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Systematic literature review on interplay of dislocated work, ICT communication and team relations

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Kurzfassung

Mit der wachsenden Popularität und der raschen Entwicklung der Informations- und Kommunikationstechnologien (IKT) und den neuen Möglichkeiten, die diese Kommunikationsmittel bieten, sowie mit der zunehmenden Globalisierung, dem Marktdruck und den ungleich verteilten spezialisierten Arbeitskräften gewinnen neue dislozierte Teampraktiken an Bedeutung. Die wachsende Zahl virtueller und flexibler Teams wird wahrscheinlich nicht mehr zurückgehen. Reduzierte persönliche Kontakte und persönliche Kommunikation beeinflussen jedoch die Teambeziehungen und Teamergebnisse.

Die vorgeschlagene Forschung versucht daher, die folgende Forschungsfrage zu beantworten: **„Welche Auswirkungen hat das dislozierte Arbeiten in Teams, die von der IKT-Kommunikation abhängig sind auf die Teambeziehungen?“** Zur Beantwortung dieser Forschungsfrage wurde eine systematische Literaturanalyse durchgeführt und ihre Ergebnisse werden vorgestellt.

Die Ergebnisse deuten darauf hin, dass der Aufbau von Beziehungen in dislozierten Teams mehreren Herausforderungen unterliegt. Die Verwendung verschiedener Kommunikationsmittel und deren Anpassung an die Aufgabe haben einen positiven Einfluss auf die Teambeziehungen und die Ergebnisse des Teams. Der geschickte Einsatz von IKTs erfordert jedoch, spezifische technologiebezogene Fähigkeiten und die Arbeit in dislozierten Teams, spezifische Persönlichkeitsmerkmale.

Die Analyse zeigte außerdem, dass es mehrere Forschungslücken und mögliche zukünftige Forschungsrichtungen gibt, insbesondere wenn es um neu entstehende Kollaborationswerkzeuge und dislozierte Teams im Nicht-IT-Bereich geht.

Abstract

With the growing popularity and rapid development of information communication technologies (ICT), and the new possibilities offered by this communication means along with increasing globalisation, market pressure, and unequally distributed specialised workforce, new dislocated team practices gain importance. Growing number of virtual and flexible teams is not likely to turn back. Reduced personal contact and face-to-face communication however influence team relations and its outcomes.

Therefore, the proposed research strives to answer the following question: **What is the impact of dislocated work in teams that depend on ICT communication on team relations?** In order to answer this research question a systematic literature analysis was conducted and its findings are presented.

The results suggest that the relationship building in dislocated teams underlies several challenges. The use of variety of communication tools and their fit to the task have positive influence on team relations and team outcomes. However, the skilful usage of ICTs requires specific technology related skills and work in dislocated teams, specific personality traits.

Further, the analysis showed that there exist several research gaps and possible future research directions especially when it comes to new emerging collaboration tools and dislocated teams in non-IT sector.

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1 Introduction

Computer mediated communication (CMC) can be dated to around World War II when the first digital computer was invented or at least to early 60s when first recorded exchange of prototype emails took place (Thurlow, Lengel, & Tomic, 2004, p. 14). The popularisation of personal computers in 1990s accelerated immensely the use of CMC. Around this time computers started to be a common equipment in offices, schools, and private homes (Thurlow, Lengel, & Tomic, 2004, p. 15). At the same time World Wide Web was developed (CERN, 2008). Beginning of 1990s the first SMS was sent (Schuh, 2006, p. 17). At the end of 20th century emojis were developed (Balagdon, 2013). At the beginning of 21st century the expansion of internet was very rapid, thanks to high speed connections and lower prices (An initiative of the computer & communications industry association., 2013). Shortly, after the beginning of new century the mobile revolution took place, enabling access to internet through mobile devices (NNT docomo, 2020). Smartphones enabled being online everywhere and all the time, to communicate not only via voice but also via picture and video, instant sharing of information and knowledge even “on the move” – in opposition to classic desk at work.

The development of computer and more the emergence of internet and as a result information and communication technology (ICT) that integrates computers, telephone, as well as other devices, caused an evident social and cultural transformation. New ways of communication, building social interactions in private as well as professional life are constantly being changed or influenced by the internet (Thurlow, Lengel, & Tomic, 2004). Work related ICT is growing in popularity and became a mandatory part of nowadays professional working conditions. “Communication and the use of technology are indispensable to team functioning in any circumstance, exponentially more so with virtual teams” (Dunn, Grannan, Raisinghani, & Stalling, 2015, p. 371). ICT enabled global access to highly educated and skilled workforce, and expertise for highly specialised disciplines (Hinds & Mortensen, 2005). However, this accessibility is not without costs – increased reliance on ICTs poses new challenges in front of management considering coordination of team, building team relations, and achieving expected outcomes.

At the same time, fast changing conditions in the current global economy are constantly increasing the pressure on the enterprises and presenting new challenges that must

be tackled in order to survive on the global market (Haiyan & Feng, 2007, p. 565). With the proceeding globalisation the access to specialised knowledge that is often unequally distributed became a necessary condition to stay competitive on the market (Iorio & Taylor, 2014, p. 340).

Companies used to tackle challenges on the market by team-based practices (Mikl-Horke, 2007, p. 156). They were and still are an important part of organisational life, however not a new one. Teams used to approach problems and challenges that a sole worker was not able to overcome. Traditionally teams are defined as collectives ‘‘who exist to perform organizationally relevant tasks, share one or more common goals, interact socially, exhibit task interdependencies, maintain and manage boundaries, and are embedded in an organizational context that sets boundaries, constrains the team, and influences exchanges with other units in the broader entity’’ (Kozlowski & Bell, 2003, p. 334). Team based practices were generally designed as those whose membership was stable overtime, primary to the team, shared common goals, performed defined roles, worked on a defined task, and shared common location (Tannenbaum, Mathiey, Salas, & Cohen, 2012, p. 3). Such stable teams do still exist, however more and more often people belong to more than one team or change teams regularly, work in different project team, in different places and connect via ICT. Nevertheless, the goals of teamwork, even in virtual teams, stayed unchanged.

“Two decades ago, virtual teams were almost non-existent. Today, technology, globalisation, and the need for fast response to market demands have dramatically changed the way business is conducted” (Siau & Ling, 2017, p. 48). Thanks to rapid development of ICT, “(…) modern organizations become more flexible, form virtual teams, and allow working to the employees far off at home, being in the different countries.” (Shvetsova, Dobrynina, & Romanov, 2016, p. 108). The fast-moving development of ICT offers new working styles, where participants in remote locations can communicate and collaborate on projects to achieve a common target (Wang, Love, Kim, & Wang, 2011, p. 1971). The new working styles encompasses purely virtual teams, teams that are mixed/hybrid (partly virtual and partly co-located) or teams working within flexible working arrangements, all of them having different characteristics from each other and from traditional co-located teams.

Nowadays companies are increasingly dependent on virtual teams, in which geographically distributed employees, with different cultural background, and using

different technological means of communication, daily strive for achievement of a common goal. The economic reasons for vast implementation of virtual teams can also serve strategic decisions aiming at gaining a competitive advantage (Siau & Ling, 2017).

Virtual team success is however dependent on effective communication and knowledge sharing among the members (Lockwood, 2015). The usage of appropriate communication tools for specific communication task as well as disposure of several communication behaviours are inevitable to assure smooth, efficient, and effective cooperation in a dislocated team. (Dennis & Valacich, 1999; Dennis, Fuller, & Valacich, 2008)

As depicted in this introductory part, there exist several factors that influence each other in the non-co-located (virtual) or partly co-located (hybrid) teams. ICT communication being an inevitable part of professional life in virtual, hybrid but also traditional teams influences team relations and finally team outcomes posing several new challenges in companies' life. Therefore, the aim of this work is to deepen the understanding based on the current state of research on the interplay of defined factors (dislocated work setting, ICT communication, and team relations), as well as to identify possible gaps in research and future research directions. In order to meet this objective a research question was defined as: **What is the impact of dislocated work in teams that depend on ICT communication on team relations?** In order to answer this question, the thesis is divided into three main parts. First, a theoretical background is presented, giving an overview of ICT communication and related theories, sharpening the definition of dislocated work arrangements, as well as describing basic team relations. Second, the methodological approach and a scientific background for chosen methodology (systematic literature analysis) is presented. Third, the findings are profoundly analysed both from statistical as well as substantive angle. Finally, the weaknesses and limitations of the findings, and used method are presented unveiling the research gap and possible further directions of research, and possible developments and improvements.

2 Theoretical Background

The world of professional life is undergoing a permanent change that accelerated immensely with the emergency of ICT (Wallace, 2004). The increasing flexibility of professional world can be clearly observed. Forty hours, five days week behind the desk in the office is almost no longer existent (Landry, Mahesh, & Hartman, 2005). As a result, with the undergoing changes, continuous scientific research was constantly following the situation in order to investigate the situation and change process. Therefore, this chapter summarises the state-of-art in research, presenting the widely spread theories, and being a basis for the development of methodological part of this thesis.

Thus, the first section deals with different forms of work, serving the definitions and descriptions of virtual, hybrid, and traditional teams. Next, the second section focuses on team relations and influence of ICT on team relations as well as challenges faced by dislocated teams. Finally, in third section computer-mediated communication theories are presented in the order of their emergence.

2.1 Different forms of teamwork

Rapid changes and fluctuation in the global economy increases the pressure on enterprises. With the development of globalisation and high distribution of specialised knowledge organisation tends to work in different decentralised settings. Rapid development of information technologies enabled higher flexibility of professional environment and creation of new working arrangements including practices as home office, satellite office, flexible work, and creation of hybrid or even purely virtual teams (Shvetsova, Dobrynina, & Romanov, 2016, p. 108).

Woods and West (2010) defined team as “(…) a relatively small group of people working on a clearly defined, challenging task that is most efficiently completed by a group working together rather than individuals working alone or in parallel: who have clear, shared, challenging, team level objectives derived directly from the task: who have to work in closely and interdependently to achieve these objectives; whose members work in distinct roles within team” (Woods & West, 2010, p. 482). Similar definition was proposed by Thompson – “team is a group of people who are interdependent with respect to information, resources, knowledge and skills and who

seek to combine their efforts to achieve a common goal" (Thompson, 2008, p. 2).This definitions do not consider the factor of geographical proximity or virtualness of the team. Contrary to team definition, based on the literature research it is clearly visible that there is a little consensus on the definition of virtual team. *Virtualness* can be defined based on the time that the team do not spent together while working on a specific task, by the physical distance separating the members of the team, frequency of use, and variety of technical support (Fiol & O'Connor, 2005, p. 29). The degree of dislocation, frequency of face-to-face contact, and as a result the intensity of ICT usage leads to definition of three teamwork forms. As the definition and characteristic of traditional team is clear there exist several definitions or characteristics of virtual team. Fiol and O'Connor (2005) proposed following team definitions:

Traditional/ face-to-face teams are characterised by frequent face-to-face contact and therefore least uncertainty, most visibility, greatest number of rich individuating cues being regularly transmitted as well as greatest influence of politeness rituals, and typically least diversity (Fiol & O'Connor, 2005, p. 29).

Hybrid/ flexible teams are characterised by occasional face-to-face contact and therefore moderate degree of uncertainty, moderate levels of visibility, intermittent rich individuating cues, moderate degrees of diversity, and intermittent politeness rituals (Fiol & O'Connor, 2005, p. 29).The workers working in flexible teams carry out their professional activities out of the premises of the employer with help of information technology at regular basis (European Foundation for the Improvement of Living and Working Conditions, 2010, p. 2).

Pure virtual teams are characterised by absence of face-to-face contact and therefore most uncertainty, least visibility, fewest rich individuating cues, most diversity, and fewest politeness rituals (Fiol & O'Connor, 2005, p. 29).

According to Lipnack and Stamps (1997) a virtual team is a group of people who interact through interdependent tasks guided by a common purpose and work across space, time, and organisational boundaries with links strengthened by webs of communication technology.

Gibson and Manuel (2003) propose the definition of virtual team by assignment of three basic attributes: members must be functioning teams, that is they must be interdependent in task management and must have shared responsibility with regard

to outcomes; team members must be geographically dispersed; and team members must rely on technology-mediated communication to carry out their tasks.

Finally, in comparison to traditional teams, virtual teams can collaborate and communicate remotely using technology, in order to achieve the same goal, while the dispersed expertise can be used without geographical limitations and differences (Lipnack & Stamps, 2000).

2.2 Influence of ICT on team relations

Virtual teams working beyond geographical boundaries are increasingly common in organisation around the globe (Kirkman, Rosen, Gibson, Tesluk, & McPherson, 2002; Lipnack & Stamps, 1997). Virtual teams are becoming more popular work structure because specialised knowledge is often geographically distributed (Iorio & Taylor, 2014, p. 340). Being supported by ICT virtual team allow access to diversified employee pools, help to reduce costs, and compete on the market (Lipnack & Stamps, 1997). However, virtual teams face also challenges. Virtual teams' success depends on the effective communication and knowledge sharing among its members (Lockwood, 2015). Although there exists a variety of communication channels, if not used wisely and appropriately, communication difficulties may arise. As a result, "working in a virtual team apart from the relevant technical knowledge also requires a range of skills and personal attributes. In the first place, these include: knowledge and technical skills related to the use of e-tools, then personality traits such as openness, willingness to share knowledge, tolerance of uncertainty, the ability to cope with stress, the ability to accept different points of view, and in the case of global teams, cultural intelligence." (Czarnecka, 2013, p. 58). The high number of communication tools with different characteristic, that propose on one hand a wide choice for a specific communication task may on the other hand be overwhelming for the user. The choice of the communication channel is a topic of research on media selection (see Daft & Lengel, 1986; Short, William & Christie, 1976) and is discussed in the following chapter.

Both virtual and flexible teams consist of members whose interactions are mediated by different information technologies, which allow them to work across space and time. Although such teams have a clear advantage for the organisations, they must cope with team's tasks in the context of reduced or no opportunities to physically meet teammates and share their experiences, knowledge etc. (Rico, Alcover, Sanchez-

Manzanares, & Gil, 2009, p. 230). Team members are therefore forced to communicate fully or partially using the ICT to achieve common organisational and team goals (Shvetsova, Dobrynina, & Romanov, 2016, p. 108).

Communication is a key component of flexible and virtual work. It is a way to exchange information, share ideas, share knowledge, coordinate effort in team, provide mutual feedback and create team bonds. Communication and its quality provide a basis for other factors determining the performance of the team (de Leede & Nijland, 2017, p. 79).

Due to the lack of opportunities to communicate in person the interactions of team members are performed mainly through telephone, teleconference, messaging, e-mail, videoconference, etc. All those “computer-mediated communication technologies face the same drawback due to the lack of verbal and/or nonverbal cues, compared to traditional face-to-face communication. The verbal cues (i.e. tone of voice, verbal hesitation, volume) and non-verbal cues (i.e. facial expression, body movement, emotion) are however important sources to process information from team members for tasks” (Bhat, Pande, & Ahuja, 2017, p. 35).

Reduction of clues in computer-mediated communication can lead to miscommunication incidents. “Information sharing, understanding the other, and language are clearly the top three most common factors of miscommunication among engineering professionals “ (Amant, 2015, p. 61). Miscommunication during information sharing can also occur due to “lack of clear detail, incorrect assumptions about receiver knowledge, disparity of information, unnecessary information, volume of correspondence, and missing information” (Amant, 2015, p. 61). As information sharing is a vital part for goal achievement and team success it is important to encourage individuals to share information openly with other team members. Information sharing takes place if team members share mutual goals and experiences and come together to exchange ideas. In geographically distributed teams there is a reduced information sharing (Crampton, 2002) caused by reliance on technology, physical distance between co-workers, different work norms, cultural, and language differences. The process of information sharing involves the conversion of knowledge from individual to individual or to a group in an understandable, absorbable, and reusable form (Bhat, Pande, & Ahuja, 2017, p. 35). Lack of information sharing disrupts three primary enablers of distributed work – shared understanding, integration, and

mutual trust (Gibson & Cohen, 2003, p. 12) Shared understanding represents common beliefs, expectations, skills, knowledge, or abilities of teams members. It is a “collective way of organizing relevant knowledge” (Gibson & Cohen, 2003, p. 21) and is critical for coordination of work. One key barrier to development of shared understanding is the reduced possibility of sharing informal, unintentional information among co-workers (Johri, 2015, p. 422).

Further form of a communication in a team is social communication that is an informal, casual, and unplanned communication between the team members, not necessarily related to the team’s tasks. This form of communication is however vital for a team to create positive team relations influencing the effectiveness of a team. Social communication is identified as a key to develop trust in a team, that is crucial for team performance (Amant, 2015, p. 80). In general, the more virtual the team is, the more it may struggle to build trust and form cohesive bonds necessary for open information and knowledge sharing (Amant, 2015; Warkentin, Sayeed, & Hightower, 1997; Carlson, Carlson, Hunter, Vaughn, & George, 2013).

Another precondition of building trust and open information sharing is identity communication. It is defined as a set of methods an individual use to convey themselves. It provides a sense of coherence, a feeling of being known and understood by others. A positive identity communication is therefore a predictor for team relations and performance. It promotes social relations and perceived membership, and strengthen cooperation, cohesiveness, identification with a group improving team outcomes (Wilson, Thatcher, & Brown, 2015, p. 703; Timmerman & Scott, 2006, p. 111).

Duarte and Snyder identify team unity (cohesiveness) as a primary goal for a virtual team, that cannot be achieved by many traditional means due to the work arrangement (Duarte & Snyder, 1999). As with the higher degree of vitalness the social influences and social identity are reduced or harder to establish, “negative impacts associated with low cohesion should be amplified as teams become more virtual” (Workman, Kahweiler, & Bommer, 2003, p. 796). Cohesion of the team increases cooperation, positively influence shared meaning, improves building collective knowledge (knowledge sharing) resulting in higher effectiveness and performance (Carlson & Zmud, 1999, p. 2).

Finally, communication is a core of virtual team processes and is a key antecedent of trust building (Gibson & Manuel, 2003; Powell, Piccoli, & Ives, 2004; Jarvenpaa & Leidner, 1999). Trust building requires interaction between team members and information exchange. The extensive use of information communication technologies and other collaboration tools in flexible and virtual teams, along withnthe reduced or no face-to-face meetings hinders the establishment of shared context and shared knowledge, which are important conditions for trust development (Iorio & Taylor, 2014, p. 341).

Within the flexible and virtual work arrangements the development of trust is an important factor for the team success as willingness for knowledge sharing and information exchange are highly dependent on trust. (Gibson & Cohen, 2003) Distributed work setting may challenge the trust development, however skillful usage of computer-mediated communication technologies can facilitate or help the development and maintance of interpersonal trust (Julsrud & Bakke, 2008, p. 183). The media used to communicate must support not only information exchange and other task-related activites but also enable social relations that support building and maintenance of team trust, and therefore member communication satisfaction and commitment (Siau & Ling, 2017, p. 50). Trust has an impact on many team relations and moderates the outcome of a team (Gibson & Cohen, 2003, p. 12).

2.3 Computer-mediated communication theories

Computer-mediated communication became an inevitable part of the professional world. It became integral to the information sharing processes in work-related context, but also development and maintenance of interpersonal relationships (Walther J. , 2011, p. 443). Media capacity theories describe the media by ascription of set of characteristics to the specific medium such as richness, social presence, and characteristics of the channel as speed or interactivity. These characteristics do not define any specific medium, but rather describe the features of the medium enabling the achievement of a specific communication goal by the specific communication system (Montoya, Massey, Hung, & Crisp, 2009, p. 141). Since the emergence of information communication technologies, a broad range of theories considering computer-mediated communication was developed. In the following ones most prevalent are described.

2.3.1 Social presence theory

Short, Williams, and Christie's (1976) social presence theory argues that various communication media vary in their capacity to transmit nonverbal clues. It suggests that social presence will affect the way individuals perceive their discussions and their relationships with others. According to this theory, communication media vary in their degree of social presence and people tend to choose media compatible with their needs for social presence (Gonzalez-Ibanez, Haseki, & Shah, 2013, p. 1167). The fewer the number of nonverbal cues the less personal content is transmitted, and the less warmth and involvement is developed between users (Short, Williams, & Christie, 1976). In face-to-face communication the highest number of nonverbal cues and as a result the strongest social presence is to be found. Videoconferencing, telephone-conferencing, and chat offer a lower level of nonverbal cues and therefore lower social presence than face-to-face communication. Finally, the lowest social presence is represented by written form as an email, a memo, or a book. High social presence enables the conveyance of social context clues and symbolic content, whereas low social presence filters these out. Social presence is highly related with richness (Montoya, Massey, Hung, & Crisp, 2009, p. 141).

2.3.2 Media richness theory

In 1986, Daft and Lengel proposed another theory called media richness theory, which describes the suitability of media according to its richness to a specific task. The "richness" of the medium is defined through the immediacy of feedback, possibility of giving multiple instructions (gesture, tone etc.) to avoid information ambiguity, message content and language variety (Daft & Lengel, 1986, pp. 554-571). Media richness is the degree to which the medium facilitates understanding during the communication. Daft and Lengel (1986) argue that the richer the medium the more efficient it is. "[…] Rich media facilitate equivocality reduction by enabling managers to overcome different frames of reference and by providing the capacity to process complex, subjective messages. Media with low richness process fewer cues and restrict feedback and are less appropriate for resolving equivocal issues" (Daft & Lengel, 1986, p. 560). Considering the media richness theory, similarly to social presence theory face-to-face communication is the richest communication mode as it enables transmission of multiple cues, simultaneous sender, and receiver contact (immediate feedback) along with message personalisation. During face-to-face

communication people can rapidly convey content and meaning both verbally and nonverbally. Audio communication allows conveyance of certain nonverbal information, and text chat communication only allows conveyance of textual information (Gonzalez-Ibanez, Haseki, & Shah, 2013, p. 1167). Further the media richness theory takes into consideration the equivocality of situation, defined as subjectivity of interpretation of situation and information, stating that the richness of the media should be aligned with the equivocality of situation. The greater the equivocality the richer the medium und the less the equivocality the leaner the medium should be (Daft & Lengel, 1986, p. 449). Richer media are therefore appropriate for contexts in which tasks communication is unstructured and ambiguous.

2.3.3 Media synchronicity theory

In the consecutive years, in further studies the media richness theory was examined multiple times and various adaptations were developed. One of the most well-known is the media synchronicity theory building on the concepts of media richness. It looks beyond media richness to media synchronicity as a predictor of communication performance. Media synchronicity theory (MST) focuses on the capability of media to support synchronicity, which is defined as "a state in which individuals are working together at the same time with a common focus" (Dennis & Valacich, 1999, p. 19). Media synchronicity theory specifies the characteristics of the media that facilitate "shared patterns of behaviour and shared understanding (i.e., successful communication of desired information), depending on the fit of the medium's synchronicity with the requirements of a communication task" (Wilson, Thatcher, & Brown, 2015, p. 704). Media synchronicity theory introduces a set of media characteristics including transmission velocity, symbol sets, parallelism, rehearsability, and reprocessability. These characteristics influence the ability of users to transmit and process information.

Transmission velocity refers to the speed of message exchange that is the speed in which the message can be delivered to the recipient and the feedback can be received by the original sender. *Symbol sets* refer to number of ways or cues that can be transmitted via the medium (visual, audio, text-based). *Parallelism* refers to multiple simultaneously transmitted messages. *Rehearsability* refers to the ability of sender to rehearse the message (prepare and adjust/modify to present the content precisely)

before it is communicated. Finally, *reprocessability* is the extent to which a prior message can be re-examined, reprocessed, or reviewed.

Dennis, Fuller and Valacich (2008) introduced in their papers, almost ten years later after the analysis of the communication needs to fulfil the task, the fundamental processes relevant to all tasks. "*Conveyance processes* are the transmission of a diversity of new information- as much new, relevant information as needed- to enable the receiver to create and revise a mental model of the situation" and "*Convergence processes* are the discussion of pre-processed information about each individual's interpretation of a situation, not the raw information itself. The objective is to agree on the meaning of the information, which requires individuals to reach a common understanding and to mutually agree that they have achieved this understanding" (Dennis, Fuller, & Valacich, 2008, p. 580). Conveyance and convergence processes have different requirements in terms of media synchronicity; however, one must engage and perform both during communication process. This suggests that different technologies are suited better for different tasks. Asynchronous technology will be better suited for conveyance task as to simultaneous presence of all receivers is not required as well as they must not agree on the meaning of the message (Dennis, Fuller, & Valacich, Media, Tasks, and Communication Processes: A Theory of Media Synchronicity, 2008, pp. 580-582). Asynchronous ICTs are therefore leaner, lower on interactivity and lower on the social presence. Oppositely, if development of shared meaning and understanding is required as in the convergence processes, synchronous ICTs will support better those processes as they are richer in term of social presence and interactivity (Montoya, Massey, Hung, & Crisp, 2009, p. 141).

3 Methodological Approach: Systematic Literature Review

The objective of this work is the analysis of the state of research dealing with the dislocated work patterns, ICT communication, and team relations, and the interplay of these factors. Further research directions and research gap should be identified beside the summary of the results of systematic literature review.

There exists a huge amount of the literature dealing with the dislocated work patterns as work in purely virtual teams, in hybrid teams, within flexible work schedule and hours, flexible workplace etc., ICT communication, and resulting team relations, and outcomes. This literature analyses the situation in different branches, using different methods and restricting its usability to specific case considering only some factors.

In order to meet the goal of the thesis, a methodological approach which follows a structured, documented, and repeatable way (EPPI-Centre, 2019) – systematic literature review was chosen. The literature reviews in the science are carried out for different purposes such as investigation of theoretical background for the subsequent research, presentation of the variety and breadth of research being already conducted in the specific field or unrevealing the existing research gap and indication of the possible fields of future research. Independent of the goal, a literature review should always be a critical reflection of the scientific publications in the predetermined field of interest.

The most popular purpose for conducting a literature review is to provide a theoretical background of the research topic and to put the chosen research question into the context of existing scientific results. In most of the cases the literature review is a thorough part of the scientific work published as an introductory section of an article or academic thesis, but not its core. However, there exist another type of literature review called a stand-alone review, which is an original and valuable work of research in and of itself (Okoli & Schabram, 2010, p. 1). This kind of literature reviews provide a solid basis and a great guidance for other academic researchers in the field. According to Fink (2005) a rigorous stand-alone literature review must systematically follow a methodological approach, explicitly explain the procedures according to which it was

conducted, be comprehensive in the scope of included and excluded materials, and be reproducible by other who would follow the same approach.

3.1 The need for systematic literature review

Literature reviews as being regularly encountered in all types of scientific work are presenting an overview of previous work in the specific field of research, without describing the methods by which the set of sources was identified, selected, and evaluated as relevant or not for the topic of subsequent research. These traditional literature reviews are in the result often restricted to source already known and popular to the authors or easily found without a structured procedure. This leads to frequent citation of popular and successful studies, and introduces a possible bias of primary studies to literature review (Mallett, Hagen-Yanker, Slater, & Duvendack, 2012, p. 448).

Systematic reviews therefore provide an objective summary of previous research in a chosen scientific field. They differ fundamentally from non-systematic reviews. Rousseau et al. (2008) point out that the main difference lies in the representativeness of the reviews. While traditional reviews tend to be “cherry-picking” studies advocating a point of view, systematic reviews provide a full overview of research conducted in a specific field up to present date. The replicability of scientific findings that is provided by the systematic review is the main advantage of this method over traditional reviews.

The approach to the literature review is a systematic one, when several criteria are fulfilled. These are: explicitness and transparency of used methods, standardised set of stages and steps, accountability, replicability, updatability, and the involvement of user in order to ensure relevancy and usefulness of the reports (EPPI-Centre, 2019).

If the literature review was conducted rigorously, the following advantages are represented:

- improved transparency of the generated conclusions due to qualitative evaluation of relevancy;
- reduction of implicit researcher biases due to structured search methodology;
- exhaustivity of search through inclusion of studies beyond researcher own subject areas and network;

- synthesis of sound searches reducing large amount of information into a manageable form;
- explicitness of methodology allowing the reader to assess the reliability and validity of review (Mallett, Hagen-Yanker, Slater, & Duvendack, 2012, p. 448; Gough & Elbourne, 2002, p. 226; Petticrew & Roberts, 2006, pp. 10-11).

Despite the advantages provided by the systematic literature review, several practical problems can be encountered. Systematic reviews demand an access to wide range of databases and journals in order to cover most of the available sources, which can be problematic and costly especially for non-academic staff. The main advantage of a systematic literature review is its objectivity, however, there exists an inevitable subjectivity in the screening process including definition of inclusion and exclusion criteria. Finally, due to time a resource constrains, we rely on the research design and results presented by authors which introduce another source of bias (Mallett, Hagen-Yanker, Slater, & Duvendack, 2012, pp. 448-449).

The approach of a systematic literature review stands in the middle point of the presented master thesis being a stand-alone review of the state of research in the area of virtual/hybrid work, ICT, and relations within a team. Team relations in dislocated teams that rely on ICT communication is put under investigation. The chosen methodology allows the author to present the relevant studies, synthetize and compare their results, and reveal the gap in the research, and possible future research directions.

In the following chapter the carried-out procedure is presented.

3.2 Procedure followed to conduct systematic literature review in the thesis

As described in a previous chapter a systematic literature review follows a structured step-by-step procedure with different stages. Variety of sources define those steps with different grade of differentiation and division. A three-phase procedure constituting seven steps was developed basing on several sources that ensure a systematic way of conducting a literature review (Fink, 2005, p. 5; Petticrew & Roberts, 2006, p. 27; Cronin, Ryan, & Coughlan, 2008, p. 39; Ramdhani, Ramdhani, & Amin, 2014, p. 49;

Crossan & Apaydin, 2010, p. 1158; Transfield, Denyer, & Palminder, 2003, pp. 214-219; Stone, 2012, p. 114). The procedure is visualised on Figure 1.

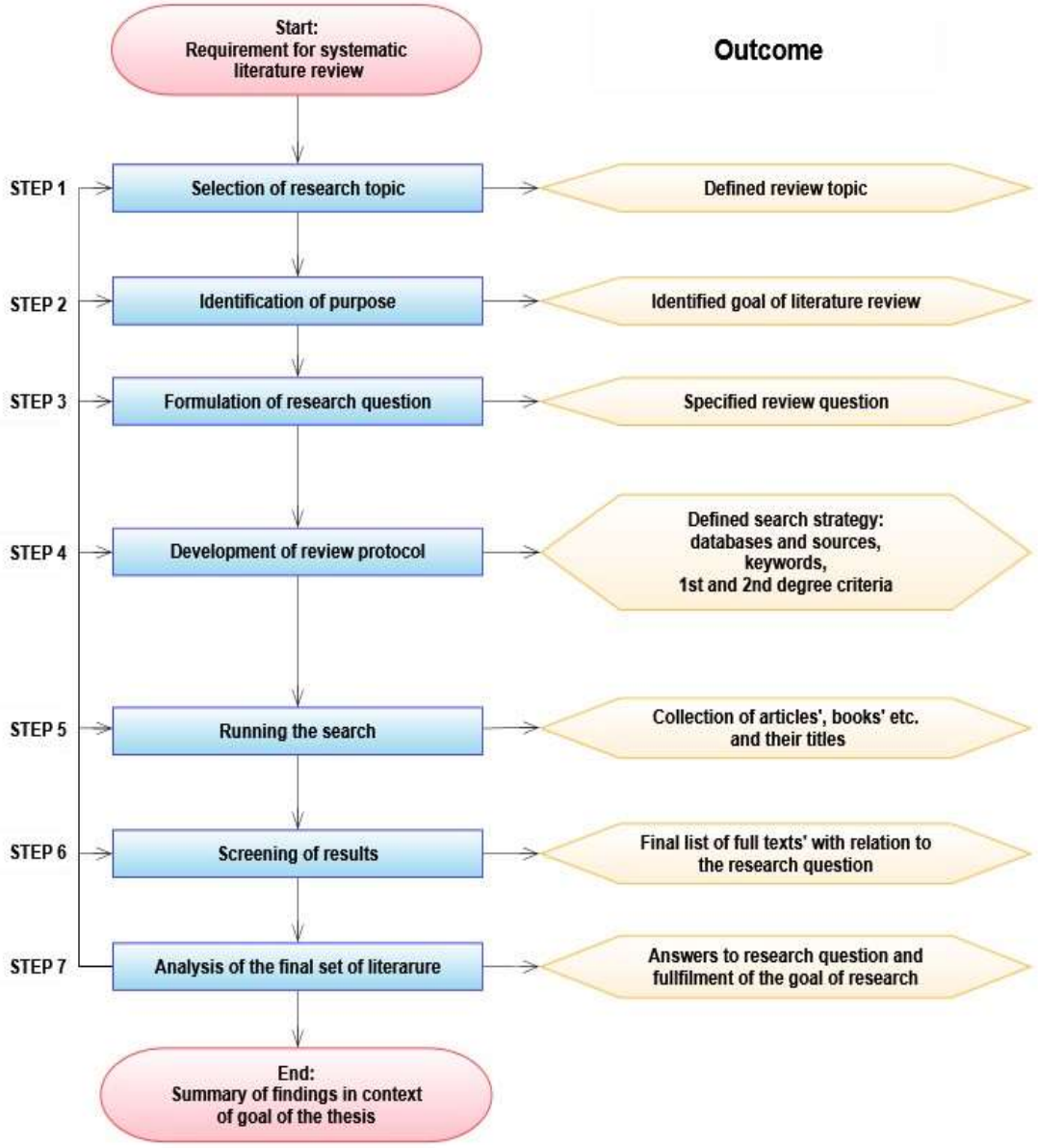

Figure 1 Structured approach for systematic literature review

3.3 Application of systematic literature review procedure in the thesis

PHASE 1: Planning the review
STEP 1 – Selection of research topic

General: The topic of the review is defined and serves a frame for the search of relevant literature. It ensures that review questions defined in STEP 3 are within the relevant topics (frame of research).

Outcome STEP 1: Defined review topic

The main review topics of the systematic literature review are dislocated work settings (virtual and hybrid teams), ICT communication, and team relations, and its coexistence interplay.

STEP 2 – Identification of the purpose for literature review

General: The exact purpose and goal of literature review is to be identified, and its commitment to answering the research question is presented to the reader.

Outcome STEP 2: Identified purpose and goal of review

The main purpose of the review is the identification of current state of knowledge in the specified area and depiction of existing research gap, and future research directions.

STEP 3 – Formulation of research question

General: The goal of a systematic literature review is answering of the specific questions or serving an overview of the present state of knowledge in a specific area of research. The formulation of research question is the inevitable part of the research project. Clear und precise research question(s) are to be defined enabling the derivation of keywords for systematic literature review.

Outcome STEP 3: Specified review questions

The research question has been formulated as stated in the introduction: **What is the impact of dislocated work in teams that depend on ICT communication on team relations?**

STEP 4 – Development of a review protocol

General: The review protocol defines the methods used to conduct the systematic literature review. It ensures comprehensiveness and systematicity throughout the search through the definition of criteria.

Outcome STEP 4: Defined search strategy: databases and sources, keywords, first degree criteria and semantic criteria

Based on the STEPs 1, 2 and 3 the review protocol was developed. The process of development was an iterative one and consisted of 6 rounds that led to 539 results. Due to very high initial number of results an automated search was developed (see 7.2 Software user manual – automated search), that accelerated the process enabling export of title list, keywords, WOS Disciplines etc. The detailed description of the iteration in STEP 4 is to be found in Appendix 7.1.

The final review criteria were defined as follows:

General criteria:

- **Definition of search strategy:** the literature review as a web-based search using the online scientific databases
- **Determination of databases and sources used for the search:** database Web of Science

First degree inclusion/exclusion criteria: criteria that defined the relevancy of sources applied during the automated search

- **Timeframe of publication:** 2006-2018
- **Language of publication:** English
- **Keywords and search terms used:** A AND B AND C (exhaustive list of combinations of keywords from each group)

Table 1 Keywords

A: ICT Communication	B: Relationship	C: Dislocated work setting
Comm*	Relat*	Virtual work*
Telecom*	Connection	Flexible work*
Info*	Shared goals	Alternative work*
Conveyance	Mutual respect	Telework*

Convergence	Team	Telecommut*
Accuracy	Shared knowledge	Home work*
Richness	Accountability	Home office
Synchronicity	Loyalty	Remote work*
Coord*	Commitment	Flextime
Media	Transparency	Flexitime

- **Exclusion keywords:** keyword that eliminates the paper form the list of relevant sources

Table 2 Exclusion keywords

Discipline	Exclusion keywords
Agriculture	*land*, *rural*, *soil*, agro*, agri*
Architecture	*architect*
Biology	*carb*, *energ*, *environment*, *food*, *forest*, *natur*, *plant*, *power*, *species, *water*
Chemistry	*chemi*
Education	*academ*, *child*, *educated*, *e-learn*, *lesson*, *school*, *student*, *teach*, *universi*
Geography	*solar*, *temper*, *there*, *transp*
Literature	novel*, litera*
Mathematics	*algorit*, math*
Medicine	blood*, *brain*, *cancer*, *care*, *clinic*, dement*, *diabet*, *diagnos*, *disease*, *disorder*, *drug*, elder*, *emergen*,*genet*, generati*, *heal*, *heart*, *hospi*, *injur*, lab*, *medic*, mental*, *memor*, molecule*, neur* *nurs*, older*, *optic*, *pain*, palliat*,*patient*, *phys*, prevent* *rehab*, *risk*, *spectr*, *therap*, *treat*
Others	*industr*, *laser*, *manufact*, *pilot*, famil*
Politics	*urban*, nation*
Robotics	*robot*, *sensor*

- **Relevant research disciplines:** choice of disciplines relevant for the review

The exhaustive list of Web of Science Disciplines (252) in connection with title list (in the 5 iteration round – see 7.1) was screened and the irrelevant disciplines were excluded. The list of relevant WOS disciplines (27) was created.

Table 3 Web of Science Disciplines

WOS Disciplines	
Business	Language & Linguistics
Business, Finance	Linguistics
Communication	Management
Computer Science, Information Systems	Operations Research & Management Science
Computer Science, Interdisciplinary Applications	Psychology
Computer Science, Theory & Methods	Psychology, Applied
Economics	Psychology, Multidisciplinary
Education & Educational Research	Psychology, Social
Education, Scientific Disciplines	Social Issues
Engineering, Industrial	Social Sciences, Interdisciplinary
Engineering, Multidisciplinary	Social Sciences, Mathematical Methods
Ethics	Sociology
Humanities, Multidisciplinary	Telecommunications
Industrial Relations & Labour	

- **Literature kind:** research articles (journal or conference), books, dissertations, thesis
- **Amount of text required (100%= full text):** full text required

Semantic inclusion/exclusion criteria:

- **Relation to the research topic (Yes/No):** researcher judgement during screening
- **Suitability for answering the review questions (Yes/No):** researcher judgement during screening
- **Required quality of literature (Yes/No):** researcher judgement during screening.

PHASE 2: Conducting the review

STEP 5 – Running the search

General: The goal of STEP 5 is the identification of exhaustive list of publication that fulfil the general and first-degree criteria. The first-degree criteria are applied directly online.

Outcome STEP 5: Collection of articles, books, etc. and titles

The literature review resulted in 1001 findings after automated search applying first degree inclusion/exclusion criteria (key words, exclusion key words, timeframe, language, literature kind) and 539 findings after application of the first degree criterium – research disciplines out of which 214 titles were within the relevant disciplines and 325 titles being in both relevant and not relevant WOS disciplines.

STEP 6 – Screening of results

General: The semantic criteria are applied manually. The final selection of papers is created by detailed review conducted through full-text screening. The list of 539 were screened.

Interim Result 1: List of findings in database (online) or as a downloaded file

The application of titles screening is performed.

A manual selection based on titles of 539 preselected publication was conducted resulting in 63 titles out of ones only in relevant categories and in 53 titles out of ones being both in relevant and non-relevant categories giving in total 116 papers being possibly in scope of research.

Interim Result 2: Downloaded findings (locally stored)

Further exclusion based on the abstracts is carried out.

Further assessment of relevance was conducted after reading the abstracts of preselected 116 publication and resulted in 18 papers in scope, 12 possibly in scope, 72 out of scope and 14 papers not (yet) available.

Interim Result 3: Locally stored publication for full-text screening

The full-text screening is carried out.

In the very last round downloaded available full texts in the number of 37 was screened resulting in the selection of 27 papers for the final analysis.

Outcome STEP 6: Final list of full text with relation to research question.

The full list of papers selected for the analysis with additional information and summary of findings of each paper is to be found in the Appendix 7.4 Results of search procedure on page 83.

PHASE 3: Documentation of the search
STEP 7 – Analysis of the final set of literature

General: The final set of literature is put under the analysis aiming at answering the research question and meeting the goal of the research.

Outcome STEP 7: Answer to the defined research question and fulfilment of the goal of the research. The statistical analysis is presented below. For the structural overview see Chapter 4.1 Structural analysis of the final set of literature and for the content analysis see Chapter 4.2 Findings of systematic literature review.

In the Table 4 the results after applying first degree and semantic inclusion/exclusion criteria are summarised and visualised on the Figure 2Figure 2 Search results - Web of Science. The total number of results after application of semantic criteria is higher than 27 as some of the papers are to be found under more than one search term.

Table 4 Search results – Database Web of Science

Search Term (plus exclusion keywords)	Number of results after first degree criteria	Number of results after semantic criteria
(Coord* AND Commitment) AND Remote work*	1	1
(Info* AND Commitment) AND Remote work*	1	1
(Media AND Relat*) AND Telework*	1	1
(Media AND Team) AND Telework*	1	1
(Richness AND Relat*) AND Telework*	1	1
(Richness AND Relat*) AND Virtual work*	3	3
(Richness AND Team) AND Telework*	1	1

(Richness AND Team) AND Virtual work*	5	3
(Comm* AND Commitment) AND Remote work*	2	1
(Comm* AND Team) AND Telework*	2	1
(Coord* AND Team) AND Remote work*	2	1
(Media AND Team) AND Virtual work*	22	8
(Comm* AND Relat*) AND Telework*	3	1
(Comm* AND Team) AND Home work*	3	1
(Coord* AND Commitment) AND Virtual work*	3	1
(Comm* AND Team) AND Virtual work*	84	17
(Coord* AND Relat*) AND Remote work*	5	1
(Info* AND Commitment) AND Virtual work*	5	1
(Info* AND Team) AND Remote work*	10	2
(Info* AND Team) AND Virtual work*	52	8
(Media AND Relat*) AND Virtual work*	34	5
(Comm* AND Commitment) AND Home work*	7	1
(Comm* AND Commitment) AND Virtual work*	20	2
(Coord* AND Team) AND Virtual work*	11	1
(Comm* AND Team) AND Remote work*	25	2
(Comm* AND Relat*) AND Virtual work*	125	9
(Comm* AND Shared knowledge) AND Virtual work*	23	1
(Info* AND Relat*) AND Remote work*	26	1
(Coord* AND Relat*) AND Virtual work*	28	1
(Info* AND Relat*) AND Virtual work*	93	3
(Comm* AND Relat*) AND Home work*	34	1

As it can be observed the 27 relevant papers were generated by the limited number of keywords combinations, that is 32 search queries, and only following keywords creating relevant combinations can be found:

Table 5 Search results – keywords in final selection

A: ICT Communication	B: Relationship	C: Dislocated work setting
Comm*	Relat*	Virtual work*
Info*	Team	Telework*

Richness Coord* Media	Shared knowledge Commitment	Home work* Remote work*

As described previously a limited number of keyword combinations led to the final selection of relevant 27 publications. The 27 relevant publication are generated and found under the 32 keyword combinations that are presented on Figure 2 on the following page. Figure 2 Figure 2 Search results - Web of Science presents the distribution of papers per keywords combination after application of first degree and semantic criteria. Three main observations that can be drawn based on the Figure 2, are depicted on the graph and these are:

- High ration of findings fulfilling semantic criteria (8 publications included in final selection) to findings fulfilling first degree criteria (22 publications) being included into the final set of literature for Media AND Team AND Virtual work. The combination of keywords: Media AND Team AND Virtual work as a search term therefore fulfilled very well the criteria defined to reach objective of the thesis, resulting in high number of relevant publications in comparison to not relevant ones.
- High number of findings fulfilling semantic criteria (17 publications) to findings fulfilling first degree criteria (84 publications) being included into the final set of literature for Comm* AND Team AND Virtual work. As in the previous point the combination of keywords: Comm* AND Team AND Virtual work as a search term therefore fulfilled very well the criteria defined to reach objective of the thesis, resulting in high number of relevant publications in comparison to not relevant ones.
- Low ratio of findings fulfilling semantic criteria (3 publications) to first degree criteria (93 publications) included in the final set of literature for Info* AND Relat* AND Virtual work. Contrary to previous two keyword combinations search query Info* AND Relat* AND Virtual work, resulted in huge number of irrelevant sources comparing to ones that are to be found in the final selection, likely due to the very generic terms contained in this search query.

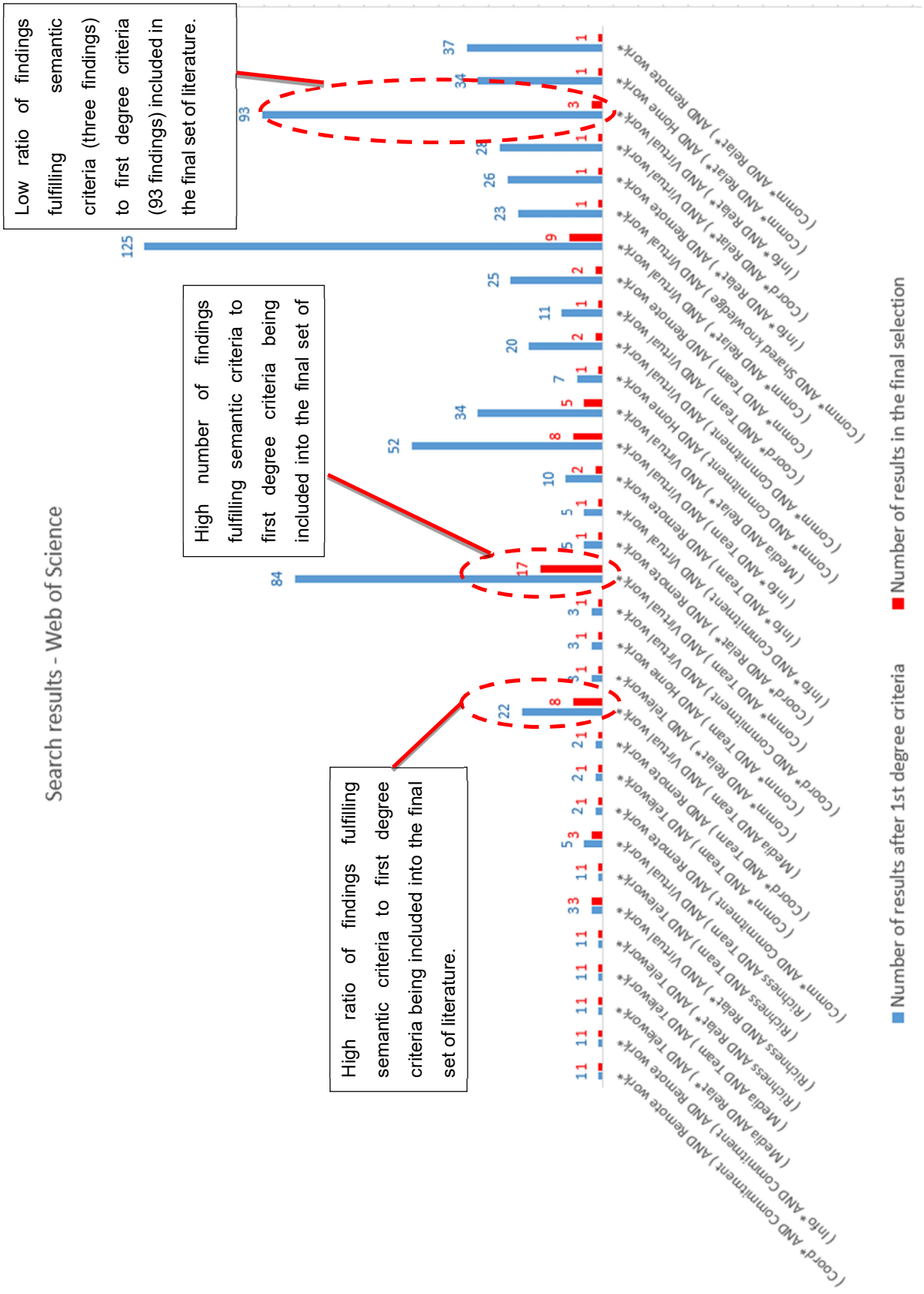

Figure 2 Search results - Web of Science

4 Results of the Systematic Literature Review

In the following, the results of the conducted automated search (applying the first-degree inclusion/exclusion criteria) and manually applied semantic criteria are summarised. At first the structural overview is presented, followed by the content analysis presenting a summary of evidence and attempt to explain the findings.

4.1 Structural analysis of the final set of literature

The 27 papers selected for the final analysis are all listed in the Table in Appendix 7.4 providing information on title of the article, publication type (article, book chapter, proceeding paper), year of publication, language of publication, author keywords, and WOS keywords plus, number, and names of author, country of origin, institution, research areas, and WOS disciplines. In the second part of the table, for each publication a summary of theoretical framework, relevant objectives/hypothesis, presentation of methodology, research design, research method, country of research, sample field and, size and, type of team is presented. Finally, if present, dependent and, independent variables are described along with the result of research.

In the following the distribution of the papers and their properties along several categories is presented.

When it comes to the publication type out of 27 selected papers 15 are articles, 6 book chapters and 14 proceeding papers, including several being published in more than one category. In terms of publication time span it can be observed that nine of the papers comes from years 2015 and 2017. Further most of the papers (14) present a descriptive research design, 8 out of 27 papers a hypothesis test and 5 out of 27 have an explanatory character.

The distribution of used research method is as following:

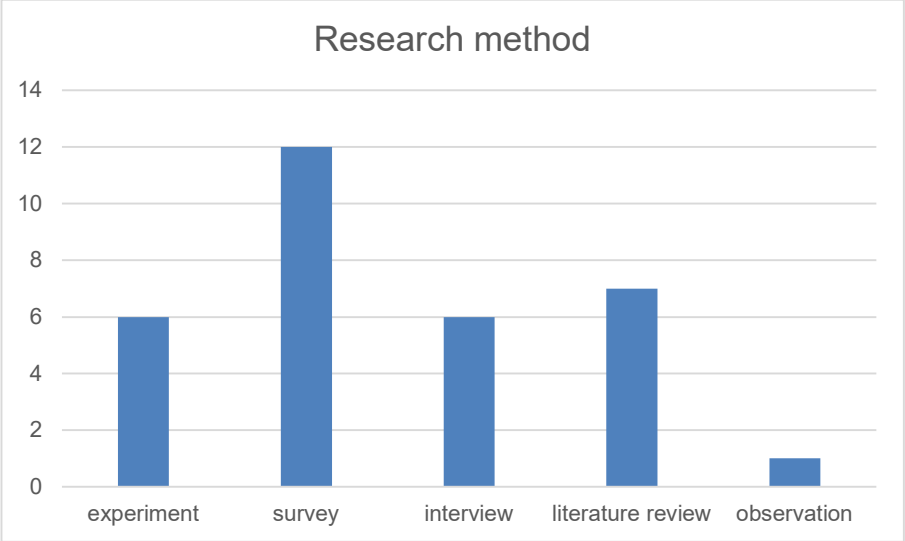

Figure 3 Research method

Most popular research method within the chosen set of publications is survey, followed by literature review, experiment and observation, whereby several papers combined different methods. The researches were carried out in US, North and Latin America, China, United Arab Emirates, and several European countries as Denmark, Norway, Finland, or Latvia. Most of the publications covered the IT sector (10 out of 27) followed by engineering and civil engineering, finance, public administration, and services.

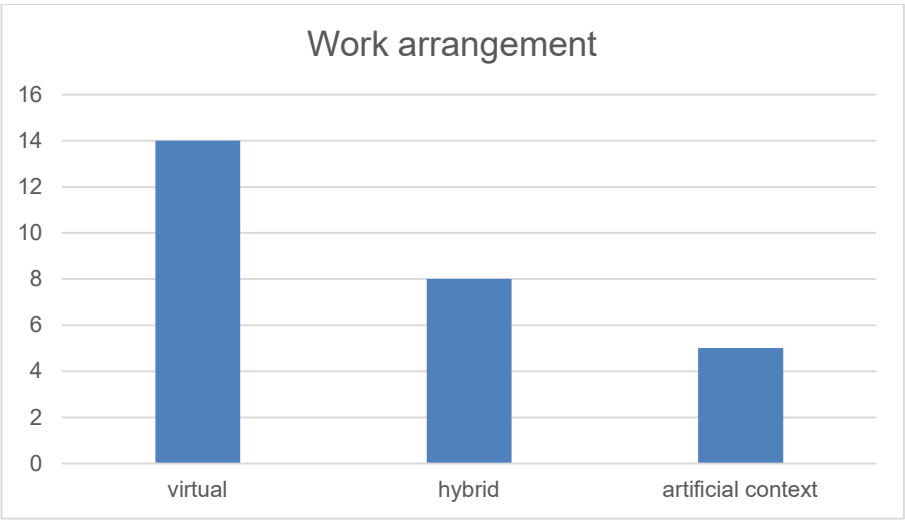

Figure 4 Work arrangements

Finally, 13 publication deal with virtual work, two compare virtual and co-located arrangements, seven deal with hybrid arrangements, and five conducted research in an artificial context (e.g. experiment on students put into “virtual” setting).

4.2 Findings of systematic literature review

In the following the analysis of the content of the selected papers is presented. As in the search queries terms that apply to both virtual and hybrid setting were present, within the selected publications both groups were represented. In order to carry the analysis of the content the publications were grouped according to the work arrangement into three groups, that is virtual team, hybrid teams and artificial setting (research carried out for example on group of students put under investigation that simulates a virtual setting) .

To conduct the analysis of the content of the final set of publications several concept maps were created. This method, chosen to visualise and systematise the findings, facilitates further analysis. In general, concept maps present an organisation and graphical representation of knowledge, especially of large size. Concepts are defined as a „perceived regularity in events or objects, or records of events or objects, designated by a „label“”. The origin of concept maps can be dated to beginning of 70’s, when researchers strived to understand changes in children’s knowledge and represent their findings in form of a concept map (Novak & Canas, 2008, pp. 1-3). On the concept maps relations between factors presented in the chosen literature are visualised.

As the selected literature deals with both virtual and flexible teams, and test some relations in “artificial setting” (i.e. virtual work in the group of students) three concept maps summarising the relations in the virtual team, flexible team, and artificial context were created to facilitate drawing conclusion presenting the findings in a graphical form (see Figure 5, Figure 6, Figure 7). On the concept maps the following colour coding was used: green - ICT/Media related factors, blue – communication related factors, yellow – team relations related factors, red – outcomes, grey – other factors.

Finally, in all three groups an in-depth analysis of the content of publication were conducted and totality of findings is presented in the following.

4.2.1 Virtual team – presentation of findings

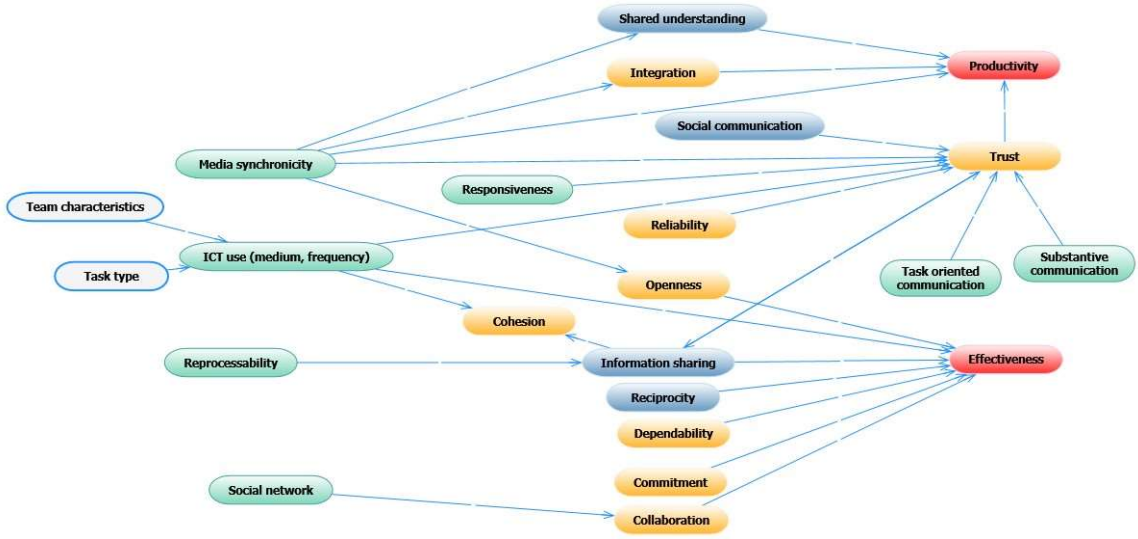

Figure 5 Concept map – summary of relations presented in the selected literature in virtual teams

As described above, in the beginning of the analysis of content of selected publications concept maps were created to draw first observations which are deepened in the following. On Figure 5, two outcomes – productivity and effectiveness are present. Productivity is strongly connected to trust which in turn is strongly dependent on several communication patterns like responsiveness, information sharing, and ICT use. This shows the importance of information sharing and social communication, and their direct impact on team's performance. The choice of medium is also very apparent in this graph through communication characteristics, such as reprocessability, synchronicity or ICT use pattern (medium and frequency of use). All these characteristics contribute directly or indirectly to a better team performance by increase of collaboration behaviours. This shows a very strong dependency between the choice of medium and communication patterns, and finally team outcomes.

The profound analysis of the chosen set of literature dealing with virtual setting proved that the traditional communication tools as email, instant messaging or conferencing tools make it easier to disengage and become less productive. This effect may occur due to lower social presence in comparison with traditional teams. New emerging collaboration tools as video tools, application sharing, social network can address this challenge, facilitating more engagement, spontaneous communication, and in result

increasing the chances of goal achievement in a virtual team (Dunn, Grannan, Raisinghani, & Stalling, 2015, p. 367; Siau & Ling, 2017, p. 61). „New conferencing tools on PCs and cell phones make it easier for employees to communicate with team members more spontaneously, rather than formal scheduled meetings the old “video conference room” way, facilitating more engagement from employee” (Dunn, Grannan, Raisinghani, & Stalling, 2015, p. 367). Further, “with the advancement in mobile communication tools such as instant messaging, audio/video-conferencing, or whiteboards, mobile collaboration could help maximize virtual team members’ flexibility, accessibility, and efficiency” (Siau & Ling, 2017, p. 61). Such tools promote the spontaneous, personal communication carrying higher load of personal content and therefore higher social presence which reflects the concept of social presence theory.

In order to achieve good performance every virtual team should use a variety of tools, aiming at reduction of diminished social and informal information sharing due to the absence of physical meetings. In computer-mediated environment the spontaneous and expressive communication is less common, which results in lower sense of presence, loss of communication cues, and lacking trust. This kind of communication is an inevitable one as “exchanging social and informal messages is needed to maintain positive atmosphere and trust within the team” (Han, Jeong, & Beyerlein, 2017, p. 112).

Other reasons for lacking trust are no conflict handling (which is a management task), too little communication, unpredictable communication, and low responsiveness (Moe & Smite, 2007; Timmerman & Scott, 2006; Amant, 2015).

Lacking trust and relationship along with insufficient information sharing, common understanding, and possible language skills are the most common factors leading to miscommunication. Another reason for incidents of miscommunication is “attributed to technology failure as well as lack of richness for expressing tone and emotions” (Amant, 2015, p. 74).

The emerging collaborative tools and social media enable more personal communication and therefore trust development, which can be achieved through usage of "rich" communication channels, establishment of rules of communication, definitions of roles in virtual teams, carrying out training courses on information

technology (Shvetsova, Dobrynina, & Romanov, 2016; Han, Jeong, & Beyerlein, 2017). The rich channels as for example video/based channel "achieved the top trust level much quicker than the other channels, however, through the video-based channel, the damage to the trust was much quicker than the other channels. These proved that more information exchange caused more trust change in both positive and negative way" (Wang, Love, Kim, & Wang, 2011, p. 1987). The richer the media the lower the ambiguity of interpretations and lower the chance of misunderstanding and conflict which in result may lead to faster achieved high trust level. Clearly, introduction of such tool is not enough and constant work on trust and positive team relations is vital to ensure high degree and high quality of communication. Additionally, "working in virtual team apart from relevant technical knowledge also requires a range of skills and personal attributes. In the first place, these include: knowledge and technical skills related to the use of e-tools, then personality traits such as openness, willingness to share knowledge (…)" (Czarnecka, 2013, p. 58). In order to assure an effective communication and gain the mentioned skills the companies can take upon several actions bearing in mind that "(…) technology alone cannot guarantee good outcomes. The importance of policies, training and processes under the dynamic of environment also reinforce team performance" (Dunn, Grannan, Raisinghani, & Stalling, 2015, p. 371).

Another crucial factor for trust maintenance is a predictable communication being "positively related to trust" (Rico, Alcover, Sanchez-Manzanares, & Gil, 2009, p. 242). Predictable communication is also positively related to performance, while "use of asynchronous tools, unwillingness (…) to act on partner's suggestions leads to poor, unpredictable communication" and decreased performance (Moe & Smite, 2007, p. 27). Therefore, members of a team should define standards, rules and consider all available communication modes, use synchronous media regularly and set priority levels to the messages. In general, high responsiveness, reliability, participation in social and, regular communication positively influence trust building.

Improved virtual communication is positively related to trust in peers (Politis, 2014, p. 258). If trust building process through communication is not successful it leads to productivity and quality decrease, decreased information exchange and feedback, competition instead of cooperation, self-protection, relationship, conflict and, preference of individual goals over collective goals (Moe & Smite, 2007, p. 28).

Further, along the presented theories (see Chapter 2.3 Computer-mediated communication theories) the analysis proved that the choice of communication medium has to fit task and time requirements of the task (urgency). “The choice of communication methods to be used should be consistent with the task and time requirements” (Birchall, Giambona, & Gill, 2008, p. 222). The importance of communication media choice is growing dependent on the specific task but also on the make of group.

Volume and frequency of task-oriented communication should be increased to improve coordination and to establish high performance. Additionally, “(…) task-oriented communication is strongly related to trust” (Rico, Alcover, Sanchez-Manzanares, & Gil, 2009, p. 241) and “substantive communication relates positively to trust when task interdependence is high” (Rico, Alcover, Sanchez-Manzanares, & Gil, 2009, p. 243).

The reproducibility of information (through for example recording of Skype meeting) enhances information sharing. Reduction of mail use in advantage of collaborative tools (accessibility to information for broader group of people) leads to higher shared understanding, integration and mutual trust resulting in better performance.

Next, the creation of an effective virtual team depends on dependability on each other, dealing with time, concern for collaboration, information penetration, variety of information, reliability on technology, tools used for communication and, implementation of results (Bhat, Pande, & Ahuja, 2017, p. 39). The effectiveness of a team in related to reciprocity (exchange of information, assistance), openness and, commitment to achieve common goal.

Further, one can observe the emergence and growing popularity of new collaboration tools and mobile application, which “development (…) is changing the nature of virtual team collaboration” (Siau & Ling, 2017, p. 63). Although they are “able to create a culture of openness and transparency that rewarded information sharing” (Johri, 2015, p. 428) and therefore “support three enablers of virtual work: shared understanding, integration, and trust” (Johri, 2015, p. 422), “modern collaboration tools (…) doesn’t compensate for the lack of face-to-face meetings” (Moe & Smite, 2007, p. 26)

4.2.2 Hybrid team – presentation of findings

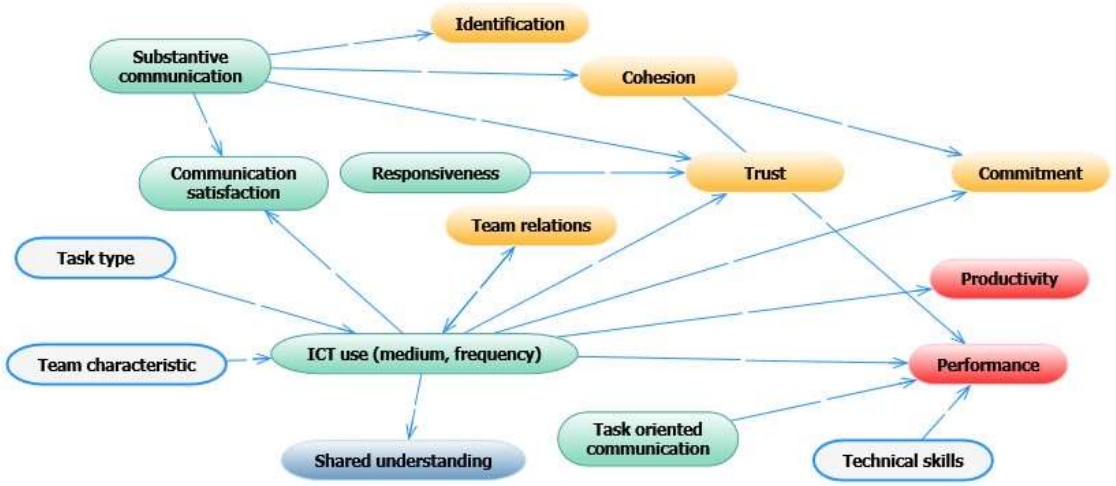

Figure 6 Concept map – summary of relations presented in the selected literature in flexible/ hybrid teams

On Figure 6 presenting the relations in hybrid teams, ICT use plays a central role in the teams' productivity and performance. ICT use in this context is also a strong factor for trust and commitment within the team. Several other communication related factors are to be found and influence team relations and finally outcomes of the team.

The choice of medium is dependent on structural predictors as team size, number of member locations, time zones and organisation type (Montoya, Massey, Hung, & Crisp, 2009; Birchall, Giambona, & Gill, 2008). The relationship between sender and receiver also influences media choice (the better the relationship the more complex task can be discussed through media with lower richness) - "If you know the other person well, you can for example discuss rather complicated tasks even on the phone" (Bergum, 2010, p. 43).

Further the complexity and type of the tasks determines the choice of media (Bergum, 2010, p. 42). For project tasks use of array of synchronous and asynchronous media "appears to be positively related to perceived performance" (Montoya, Massey, Hung, & Crisp, 2009, p. 151). For conveyance tasks greater usage of repositories and instant messaging for "questions and answers" led to more focused conveyance efforts and positive effects on perceived team performance. For convergence tasks multiple communication methods lead to positive perception of performance. For social/relational tasks "in addition to traditional means instant messaging is a way to

advance the development of team relationships" and leads to higher perception of team performance (Montoya, Massey, Hung, & Crisp, 2009, p. 151). These findings demonstrate obvious similarities to media synchronicity theory.

Depending on the team make and its characteristics (virtualness), teams should use different technologies. It is essential not only to use appropriate technologies but also to develop the technological competence of team members (Laitinen & Valo, 2018, p. 21). The use of ICTs is also dependent on the virtualness of the team. That is "when team members are highly dispersed they tend to use an array of synchronous ICTs (…) to replace face-to-face interaction" (Montoya, Massey, Hung, & Crisp, 2009, p. 152). In case of increasing virtualness the usage of "multiple communication methods that can lead to positive perceptions of performance" (Montoya, Massey, Hung, & Crisp, 2009, p. 151) and the connectedness can be positively influenced by "conferencing platforms perceived as bringing individuals closer to another (…) as a way to connect with one another" (Laitinen & Valo, 2018, p. 19). As in the case of virtual teams through the use of a variety of synchronous tools the higher social presence and personal content may be transmitted that replaces the face-to-face communication which is the richest way of interaction between parties.

In flexible teams more frequent communication increases level of identification by occurrence of high effort to understand each other. "(…) when teams emphasised communication competencies such as being thorough, responsive and making effort to understand" the identification increases (Timmerman & Scott, 2006, p. 121). High level of channel selection to maintain connectedness, argumentativeness, engagement, and electronic messaging increases communication satisfaction. Further "high level of efforts to understand one another, more frequent use of electronic messaging increases the level of identification to a greater degree than when there are lower levels of efforts to understand" clearly showing the impact of team relations and behaviours on the outcomes (Timmerman & Scott, 2006, p. 126). More frequent traditional office technology use increases cohesiveness at high level of argumentativeness. Face-to-face interactions increase trust at high rate of responsiveness. "Thus, communicative predictors moderate the relationships between electronic messaging and identification and communication satisfaction, traditional office media and cohesiveness, face-to-face interaction and trust (…) while technology use is not directly related to team outcomes" (Timmerman & Scott, 2006, pp. 128-131).

At low level of engagement and channel selection to maintain connectedness, more frequent face-to-face interaction increases trust. Cognitive and affective trust are related to different media – that is “affective and cognitive ‘trust flows’ were related to the use of mobile ICTs in different way, while e-mail appeared as a channel for work-related communication and cognitive trust, SMS was closely related to the flow of affective trust” (Julsrud & Bakke, 2008, p. 198). Affective relations are positively correlated with SMS while cognitive relations with emails and phone dialogue.

Finally, team outcomes as identification, cohesiveness, trust, and communication satisfaction are correlated with competent communication and careful channel selection consideration aiming at increased connectedness. Cohesiveness increases with increasing level of engagement (Timmerman & Scott, 2006, p. 123). The usage of appropriate medium and high frequency of communication are positively related to perceived team performance (high-quality decisions, efficiency, and efficacy of work, satisfaction with team's performance, process of decision making, and team's discussions) (Timmerman & Scott, 2006, pp. 127-128). The appropriateness of the medium chosen can be defined by the concepts presented in media synchronicity theory. The performance of the team is also related to perceived cohesion in the team, socio-technical skills, and well-balanced task-relationship orientation. The dependence of cohesion and performance is as follows: “cohesion is moderated by virtualization such that teams are nearly fully proximal or nearly fully virtual, performance is decreased.” (Workman M. , 2007, p. 799). Task-oriented people experience better performance when virtualisation increases than relationship-oriented people (Workman M. , 2007, p. 799). People with technical skills outperform ones with social skills as virtualisation increases.

Hybrid teams may offer great potential for performance improvement over proximal or virtual teams, providing that workers are both trained technically and conditioned for lower structure, greater level of individual work, and elevated levels of ambiguity that accompanies virtualisation (Workman M. , 2007).

4.2.3 Artificial setting – presentation of findings

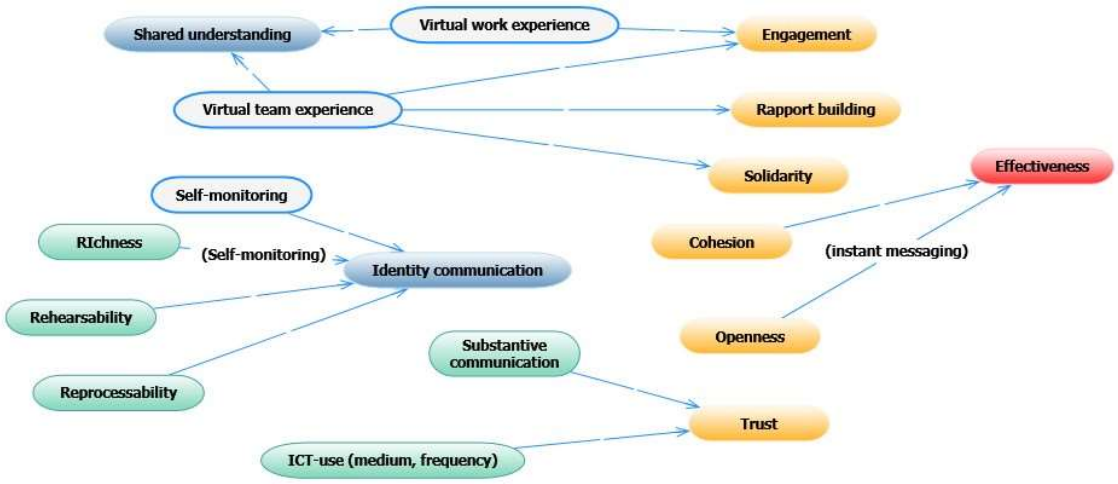

Figure 7 Concept map – summary of relations presented in the selected literature in artificial context

On Figure 7 presenting findings of research conducted in artificial setting, one can see that the relationship between the choice of communication medium and the team effectiveness is not direct. In the artificial setup, ICT use plays a less central role as in fully virtual teams. Finally, there are three connected groups of factors, with no connection in between. This occurrence can be present due to small number of papers in the "artificial setting" collection or incomparability and diversity of researched direction within artificial setting.

As in virtual and hybrid teams the reflection of media theories in artificial setting was present. Findings proved that media richness, rehearsability and reprocessability exhibit significant positive effect on perceived identity communication. Several new observations comparing to virtual and hybrid teams can however be drawn. "Self-monitoring (the degree of monitoring of own expressive behaviour and nonverbal affective displays) impacts significantly perceived identity communication and moderates the impact of media richness on perceived identity communication, with higher self-monitoring reducing the impact of media richness" (Wilson, Thatcher, & Brown, 2015, p. 708). Based on the study presented by Wilson, Thatcher and Brown the suggestion can be drawn "how to improve identity communication through the use of a specific characteristics of technology" (Wilson, Thatcher, & Brown, 2015, p. 708), as the dependencies between richness, rehearsability, and reprocessability, and identity communication were positive. Further the study demonstrated that "regardless

of whether the environment provides rich communication cues, reprocessability and repeatability have significant influence" (Wilson, Thatcher, & Brown, 2015, p. 709) on identity communication. These results indicate that, contrary to intuitive assumption that rich media are most effective means of communication, "when users are able to carefully consider and edit their communication, they are able to more effectively present identity information to others" (Wilson, Thatcher, & Brown, 2015, p. 709). A final contribution of the authors state that "self-monitoring is a predictor of perceived identity communication (…), however self-monitoring reduces the impact of media richness on perceived identity communication (Wilson, Thatcher, & Brown, 2015, p. 709). This finding "suggests that self-monitors may feel they have more control when communicating identities in less rich environment, here they are able to carefully construct the message being communicated" (Wilson, Thatcher, & Brown, 2015, p. 709).

Contrary to previous findings in artificial setting not posting frequency, but content of posting influenced trust building (Shinnishi, Higa, Kanamaru, & Fukasawa, 2015, p. 52). The trust building and levels over time are dependent on the mode of communication and exchange channel (video-net mode achieved highest level; net mode provided fastest trust building) (Wang, Love, Kim, & Wang, 2011, pp. 1986-1987).

Finally, "team cohesion plays a positive and significant role in the effectiveness of teams in virtual setting. (…) Team openness has also a positive relationship with team effectiveness. The effects of openness are enhanced by the subject's experience with instant messaging such that the team member can utilize openness to facilitate higher effectiveness" (Carlson, Carlson, Hunter, Vaughn, & George, 2013, p. 11). In cohesive virtual teams, team members can share the knowledge via ICT in a way that allows them to be more effective. Further the openness is positively linked with team outcomes. "Thus, the effectiveness was higher if team members were willing to communicate in a more open matter (…) and experience with instant messaging allowed teammates to more efficiently share and receive knowledge via CMC medium" (Carlson, Carlson, Hunter, Vaughn, & George, 2013, p. 12). A mode or skilful use of a provided communication medium that encourages the communication can strengthen the positive outcomes in a team. The interpersonal processes, cohesiveness, and openness in a virtual team are beneficiary to team outcomes in virtual settings.

Last but not least, in the artificial setting, the influence of previous experience in virtual teamwork and virtual world experience on team outcomes was studied. Prior virtual world experience “exhibits the strongest effect on each technological and interactional dependent variables” (Iorio & Taylor, 2014, p. 345) that is shared context, and rapport building, solidarity, and engagement. This leads to the implication that “the processes of rapport building, creating solidarity and maintaining engagement that have been shown to be an effective leadership in virtual teams may require that leaders in virtual settings change their interactional patterns” (Iorio & Taylor, 2014, p. 346). Further virtual teams having experience working previously in virtual setting and familiarity with specific technological medium though which interactions occur, are more likely to engage in effective leadership behaviours. “The effect of prior virtual team experience in reinforced by the prior virtual world experience” (Iorio & Taylor, 2014, pp. 346-347). Finally, for creation of shared context there is a clear link between virtual team experience and experience with a specific medium of interaction. The higher the familiarity the more likely the adoption of an active role in resolving technological conflicts and understanding contextual information (Iorio & Taylor, 2014, p. 347).

4.2.4 Commonalities and differences in virtual, hybrid, and artificial settings

The conducted research and the analysis of the results in all three settings reflected the ideas presented in the computer-mediated communication theories. In virtual and in flexible team the media choice and its fit to the task proved to play an important role which is the concept presented in the media synchronicity theory. The consistency of task and time requirement with the choice of media is inevitable to guarantee high performance (Birchall, Giambona, & Gill, 2008, p. 222; Bergum, 2010, p. 42; Montoya, Massey, Hung, & Crisp, 2009, p. 151).

Further there exists mixed finding when it comes to trust. In virtual setting where spontaneous communication is reduced, level of trust tends to lower due to lower sense of presence and less communication cues (Han, Jeong, & Beyerlein, 2017, p. 112). As presented in the social presence theory the less nonverbal clues are transmitted the less warmth and personal content is perceived in the communication. In flexible teams, communication predictors defined as thoroughness of communication, responsiveness, and willingness to make an effort to understand each

other influence trust. It is not necessarily technology use that is directly related to outcomes (Timmerman & Scott, 2006, pp. 128-131). In artificial setting it is not the communication frequency, but its content that influences trust building (Shinnishi, Higa, Kanamaru, & Fukasawa, 2015, p. 52). Further the exchange channel, but also the communication mode (e.g. video-net mode) influence the trust building and maintenance in teams (Wang, Love, Kim, & Wang, 2011, pp. 1986-1987).

In case of team performance in virtual setting the high frequency of communication (task-oriented communication) is positively related to the outcome (Rico, Alcover, Sanchez-Manzanares, & Gil, 2009, p. 241). In flexible team the media fit and high frequency of communication are also positively related to performance (Timmerman & Scott, 2006, pp. 127-128). Further, task-oriented workers experience better performance when virtualisation of team increases (Workman, Kahweiler, & Bommer, 2003, p. 799).

All these findings resemble the ideas presented in social presence theory, media richness theory, and media synchronicity theory. Media characteristics and their capacities to transmit different cues and suitability to serve different purposes in the professional life are present in the above considerations. Moreover, the dependency of choice of proper media to proper task and its influence on further outcomes is also demonstrated.

Further, in all three work settings the skills of workers are perceived as an important factor. Work in dislocated teams requires technical skills related to usage of ICT, as well as a range of personality traits (Czarnecka, 2013, p. 58; Iorio & Taylor, 2014, pp. 345-347). Those competencies considering skilful usage of ICT can be gained during trainings (Dunn, Grannan, Raisinghani, & Stalling, 2015, p. 371; Workman M. , 2007; Laitinen & Valo, 2018, p. 21). Further several rules and policies are to be defined (Dunn, Grannan, Raisinghani, & Stalling, 2015, p. 371). Previous experience of work in virtual setting, that consequently increases the familiarity with ICT also positively influences performance (Iorio & Taylor, 2014, pp. 345-347).

Finally, in virtual setting the emerging collaboration tools were put under analysis. The results show that such tools facilitate positive team relations, trust development, engagement, spontaneous communication and therefore increase the chances of high

performance in team (Dunn, Grannan, Raisinghani, & Stalling, 2015, p. 61; Siau & Ling, 2017).

5 Discussion and Outlook

This thesis aimed at the analysis of the current state-of-art within the area of virtual/flexible work, team relations, and usage of ICT, and its interplay, and resulting effects. The research question defined at the very beginning of the process was:

What is the impact of dislocated work in teams that depend on ICT communication on team relations?

To fulfil the goal of the thesis and answer the research question, the systematic literature review has been through a web-based database called Web of Science containing large number of scientific publications in relevant research areas and its results were put under analysis.

5.1 Summary of results and findings

The systematic literature review resulted in high number of initial findings, that can be explained by the wide range of applications of the topic in different domains (e.g. health care, education etc.) and by the ambiguity of several keywords. On top of that, the time constrains prevented the screening of all publications, therefore further criteria (semantic criteria) were applied in order to pick the most relevant publications. The results of the systematic literature review can be summarised as follows:

- **Database used for the research:** Web of Science
- **Number of search queries:** 1100
- **Results:** 539 after application of first-degree criteria
- **Considered literature:** 27 publications considered in the final analysis
- **Presentation of results**: Table in Appendix (Chapter 7.4 Results of search procedure)
- **Reasons for high ratio (findings/final selection of publication):** wide range of application, time constrain for screening the results, ambiguity of keywords

The research proved that there exists an influence of ICT communication on team relations and performance. With increasing virtualness the trust building and maintenance is challenged, due to reduced spontaneous, personal communication, however this hurdle can be addressed with the use of variety ICT and their appropriate choice. Surprisingly it is not necessarily the frequency of communication that plays the

most important role for trust building but the channel selection and personality traits, and attitude. The best medium is not always the richest one. Further the fit of medium to task type and time requirement plays an important role regardless of work setting for goal achievement. Therefore, it is important to use a variety of ICTs to foster building of a positive atmosphere in team and enable high team performance.

In all three analysed groups the importance of skills related to ICT used was underlined. This “digital literacy” can be developed through trainings and daily work. Further the personality traits also predefine the capability of employees to develop team relations and perform in dislocated teams. With the increasing popularity of virtual team and growing array of ICTs, the need to manage the collaboration and communication in such environments also increases. It is important for the industry to not only invest and develop new communication technologies, but also to work on technological competences of members of dislocated teams. With the constantly emerging new tools that offer new possibilities, it is essential to develop the technical skills of workers, to assure the development of positive team relation and achievement of organisational goals. Further the choice of employees with a set of several personality traits that enhance successful relationship building and performance in dislocated work is to be considered when such teams are created.

All in all, dislocated teams can develop positive team relations even if communicating solely via ICT tools, if several conditions are fulfilled. With the growing choice of different tools that offer new features that promote relationship building the chances of successful teamwork grow, at the same time making the choice of right communication channel more difficult and therefore increasing the importance of development of skills related to ICT use and posing new challenge for management.

Taking into consideration the above summarised findings several implications can be drawn. In teams that perform the work within hybrid or virtual setting the choice of team members plays a vital role. If possible, the choice of employees with previous experience of work in virtual team is advantageous due to their acquaintance and familiarity with this mode of work, communication through ICT and challenges faced by such teams. Further the personality traits of employees such as openness and willingness to share knowledge predestine employees who display these characteristics to work in dislocated teams. Fortunately, even if the previous experience in virtual work is not given the technological competencies enabling skilful

usage of ICT can be developed through training. Further, in dislocated teams predictable communication has a positive influence on team relations and outcomes. Therefore, it is recommended to set with the team communication rules in order to establish common understanding and set mutual expectations when it comes to computer-mediated communication. The establishment of competent communication regardless of the used tools leads to positive team relations as trust, identification, and cohesiveness. These team relations are also strengthened through spontaneous informal communication, preferably through rich channels. Consequently, it is advisable to promote those type of communication, which in case of lack of face-to-face meeting can be performed through chats, social media or new collaboration tools enabling transmission of richer cues.

5.2 Discussion of used methodology, limitations, and future directions

The methodology chosen for the thesis was a stand-alone systematical literature review that enables the selection of the relevant studies that is conducted in a systematical way, after development of an explicite procedure, and that can be reproduced. The selection of publications was then put under analysis, the results synthetised and the research gap revealed.

The actual approach used in the thesis is based on well proven scientific method. A final analysis, however, leads to the following reflection presenting the potential for improvement for the future.

- Time constrains prevented analysis of all results delivered after application of first-degree criteria.
- Time constrains prevented reading and analysis of the totality of literature delivered in search procedure.
- Additional publication may increase the quality and reliability of results.
- The development of the automated search accelerated the iterative process of selection of relevant publications immensely.

All in all, the developed and performed approach used to answer the research question is considered enough and goal-oriented, however it could be improved when the above aspects would be implemented initially.

The developed automated search tool (see Code in Appendix 7.3.4 Code) can be reused for further research on similar or other topics with no or minor changes.

Taking into consideration the analysis of the results several limitations can be depicted. First, the number of papers considering the interplay of the predefined factors seems to be currently limited, and consequently leaves space for further research.

Further, most of the chosen sources focused their research of workers from the IT branch of industry. It is obviously the sector where the popularity of virtual teams is the highest, however there are worldwide companies in other sectors applying either virtual or hybrid settings. (CultureWizard, 2019) Non-IT sector can therefore bet put under analysis.

In the chosen publications factors as age, cultural background, former experiences are not considered. As the groups under research are very diverse, the question of comparability of result arises. The tests run in the artificial settings are hardly comparable as “workers” might have known each other before being put in the test setting showing low external validity. In order to improve the comparability, it is desirable, that such factors are clearly stated in the publications.

Moreover, the degree of virtualness is continuous. Hybrid team put under research may display different levels of virtualness. In order to provide a comparison, the degree of virtualness must be defined, or in case of virtual teams the conditions defined (for example no physical meeting, or not more than once a year etc.). As this information is commonly not provided in the publications it is hard to assess whether the compared results and conclusions drawn are based on the same assumptions.

Most of the sources focus on traditional ICT media. The analysed papers date to 2006-2018. With the current emergence of new collaboration tools (Microsoft Teams-release in 2017, HeySpace-2018, Wire-2014, Slack-2009, etc.) and mobile applications (compatible with this tools) that enable different communication types, filesharing, brainstorming, tracking of activities, shared calendars, and planners, and management features, a new research area emerge. The collaboration tools were put under analysis in two papers in the selected group, as their emergence date to last few years and no specific, and broad investigations are yet conducted.

Therefore, new emerging collaboration tools and their influence of communication patterns, and outcomes should be further analysed. The applicability of the presented theories on the new tool can be put under consideration. The emergence of new collaboration habits and its influence on team relation, and outcomes can be researched.

5.3 Conclusion

Relating to the initially defined research question of the impact of dislocated work in teams that depend on ICT communication on team relations – this thesis offers following answer: team relations' building and maintenance in dislocated teams that depend on ICT communication underlies several challenges, however it is possible to create positive team atmosphere and relations, and assure successful team work if ICT tools are used skilfully and competences of team members regarding ICT use are present. The success of hybrid and virtual teams is dependent on the range of skills and personality traits of employees as well as goal-oriented leadership practices along with the awareness of challenges faced in dislocated teams.

The increasing popularity of dislocated work resulting in increased use of ICT communication and increasing number of virtual teams is not likely to turn back. The skills management considering ICT use and management practices in dislocated teams will continue to gain on importance and play a central role for effective work in dislocated teams. As new branches of industry (apart from IT) are increasingly implementing virtual or hybrid teams, new challenges will also surely arise. Therefore, the need for further studies and guidelines for management aiming at improvement of the quality both in terms of team relations and team outcomes will be gaining attention. With the further research and findings new valuable recommendation will surely be drawn beside the one presented.

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7 Appendix

7.1 Detailed description of STEP 4

Round 1

At first keyword were defined as follows:

Table 6 Keywords definition - Version 1

A: ICT Communication	B: Team Relation	C: Dislocated work setting
Comm*	Relat*	Virtual
Telecom*	Connection	Flexible
Info*	Shared goals	Alternative work*
Conveyance	Mutual respect	Telework*
Convergence	Team	Telecommut*
Accuracy	Shared knowledge	Home work*
Richness	Accountability	Home office
Synchronicity	Loyalty	Remote work*
Coord*	Commitment	Flextime
Media	Network	Flexitime
	Transparency	

The first search was conducted for two combination options A AND B AND C, and A OR B AND C. The search with A AND B AND C gave 132 237 results (incl. duplicates) while the search A OR B AND C gave 4 635 567 results (incl. duplicates), which was a clear indication for the first option. As an output the list of number of results per search was generated and titles were available online.

Round 2

Based on the out from first round and number of results per search the refining of keyword was performed.

Table 7 Keywords definition - Version 2

A:ICT Communication	B: Relationship	C: Dislocated work setting
Comm*	Relat*	Virtual work*
Telecom*	Connection	Flexible work*
Info*	Shared goals	Alternative work*
Conveyance	Mutual respect	Telework*
Convergence	Team	Telecommut*
Accuracy	Shared knowledge	Home work*
Richness	Accountability	Home office
Synchronicity	Loyalty	Remote work*
Coord*	Commitment	Flextime
Media	Network	Flexitime
	Transparency	

The second search output was 53 984 results (incl. duplicates) which represented 36 753 unique results represented by generated list of titles.

Round 3a

After second round it was observed that the keyword „network“ generates huge number of results. In order to investigate the results given by the combinations with keyword network the list of titles was generated reaching 13 349 unique results. After screening of titles, the decision to exclude the keyword network was made. The result generated were mostly strongly dealing with information technology topics being out of scope of the research.

Round 3b

In round 3b the search was conducted with the keyword defined in the second round excluding the keyword “network”. The outcome the list of 26 173 unique results.

Round 4

To refine the search further steps were necessary. With the help of the developed program, the word count of frequency of occurrence of words in the titles was created.

After researcher screening of 500 most common word the list of exclusions was created.

Table 8 Exclusion keywords definition - Version 1

Discipline	Exclusion keywords
Agriculture	*land*, *rural*, *soil*
Architecture	*architect*
Biology	*carb*, *energ*, *environment*, *food*, *forest*, *natur*, *plant*, *power*, *species, *water*
Chemistry	*chemi*
Education	*academ*, *child*, *educat*, *e-learn*, *learn*, *lesson*, *school*, *student*, *teach*, *universi*
Geography	*solar*, *temper*, *therm*, *transp*
IT	* computing*
Literature	novel*, litera*
Mathematics	*algorit*
Medicine	blood*, *brain*, *cancer*, *care*, *cell*, *clinic*, dement*, *diabet*, *diagnos*, *disease*, *disorder*, *drug*, elder*, *emergen*,*genet*, generati*, *heal*, *heart*, *hospi*, *injur*, lab*, *medic*, mental*, *memor*,molecule*, neur* *nurs*, older*, *optic*, *pain*, palliat*,*patient*, *phys*, prevent* *rehab*, *risk*, *spectr*, *therap*, *treat*
Others	*industr*, *laser*, *manufact*, *pilot*, famil*
Politics	*urban*, nation*
Robotics	*robot*, *sensor*

The search was run again resulting in 1003 unique results.

Round 5

The output of round 4 was screened and interpreted again. Additionally, the word count list was created as well as keyword count was created. List of excluded results was created. Based on the analysis final list of exclusion keyword was created. Three exclusion keywords were added: agro*, agri*, and math*, and three excluded from exclusion list *learn*, *computing*, and *cell*.

Table 9 Exclusion keywords definition - Version 2

Discipline	Exclusion keywords
Agriculture	*land* , *rural*, *soil*, agro*, agri*
Architecture	*architect*
Biology	*carb*, *energ*, *environment*, *food*, *forest*, *natur*, *plant*, *power*, *species, *water*
Chemistry	*chemi*
Education	*academ*, *child*, *educat*, *e-learn*, *learn*, *lesson*, *school*, *student*, *teach*, *universi*
Geography	*solar*, *temper*, *therm*, *transp*
Literature	novel*, litera*
Mathematics	*algorit*, math*
Medicine	blood*, *brain*, *cancer*, *care*, *clinic*, dement*, *diabet*, *diagnos*, *disease*, *disorder*, *drug*, elder*, *emergen*,*genet*, generati*, *heal*, *heart*, *hospi*, *injur*, lab*, *medic*, mental*, *memor*,molecule*, neur* *nurs*, older*, *optic*, *pain*, palliat*,*patient*, *phys*, prevent* *rehab*, *risk*, *spectr*, *therap*, *treat*
Others	*industr*, *laser*, *manufact*, *pilot*, famil*
Politics	*urban*, nation*
Robotics	*robot*, *sensor*

The search was run again resulting in 1001 unique results.

7.2 Software user manual – automated search

The research presented in this document required running a large amount of search queries against a database of scientific papers. There were multiple rounds of 1100 queries to run - all combinations of keywords coming from three lists, two of 10 words and one of 11: 10*10*11=1100. Databases of scientific papers usually contain a large amount - several millions - of papers and provide a mean to search for specific entries through a predefined search language. The database chosen for this research is Web of Science.

There are multiple interfaces allowing users to search through the Web of Science database. The most commonly used interface is the web interface, accessible through

the internet address https://www.webofknowledge.com/. This interface presents a graphic environment allowing easy research and interpretations of the results. Unfortunately, running more than 1000 queries against this interface can take a very long time. If one query requires the user to spend 5 minutes - a low estimation - per query, running 1100 queries would take over 91 hours, or 11 days if the user is only dedicating 8 hours per day to this action. If a mistake is made during the process, or if multiple rounds of searches are required, the numbers may grow even larger.

Fortunately, the database also offers another interface to search through its records. This second interface is called application programming interface or API. API allows the user to programmatically run searches against the database, opening the door to more automated ways of searching.

The API allows the user to access the database through a program and to automatically handle the results returned by the database. It also means that queries can be run with a much higher frequency, as fast as 6 queries per second, which is the maximal rate allowed by Web of Science. At a rate of 1 query per second, the time needed to run the full set of 1100 queries drops below 20 minutes, allowing multiple rounds of searches per day. Thank to Enrico Bacis, an implementation of the Web of Science API is available on GitHub under license MIT, allowing me to reuse the code to create a new client to run the searches.

The following pages will present the requirements of the software, with an explanation of each functionality, detailed description of the implementation and the choices made, and finally give some recommendation on how to use this program to run other searches.

7.2.1 Requirements towards the software

In order to ease the development of the software running the queries, a set of requirements was defined. The requirements are divided in two categories:

- **Must**: this category contains all the hard requirements of the software. Without any of these, the functionality of the program would be dramatically reduced, and more manual work would be required.

- **Nice to have**: this category contains a list of side ideas that could deliver more value for the research but are not technically required for the program to be useful. Some of these requirements could not be implemented.

All the requirements are described, and a short explanation is given on why they are present in this list.

7.2.1.1 Must

The must requirements are all the requirements without which the functionality of the program would not be enough and would be replaced by a large amount of manual work.

Be able to combine all the search criteria

The goal of the research was to run multiple queries based on an exhaustive combination of three lists of search criteria (keywords). These lists contained each 10 or more keywords. Being able to automatically generate the list of queries based on the provided list of words would allow flexibility when running the automated searches and allow easier adaptation to evolving lists of keywords.

As the lists were expected to change multiple times over the period of the research, this was a must requirement to avoid losing time recomposing the list after every modification of the keywords.

Connect automatically to the research database

In order to fetch all the data from the research database, the program must be able to connect to it. This requirement implies that when the machine is running, it has an Internet access and a running VPN client through which access to the database is granted. Once these two preconditions are met, the program must be able to automatically connect to the database against which the queries will be run.

Not meeting this requirement would mean that every connection to the database would be manual, dramatically increasing the time of running a search.

Run all the queries against the database, respecting the rate allowed by the server

The core of the program is running all the queries against the database without human intervention. This is a key requirement as this allows the process to run by itself, possibly in parallel of other actions.

One important specification of this requirement is the rate at which the requests are sent to the database. Web of Science only allows a limited number of queries per second. Excess of this limit trigger an automated process blocking the user for several minutes. Failing to handle this request limit could result in longer running time or worse, corrupted research results.

Limit the queries to the interesting time frame

The time frame containing interesting papers was defined in the research methodology. To keep the results of the program relevant to the research, being able to implement this requirement was crucial.

Exclude a list of keywords from each search

Search engines of scientific papers usually offer the possibility to exclude some keywords from the results. In general, this takes the form of a list of keywords to exclude added to the search query. For instance, searching for “virtual team” excluding “computer” would result in “virtual team NOT computer”.

The list of terms and combination operators yielded a very large number of results at the beginning. After a first analysis, it became clear that some categories of papers could be excluded automatically by choosing an appropriate exclude keyword. As multiple exclusions had to be appended to all the searches and given the number of searches, it was important and very time efficient to be able to run this part of the process automatically.

Fetch all the results from the database, including titles, keywords, journal, author, and publication date

Once the queries have run in the database, the response usually contains a list of papers and some metadata associated with each entry. Some of this metadata could be used to filter out irrelevant entries or to identify series of out of scope results and generate a list of further exclusion keywords.

The metadata associated with each paper had to be stored in a structured format to enable automated analysis of the results with other programs. The format chosen for this use case is CSV for its ease of implementation and flexibility.

Run analysis on the collected data to support the scientific research

Given the very large number of results provided by the original queries, more than 4 million papers, the analysis process had to be automated. One important step of this analysis was the deduplication of results, filtering out all duplicate entries from the results to generate a list of unique papers.

Another important automated analysis was the ability to count the frequency of occurrence of words in the collected titles. This functionality enabled quick iterations during the exclusion list generation as some topic completely out of scope could be identified when a high number of results containing keywords irrelevant to our topic.

7.2.1.2 Nice to have

The research process was speeded up and made more reliable by implementing some of the non-strictly necessary requirements.

Be able to resume an aborted search

Running a list of queries over a long period of time is subject to the reliability of many components through which the internet connectivity of the computer running the program passes. The reliability of this connection is not perfect and when the connection is breaking during a search, all the subsequent queries fail.

To reduce the time necessary to rerun the failed searches but keep the benefit of the already finished ones, a temporary storage function was implemented. This function would, upon interruption of the search, store the current state of the searches in a file. When then program is restarted, it will read the state file and resume when it left.

Handle errors of the database

When running automated searches against application programmable interfaces, one must take the failure modes of this interface into account. Failure modes are diverse and includes for instance:

Too many requests: This usually means that the user is trying to query the database at a higher rate than the authorised one.

Not authorised: This usually means that the user is trying to access a part of the database that is not accessible. This error often occurs when the database is accessed outside of a university network.

Connection failure: This is not a failure more of the database per se but outlines a connection issue between the client and the server.

All these error and possibly other ones affect the quality of the results. Detecting these errors is important as the reaction of the program to such errors can influence its usability.

The approach of nice retry was taken here. This means than upon reception of an error, the program would wait for exponentially increasing amount of time and retry to run the query and continue. If these retries fail too many times, the program will end.

Support multiple databases

When conducting this type of research, to ensure that the coverage of available papers is as broad as possible, one should run its own queries against multiple scientific databases in order to avoid possible database content biases, content availability issues and to narrow result scope. Writing an automation program makes it possible to run the same query against multiple databases in parallel, increasing the speed of the research and the reliability of the results as we can guarantee that the searches were exactly run in the same way on multiple databases.

This requirement was not necessary for the first version of the program. It turns out that the first database implemented provided more results than expected and the need for a second database to compare was less urgent. The second database that would have been implemented was Scopus, which also provides a python interface to run queries in a programmable way.

Download the papers from the database

A state-of-the-art procedure requires the person conducting the research to read and analyse all the relevant papers returned by the predefined search queries. Ideally, there would be a way to automate the recuperation of all the papers once their

metadata have been found in a database. This would allow automatic classification of the papers and would avoid long times necessary to find these.

Unfortunately, the papers are not directly accessible through the database programmable interface and there was not direct link enabling an automated procedure to download the papers. Writing this feature would have required complex text and language processing, and the trade-off between programming time and benefit led me to take the decision not to implement this.

7.2.2 Implementation

7.2.2.1 Choice of the programming language

The implementation of the program for this research was led by multiple factors. The implementation followed several rules:

- Easy to iterate on multiple versions: the requirements are expected to change as the results of the first search queries are discovered. The program should be flexible and easily adaptable to the changing environment.
- Easy to extend to multiple sources if needed: The number of data sources required to collect a significant amount of papers was unknown. The program should allow easy extension to support new data sources.
- In a widely supported language: Ideally, an application programming interface for the database should already be available to increase the velocity of iteration cycles.
- The code should be easy to read by other people: this foster sharing and reuse of the program.

As a result of all these criteria and based on the availability of a library for Web of Science, the decision to implement the program in Python was met.

7.2.3 Program structure

Multiple actions were to be integrated in the program. These actions are grouped in two categories:

- Running the searches against the database
- Running analysis on the results yielded by these searches

7.2.3.1 Running the searches against the database

This part of the program represents a large part of the time required by the program to run. The running time is heavily dependent on the quality of the internet connection, the responsivity of the database, and the number of queries to run.

To guarantee high quality results for the searches, multiple error modes had to be handled, such as the unreliability of the tunnelled connection, the errors returned by the database, and other rate limiting. All these errors are handled here.

This part of the program is the main data source for the research.

7.2.3.2 Running analysis on the results yielded by theses searches

Once all the papers information has been collected, one need to identify if the dataset corresponds to the expectation. Given the large amount of results, one can only proceed with statistical analysis on this part to eliminate the search criteria that are too broad and add some excluded keywords in order to reduce the amount of results generated by the searches.

These analyses are run in the second part of the program. To allow multiple iterations of the analysis on the same dataset, this part is independent and very modular. The result of these analysis is presented in detail in the Chapter 4.2 Findings of systematic literature review.

7.3 User manual

The program is divided into three different executables.

7.3.1 fetcher.py

The fetcher is the main part of the program. This part handles the collection of results from the database, the possible errors and recovery from these searches, and the storage of the results in a structured way for further analysis.

7.3.1.1 Usage

```
$ python fetcher.py --help        20:57
```

```
usage: fetcher.py [-h] --output_directory [OUTPUT_DIRECTORY]
                  [--from_date [FROM_DATE]] [--qps [QPS]]
                  [--first_term_file [FIRST_TERM_FILE]]
                  [--second_term_file [SECOND_TERM_FILE]]
                  [--third_term_file [THIRD_TERM_FILE]]
                  [--first_connector [FIRST_CONNECTOR]]
                  [--second_connector [SECOND_CONNECTOR]]
                  [--exclusions_file [EXCLUSIONS_FILE]]


Run a set of search queries against the Web of Science database. This set of
queries is defined by the exhaustive list of combination of search terms
provided in three different files.


optional arguments:
  -h, --help            show this help message and exit
  --output_directory [OUTPUT_DIRECTORY]
                        Directory to write the output to.
  --from_date [FROM_DATE]
                        Date from which to search the papers in format YYYY-
                        MM-DD. Default is no limit.
  --qps [QPS]           Number of search query per second. Default is 1, max
                        for Web of Science is 6.
  --first_term_file [FIRST_TERM_FILE]
                        Search term list for A in A <CONNECTOR> B <CONNECTOR>
                        C.
  --second_term_file [SECOND_TERM_FILE]
                        Search term list for B in A <CONNECTOR> B <CONNECTOR>
                        C.
  --third_term_file [THIRD_TERM_FILE]
                        Search term list for C in A <CONNECTOR> B <CONNECTOR>
                        C.
  --first_connector [FIRST_CONNECTOR]
                        The first connector to use in search A <CONNECTOR> B
                        <CONNECTOR> C.
  --second_connector [SECOND_CONNECTOR]
                        The second connector to use in search A <CONNECTOR> B
                        <CONNECTOR> C.
  --exclusions_file [EXCLUSIONS_FILE]
                        List of terms to exclude from all searches.
```

7.3.1.2 Example

```
$ python fetcher.py --output_directory output --from_date 2006-01-01 --qps 1 --first_term_file
communication_final.txt --second_term_file beziehung_final.txt --third_term_file
flexible_final.txt --first_connector AND --second_connector AND --exclusions_file
exclusions_final.txt
Loading state from state_wos
Connecting to Web of trust
Authenticated (SID: D4t4BUW1utuFSjOCQdv)
1000 searches to run
```

```
WoS - 1/1000 - ( Accuracy AND Accountability ) AND Alternative work*
WoS - 2/1000 - ( Accuracy AND Accountability ) AND Flexible work*
WoS - 3/1000 - ( Accuracy AND Accountability ) AND Flexitime
WoS - 4/1000 - ( Accuracy AND Accountability ) AND Flextime
WoS - 5/1000 - ( Accuracy AND Accountability ) AND Home office
WoS - 6/1000 - ( Accuracy AND Accountability ) AND Home work*
WoS - 7/1000 - ( Accuracy AND Accountability ) AND Remote work*
WoS - 8/1000 - ( Accuracy AND Accountability ) AND Telecommut*
WoS - 9/1000 - ( Accuracy AND Accountability ) AND Telework*
WoS - 10/1000 - ( Accuracy AND Accountability ) AND Virtual work*
[...]
```

7.3.2 word_count.py

Word_count is the part of the program that helped filtering out irrelevant keywords from the research. This part of the program counts the frequency of occurrence of words in the returned title or keywords and its returns a list sorted by the number of occurrences of each word. By looking at this list one can identify if the searches return papers in the area of interest or if some results are off topic.

7.3.2.1 Usage

```
$ python word_count.py -h
usage: word_count.py [-h] --directory [DIRECTORY] [--output [OUTPUT]]



Deduplicate titles and count words in each title.



optional arguments:
  -h, --help            show this help message and exit
  --directory [DIRECTORY]
                        Directory containing the csv files to read from. CSV
                        files must contain the title in the first column.
  --output [OUTPUT]     Output to write the word count to.
```

7.3.2.2 Example

```
$ python word_count.py --directory output/wos_suche6/searches
syzygies,1
mackerel,1
precondition,1
telepathology,1
137-m,1
koussis,1
woods,1
```

```
asian,1
codification,1
paris,1
[...]
from,44
design,46
model,46
information,49
system,51
using,66
analysis,67
based,68
with,93
virtual,105
```

7.3.3 Deduplicate_titles.py

Deduplicate_titles was used to generate the final list of papers used for the further analysis. When running multiple search queries in a narrow field of knowledge, it can happen that the same paper is returned multiple times by different queries. In order to have a list of unique papers, the list had to be deduplicated. The operation of deduplication consists of removing all the duplicates in a list.

7.3.3.1 Usage

```
$ python deduplicate_titles.py -h
usage: deduplicate_titles.py [-h] --directory [DIRECTORY] [--output [OUTPUT]]



Generate a list of unique papers found in all the searches (deduplication).



optional arguments:
  -h, --help            show this help message and exit
  --directory [DIRECTORY]
                        Directory containing the csv files to read from. CSV
                        files must contain the title in the first column.
  --output [OUTPUT]     Output to write the word count to.
```

7.3.3.2 Example

```
$ python deduplicate_titles.py --directory output/wos_suche6/searches | head -10
"Hydraulic modelling and experimental study of three heat sources and three rings heating networks","10TH INTERNATIONAL SYMPOSIUM ON HEATING, VENTILATION AND AIR CONDITIONING, ISHVAC2017","No keywords","hydraulic intersection user,Virtual heat source,three heat sources and three rings,simulation model,common pipe section"
```

"Information inference in scholarly communication infrastructures: the OpenAIREplus project experience","10TH ITALIAN RESEARCH CONFERENCE ON DIGITAL LIBRARIES (IRCDL 2014)","No keywords","text mining,OpenAIRE infrastructure,big data,data processing system,data mining"
"Modelling of large deformations of elastoplastic solids using FEM","11TH INTERNATIONAL CONFERENCE ON MESH METHODS FOR BOUNDRY-VALUE PROBLEMS AND APPLICATIONS","No keywords","STRAINS"
"Speech Transcript Evaluation for Information Retrieval","12TH ANNUAL CONFERENCE OF THE INTERNATIONAL SPEECH COMMUNICATION ASSOCIATION 2011 (INTERSPEECH 2011), VOLS 1-5","No keywords","speech recognition,speech retrieval,evaluation,rank correlation,information retrieval"
[...]

7.3.4 Code

Full code is to be found below.

Legend:

Violet: word of the python language
Blue: Classes
Green: Strings
Red: Numbers
Grey: comments
Black: rest

7.3.4.1 fetcher.py

```
# -*- coding: utf-8  -*-
"""Search in databases for papers.

This program runs a set of queries against the Web of Science database and
stores the output in a set of CSV files.

Example:
$ python fetcher.py \
    --output_directory output \
    --from_date 2006-01-01 \
    --qps 1 \
    --first_term_file communication_final.txt \
    --second_term_file beziehung_final.txt \
    --third_term_file flexible_final.txt
    --first_connector AND \
    --second_connector AND \
    --exclusions_file exclusions_final.txt
"""

import argparse
import csv
import datetime
import json
import os
import os.path
```

```
import time
import wos_client

STATE_WOS={}
STATE_WOS_FILE="state_wos"

TIME_END="%s" % datetime.datetime.now().strftime("%Y-%m-%d")

CSV_EXTENSION=".csv"

OUTPUT_DIR_WOS="wos_%s" % TIME_END

### Do not change after this line.

def readFile(filename):
  """Read a file, return a list with one line per element."""
  with open(filename, "r") as f:
    return f.read().splitlines()


def createDirIfNotExist(dir):
  if not os.path.isdir(dir):
    os.mkdir(dir)


# Handle state for interrupted searches.
def loadState(filename):
  """Load a previously saved state from file."""
  print "Loading state from %s" % filename
  if not os.path.exists(filename):
    print "Not loading state, file %s does not exist" % filename
    return {}
  with open(filename, "rb") as f:
    return json.load(f)

def saveState(filename, state):
  """Save the current search state to a file."""
  with open(filename, "wb") as f:
    f.write(json.dumps(state))

def searchTermToFilename(searchTerm):
  """Transform the search to use as a filename."""
  return "%s%s" % (searchTerm.replace("*", "").replace(" ", "_"), CSV_EXTENSION)

def writeToFile(filename, string):
  with open(filename, "ab") as f:
    csv_writer = csv.writer(f, quoting=csv.QUOTE_ALL)
    csv_writer.writerow(string)

def readSearches(filename):
  """Read a list of predefined searches stored in filename."""
  with open(filename, "r") as f:
    return f.read().splitlines()

def generateSearches(
    comm_words, rel_words, flex_words=None, conn1=None, conn2=None):
  """Generate the list of searches based on each word list."""
  searchTerms = []
```

```
  for i in comm_words:
    for j in rel_words:
      if not flex_words:
        searchTerms.append(' '.join(["(", i, conn1, j, ")"]))
        continue
      for k in flex_words:
        searchTerms.append(' '.join(["(", i, conn1, j, ")", conn2, k]))
  return searchTerms


def storeRecord(r, outputFile):
  """Write a research result (called record) to outputFile."""
  writeToFile(outputFile,
              [r.getTitle(), r.getPublicationDate(), r.getPublicationType(),
               r.getJournalName(), r.getCategories(), r.getKeywords()])


def storeRecords(recordList, outputFile):
  """Write a list of results to outputFile."""
  for el in recordList:
    storeRecord(el, outputFile)


def saveToState(state, search, error=None, nb=None, result=None):
  """Save the current state of a search into a state.

  This state is used to resume searches that fail or are stopped before being
  completed.
  """
  if search not in state.keys():
    state[search] = {}
  state[search]['error'] = error
  state[search]['nbreply'] = nb


def runSearchesOnWos(searches, output_directory, qps=1):
  """Run the searches on Web of Science."""
  for i, s in enumerate(searches):
    if s in STATE_WOS and not STATE_WOS.get(s).get("error"):
      print "%s already done, continuing" % s
      continue
    print "WoS - %d/%d - %s" % (i + 1, len(searches), s)
    outputFile = os.path.join(output_directory, OUTPUT_DIR_WOS,
searchTermToFilename(s))
    _fetchAllWosRecords(s, outputFile, qps)
    time.sleep(1/qps)
  saveState(STATE_WOS_FILE, STATE_WOS)


def _fetchSearchNumbers(s, outputFile):
  result = wosClient.query(s)
  writeToFile(outputFile, [s, result.recordsFound])


def _fetchAllWosRecords(s, outputFile, qps):
  result = wosClient.query(s)
  queryId = result.queryId
  xmlResp = wos_client.WOSResponseTree(result.records)
  while xmlResp.getNumberOfRecords() < result.recordsFound:
```

```
    fetched = xmlResp.getNumberOfRecords()
    xmlResp.addNewRecords(wosClient.retrieve(queryId, 100, fetched+1).records)
    print "fetched %d/%d for %s" % (
        xmlResp.getNumberOfRecords(), result.recordsFound, s)
    time.sleep(1/qps)
  writeToFile(outputFile, [s, result.recordsFound])
  storeRecords(xmlResp.getRecordList(), outputFile)
  saveToState(STATE_WOS, s, None, xmlResp.getNumberOfRecords())
parser = argparse.ArgumentParser(
    description='Run a set of search queries against the Web of Science '
    'database. This set of queries is defined by the exhaustive list of '
    'combination of search terms provided in three different files.')
parser.add_argument('--output_directory', nargs='?', type=str, required=True,
                    help='Directory to write the output to.')
parser.add_argument('--from_date', nargs='?', type=str, required=False,
                    default="",
                    help='Date from which to search the papers in format YYYY-MM-
DD. Default is no limit.')
parser.add_argument('--qps', nargs='?', type=int, required=False,
                    default=1,
                    help='Number of search query per second. Default is 1, max for
Web of Science is 6.')
parser.add_argument('--first_term_file', nargs='?', type=str, required=False,
                    default="",
                    help='Search term list for A in A <CONNECTOR> B <CONNECTOR>
C.')
parser.add_argument('--second_term_file', nargs='?', type=str, required=False,
                    default="",
                    help='Search term list for B in A <CONNECTOR> B <CONNECTOR>
C.')
parser.add_argument('--third_term_file', nargs='?', type=str, required=False,
                    default="",
                    help='Search term list for C in A <CONNECTOR> B <CONNECTOR>
C.')
parser.add_argument('--first_connector', nargs='?', type=str, required=False,
                    default="AND",
                    help='The first connector to use in search A <CONNECTOR> B
<CONNECTOR> C.')
parser.add_argument('--second_connector', nargs='?', type=str, required=False,
                    default="AND",
                    help='The second connector to use in search A <CONNECTOR> B
<CONNECTOR> C.')
parser.add_argument('--exclusions_file', nargs='?', type=str, required=False,
                    default="",
                    help='List of terms to exclude from all searches.')

args = parser.parse_args()

STATE_WOS = loadState(STATE_WOS_FILE)
communication_words = readFile(args.first_term_file)
relation_words = readFile(args.second_term_file)
flexible_words = readFile(args.third_term_file)
excluded_words = readFile(args.exclusions_file)
wosClient=wos_client.WOSClient()
wosClient.setTimeSpan(args.from_date, TIME_END)
wosClient.addExclusions(excluded_words)
createDirIfNotExist(os.path.join(args.output_directory, OUTPUT_DIR_WOS))

searchTerms = generateSearches(
    communication_words, relation_words, flexible_words,
```

```
    args.first_connector, args.second_connector)
print "%d searches to run" % (len(searchTerms))
try:
  runSearchesOnWos(searchTerms, args.output_directory, args.qps)
except Exception, KeyboardInterrupt:
  saveState(STATE_WOS_FILE, STATE_WOS)
raise
```

7.3.4.2 wos_client.py

```
#!/usr/bin/python
# -*- coding=utf8 -*-

import xml.etree.ElementTree as ET
import wos.client

KEYWORD_SEPARATOR=","

class WOSClient(object):

  def __init__(self):
    print "Connecting to Web of trust"
    self.client =  wos.client.WosClient()
    self.timespan = None
    self.client.connect()
    self.exclude = ""

  def query(self, query):
    if self.exclude:
      query = "TS=(%s %s)" % (query, self.exclude)
    else:
      query = "TS=(%s)" % query
    return self.client.search(query, count=100, timeSpan=self.timespan)

  def addExclusions(self, wordList):
    queryStr = ""
    for word in wordList:
      queryStr = "%s NOT %s" % (queryStr, word.lower())
    self.exclude = queryStr

  def retrieve(self, uid, count, offset):
    return self.client.retrieve(uid, count=count, offset=offset)

  def fetchFurther(self, queryId):
    return wos.utils.retrieve(self.client, queryId)

  def setTimeSpan(self, begin, end):
    """Format YYYY-MM-DD"""
    self.timespan = {"begin": begin, "end": end}

  def __del__(self):
    self.client.close()


class WOSResponseTree(object):

  def __init__(self, root):
```

```
    self.root = self.getXmlRoot(root)
    self.numberOfRecords = None
    self.records = []

  def getXmlRoot(self, xmlAsString):
    return ET.fromstring(xmlAsString.encode('utf-8'))

  def getRecordList(self):
    if not self.records:
      for child in self.root:
        self.records.append(WOSRecord(child))
    return self.records

  def getNumberOfRecords(self):
    return len(self.getRecordList())

  def addNewRecords(self, xmlAsString):
    records = ET.fromstring(xmlAsString.encode('utf-8'))
    for child in records:
      self.records.append(WOSRecord(child))


class WOSRecord(object):

  def __init__(self, r):
    self.r = r
    self.title = None
    self.pub_year = None
    self.author = None
    self.uid = None
    self.pub_type = None
    self.pub_name = None
    self.keywords = None
    self.categories = None

  def getTitle(self):
    if not self.title:
      for item in self.r.iter():
        if "item" in item.attrib.values():
          self.title = item.text
    return self.title

  def getPublicationDate(self):
    if not self.pub_year:
      for item in self.r.iter():
        if "sortdate" in item.attrib:
          self.pub_year = item.attrib.get("sortdate")
    return self.pub_year

  def getPublicationType(self):
    if not self.pub_type:
      for item in self.r.iter():
        if "pubtype" in item.attrib:
          self.pub_type = item.attrib.get("pubtype")
    return self.pub_type

  def getJournalName(self):
    if not self.pub_name:
      for item in self.r.iter():
```

```
        if "source" in item.attrib.values():
          self.pub_name = item.text
    return self.pub_name

  def getUid(self):
    if not self.uid:
      for item in self.r.iter():
        if "UID" in item.tag:
          self.uid = item.text
    return self.uid

  def getCategories(self):
    if not self.categories:
      categories = []
      for item in self.r.iter():
        if "subject" in item.tag and item.attrib.get("ascatype") == "traditional":
          categories.append(item.text)
      self.categories = set(categories)
    return KEYWORD_SEPARATOR.join(self.categories)

  def getKeywords(self):
    if not self.keywords:
      keywords = []
      for item in self.r.iter():
        if item.tag.endswith("keyword"):
          keywords.append(item.text)
      self.keywords = set(keywords)
    return KEYWORD_SEPARATOR.join(self.keywords)
```

7.3.4.3 word_count.py

```
#!/usr/bin/python
#-*- coding=utf8 -*-

import argparse
import csv
import operator
import os
import string
import sys


ANALYSED_FILENAMES = set()

def getFileList(dir):
  """Returns all the files in dir."""
  if os.path.isdir(dir):
    return [os.path.join(dir, filename) for filename in os.listdir(dir)]
  return [dir]


def normalizeWord(word):
  """Normalize word to count properly.

  "word" is defined as a set of characters between two spaces. This sometimes
  inclues punctuation, and words also get their first letter capitalized when
  they are at the beginning of a title. This function normalizes the words so
```

```
  the count returns the right value.

  For instance, with this function:
  The -> the
  And, -> and
  "team" -> team
  """
  word = word.lower()
  word = string.strip(word)
  word = word.replace(".", "")
  word = word.replace(",", "")
  word = word.replace("'s", "")
  word = word.replace("?", "")
  word = word.replace(":", "")
  word = word.replace("\"", "")
  word = word.replace("'", "")
  return word


def addWordsToMap(wordMap, wordList):
  """Add a list of words to the map of words we count.

  To avoid having to many articles and prepositions in the list, words we are
  not interested in, we consider only the words that are 4 letters or more.
  Some conjunctions remain (e.g. with) but they can be manually filtered out.
  """
  for word in wordList:
    wordNormed = normalizeWord(word)
    if len(wordNormed) < 4:
      continue
    if not wordNormed in wordMap.keys():
      wordMap[wordNormed] = 0
    wordMap[wordNormed] = wordMap[wordNormed] + 1


def countWords(wordMap, file):
  """Count all the words in the titles in file."""
  with open(file, "r") as f:
    csv_reader = csv.reader(f, delimiter=",", quoting=csv.QUOTE_ALL)
    line_count = 0
    for line in csv_reader:
      # The first line contains the number of papers.
      if line_count == 0:
        line_count += 1
        continue
      # The first item in the line is the title.
      if line[0] not in ANALYSED_FILENAMES:
        addWordsToMap(wordMap, line[0].split(" "))
        ANALYSED_FILENAMES.add(line[0])
      line_count += 1


def countAllWordsInTitles(dir):
  for filename in getFileList(dir):
    countWords(WORD_MAP, filename)

parser = argparse.ArgumentParser(
    description='Deduplicate titles and count words in each title.')
parser.add_argument('--directory', nargs='?', type=str, required=True,
```

```
                    help='Directory containing the csv files to read from. CSV
files must contain the title in the first column.')
parser.add_argument('--output', nargs='?', type=str, required=False,
                    default=sys.stdout,
                    help='Output to write the word count to.')

args = parser.parse_args()

WORD_MAP = {}
countAllWordsInTitles(str(args.directory))
sorted_words = sorted(WORD_MAP.items(), key=operator.itemgetter(1))
# Print output
output = args.output
if output == sys.stdout:
  f = sys.stdout
else:
  f = open(output, "w")
for item in sorted_words:
  f.write("%s,%s\n" % (item[0], item[1]))
# If we wrote to a file, close it.
if output != sys.stdout:
  f.close()
```

7.3.4.4 deduplicate_titles.py

```
#!/usr/bin/python
#-*- coding=utf8 -*-

import argparse
import csv
import operator
import os
import string
import sys


def getFileList(dir):
  """Get all the files in the directory dir."""
  return [os.path.join(dir, filename) for filename in os.listdir(dir)]


def getTitle(line):
  """Get the title in the line. It's the first element of the line."""
  return line[0]


def getJournal(line):
  """If the journal is present, then returns it, else Journal Unknown."""
  if len(line) >= 4:
    return line[3]
  return "Journal Unknown"

def getCategories(line):
  """If the keywords are presents, then returns them."""
  if len(line) >= 5:
    return line[4]
  return "No keywords"
```

```
def getKeywords(line):
  """If the keywords are presents, then returns them."""
  if len(line) >= 6:
    return line[5]
  return "No keywords"


def countTitles(titleMap, filename):
  """Count the single occurences of titles in filename."""
  with open(filename, "r") as f:
    csv_reader = csv.reader(f, delimiter=",", quoting=csv.QUOTE_ALL)
    line_count = 0
    for line in csv_reader:
      if line_count == 0:
        line_count += 1
        continue
      title = line[0]
      if title not in titleMap.keys():
        titleMap[title] = "%s\",\"%s\",\"%s" % (getJournal(line),
getKeywords(line), getCategories(line))
      line_count += 1


def countAllWordsInTitles(dir):
  for filename in getFileList(dir):
    countTitles(TITLE_MAP, filename)

parser = argparse.ArgumentParser(
    description='Generate a list of unique papers found in all the searches
(deduplication).')
parser.add_argument('--directory', nargs='?', type=str, required=True,
                    help='Directory containing the csv files to read from. CSV
files must contain the title in the first column.')
parser.add_argument('--output', nargs='?', type=str, required=False,
                    default=sys.stdout,
                    help='Output to write the word count to.')

args = parser.parse_args()


TITLE_MAP = {}
countAllWordsInTitles(str(args.directory))
sorted_titles = sorted(TITLE_MAP.items(), key=operator.itemgetter(1))
# Print output
output = args.output
if output == sys.stdout:
  f = sys.stdout
else:
  f = open(output, "w")
for item in sorted_titles:
  f.write("\"%s\",\"%s\"\n" % (item[0], item[1]))
# If we wrote to a file, close it.
if output != sys.stdout:
  f.close()
```

7.4 Results of search procedure

No.	TITLE OF ARTICLE	JOURNAL / BOOK	TYPE OF PUBLICATION	YEAR	LANGUAGE	AUTHOR KEYWORDS	KEYWORDS PLUS	AUTHOR(S)					WOS DISCIPLINES	METHODOLOGY OF EMPIRICAL STUDY							DEPENDENT VARIABLE(S) = OUTCOMES		INDEPENDENT VARIABLES = MOTIVES / ANTECEDENTS		RESULT(S) OF RESEARCH	FURTHER RESULT(S) OF RESEARCH
								No.	NAME	COUNTRY	INSTITUTION	RESEARCH AREAS		THEORETICAL FRAMEWORK	RELEVANT OBJECTIVES / HYPOTHESES	RESEARCH DESIGN: qualitative vs. quantitative	RESEARCH DESIGN	METHODS	COUNTRY	SAMPLE: FIELD / INDUSTRIAL SECTOR	SAMPLE: OCCUPATIONAL GROUPS	SAMPLE SIZE	TYPE OF TEAM: VIRTUAL/HYBRID /ARTIFICIAL CONTEXT	No.	OUTCOME(S)	No.	ANTECEDENTS		
1	Communication Strategies for Successful Virtual Teams	Proceedings of the Annual Hawaii International Conference on System Sciences	Proceedings Paper	2015	English			4	Dunn, S; Gramsch, C; Rasinghani, M; Stalling, H	USA	TWU School of Management	Computer Science; Operations Research & Management Science	Computer Science, Information Systems; Computer Science, Theory & Methods; Operations Research & Management Science	Collaboration tools, its characteristic, and (dis)advantages. (Law, 2013) Dysfunctions of a team (Lencioni, 2005)	Literature review of managing global workforce, technology tools available and challenges of managing a global workforce with use of such tools. Extension of current research on the effectiveness and ineffectiveness of basic digital communication tools in use at firms with geographically dispersed workforces such as email, instant messaging, video based conferencing, document management systems, application sharing, and corporate social media tools.		descriptive	literature review		-	virtual						Conferencing tools facilitate more engagement from employee and facilitates spontaneous communication. Social networks promotes brainstorming and collaboration. Limited ability to facilitate face-to-face collaboration, employees in virtual team can easily become disengaged, dissatisfied and not really see the connection in the work they are doing relative to objectives of the company. Typical communication tools (email, instant messaging and video conferencing) makes it easier to disengage and become less productive. New tools as PC/mobile video, application sharing, social networks promise to address this gap. However, leveraging such digital communication tools is not enough / constant work on trust maintenance in the team to ensure high degree of communication is vital.
2	Supporting Global Virtual Work through Blogs and Micro-Blogging	Proceedings of the Annual Hawaii International Conference on System Sciences	Proceedings Paper	2015	English		Distributed Teams	1	Jahn, A	USA	George Mason University	Computer Science; Operations Research & Management Science	Computer Science, Information Systems; Computer Science, Theory & Methods; Operations Research & Management Science	Information sharing as enabler for shared understanding, integration, and mutual trust (Cohen & Gibson, 2003)	RQ: Is it possible for blogs to support information sharing in globally distributed virtual organizations? What mechanisms enable their productive use?	mixed	descriptive	interview/ survey	North America and Europe	IT	Developers	5/26	virtual						Geographic distribution and use of social media were central to firm's work practices. Information sharing was enhanced through team's blog and personal blogs of team members. Recordings of Skype meeting posted on blogs enhanced information sharing. (Reprocessability) Reduced usage of email (prevention of silos communication) and usage of blogs to higher extend enhanced shared understanding, integration and mutual trust leading to higher productivity. Culture of openness and information sharing was created through blogs (informal, documented, easy to monitor) Usage of blogs reduced subgroup dynamics and resulted to common norms across the company.
3	The Conditions of Working in a Successful Virtual Team	Business and Non-Profit Organizations Facing Increased Competition and Growing Customers Demands	Proceedings Paper/ Article	2013	English	virtual team; communication in a virtual team; organizing a virtual team; effectiveness of a virtual team	virtual team, communication in a virtual team; organizing a virtual team; effectiveness of a virtual team	1	Czarnecka, B	Poland	Wyższa Szkoła Bizesu - National-Louis University	Business & Economics	Business; Business, Finance; Economics	Swift trust (Meyerson, Weick & Kramer, 1996; Kirkman et al., 2002) Team Skills in Virtual Teams (Berry, 2011) Information sharing in virtual teams (Berry, 2011; Cummings, 2011)	Differences between traditional and virtual team, and their meaning for management.		descriptive	literature review		-	virtual						Definition of traditional, dispersed and virtual team. Trust relationships in the initial period of work the willingness to share information is lower, however this situation changes when the period of cooperation is extended. Effectiveness is dependent on reciprocity (exchange of information, assistance), openness and commitment to achieve common goal. Swift trust is possible in temporal conditions as relationships are based on competences.
4	Virtually Working: Communicative and Structural Predictors of Media Use and Key Outcomes in Virtual Work Teams	Communication Monographs	Article; Proceedings Paper	2006	English	virtual teams; outcomes; structuration; communication; communication technology	decision-making; technology; organizations; richness; performance; knowledge; choice; satisfaction; perspective; leadership	2	Timmerman, CE; Scott, CR	USA	University of Wisconsin	Communication	Communication	Key team outcomes: trust (Jarvenpaa et al., 1998); identification (Scott, Corman & Cheney, 1998), cohesiveness (Chidambaram, 1996), communication satisfaction (Keyton & Wall, 1997) Use of Communication technology: synchronous and asynchronous media Communication predictors: channels selection considerations (Daft & Lengel, 1986; Short, Williams & Christie, 1976), competent communication style (shared understanding - Wayland, M.A.; Ng, K.; King, Kathleen A & Ilie, 2009), theoretical framework (reverse shift - Yuni et al., 1999; constructivist interpretation style - Poirier & Bakhayaut, 2002) Structural predictors: proposal distance (Griffin, Sawyer & Neale, 2003), time zones difference, team size (Hoopella et al., 2003)	RQ: Was is the relationship between communication technology and key outcomes (identification, cohesiveness, trust, communication satisfaction) in virtual teams? H1: Channel selection considerations (task, cultural/regional, trust, connectedness) are related to communication technology use in virtual teams. H2: Competent communication (effort to understand, argumentativeness, thoroughness, engagement) styles and channel selection considerations are related to key outcomes in virtual teams. H3: Structural predictors (team size, number of member location, number of member time zone, organization type) are related to communication technology use in virtual teams. H4: Structural predictors are related to key outcomes in virtual teams.	quantitative	hypothesis test	survey	USA			98	hybrid	1.	Team Outcomes (identification, cohesiveness, trust, communication satisfaction)	1.1	Technology Use (electronic messaging, traditional office, face-to-face, teleconferencing)	not directly supported	Communicative Predictors moderate the relationship between a) electronic messaging and identification and communication satisfaction, b) traditional office media and cohesiveness, c) face-to-face interaction and trust. As More frequent communication increases level of identification by occurrence of high-effort to understand each other. High level of channel selection to maintain connectedness, argumentativeness, engagement and electronic messaging increases communication satisfaction. Time zone difference and team size moderate the relationship between the level of engagement and trust. If face-to-face interaction increase trust at high rate of responsiveness. At low level of engagement and channel selection to maintain connectedness, more frequent face-to-face interaction increases trust.
																							1.2	Communicative Predictors (competent communication, channel selection considerations)	substantially supported	
																							1.3	Structural Predictors (team size, number of member locations, number of member time zone, organization type)	not supported	
																						2.	Technology Use (electronic messaging, traditional office, face-to-face, teleconferencing)	2.1	Channel Selection Considerations (taste, cultural/regional, trust, connectedness)	not supported	
																							2.2	Structural Predictors (team size, number of member locations, number of member time zone, organization type)	selectively supported	
5	Can You Hear Me Now? Communication in Virtual Product Development Teams	Journal of Product Innovation Management	Article	2009	English		cross-functional cooperation; to-face interaction; information technology; media selection; performance; management; organizations; consequences; antecedents; perceptions	4	Montoya, MM; Massey, AP; Hung, YT ; Crisp, CB	USA	North Carolina State University	Business & Economics; Engineering	Business; Engineering, Industrial; Management	Task type: conveyance (gathering and exchanging work-related information), convergence (problem-solving and decision making), project management (coordinating social/relational relationship building and remote boosting). (Maruta, Martinez & Zaccaro, 2001) ICT media use: synchronicity; synchronous media (telephone/teleconferencing, videoconference, shared applications, instant messaging), asynchronous media (e-mail, voicemail, groupware, shared documents, discussion boards) and additionally face-to-face interactions. (Media capacity theories: Dennis & Valacich, 1999; Daft, Lengel & Trevino, 1987; Short, William & Christie, 1976) Team performance: high-quality decisions, efficiency and efficacy of work, satisfaction with teams' performance, process of decision making and teams' discussions. Team characteristics/ situational factors: team purpose, demographics, , and degree of co-location (Social dynamics media theories: structuration theory - DeSanctis & Poole, 1994; social influence theory / Fulk, Schmitz & Steinfield, 1990; social information processing theory - Walther, 1992).	H1: ICT use by virtual team members is contingent on task type, ICT type, and situational factors. H2: Distinct patterns of ICT use are related to a) task type and b) situational characteristics. H3: The different patterns of ICT use by virtual NPD (new product development) team members are associated with different levels of perceived performance.	quantitative	hypothesis test	survey	global	Manufacturing/IT	Product developers	184	hybrid	1.	ICT use (frequency)	1.1	Task type (convenyance, convergence, project management, social/relational), ICT type (synchronous, asynchronous) and situational factors (team characteristics)	supported	For project tasks use of array of synchronous and asynchronous media is positively related to perceived performance. For convenyance tasks greater usage of repositories and instant messaging for "questions and answers" led to mire focused convenyance efforts and positive effects on perceived team performance. For convergence tasks multiple communication methods lead to positive perception of performance. For project management tasks substitution to traditional means instant messaging is a way to advance the development of team relationships. Use of multiple ICTs is positively related to perceived.
																							1.2	Task type (convenyance, convergence, project management, social/relational)	supported	
																							2.	Patterns of ICT use (medium, frequency)	2.1	Situational characteristics (team characteristics)	supported	
																							3.	Perceived performance	3.1	Patterns of ICT use (medium, frequency)	supported	
6	The Effect of e-Leadership on Organizational Trust and Commitment of Virtual Teams	Proceedings of the Conference on European Management Leadership and Governance	Proceedings Paper	2014	English	commitment; e-leadership; interpersonal trust; remote workers; virtual teams	impact; model; fit; performance; support; work	1	Pishtin, I	Australia	Charles Darwin University	Psychology; Business & Economics	Psychology, Applied; Management	E-leadership: (Montoro 2012): manage by results, not activity; improve virtual communication; handle virtual meeting and schedules; provide virtual feedback and support Interpersonal trust (Mayer, Davis & Schoorman, 1995); faith of remote peers and virtual management and confidence of remote peers and management to achieve organizational performance through virtual communication, virtual schedules, and feedback. Commitment (Cook & Wall, 1980): identification, involvement, and loyalty.	H1: The relationship between interpersonal trust and e-leadership will be negative and significant. H2: The e-leadership measures will be positively and significantly related to organizational commitment of virtual workers.	quantitative	hypothesis test	survey	United Arab Emirates	Service organization		193	virtual	1.	Interpersonal trust (Faith in peers; confidence in peers; confidence in management)	1.1	e-Leadership (manage by results not activities; improve virtual communication; handle virtual schedules; provide virtual feedback & support)	selectively supported	Improved virtual communication is negatively related to faith in peers and with confidence in management. Effect of improved virtual communication on confidence in peers was positive and significant. The relationship between private virtual feedback and support and faith in peers and on confidence on management were positive and significant. The relation between handle virtual schedule and confidence in peers is negative.
																						2.	Commitment (identification, involvement)	2.1		selectively supported	

									AUTHOR(S)							METHODOLOGY OF EMPIRICAL STUDY							DEPENDENT VARIABLE(S) + OUTCOMES		INDEPENDENT VARIABLES + MOTIVES / ANTECEDENTS			RESULT(S) OF RESEARCH	
No.	TITLE OF ARTICLE	JOURNAL / BOOK	TYPE OF PUBLICATION	YEAR	LANGUAGE	AUTHOR KEYWORDS	KEYWORDS PLUS	No.	NAME	COUNTRY	INSTITUTION	RESEARCH AREAS	WOS DISCIPLINES	THEORETICAL FRAMEWORK	RELEVANT OBJECTIVES / HYPOTHESES	RESEARCH DESIGN: qualitative vs. quantitative	RESEARCH DESIGN	METHODS	COUNTRY	SAMPLE: FIELD / INDUSTRIAL SECTOR	SAMPLE: OCCUPATIONAL GROUPS	SAMPLE SIZE	TYPE OF TEAM: VIRTUAL/HYBRID /ARTIFICIAL CONTEXT	No.	OUTCOME(S)	No.	ANTECEDENTS		FURTHER RESULT(S) OF RESEARCH
7	Interpersonal trust and mobile communication: a social network approach	Trust and New Technologies: Marketing and Management on the Internet and Mobile Media	Article; Book Chapter	2008	English		informal networks; virtual teams; organizations; performance; media; work	2	Jukrud, TE; Bakke, JW	Norway	Norwegian University of Science & Technology	Business & Economics	Business; Management	Trust as a "psychological state comprising the intention to accept vulnerability based upon positive expectations of intentions of others" (Rousseau et al., 1998) Cognitive and affective dimensions of trust (McAllister, 1995) Social network analysis - structural aspects of social relations have impact on Indi duals, groups and organizations (Erickson, 1988; Scott, 2000): perceived relationships (mental attitude towards others), interaction-based relations (based on communication patterns and frequency) that influence formal organization networks;	Exploration and explanation of interrelationships between interpersonal trust and mobile phone dialogues, SMS, and email messages.	mixed	exploratory	interviews/ survey	Norway/ Denmark	Engineering		13	hybrid					Cognitive and affective trust are related to different media. Affective relations are positively correlated with SMS while cognitive relations with emails and phone dialogue. E-Mail is the main channel for job related communication, while SMS is used for ad hoc, last minute or private communication.
8	Virtual Team Effectiveness: An Empirical Study Using SEM	Procedia Computer Science	Article	2017	English	Virtual Teams; Trust; Team Effectiveness; Information Sharing; Communication; SEM; Information Technology	trust; model; communication; collaboration	3	Bhat, SK; Pande, N; Ahuja, V	India	Jaypee Business School	Business & Economics; Information Science & Library Science; Mathematical Methods In Social Sciences	Business; Information Science & Library Science; Management; Social Sciences, Mathematical Methods	Trust and shared understanding in virtual teams (Jarvenpaa, Shaw & Staples, 2004). Information sharing in virtual teams as a result of mutual purpose, conversion and distribution of knowledge (Lin, Standing & Liu, 2008)	Recognition of factors of virtual team that are critical one for effectiveness.	quantitative	descriptive	survey	-	IT		520	virtual					The creation of effective virtual team is dependent on: dependability on each other, dealing with time, concern for collaboration, information penetration, variety of information, reliability on technology, tools used for communication and implementation of results. Communication model as tools used for communication, reliability on technology, implementation of results. Information sharing model as penetration of information and variety of information shared. Trust model as dependability on each other, dealing with time and concern for collaboration.
9	Meanings of communication technology in virtual team meetings: Framing technology-related interaction	International Journal of Human-Computer Studies	Article	2018	English	Communication technology; Virtual team; Team interaction; Meaning; Frame analysis; Frame category	face-to-face; computer-mediated communication; information technology; frames; perspective	2	Lattimer, V; Vaits, M	Finland	University of Jyvaskyla	Computer Science; Engineering; Psychology	Computer Science; Engineering; Ergonomics; Psychology, Multidisciplinary	The social influence model (Fulk et al., 1990): construction and sharing of meaning attached to communication technology Adaptive structuration theory (De Sanctis & Poole, 1994): social structures affect fundamentally mediated communication.	RQ1: How is communication technology framed in virtual teams' technology-related interaction? RQ2: What meanings are given to communication technology in virtual team meetings?	qualitative	descriptive	observation	Finland	Consulting/IT		6	hybrid					Frames are influences by meanings of communication in virtual team: practical frame (subject of guidance, challenge), work frame (tools, useful benefits), user frame (object of competence, reasons for uncertainty), relational frame (affection, shared space) that plays role in team interactions and team members' subjective levels (experience and interpretation guided by frames). Video connection was crucial for relational frame. Conferencing platforms foster the appearance of relational and user frame.. Different teams should use different technologies. It is essential not only to use appropriate technologies but also to develop the technological competence of team members.
10	Patterns That Challenge the Effectiveness of Global Virtual Teams	International Virtual Teams: Engineering Global Success	Article; Book Chapter	2015	English		communication; choice; performance; workplace	1	Al Amiani, K	USA	University of North Carolina	Business & Economics; Engineering	Business; Engineering, Electrical & Electronic	Information Communication Technologies and their characteristics (Thomas & Bostrom, 2010) Trust and creditability in virtual team (Lipnack & Stamps, 1997) Social communication (Lipnack, 2008)	Identification of pattern of communication in virtual team, their recognition and addressing of communication challenges.	mixed	descriptive	interview/ survey	-	Engineering		-	virtual					Miscommunication is mainly caused by insufficient information sharing, understanding the other and language skills. Communication should be face-to-face, if not then synchronous. Trust building is positively influenced by high responsiveness, reliability, participation in social communication and regular communication. Social communication is more complicated at distance due to lack of richness of technology.
11	Virtual Team Effectiveness: Investigating the Moderating Role of Experience with Computer-Mediated Communication on the Impact of Team Cohesion and Openness	Journal of Organizational and End User Computing	Article	2013	English	Channel Expansion Theory; Computer-Mediated Communication; Team Effectiveness; Virtual Teams; Team Processes	face-to-face; channel expansion theory; conflict management; cohesion; openness; effectiveness; performance; work; richness; consequences; information	5	Carlson, JR; Carlson, DS; Hunter, EM; Vaughn, PL; George, JF	USA	Baylor University	Computer Science; Information Science & Library Science; Business & Economics	Computer Science; Information Science & Library Science; Management	Hypothesis of moderating role of experience with CMC on the relationship between team interpersonal processes (cohesion, openness), and team effectiveness in virtual team. Channel Expansion Theory (Carlson & Zmud, 1999): four key knowledge based experience driving the ability to communicate richly on a given medium: experience with the medium, experience with communication co-participants, experience with topic, and communication context. Shared Mental Model (Cannon-Bowers & Salas, 2001): knowledge structures held by members of a team that enable them to form accurate explanations and expectations, and coordinate and adapt their behaviours to demands of task and other members. Openness: interpersonal state in team when members share facts, values, ideas and feelings, and are willing to receive this information (Burke, 2003)	H1: Cohesion will be positively related to team effectiveness. H2: Openness will be positively related to team effectiveness. H3: Experience with IM (instant messaging) will moderate the impact of cohesion on effectiveness such that the impact of cohesion will be greater with more experience with IM. H4: Experience with IM will moderate the impact of openness on effectiveness such that the impact of openness will be greater with more experience with IM.	quantitative	hypothesis test	experiment/ survey	USA	-	students	365	artificial context	1. 2. 3. 4.	Team Effectiveness	1.1 2.1 3.1 4.1	Team Cohesion Team Openness Team Cohesion with IM Experience as moderator Team Openness with IM Experience as moderator	supported supported not supported supported	Team cohesion plays a positive and significant role in the effectiveness of teams in virtual setting. Team openness has a positive relationship with virtual team effectiveness. The effects of openness are enhanced by the subject's experience with instant messaging such that the team member can utilize openness to facilitate higher effectiveness.
12	Understanding Lacking Trust in Global Software Teams: A Multi-case Study	Product-Focused Software Process Improvement	Proceedings Paper	2007	English	trust; global software development; global software teams; virtual teams; multi-case study	virtual teams	2	Moe, NB; Smite, D	Norway	SINTEF	Computer Science	Computer Science, Software Engineering; Computer Science, Theory & Methods	Trust and its effects on cooperation, and performance (Jarvenpaa, Shaw & Staples,2004) "Big five of teamwork" (Salas, Sims & Burke, 2005): team leadership, mutual performance monitoring, backup behaviour, adaptability, team orientation Three coordination mechanisms (Salas, Sims & Burke, 2005): shared mental models, closed-looped communication, and mutual trust.	Key factors causing lack of trust and effect of lacking trust in globally distributed teams.	qualitative	exploratory	interview	Latvia	IT	Developers	4	virtual					Main reasons for lacking trust: poor socialization, missing face-to-face meetings, poor socio-cultural fit, no conflict handling, too little communication, unbalanced contribution, insufficient competence, and unfulfilled commitments. Main effects of lacking trust: productivity and quality decrease, decreased information exchange and feedback, competition instead of cooperation, self-protection, relationship, conflict, individual goals over collective goals.

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No.	TITLE OF ARTICLE	JOURNAL / BOOK	TYPE OF PUBLICATION	YEAR	LANGUAGE	AUTHOR KEYWORDS	KEYWORDS PLUS	No.	NAME	COUNTRY	INSTITUTION	RESEARCH AREAS	WOS DISCIPLINES	THEORETICAL FRAMEWORK	RELEVANT OBJECTIVES / HYPOTHESES	RESEARCH DESIGN: qualitative vs. quantitative	RESEARCH DESIGN	METHODS	COUNTRY	SAMPLE: FIELD / INDUSTRIAL SECTOR	SAMPLE: OCCUPATIONAL GROUPS	SAMPLE SIZE	TYPE OF TEAM: VIRTUAL/HYBRID /ARTIFICIAL CONTEXT	No.	OUTCOME(S)	No.	ANTECEDENTS	RESULT(S) OF RESEARCH	FURTHER RESULT(S) OF RESEARCH
13	The joint relationships of communication behaviours and task interdependence on trust building and change in virtual project teams	Social Science Information	Article; Proceedings Paper	2009	English	Communication behaviours; Task interdependence; Trust; Virtual teams	self-managing teams; group performance; work teams; time; coordination; autonomy; antecedents; diversity; conflict; dynamics	4	Hoss, R.; Klocker, CM; Sanchez-Manzanares, M; Gil, F	Spain	Universidad Carlos III de Madrid	Information Science & Library Science; Social Sciences - Other Topics	Information Science & Library Science; Social Sciences, Interdisciplinary	Communication as core of any virtual team process (Powell, Piccoli & Ives, 2004), and key antecedent of trust building in virtual teams (Williams, 2001). Ability to develop trust through communication (Jarvenpaa & Leidner, 1999) with lack of social presence (Short, Williams & Christie, 1976 - social presence theory) Trust in virtual environments: communication behaviours (Jarvenpaa & Leidner, 1999) and task interdependence (Wageman, 1995) Task-oriented communication: creation of base to develop and resume assumptions about others and their abilities (Meyer, Davis & Schoorman, 1995). Socially oriented communication encouraging collaboration and mutual support (Lewis & Weigand, 1995) Enthusiastic communication encouraging team members to interact and fostering the sense of common identity, sign of involvement, attachment, and affection (Jarvenpaa & Leidner, 1999) Predictable communication: predictable patterns (Jarvenpaa & Leidner, 1999) Substantive communication: detailed and elaborated information that contribute to other's work, explicit and prompt feedback(Jarvenpaa & Leidner, 1999), enabling solving conflicts constructively (Gouran, 2003)	H1a: Task-oriented communications will be positively related to trust before the mid-point of a VPT's (virtual project team) project completion. H1b: Socially oriented communications will be positively related to trust before the mid-point of a VPT's (virtual project team) project completion. H1c: Enthusiasm of communication will be positively related to rust before the mid-point of a VPT's (virtual project team) project completion. H2a: Predictable communication will be positively related to trust change at the end of VPT's project completion. H2b: Substantive communication will be positively related to trust change at the end of VPT's project completion. H3: Team task interdependence will moderate the effects of communication behaviours in trust at different points of VPT's project completion: Before the mid-point of a VPT's project completion, the relationship of H3a: socially-oriented H3b: task-oriented H3c: enthusiastic communications will hold will be stronger when task interdependence is high than when task interdependence is low. At the end of VPT's project completion, the relationship of H3d: communication predictability H3e: substantive responses will hold will be stronger when task interdependence is high than when task interdependence is low.	quantitative	hypothesis test	survey	Latin America	IT	Developers	187	virtual	1.	Trust	1.1 1.2 1.3 2.1 2.2 3.1 3.2 3.3 3.4 3.5	Task-oriented communication Socially oriented communication Enthusiasm of communication Predictable communication Substantive communication Socially oriented communication with task interdependence as moderator Task-oriented communication with task interdependence as moderator Enthusiasm of communication with task interdependence as moderator Communication predictability with task interdependence as moderator Substantive response with task interdependence as moderator	supported not supported not supported supported not supported not supported not supported not supported not supported supported	Trust before the project's mid-point is associated with task-oriented communication and with enthusiastic communications only when task interdependence is high. Trust from mid-point to project end is positively associated with predictable and substantive communication when task interdependence is high. Predictable communication patterns are crucial for trust maintenance.
14	Identifying Potential Leaders for Virtual Teams	Proceedings of the Annual Hawaii International Conference on System Sciences	Proceedings Paper	2014	English	context; communication		2	Iorio, J; Taylor, J	USA	Virginia Polytechnic Institute & State University	Computer Science	Computer Science, Information Systems; Computer Science, Theory & Methods	Interpersonal behaviours: rapport building,collection of behaviours creating a congenial, and positive atmosphere (Zaccaro & Bader, 2003); solidarity: strong feelings of interpersonal attraction (Zaccaro & Bader, 2003); engagement:constant interaction, and participation (Ayavanthi & Lederer, 2002); assignments-defined tasks, and roles (Huang, Kahai & Jestice, 2010). Technological Behaviours: troubleshooting: identifying, and resolving technological conflicts (Hertel, Geister & Konradt, 2005) ; shared context (Malhotra, Majchrzak & Rosen, 2007)	RQ: What are the relationships of prior interpersonal and technological experiences with the exhibition of effective leadership in VT's (virtual team)?	quantitative	exploratory	experiment	USA	Civil engineering	students	20	artificial context	1. 2. 3. 4. 5. 6.	Rapport building Solidarity Engagement Assignment Troubleshooting Shared context	1.1 1.2 1.3 1.4 2.1 2.2 2.3 2.4 3.1 3.2 3.3 3.4 4.1 4.2 4.3 4.4 5.1 5.2 5.3 5.4 6.1 6.2 6.3 6.4	Leadership Training Industry Experience Virtual World Experience Virtual Team Experience Leadership Training Industry Experience Virtual World Experience Virtual Team Experience Leadership Training Industry Experience Virtual World Experience Virtual Team Experience Leadership Training Industry Experience Virtual World Experience Virtual Team Experience Leadership Training Industry Experience Virtual World Experience Virtual Team Experience Leadership Training Industry Experience Virtual World Experience Virtual Team Experience	not significant not significant not significant significant and positive not significant not significant not significant significant and positive not significant not significant not significant significant and positive significant and positive not significant not significant not significant not significant not significant not significant significant and positive significant and positive not significant not significant significant and positive significant and positive	VT experience and experience in the medium of interaction both significantly increase the likelihood of project networker exhibiting effective virtual leadership behaviours. VT having experience working previously in VT and familiarity with specific technological medium though which interaction occurs, are more likely to engage in effective leadership behaviours.

No.	TITLE OF ARTICLE	JOURNAL / BOOK	TYPE OF PUBLICATION	YEAR	LANGUAGE	AUTHOR KEYWORDS	KEYWORDS PLUS	AUTHOR(S)							METHODOLOGY OF EMPIRICAL STUDY							DEPENDENT VARIABLE(S) + OUTCOMES		INDEPENDENT VARIABLES + MOTIVES / ANTECEDENTS		RESULT(S) OF RESEARCH	FURTHER RESULT(S) OF RESEARCH
								No.	NAME	COUNTRY	INSTITUTION	RESEARCH AREAS	WOS DISCIPLINES	THEORETICAL FRAMEWORK	RELEVANT OBJECTIVES / HYPOTHESES	RESEARCH DESIGN: qualitative vs. quantitative	RESEARCH DESIGN	METHODS	COUNTRY	SAMPLE: FIELD / INDUSTRIAL SECTOR	SAMPLE: OCCUPATIONAL GROUPS	SAMPLE SIZE	TYPE OF TEAM: VIRTUAL/HYBRID /ARTIFICIAL CONTEXT	No.	OUTCOME(S)	No.	ANTECEDENTS		
15	Media Capabilities that Support Identity Communication in Virtual Teams	Proceedings of the Annual Hawaii International Conference on System Sciences	Proceedings Paper	2015	English	work groups; individuals; resources; design; tasks		3	Wilson, DW; Thatcher, SMB; Brown, SA	USA	University of Arizona	Computer Science; Operations Research & Management Science	Computer Science, Information Systems; Computer Science, Theory & Methods; Operations Research & Management Science	Identity communication (Swann, Milton & Polzer, 2000): sense of continuity, coherence, and feeling of being known and understood by others Media theories: media richness theory (Daft & Lengel, 1986), media synchronicity theory - Reheserability and reprocess ability (Dennis, Fuller & Valacich, 2008)	H1: A medium's richness is positively related to its users' perceived identity communication. H2: A medium's Reheserability capability is positively related to its users' perceived identity communication. H3: A medium's reprocess ability capability is positively relate to its users' perceived identity communication. H4: User self-monitoring is positively related to perceived identity communication. H5: Users self-monitoring (a) diminishes the effect of media richness, and amplifies the effects of (b) Reheserability and (c) reprocess ability, on perceived identity communication.	quantitative	hypothesis test	experiment	USA		students	186	artificial context	1. 2. 3. 4. 5.1 5.2 5.3	Perceived identity communication	1.1 2.1 3.1 4.1 5.1 5.2 5.3	media richness Reheserability reprocessability self-monitoring (individual social abilities) media richness and self-monitoring as moderator Reheserability and self-monitoring as moderator reprocessability and self-monitoring as moderator	supported supported supported supported supported not supported not supported	Media richness, rehearsability and reprocess ability exhibit significant positive effect on perceived identity communication. Self-monitoring impacts significantly perceived identity communication and moderate the impact of media richness on perceived identity communication, with higher self-monitoring reducing the impact of media richness. Self-monitoring is a predictor of perceived identity communication.
16	An analysis of trust building with awareness information in virtual teams	International Congress on Advances Applied Informatics	Proceedings Paper	2015	English	trust; awareness; virtual teams; communication		4	Shimishi, M; Higa, K; Kanemaru, T; Fukawara, S	Japan	Tokyo Institute of Technology	Computer Science	Computer Science, Information Systems	"trust in global teams is affected by amount of communication (Jarvenpaa & Leidner, 1999). Trust in virtual teams is affected by time (Iacono, 2009). Performance is correlated with awareness information derived from communication messages (Weisband, 2002). Self-awareness - information about what the particular member of team is doing at the moment. Availability awareness - information about when team members are available to 'meet' through alternate forms of communication. Process awareness - information about setting up and coordinating work. Social awareness - information about team members' relationships. (Weisband, 2002)	Effects of awareness information on trust building in a virtual team.	quantitative	descriptive	experiment/ survey	China	IT	Developers	12	artificial context						Not posting frequency, but content of posting influence trust building. Sharing of awareness information might encourage more communication and affect communication in positive manner.
17	Understanding Teamwork Behaviours in the Use of New Ways of Working	Advanced Series in Management: New Ways of Working Practices	Article; Book Chapter	2017	English	New Ways of Working; productivity; organizational commitment; teamwork behaviour; research paper	virtual teams; performance; communication; management; impact; job; interdependence; satisfaction; cooperation; integration	2	de Leede, J; Nijland, J	Netherlands	University of Twente	Business & Economics	Management	NWW: teleworking (Offi LWC, 2010), flexible workplaces at work (Thompson, 2011), flexible working hours , IT (Baane et al., 2010) Organizational Commitment (Cook & Wall, 1980) and Productivity (Staples et al., 1999) Interdependence Theory (Thibaut & Kelley, 1959; Kelley & Thibaut, 1978; Rusbult and Gernumden, 2001) Mutual Support: help each other to carry out tasks (Weimar et al., 2015) Mutual Performance Monitoring: ability to keep track of fellow members work and ensuring that others are following procedures correctly (Salas et al., 2005) Balanced Contribution: Bringing expertise to one's full potential to influence positively quality of work (Haeg & Gernumden, 2001) Team Cohesion: perception of belonging together (Weimar et al., 2013) Team work behaviour: mutual communication, mutual support, balanced contribution, mutual performance monitoring, and team cohesion	H1a: Communication between colleagues will moderate the relationship between NWW and productivity. Better communication will positively moderate the relationship between NWW and productivity. H1a: Communication between colleagues will moderate the relationship between NWW and organizational commitment. Better communication will positively moderate the relationship between NWW and organizational commitment. H1b: Balanced contribution will moderate the relationship between NWW and productivity. The more balanced contribution, the more positive is the relationship between NWW and productivity. H2b: Balanced contribution will moderate the relationship between NWW and organizational commitment. The more balanced contribution, the more positive the relationship between NWW and organizational commitment. H1c: Mutual support between colleagues will moderate the relationship between NWW and productivity. The higher the perceived mutual support, the more positive the relationship between NWW and productivity. H2c: Mutual support between colleagues will moderate the relationship between NWW and organizational commitment. The higher the perceive mutual support, the more positive the relationship between NWW and organizational commitment. H1d: Mutual performance monitoring will moderate the relationship between NWW and productivity. The higher the mutual performance monitoring, the more positive the relationship between NWW and productivity. H2d: Mutual performance monitoring will moderate the relationship between NWW and organizational commitment. The higher the mutual performance monitoring, the more positive the relationship between NWW and organizational commitment. H1e: Team cohesion will moderate the relationship between NWW and productivity. The higher the team cohesion, the more positive the relationship between NWW and productivity. H2e: Team cohesion will moderate the relationship between NWW and organizational commitment. The higher the team cohesion, the more positive the relationship between NWW and organizational commitment. H1f: Teamwork behaviour will moderate the relationship between NWW and productivity. The better the teamwork behaviours, the more positive the relationship between NWW and productivity. H2f: Teamwork behaviour will moderate the relationship between NWW and organizational commitment. The better the teamwork behaviours, the more positive the relationship between NWW and organizational commitment.	quantitative	hypothesis test	survey	Denmark	Finance		258	hybrid	1. 2.	Productivity Organizational commitment	1.1 1.2 1.3 1.4 1.5 1.6 2.1 2.2 2.3 2.4 2.5 2.6	NWW and communication as moderator NWW and balanced contribution as moderator NWW and mutual support as moderator NWW and mutual performance monitoring as moderator NWW and team cohesion as moderator NWW and teamwork behaviour as moderator NWW and communication as moderator NWW and balanced contribution as moderator NWW and mutual support as moderator NWW and mutual performance monitoring as moderator NWW and team cohesion as moderator NWW and teamwork behaviour as moderator	not supported not supported not supported not supported not supported not supported not supported not supported not supported not supported not supported not supported	There exists a positive relationship between NWW and productivity and NWW and commitment. When NWW is implemented at high level, the best solution would be a medium level of teamwork behaviour to realise highest commitment. Only relationship between teleworking and productivity and IT and productivity are significant. Social team cohesion brings more commitment on moderate level of NWW, and less for high level of NWW. Another team behaviours behave similarly.

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18	Who is on the other side of the screen? The role of trust in virtual teams	Trust and New Technologies: Marketing and Management on the Internet and Mobile Media	Article; Book Chapter	2008	English		computer-mediated communication; decision making; organization; work; time; performance; management; innovation; efficacy; behaviour	3	Birchall, D ; Giambona, G; Gill, S	England	University of Reading	Business & Economics	Business; Management	Trust in virtual team (Jarvenpaa, Shaw & Staples, 2004) Trust development (Lewis & Weigert, 1985) Media fit (Kraemerh & Lockner, 2010) Virtual team characteristics (Gibson & Manuel, 2003)	Nature of virtual team, trust in virtual teams, impact of technology, and contextual factors on the functioning of the team.	-	descriptive	literature review	-	-	-	virtual						In computer-mediated environment the spontaneous expressive communication is less common (social communication). This results in diminish sense of presence and loss of communication cues and lacking of trust. Choice of communication medium should be consistent with task and time requirements (richness, synchronicity)
19	Instruments of Personal Communications in Global Teams	V Forum Strategic Partnership of Universities and Enterprises of Hi-Tech Branches (Science Education Innovations)	Proceedings Paper	2016	English	personnel communication; virtual team; tools of communication; social media; virtual projects; virtual office		3	Shvetsova, OA; Dobrynina, NA; Romanov, OK	South Korea	Korea University of Technology & Education	Education & Educational Research; Engineering	Education, Scientific Disciplines; Engineering, Electrical & Electronic	Communication as verbal and nonverbal signals (Walther, 1999) Media richness (Daft & Lengel, 1986) Knowledge sharing is dependent on trust, leadership and used technologies (Sosmon, 1995)	Main approaches to the definition of communication tools for global teams.	-	descriptive	literature review	-	-	-	virtual						Social media as emerging communication tool for companies enabling more personal communication and trust development. Trust development can be achieved through: usage of "rich" communication channels, establishment of rules of communication, definitions of roles in virtual teams, carrying out training courses on information technology
20	Let's search together, but not too close! An analysis of communication and performance in collaborative information seeking	Information Processing & Management	Article	2013	English	Collaboration; Information seeking; Communication; Information; Human factors; Measurement	video-mediated communication; dialogue structure; task-communication; interaction; awareness; context; teams; model	3	Gonzalez-Ibanez, R; Haseki, M; Shah, C	USA	Rutgers State University New Brunswick	Computer Science; Information Science & Library Science	Computer Science, Information Systems; Information Science & Library Science	Collaborative information seeking: social process in which several individuals intentionally and explicitly work together with the aim of cooperating to accomplish common goals (Foster, 2006) Social processes (Morris & Horvitz, 2007): three key features supporting collaborative search: awareness, division of labour, persistence. Media theories: media richness (Daft & Lengel, 1984), social presence (Short, Williams & Christie, 1976) Cognitive and affective factors in communication (Heuwerth & Anderson, 2005)	RQ1: How do communication dynamics in different communication context (face-to-face, text chat, audio + text chat) affect teams' interaction within a CIS-task? RQ2: How does the communication context affect the performance of teams within CIS-task? RQ3: How does communication context affect cognitive and affective load of teams within CIS-task?	mixed	exploratory	experiment	USA	-	students	30	mixed: virtual and co-located						Computer-mediated context limits the social aspects of communication, due to limited capacity of information exchange and extra-effort needed for communication. The condition with remotely located participants with audio support seemed to provide the best cost benefit ratio of communication effort and productivity. The level of social presence capacity in this condition was sufficient to support interactions for decision making processes, but not too high to distract teams from doing work. F2F is not always better and more productive, the choice for spatial setup and/or communication preference may depend heavily on the nature of the task.
21	Mobile Collaboration Support for Virtual Teams: The Case of Virtual Information Systems Development Teams	Journal of Database Management	Article	2017	English	Mobile Applications; Mobile Collaboration; Value-Focused Thinking; Virtual Team		2	Sias, K ; Ling, M	USA	Missouri University of Science & Technology	Computer Science	Computer Science, Information Systems; Computer Science, Software Engineering	Work System Theory (Alter, 2002): business processes surrounded by participants, technology, and information	Investigation of values of mobile support for virtual teams.	qualitative	descriptive	interview	IT	Developers	30	virtual						Means-objective: maximize awareness of member presence, maximize real-time interaction to achieve fundamental objectives as maximizing awareness and accessibility. Reduce time to gather information and facilitate communication processes. Transformation from traditional to virtual team changes the way of working and communication. The importance of communication media choice is growing and dependent on task and make of the group. The media has to fit the task (media synchronicity). In case of self-attribution, distributed members more frequently identified partners as the cause of their own negative behaviour, while in co-located groups they more frequently acknowledged their own behaviours.
22	The Proximal-Virtual Team continuum: A study of performance	Journal of American Society for Information Science and Technology	Article	2007	English		interpersonal communication; media richness; telework; work; organizations; computers; technology; leadership; groupthink; agreement	1	Workman, M	USA	Florida Institute of Technology	Computer Science; Information Science & Library Science	Computer Science, Information Systems; Information Science & Library Science	Social identity theory (Tajfel & Turner, 1979, 1986) Social influence theory (Deutch & Gerard, 1955): team interaction and identification (Shaw & Barrett-Power, 1998, Workman 2001), cohesion (Hertel et al., 2004) Virtualization and technical intermediation (Gibson & Cohen, 2003; Martins et al., 2004, Daft & Lengel, 1986): ambiguity of environment	H1: Virtualization will moderate cohesion such that as cohesion decreases or increases towards the poles of the proximal/virtual continuum there will be decreased performance. H2: Virtualization will moderate conflict such that as virtualization increases there will be greater conflict leading to decreased performance. H3: Virtualization will moderate epistemological weighting such that as virtualization increases task-oriented people will experience better performance compared with relationship-oriented people. H4: Virtualization will moderate epistemological weighting such that as virtualization increases, people with technical skills will experience better performance compared with people who have social skills.	quantitative	hypothesis test	survey	global	IT	-	848	hybrid	1. 2. 3. 4.	Performance (budget conformance and service deliver schedule conformance)	1.1 1.1 1.1 4.1	Cohesion (perceived cohesion) Conflict Relationship-task orientation Social/technical skills	supported not supported supported supported	Cohesion is moderated by virtualization such that when teams are nearly fully proximal or nearly fully virtual, performance is decreased. For conflict there exists significant interaction such that when teams are nearly fully proximal or nearly fully virtual there is a decrease in performance. Task-oriented people experience better performance when virtualization increases than relationship-oriented people. People with technical skills outperform ones with social skills as virtualization increases. Hybrid teams may offer great potential for performance improvement over proximal or virtual teams, providing that workers are both trained technically and conditioned for lower structure, greater level of individual work, and elevated levels of ambiguity that accompanies virtualization.
23	(Mis)Attribution of Blame in Distributed Work	Destructive Organizational Communication: Processes, Consequences, and Constructive Ways of Organizing	Article; Book Chapter	2009	English		computer-mediated communication; understanding conflict; social inference; distance matters; shared mental models; shared knowledge; trust; actor	2	Bazarova, NN; Walther, JB	USA	Cornell University	Communication	Communication	Attribution theory (Malle, 1999; Jones & Nisbett, 1971)	Discussion of basic premises of attribution theory with regard to impact of distance and technological constrains in virtual teams.	-	descriptive	literature review	-	-	-	mixed: virtual and co-located						Physical separation and mediated communication exacerbate the attributional biases (how people generate explanations for outcomes and actions). Geographical distance can systematically affect attribution since partners make. Due to limited mutual knowledge, partners blame rather personalities and traits than environmental factors and experiences to their accounts. It is unclear whether attributional biases are unique to distributed collaborators and uncommon to co-located groups.
24	Talent Development of Global Virtual Team Leaders and Strategies	Talent Development and The Global Economy: Perspectives From Special Interest Groups	Article; Book Chapter	2017	English		geographically dispersed teams; face-to-face; temporal coordination; conflict management; cultural diversity; distributed teams; swift trust; work teams; communication; performance	3	Yen, SC; Imrag, S; Beyerlein, M	USA	Texas A&M University	Education & Educational Research	Education & Educational Research	Team processes (Kozlowski & Ilgen, 2006): cognitive, affective-motivational, behavioural.	Exploration the process factors that disable global virtual team processes and identify strategies that can be use for virtual team development.	-	descriptive	literature review	-	-	-	virtual						Using collaboration technologies hinders trust building. Diminished informal or social information sharing reduce trust. Virtual team should use variety of communication tools. Volume and frequency of task-oriented communication should be increased to improve coordination and to establish high performance. Communication technologies that are rich in social cues should be used (training in ICT technologies recommended). Exchange of informal and social information positively influences atmosphere and trust. Face-to-face meetings help to gain trust and interpersonal relations.

								AUTHOR(S)						METHODOLOGY OF EMPIRICAL STUDY								DEPENDENT VARIABLE(S) + OUTCOMES		INDEPENDENT VARIABLES + MOTIVES / ANTECEDENTS			
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25	Studying the Effects of Information Exchange Channels in Different Communication Modes on Trust Building in Computer-mediated Remote Collaborative Design	Journal of Universal Computer Science	Article	2011	English	Trust; Communication modes; Information exchange channels; Collaboration; Design	decision-making; participation; performance; networks; teams	4	Wang, R; Liew, PZD; Kim, MJ; Wang, L	South Korea	Kyung Hee University	Computer Science	Computer Science, Software Engineering, Computer Science, Theory & Methods	Trust building through virtual interaction (Jarvenpaa et al., 1998) Framework of communication modes (Dong et al., 2005)	Exploring effects of communication modes and information exchange channels on trust levels in a computer mediated collaborative remote design teams. H1: The text-based channel of information exchange will built the highest trust in the sequence mode in computer mediated remote collaborative design. H2: The video channel of information exchange will build the highest trust in the layer mode in the computer mediated collaborative design. H3: The video channel of information exchange will build the highest trust in the net mode in the computer mediated remote collaborative design.	quantitative	hypothesis test	experiment	-	IT	student	40	artificial context (virtual)	1. 2. 3.	Trust	1.1 2.1 3.1	Text-based channel information exchange in the sequence mode Video channel information exchange in the layer mode Video channel information exchange in the net mode	supported not supported supported	Combination of the communication mode and information exchange channel has a significant effect on the group time distribution. The highest trust level was achieved in the video-net combination. The net mode was the quickest in building trust. In the sequence mode text-based channel achieved the highest trust level, then audio-based and video-based (probably due to lack of information maintenance in the sequence mode). In the layer mode and net mode the highest trust was achieved with video-based channel, than audio-based and text-based. Trust levels changed over time, it was build from lower level to the max, than it fell down and flatted out. -> Using net mode and video-based channel at the beginning can accelerate trust building but with the time passing it can destroy it faster.
26	Management of Subordinates at a Distance: A Balance Between Co-Located and Virtual Activities	European Conference on Management Leadership and Governance	Proceedings Paper	2010	English	telework; management; media choice; proximity; distance	leadership; teams	1	Bergum, S	Norway	Lillehammer University College	Business & Economics; Government & Law	Management; Political Science	Management at distance (Duckworth, 2002; Connaughton & Daly, 2004; Hambley, O'Neill & Kline, 2007) Media choice theories (Trevino, Daft & Lengel, 1990 - media richness; Webster & Trevino, 1995- social context) Influence through scarcity (Cialdini, 2001) - scarce items, opportunities are more valuable	Managerial decisions about media use and distance for successful management.	mixed	descriptive	interview	Norway	Public Administration	Manager	10	hybrid						Rationale of theories of media choice (Daft & Lengel, 1986) is supported. Media richness is not necessary for managers' effective management of co-located subordinates, are related to more planning and clarification of goals, more consciousness on the use of media in communication, and more independent subordinates. Telework requires more planning time for manager and reduces social communication. Complexity of the task decides on media choice. Other situational factors also influence media choice. Relationship between sender and receiver also influences media choice (the better the relationship the more complex taste can be discussed through media with lower richness).
27	Study on communication problems in virtual project teams in global economy	International Conference on Enterprise Engineering and Management Innovation	Proceedings Paper	2007	English	virtual project team; communication; control	conflict	2	Haiyan, T; Feng, H	China	Shanghai Lixin University of Accounting & Finance	Business & Economics; Computer Science; Operations Research & Management Science	Business; Computer Science, Artificial Intelligence; Computer Science, Interdisciplinary Applications; Economics; Management; Operations Research & Management Science	Virtual team dynamics and effectiveness (Maznevski & Chudoba, 2000) Technology in virtual team (Townsend, DeMarie & Hendrickson, 1998)	Communication problems in virtual project teams in global economy	-	descriptive	literature review	-			-	virtual						Communication mode (synchronous vs. asynchronous, level of richness) should be set dependent of task and its urgency. Members of team should define standards and consider available communication modes, use synchronous media regularly, set priority levels to the message. The more interdependent the team the more efficient the communication has to be. Cohesion of the team can be enhanced by leadership practices and usage of appropriate media to improve information sharing and goal achievement.

8 List of Figures

9 List of Tables

10 List of Abbreviations

CIS	Collaborative Information Seeking
CMC	Computer Mediated Communication
CSV	Comma Separated Values
ICT	Information and Communication Technology
IKT	Informations- und Kommunikationstechnologie
IM	Instant Messaging
MST	Media Synchronicity Theory
RQ	Research Question
SMS	Short Message Service
VPN	Virtual Private Network
WOS	Web of Science