review and expert opinions, the evaluation model is shown in Fig. 1.

In this model, there are five main criteria: patient, process, technology, structure, and logistics. Besides, there exist twenty sub-criteria of these main criteria.

In this paper, there are six digital technology alternatives: Advancing Data Analytics (Big Data) (A1), Internet of Things/Sensors (A2), Healthcare On-Demand Models (A3), Robotics and Automation (A4), Augmented Reality (A5), and Additive Manufacturing (A6).

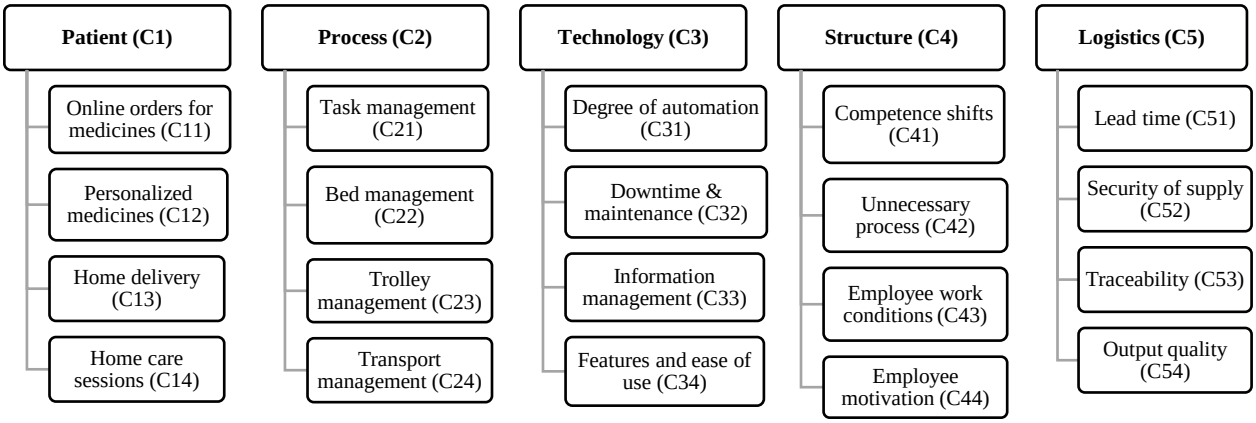

Fig. 1. Evaluation model [1, 8, 11, 12]

3.2. Fuzzy AHP method

AHP was proposed by Saaty [13]. AHP is a robust decision-making methodology to determine priorities between different criteria. The flexibility of AHP in a fuzzy environment provides flexibility.

The steps of fuzzy AHP are:

Step 1. Construct the evaluation matrix by binary comparison. The fuzzy linguistic expressions are used to evaluate the criteria in the fuzzy AHP method. They are given with their abbreviations in Table 1.

Table 1. Linguistic scale for Fuzzy AHP [14]

Linguistic term	Abb.	TFN
Equal	E	(1,1,1)
Equally Important	EI	(1,1,2)
Weakly More Important	WMI	(2,3,4)
Strongly More Important	SMI	(4,5,6)
Very Strongly More Important	VSMI	(6,7,8)
Absolutely More Important	AMI	(8,9,10)

Step 2. Transform linguistic expressions into triangular fuzzy numbers (TFN). The membership function of $\widetilde{A}=(l,m,u)$ is as follows [15]:

$$\mu_{\widetilde{A}}(x)=\begin{cases}\frac{(x-l)}{(m-l)} \text{ if } l\leq x\leq m\ ,\\ \frac{(u-x)}{(u-m)} \text{ if } m\leq x\leq u\ ,\\ 0 \text{ otherwise.}\end{cases} \quad (1)$$

Step 3. Build *∝-cut* fuzzy pairwise comparison matrices by using *∝-cut* method, (∝=0.5; μ=0.5).

Step 4. Calculate the optimality index as [16]:

$$\widetilde{a_{ij}^{\propto}} = \mu a_{ij}^{\alpha} + (1-\mu)a_{ij}^{\alpha}, \quad \forall\alpha\epsilon[0,1]. \quad (2)$$

Step 5. Normalize the matrix and calculate the local weight vector [17].

Step 6. Calculate the Best Nonfuzzy Performance Value (BNP) of each factor to obtain single values from TFNs [18]:

$$BNP_{\mathrm{i}} = \frac{[(u_i-l_i)+(m_i-l_i)]}{3} + l_i, \ \forall_i. \quad (3)$$

Calculate the consistency ratio (*CR*) by using:

$$CI = \frac{\lambda_{max}-n}{n-1}. \quad (4)$$

$$CR = \frac{CI}{RI}. \quad (5)$$

CI is a consistency index, λ_{max} is the biggest eigenvector of the matrix. *n* is the number of factors, and *RI* is the random index. *CR* should be less than 0.1 for consistent results.

Step 7. Apply the same operations for sub-criteria to find local weights. Calculate final weights by the multiplication of the sub-criteria weights with main criteria weights.

3.3. Fuzzy TOPSIS method

The Fuzzy TOPSIS method used in this paper is adapted from Chen and Chen [19]. The consecutive steps of this technique are explained next [17]:

Step 1. DMs assess alternatives by utilizing the linguistic terms provided in Table 2 to construct the decision matrix. In Table 2, the linguistic terms are associated with trapezoidal fuzzy numbers. For example, an assessment as "Very Good" is transformed into "(7, 10, 10, 10)" as a fuzzy number. Then, these numbers are used in the computational steps of the methodology.

Table 2. Linguistic terms sets used in fuzzy TOPSIS technique [20]

Linguistic term	Abb.	Fuzzy Numbers
Very Good	VG	(7, 10, 10, 10)
Good	G	(5, 7, 7, 10)
Fair	F	(2, 5, 5, 8)
Poor	P	(0, 3, 3, 5)
Very Poor	VP	(0, 0, 0, 3)

Step 2. The decision matrix is normalized as:

$$\tilde{R} = [\tilde{r}_{ij}]_{m.n}, i = 1,2,\dots,m; j = 1,2,..n \quad (5)$$

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^+}, \frac{b_{ij}}{c_j^+}, \frac{c_{ij}}{c_j^+}\right) \quad (6)$$

where $C_j^+ = max_i C_{ij}$.

Step 3. The weighted normalized matrix is calculated as:

$$\tilde{v}_{ij} = \tilde{r}_{ij} \otimes \tilde{w}_j \quad (7)$$

Step 4. The distances from the positive and the negative ideal solutions are calculated as:

$d_i^* = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^*), i = 1, 2, \ldots m$; j=1,2,…n (8)

$$d_i^- = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^-), i = 1, 2, \ldots m; j = 1,2, \ldots n \quad (9)$$

where

$A^* = \{v_1^*, v_2^*, \ldots, v_n^*\}$ (10)

$A^- = \{v_1^-, v_2^-, \ldots, v_n^-\}$ (11)

$$d(\tilde{A}, \tilde{B}) = \sqrt{\frac{1}{4}\sum_{i=1}^{n} |x_i - y_i|^2} \quad (12)$$

Step 5. The relative distance to the ideal solution is calculated as:

$$C_i = \frac{d_i^-}{d_i^* + d_i^-} \quad (13)$$

Step 6. Alternatives are ranked based on their relative closeness indices in increasing order.

4. Implementation of the methodology

4.1. Phase 1: Problem definition

The proposed methodology is illustrated with an application to verify its usability. There is a company ABC that wants to invest in the field of digital technology for healthcare logistics. Here, the purpose is to answer this question: "How should ABC company select the most appropriate digital technology for healthcare logistics?". There are six possible alternatives. The company must decide according to the five main criteria and twenty sub-criteria.

4.2. Phase 2: Criteria weight calculation with fuzzy AHP method

First, the fuzzy comparison matrix between criteria is structured by using triangular fuzzy numbers in Table 1. The comparison matrix for the main criteria is shown in Table 3.

Table 3. Evaluation for main criteria

	Linguistic Expressions					Fuzzy Numbers				
C_j	C_1	C_2	C_3	C_4	C_5	C_1	C_2	C_3	C_4	C_5
C_1	E	WMI	EI	-	-	(1,1,1)	(2,3,4)	(1,1,2)	(1/4, 1/3,1/2)	(1/4, 1/3,1/2)
C_2	-	E	-	-	-	(1/4,1/3,1/2)	(1,1,1)	(1/4,1/3, 1/2)	(1/6,1/5,1/4)	(1/6,1/5,1/4)
C_3	-	WMI	E	-	-	(1/2,1,1)	(2,3,4)	(1,1,1)	(1/4, 1/3, 1/2)	(1/4, 1/3, 1/2)
C_4	WMI	SMI	WMI	E	EI	(2,3,4)	(4,5,6)	(2,3,4)	(1,1,1)	(1,1,2)
C_5	WMI	SMI	WMI		E	(2,3,4)	(4,5,6)	(2,3,4)	(1/2,1,1)	(1,1,1)

The steps of the Fuzzy AHP method by using equations (1)-(5). α-cut matrices (α =0.5; μ=0.5) are constructed by using equation and these matrices are normalized. Then, CR is checked. The normalized weights are shown in Table 4.

Table 4. The normalized decision matrix for the main criteria

	C1	C2	C3	C4	C5
C1	0.123	0.176	0.169	0.089	0.108
C2	0.046	0.059	0.042	0.050	0.060
C3	0.092	0.176	0.113	0.089	0.108
C4	0.369	0.294	0.338	0.238	0.434
C5	0.369	0.294	0.338	0.535	0.289

These steps are applied for all sub-criteria, and final global weights for all criteria are calculated. The importance of the criteria is provided in Table 5.

Table 5. Weights of criteria

Main Criteria	Weights	Sub Criteria	Local Weights	Weights	Ranking
C1	0.133	C11	0.390	0.078	7
		C12	0.066	0.013	18
		C13	0.082	0.016	16
		C14	0.462	0.092	4
C2	0.051	C21	0.140	0.028	11
		C22	0.092	0.018	15
		C23	0.145	0.029	10
		C24	0.623	0.125	1
C3	0.116	C31	0.251	0.050	9
		C32	0.106	0.021	12
		C33	0.092	0.018	14
		C34	0.551	0.110	2
C4	0.335	C41	0.407	0.081	6
		C42	0.065	0.013	19
		C43	0.076	0.015	17
		C44	0.452	0.090	5
C5	0.365	C51	0.362	0.072	8
		C52	0.046	0.009	20
		C53	0.093	0.019	13
		C54	0.499	0.100	3

At the end of the Fuzzy AHP, the most crucial criterion is C24: Transport management. The second one is C34: Features and ease of use. The third one is C54: Output quality.

4.3. Phase 3: Ranking of the alternatives with the fuzzy TOPSIS method

Experts evaluated the alternatives regarding the criteria by using the linguistic expressions provided in Table 2. Table 6 shows the experts' evaluations for the alternatives.

Table 6. Evaluations for the alternatives

	C11	C12	C13	C14	C21	C22	C23	C24	C31	C32	C33	C34	C41	C42	C43	C44	C51	C52	C53	C54
A1	VG	VG	F	G	G	G	VG	VG	F	G	G	P	P	F	P	VP	P	P	VG	F
A2	VG	VG	VG	G	G	G	G	G	G	VG	G	F	F	G	G	F	F	G	VG	F
A3	VG	VG	VG	VG	F	F	F	F	P	P	P	VG	P	G	P	P	P	G	G	VG
A4	F	F	G	G	G	F	F	F	VG	VG	VG	VG	F	VG	G	F	VG	G	G	VG
A5	F	F	F	F	P	P	P	P	VG	VG	G	VG	P	P	VG	VG	F	F	F	VG
A6	VG	VG	F	F	P	P	P	P	F	P	P	P	P	F	P	P	G	F	F	G

Equations (5) - (13) are employed to rank the alternatives. Table 7 provides the result of the fuzzy TOPSIS method.

Table 7. The ranking of the alternatives

Ai	A1	A2	A3	A4	A5	A6
Di+	19.446	19.338	19.390	19.300	19.392	19.538
Di-	0.554	0.662	0.610	0.700	0.608	0.462
Ci	0.028	0.033	0.031	0.035	0.030	0.023
Ranking	5	2	3	1	4	6

At the end of the fuzzy TOPSIS method, ABC's most appropriate alternative is Robotics and Automation (A4).

5. Conclusion

In this study, an evaluation framework of digital technologies for healthcare logistics was presented. First, the proposed model was structured with literature review and expert opinions. After that, this model was evaluated with fuzzy MCDM methods (i.e. fuzzy AHP and fuzzy TOPSIS) to calculate the criteria weights and rank the alternatives, respectively. An application was illustrated to show the methodology's effectiveness, and the results of this study are given. The most appropriate digital technology was found as "Robotics and Automation".

Automation through technologies like robotics is expected to enhance operations' speed and efficiency to meet the increasing demand for fast and direct-to-consumer deliveries.

One of the perspectives can be considering the dependence and the interaction between the criteria and to extend our analysis by applying the analytic network process (ANP) approach. The problem can be solved using other fuzzy MCDM methods to compare the other results with our result from the second perspective.

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