

SYSTEMATIC ANALYSIS OF LITERARY SOURCES ON THE ISSUES OF TACIT KNOWLEDGE TRANSFER THROUGH INFORMAL INNOVATION NETWORKS

Lyubomir TODOROV¹, Tsvetan TSVETKOV²

¹“D. A. Tsenov” Academy of Economics, 2 Em. Chakarov Str., Svishtov 5250, Bulgaria, Phone/Fax:+359/888264688; E-mail: lubomir.ivanov@uni-svishtov.bg

²University of National and Worlds Economy, Sofia, Bulgaria; E-mail: ttsvetkov@unwe.bg

Corresponding author: lubomir.ivanov@uni-svishtov.bg

Abstract

The paper explored the dynamics of researchers' interest in the scientific problem of transferring tacit knowledge, the main researchers/sources, significant problem areas and results. The main method of analysis is a systematic analysis of literary sources on the problems of the application possibilities of informal innovation networks in the transfer of tacit knowledge. The review covers 2,682 documents published in 1,806 sources indexed in the Web of Science database. The results of the review showed a growing interest in tacit knowledge transfer issues, identified specific areas of substantial application of tacit knowledge, significant organizational, social, and psychological factors, and mechanisms for sharing tacit knowledge.

Key words: tacit knowledge, informal innovation networks, knowledge transfer, systematic analysis

INTRODUCTION

This research presents a part of the results of a scientific study on "Formal and informal innovation networks", financed by the Bulgarian National Science Fund.

The purpose of the study is to establish, based on a systematic analysis of literary sources on the issues of the application possibilities of informal innovation networks in the transfer of tacit knowledge, what are the dynamics of the researchers' interest in this area, who are the main players in it and who are the most significant directions of interest to the authors. The main research questions we asked are:

(1) What is the interest of researchers who have published their publications about tacit knowledge transfer through informal networks? How does this interest change over time?

(2) Who are the main players (authors, scientific journals, universities, etc.) working in the researched area, and have sustainable links and networks been established between them?

(3) What are the main problem areas explored in the publications and what are their specific features? As a result of the research, we conclude that the researchers' interest in the

issues of the transfer of tacit knowledge through informal innovation networks is sustainable and growing.

MATERIALS AND METHODS

Due to the specificity of the research area and the research questions, we decided to conduct our research in two directions. First, we conducted an extensive systematic analysis of a sufficient and substantial number of literary sources published over an extended period [10, 5, 16], and then we continued with an in-depth analysis of selected literary sources [14].

We decided to start the systematic analysis by searching the Web of Science (WoS), database [40]. We consider it the most suitable one, due to the high degree of data structuring and good correspondence with the software we used running in the R environment. We created a search expression, that included keywords “tacit”, “knowledge”, “network”, “networks”, “informal”, and “tacit knowledge”. We searched the Topic and Title fields of the selected database. The search found publications from the period 1985-2024.

The selection of publications for in-depth analysis was based on a combination of factors.

First, up-to-date publications, indexed and referenced in the world's databases in the last 7 (seven) years are selected.

Secondly, publications should address specific problems related to the management of tacit knowledge, present new ideas regarding methods of tacit analysis and its transfer; achieve/receive interesting and significant results for theory and practice; identify significant factors influencing tacit knowledge flows; create useful models for studying, monitoring or managing the transfer of tacit knowledge; to have revealed connections and interdependencies in the transfer of tacit knowledge.

The publications were examined in terms of main results and ideas, using descriptive analysis, synthesis, comparative analysis, content analysis, grouping, summarization, graphical methods, and logical methods of finding similarity and contradiction.

RESULTS AND DISCUSSIONS

Bibliometric Analysis

A total of 2,682 documents published in 1,806 sources were found as a result of the WoS database search. The results obtained were processed using the Biblioshiny app [4].



Fig. 1. Annual number of publications on the researched topic for the period 1985 – 2024
Source: Own calculation on the basis of data processed with Biblioshiny [39].

We distinguished three periods in the dynamics of publication activity in the researched area. The first was between 1985 and 2003 when relatively low and uniform activity was observed. The second period was 2004-2011 when there was an intense increase

in activity. The third period 2012-2024 reported relatively constant but uneven activity (Fig. 1). The average age of the publications was 11.33 years.

Interest in the researched area could also be assessed according to the dynamics of the number of citations of literary sources (Fig. 2). We concluded that there was a significant difference in the average number of citations. However, for 1988-2003, it was significantly higher than for 2004-2024.

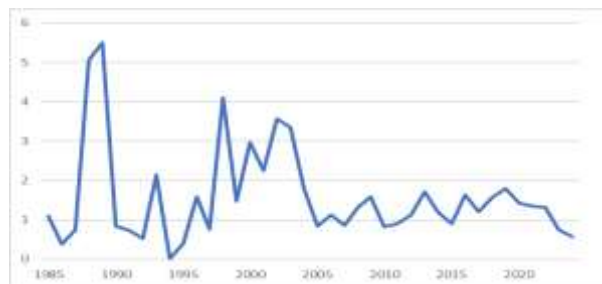


Fig. 2. Average number of citations per publication for the period 1985–2024

Source: Own calculation on the basis of data from Biblioshiny [39].

We directed the research to the publication sources. A large proportion of identified sources – 1,416 or 78% published only one paper, 233 or 13% published two papers, and 71 (4%) published three papers.

Table 1. Most actively publishing sources on the researched topic

Most Relevant Sources	No. of published articles
Journal of Knowledge Management	41
Gerontologist	21
Knowledge Management Research & Practice	21
Handbook of Research on Tacit Knowledge Management for Organizational Success	16
International Journal of Psychology	14
Sustainability	14
Vine Journal of Information and Knowledge Management Systems	14
European Planning Studies	11
Journal of Information & Knowledge Management	11
International Journal of Knowledge Management	10

Source: Own calculation on the basis of data processed with Biblioshiny [39].

The ten most actively publishing sources in the selected research area are presented in Table 1.

We revealed the authority of publication sources based on the number of citations to their publications. The analyzed publications cite a total of over 36,000 documents. A list of the most cited publications from those analyzed is presented in Table. 2.

Table 2. List of sources that published the most cited documents

Sources	Articles
Organization Science	1,701
Strategic Management Journal	1,539
Journal of Knowledge Management	1,364
Academy of Management Journal	1,059
Academy of Management Review	1,042
Administrative Science Quarterly	970
Research Policy	835
Journal of Knowledge Management	816
American Journal of Sociology	679
Management Science	636

Source: Own calculation on the basis of data processed with Biblioshiny [39].

The analyzed sources differ greatly in their impact on the development of scientific research. World practice uses several indices to assess the power of influence. Table. 3 presents the evaluation indices of the ten sources with the highest impact on the development of scientific research.

Table 3. Sources with the highest impact on the development of scientific research in the chosen field

Source	h_index	g_index	m_index
Journal of Knowledge Management	21	41	1.313
Knowledge Management Research & Practice	11	17	0.647
Journal of Economic Geography	9	10	0.409
Research Policy	9	9	0.333
International Journal of Information Management	8	9	0.333
Journal of Business Research	7	7	0.389
Organization Studies	7	7	0.219
European Planning Studies	6	11	0.261
International Journal of Knowledge Management	6	10	0.300
Technology Analysis & Strategic Management	6	7	0.207

Source: Own calculation on the basis of data processed with Biblioshiny [39].

The h-index score is “a standard scholarly metric in which the number of published

papers, and the number of times their author is cited, is put into relation. Journals also have their own H-Index scores” [17]. In turn, the g-index is “the (unique) largest number such that the top g articles received (together) at least g^2 citations” [38]. M-index displays h-index per year since the first publication” [34].

The dynamics of the sources of the publications in the studied period were very different. Fig. 3 shows the dynamics of the publications of the five sources with the highest h-index.



Fig. 3. Dynamics of the number of publications (cumulative amount) on the researched topic of five sources with the highest h-index, 1985 – 2024

Source: Own calculation on the basis of data processed with Biblioshiny [39].

Another focus of this research was the authors with the highest publication activity in the studied field. An interesting comparison could be made here between the number of authors' publications and the number of Articles Fractionalized. The second indicator quantifies the contribution of each of the authors, in the presence of co-authorship.

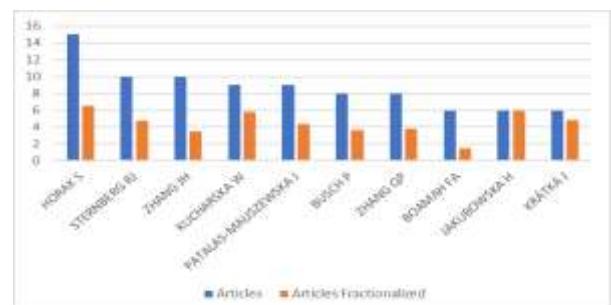


Fig. 4. Comparison between the number of publications and Articles Fractionalized of the ten authors with the highest publication activity in the researched area

Source: Own calculation on the basis of data processed with Biblioshiny [39].

In Fig. 4 a comparison was made between the publication activity of the ten authors with the

most publications and their Articles Fractionalized. One can see that Horak S. was the author of the highest number of publications – 15. The same author has the highest value of Articles Fractionalized – 6.53. For one of the authors, the two indicators match – six. One could conclude that he had published six independent publications. Other authors, such as Sternberg RJ and Zhang JH. contributed to ten publications each, but their Articles Fractionalized values were 4.78 and 3.48, respectively. This meant their publications had more co-authors and their total contribution to publication activity was lower. Not always the authors who publish the most actively had the highest contribution to the development of science in a certain field. Researchers prefer different approaches and methods for measuring the author's contribution and impact on the development of science. Indicators such as number of citations, h-index, g-index, m-index and others were very often used. Table 4 presents information on such indicators for the ten authors with the highest publication activity on the subject.

Table 4. Information on the impact of the ten authors with the highest publication activity in the researched area

Author	H index	G index	M index	Total Citations	Local Citations
HORAK S	7	15	0.636	328	70
STERNBERG RJ	8	10	0.200	711	134
ZHANG JH	4	5	0.250	29	9
KUCHARSKA W	7	9	0.778	101	27
PATALAS-MALISZEWSKA J	3	5	0.300	32	7
BUSCH P	3	8	0.125	140	32
ZHANG QP	2	2	0.100	6	0
BOAMAH FA	4	5	2.000	25	9
LEDENEVA A	5	6	0.313	177	19
KRÁTKÁ J	1	3	0.091	9	5

Source: Own calculation on the basis of data processed with Biblioshiny [39].

Total Citations reflected the number of author citations in the WoS database, while Local Citations were the citations in the population of 2,682 identified documents. The research showed that authors varied widely in their productivity. One document was published by 4,756 authors (or 88% of authors), two documents by 473 (or 87% of authors), and

three documents by 111 authors (or 21% of authors). One author had published 15 papers. Our analysis confirmed to a high degree Lotka's law of the ratio between the number of authors, and the number of documents they published.

The research focused on the authors' affiliation. It turned out that there was also a significant difference between the number of publications from different affiliations. Table 5 presented information about the activity of the ten most actively published affiliations in the selected topic. Authors from the two most active institutions – University of Toronto and University System of Ohio- had published 23 papers each, and 1,366 institutions (or over 58%) had only one publication. Publishing activity increased over time.

Table 5. Publication activity of the ten most actively publishing affiliations in the selected topic

Affiliation	Articles
UNIVERSITY OF TORONTO	23
UNIVERSITY SYSTEM OF OHIO	23
HARBIN INSTITUTE OF TECHNOLOGY	21
UNIVERSITY OF LONDON	20
STATE UNIVERSITY SYSTEM OF FLORIDA	19
UNIVERSITY OF LONDON	18
STATE UNIVERSITY SYSTEM OF FLORIDA	18
UNIVERSITY SYSTEM OF OHIO	17
UNIVERSITY OF CALIFORNIA SYSTEM	16
UNIVERSITY OF MICHIGAN	15

Source: Own calculation on the basis of data processed with Biblioshiny [39].

The countries of the corresponding authors also differed in their publication activity. The most actively publishing countries were the USA (501 publications), China (364 publications), the United Kingdom (259 publications), Australia (103 posts), Canada (97 publications), Germany (83 publications), and The Netherlands (56 publications). Seventeen countries had only one publication each. The most actively publishing countries had the following number of citations: the USA – 16,727 citations (33.4 citations on average per article), China – 2,747 citations (7.5 citations per article), United Kingdom – 8,205 citations (31.7 citations per article), Australia – 1,512 citations (14.7 citations per article), Canada – 2,471 citations (25.5 citations per article), Germany – 1,206 citations (14.5 citations per article), and The Netherlands – 1,357 citations (24.2 citations per article).

The next direction of our research was the number of documents that fell within the scope of our research. There were 2,682 of them, distributed over time as follows (Fig. 5). There was an increase in the number of publications, which was most intense for the 2003-2017 period. Fig. 5 also presented the dynamics of the average number of citations per publication for the same period.

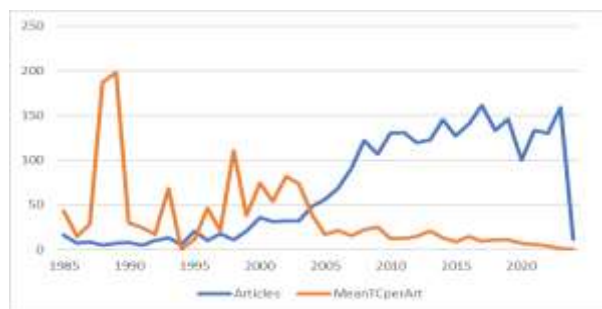


Fig. 5. Number of published documents and average number of citations per document by year, 1985 – 2024
Source: Own calculation on the basis of the data processed with Biblioshiny [39].

Initially, we analyzed the impact of the documents considering the number of citations, including global citations (all indexed in the WoS database) and local citations (within the studied set of documents). Table 6 presented the data for the first ten most cited documents.

Table 6. Number of local and global citations of the ten most cited documents in the research area

DOI/Document	Year	Local Citations	Global Citations
10.2307/41165946	1998	105	891
10.1287/orse.1080.0412	2009	98	991
10.1111/1467-6486.00260	2001	82	352
10.1108/13673271011015615	2010	74	403
WAGNER RK, 1985, J PERS SOC PSYCHOL	1985	69	369
10.1093/jeg/3.1.75	2003	67	1133
10.1177/0170840600213001	2000	53	657
10.1016/S0090-2616(01)00026-2	2001	49	229
10.1037/0022-3514.52.6.1236	1987	48	148
10.1080/09537329608524237	1996	46	284

Source: Own calculation on the basis of data processed with Biblioshiny [39].

Keywords that appear in the identified posts were also of interest. We chose to analyze author keywords, considering that they highly reflected the author's ideas, as well as Key Words Plus, which gave a good idea of the actual content of the documents.

Table 7. Occurrences of Authors' Keywords and Key Words Plus in the studied set of documents

Words	Occurrences in Authors' Keywords	Occurrences in Keywords plus
tacit knowledge	690	73
knowledge management	211	7
knowledge sharing	106	N/A
social networks	97	54
knowledge transfer	81	10
innovation	70	146
explicit knowledge	68	12
tacit knowledge sharing	67	N/A
networks	64	33
knowledge	58	63
informal networks	56	N/A
social network analysis	55	1
social capital	52	N/A
informal learning	37	N/A
trust	30	92
social support	28	24
tacit knowledge transfer	28	N/A
organizational learning	23	N/A
social network	22	5
knowledge creation	20	1

Source: Own calculation on the basis of data processed with Biblioshiny [39].

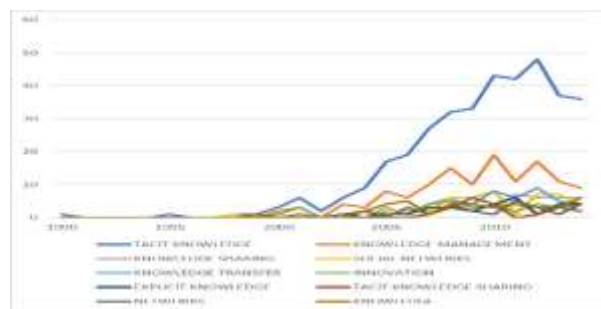


Fig. 6. Dynamics of the use of the ten most common Authors Keywords, 1990 – 2024

Source: Own calculation on the basis of data processed with Biblioshiny [39].

Key Words Plus were “words or phrases that frequently appear in the titles of an article's references, but do not appear in the title of the article itself” [12]. Table. 7 presented the twenty most frequent Authors' Keywords and the number of occurrences of the same words identified as Key Words Plus. Some of the Authors' Keywords do not appear as Key Words Plus at all.

The dynamics of the keywords used over time were also important. Figure 6 shows the dynamics of the use of the ten most common Authors' Keywords.

One can conclude that the use of the two most common keywords – tacit knowledge and knowledge management had increased intensively since 2002.

In-depth Analysis

The review of the publications made it possible to highlight several problem areas: a) the specifics/peculiarities in the application of the tacit knowledge; b) the key factors that have a significant impact on the transfer of tacit knowledge; c) the mechanisms and models for the implementation of the transfer of tacit knowledge.

The Specifics/Peculiarities in the Application of the Tacit Knowledge. Tacit knowledge arose and was enriched and developed more in certain economic and social activities than in others. The differences between these areas of its application were determined, on the one side, by the specifics of the particular area, by the environment in which the economic, social, organizational, and technological processes took place, and by the specific nature of the processes and activities themselves. This included actions and activities that were not typical, repetitive, routine, and therefore difficult to mechanize, automate, and codify. These were activities in situations that required quick decision-making of a specific nature, arising from circumstances that either couldn't be foreseen, were too rare and unusual to have ready-made recipes/instructions for action, or were just emerging and being observed/managed for the first time (e.g. in the field of emergency assistance, security, in the management of accidents, natural disasters, personal and international conflicts, etc.). On the other side, the individual areas of application of the tacit knowledge were related to the tacit knowledge itself, such as knowledge about the performance of specific human activities, knowledge related to the person and expressed in human capital (and in a broader aspect – in the social capital) – experience, routine, skills, competencies, morals, conscience, creativity, ingenuity, scientific activity, and innovations – everything that accumulated in a person during the performance of his occupational and social activities, and that was realized in them both consciously and unconsciously (intuitively).

Tacit knowledge was important in the field of **construction** activities [31]. The construction industry could be defined as highly

knowledge-based [25]. The knowledge used was different – "soft" knowledge related to the human factor, which was mainly tacit knowledge, and "hard" or technical knowledge, which was mostly codified, with complex dependencies and complex interaction processes between the different types of knowledge [37]. Unlike implicit knowledge, tacit knowledge was expressed in individual relationships, experience, work skills, ability to communicate and work in a team, and had a direct relationship to the quality of work performed [2, 28]. Due to the nature of the activities in construction, tacit knowledge had a dominant role compared to technical knowledge [1], as the latter could be more easily reproduced or recovered. In contrast, tacit knowledge was extremely important for construction companies [36] as it was lost entirely or to a significant extent in staff turnover. For this reason, the transfer of tacit knowledge was key to the successful implementation of construction projects [27]. Tacit knowledge was a key factor in the field of **emergency medical care, crisis management, security management**, and the like, where quick and adequate decisions needed to be made for specific situations occurring in real time [11]. Having experience in dealing with similar situations in the past helped to adopt appropriate strategies with less effort and time, which could be key to saving a life. Security Operations Centers were concerned with monitoring, detecting, and responding to threats in company networks, and the interaction and coordination between people, technology, and processes were based on the ability to rank threats, accumulated experience, and competence, i.e. – of implicit tacit knowledge, which was often difficult to identify and, therefore, to share. New experts encountered difficulties in the absence of context, communication was prolonged or became incomprehensible in the initial phase of problem detection, which in turn slowed down the process of limiting the damage. Lack of experience could be only partially replaced by heuristics and "brute force", while experienced analysts could know the answer to threats almost immediately.

In **research and development**, knowledge was transferred over long distances through communication channels, some of which were suitable for sharing explicit knowledge, while others, such as human flows and relationships, were mainly related to the transfer of tacit knowledge [22]. Scientific work had a strong connection to tacit knowledge [6], with sharing tied to personal contacts and researcher mobility. The co-authorship of scientific articles was the result of personal contacts, work on joint scientific projects, and participation in mobilities, conferences, and seminars. Face-to-face meetings helped build relationships based on trust [7] and increased the potential for future joint publications.

The transfer of tacit knowledge was one of the main means of **sustainable organizational innovation** [35] because it stimulated the rapid growth of knowledge [13]. The sharing of tacit knowledge among members of a network through formal and informal communication channels led to its assimilation and application by other network participants, promoted knowledge innovation, and from the perspective of the entire network, increased the aggregate utility of existing tacit knowledge [33] and supported the generation of new, implicit and explicit knowledge [21].

Tacit knowledge was of critical importance in **open innovation** [32], as it was related to the complex process of creating new ideas [3]. Tacit knowledge transfer also faced additional difficulties, as, on the one hand, participants might not be aware of their knowledge or unable to express it [24], and on the other, they might be reluctant to provide it because they could lose competitive advantages [18]. Open innovation projects were not localized in an organization or in any central location, which made the exchange of explicit knowledge difficult and made tacit knowledge and its sharing even more essential [9], especially in the context of social relations that connect people with interdisciplinary competence from different places, across geographical and organizational boundaries.

Tacit knowledge was essential in the **development and implementation of software projects** [8]. It was related to the

communication and understanding of the client's functional requirements in the design of the software modules. What the customer required, what the engineers who designed the software understood, and what was obtained as a final product in terms of functionality and interface, determined to a large extent the successful application of the software. The presence of tacit knowledge in the designers supported the correct specification of requirements, and structured communication, thus providing clear evidence of software development progress [20]. The ability of end-users to present requirements unambiguously and of engineers to interpret them correctly depended on personal contact, regular interaction, and trust [19], as such knowledge could only be shared in a specific context, for example when people were involved in the same social systems [26].

In **university education**, tacit knowledge plays an important role in the student's successful acquisition of knowledge and skill development [15]. In the learning process, groups were formed based on personal qualities but also on the ability to solve the assigned tasks, and some students could play the role of sources of tacit knowledge, and others – of users. The tacit knowledge in this case was transmitted through the joint work of the students, through their practical activities, and not in a formal way. The awareness of having tacit knowledge, that was intuitively shared, was important for team building, working together, building relationships of trust and security, and complementing formal learning with informal connections, including through social networks.

The Key Factors That Have a Significant Impact on the Transfer of Tacit Knowledge. Many factors influenced the process of tacit knowledge transfer. Tahir et al. [31] conducted a detailed literature review and identified as many as 78 factors, some of them with overlapping scopes. According to Tahir et al. [31, p. 607], the factors can be reduced to 57, and after surveying 30 specialists in the field of architecture and construction, they found 19 important factors for the construction industry in developing countries. Those included: “*trust, personal contact and*

interaction, team composition, mutual reciprocity, peer relations, system of rewards, power and sense of ownership of knowledge, individual's agreeableness, individual knowledge/skills, teamwork and shared goals, expertise development, leadership commitment, strategic thinking, individual management of time, proactive management approach, communication, leadership structure, interpersonal skills, and self-efficacy" [31, p. 612].

An important factor in the successful transfer of tacit knowledge between experts was **trust** [29], and in the specific case of security management centers [11, p. 42039], trust grew in previous work "face to face". Thus, factors such as an adequate working environment, accounting for the cultural aspects of the participants, and physical proximity of workplaces, incl. visual connection between experts, helped to overcome language barriers, enabled active and passive communication, increased the speed and productivity of work and the effectiveness of the transfer of tacit knowledge.

Jeck & Baláž [22] drew attention to the importance of the type of connectivity between actors, as flows of goods and patents transferred explicit knowledge, while mobilities of people – students, teachers, even travelers or migrants – contribute to a high degree to the transfer of tacit knowledge, which was based on informal social interactions [22, pp. 98, 107]. At the same time, despite the progress in the development of modern information and communication technologies, geography continued to play an important role in the transfer of tacit knowledge in two aspects: physical distance and cultural and linguistic boundaries. Tacit knowledge is shared more easily with already established and historically established commercial, cultural and linguistic ties between individual communities, with cooperation and shared historical heritage [22, p. 107].

Relationships between actors also mattered, particularly as measured by the symbiosis-competition scale [35]. The presence of a symbiotic interaction significantly supported the sharing of tacit knowledge, and this was

further enhanced in symmetrical symbiotic relationships. Creating an appropriate working atmosphere, and increasing trust and cooperation between participants was more easily achieved in collaborative and mutually beneficial work, supported by an adequate organizational reward mechanism that stimulated knowledge sharing. At the same time, when knowledge was perceived as personal property (*'Knowledge-based psychological personal ownership'*), serious obstacles were created to its successful sharing between participants and interaction to achieve effective and sustainable transfer was difficult [35, p. 17].

The formalization of the transfer process gave an additional impetus to the sharing of tacit knowledge [8], and this was particularly evident in software development since the knowledge of customers often does not allow them to cope with the means of expression of programmers. Finding similar social constructions made it possible to identify certain dialogic reference points, interpret tacit knowledge and model the functional requirements of the commissioned software product [8, pp. 16-17].

The situation was special when the existence of tacit knowledge was not clear or was not realized by its holders. Its transfer then took place through collaborative practical work, intuitively [15]. The factors that determined its successful transfer were related to the size of work groups – small ones (2-4 people) were best suited, as they could be constantly reorganized for different tasks to increase the possibility of sharing between more people. The separation of groups – sources of knowledge, consumers of knowledge and intermediaries, accelerated the sharing of knowledge, but at the same time reduced the transfer of tacit knowledge [15, pp. 861-862].

Terhorst et al. [32] had a different view for the role of mediators. They were needed, at least in the initial stage of work, to build connections and help participants make sense of tacit knowledge. At a later stage, this necessity faded, increasing the importance of the autonomous motivation of participants to share and absorb tacit knowledge from others. In parallel, cultivating a work culture that

fostered autonomy, competence, and connectedness led to building a positive attitude toward sharing tacit knowledge [32, p. 15].

According to Supanitchaisiri et al. [30], the factors that were central to the extraction of tacit knowledge were primarily organizational and were related to corporate policy, staff motivation, continuity in knowledge management, support for continuous and ongoing learning, supportive culture and organizational behavior. Other factors had to do with the individual qualities of the participants: preparation, knowledge and interpretation of tacit knowledge [30, p. 98].

The mechanisms and models for the implementation of the transfer of tacit knowledge. Tahir et al., [31] developed an SD ('System Dynamics') model in which they included 140 interrelationships between factors influencing the transfer of tacit knowledge in construction. They established a total of 6 loops, four of which were strengthening and two were balancing. The development of communication strengthened personal contacts and interaction between participants, thus consolidating teamwork and trust, and growing expertise and individual skills (effective self-learning). In parallel, the increase in trust reduced the sense of ownership of knowledge between individual participants and further contributed to effective sharing, enhancing communication. Model simulations showed a steady increase in tacit knowledge transfer over time.

In the field of security management centers, Cho et al. [11], used Nonaka's [26] 'SECI' model, in which there was a continuous transfer of tacit knowledge and its transformation into implicit, codified knowledge. According to them, in the separate phases, there were peculiarities caused by the specifics of the work in the crisis management centers. In the socialization phase, contacts were made and trust was built between the participants. The second phase covered the acquisition of tacit knowledge through the observation of the experts' work ('job shadowing'), application of the knowledge in simulations and a real work environment, discussion and commenting on the actions and

filling in the noticed knowledge gaps. In the third phase of combining, the new knowledge was transformed into a document to serve other participants. In the final phase, junior analysts were ready for direct client action with the updated documentation [11, pp. 42034-42036].

Jeck & Baláz [22] pointed out that the transfer of tacit knowledge in scientific research was realized through the so-called '*connectivities*', which were defined as specialized channels for communication and exchange of people, goods, and knowledge between countries [23]. In the scientific research sphere, however, the transfer of tacit knowledge manifested in the formation of two groups: core and periphery. The main part of the communication and sharing took place within the core, and concerning the periphery, there was minor intra-peripheral sharing. Over time, the sharing between the core and periphery increased [22, pp. 100, 106].

Xu et al. [35] considered the tacit knowledge transfer system in the organization as a dynamic ecosystem composed of four elements: knowledge provider, knowledge receiver, intermediary, and the organization as a whole. The sharing of heterogeneous tacit knowledge, which supported the organization's activity in a competitive environment, occurred in different forms of organization, with symbiotic ones providing significant advantages. Symmetrical relationships led to identical increases in the knowledge of participants who depended on each other to achieve their goals. Relationships were stable and led to both increased knowledge throughout the organization and sustainable organizational innovation [35, p. 18].

Dima & Vasilache [15] analyzed the mechanism of transfer of tacit knowledge in higher education, where the holders of tacit knowledge were often not aware of it. Its transfer was realized intuitively, as during their joint work the students constantly compared themselves and formed network relationships. Holders of tacit knowledge acted as experts or leaders who developed relationships with many more participants than users of tacit knowledge. When

performing specific tasks, small groups or chains of trust were formed, in which the tacit knowledge of experts was transmitted in the process of practical work, sometimes without being fully aware of it [15, pp. 861-862].

In the field of open innovation, the sharing of tacit knowledge took place within a network composed of multiple organizations with different locations [32]. Sharing in this case differed from exchange between individuals, as it acquired a social context and was realized in the process of practical activity. Best suited for effective sharing were small groups, the presence of many and varied relationships, and last but not least – the presence of mediators. With participants of a similar level of education and experience, tacit knowledge was more easily shared. Formal communication channels played a role, and being in spatial proximity also supported transfer, especially when there was visual contact [32, pp. 12, 14].

The peculiar nature of tacit knowledge determined to a high degree the specific areas in which it has a significant or even a dominant, structure-determining role in the development of companies and the implementation of innovations. This is related to the role of the human factor in the accumulation of experience, knowledge, skills and competencies (tacit knowledge), its importance in the specific field and the importance of sharing it through personal contacts and face-to-face communication. At the same time, areas are identified in which tacit knowledge is not of essential importance and can be successfully combined or even completely replaced by codified (implicit) knowledge. These areas are not permanently defined but can change continuously, parallel to the continuous and natural process of transforming tacit into implicit knowledge (knowledge codification).

Summary of the factors made it possible to conclude that the authors outline three important groups of factors: external, organizational and personal, with external factors covering elements of the environment that are largely given and cannot be changed by the organization or individuals – geographical distance, historical, political and

cultural heritage. Organizational factors describe the conditions that the organization creates or can influence, thereby facilitating or hindering the transfer of tacit knowledge – for example, a suitable work environment and physical proximity between participants, building symmetrical and mutually beneficial relationships, formalizing the knowledge-sharing process, creating a sustainable informal structure, etc. Personal factors are related to the individual qualities of the participants in the tacit knowledge transfer process and could be combined with the organizational factors or come into conflict with them, supporting or hindering the sharing of tacit knowledge – consciously or intuitively. This includes behavioral factors, motivation, communicativeness, competence, willingness to share knowledge, independence, team culture, etc.

Tacit knowledge transfer mechanisms always involve the creation of connectivity, communication channels and the building of trust. The lack of trust or an informal social structure necessitates the presence of intermediaries (brokers), at least until trust is strengthened. Physical proximity between participants is important because the sharing of tacit knowledge is often done through observation of work or through joint practical activity, where experience, knowledge and skills can be transferred even unconsciously, or intuitively.

CONCLUSIONS

The researchers' interest in the problems of the transfer of hidden (tacit) knowledge through informal innovation networks is growing. Many authors establish the importance of tacit knowledge and the difficulties in its transfer. Systematic analysis of literature sources on a specific chosen topic can be greatly facilitated with modern software products, such as those developed in the R environment. Through a systematic analysis of literary sources and their citations, the presence of clustering of researchers and research organizations, as well as the presence of informal research networks, can be established.

The sharing and, in a general sense, the management of tacit knowledge was important for specific areas of human activity associated with a high intensity of used knowledge (construction, crisis management, training, scientific research). As the complexity of knowledge, its diversity, and interdisciplinary content increased so did the importance of tacit knowledge and its transfer. The processes of sharing tacit knowledge were realized under the influence of numerous organizational, psychological, and socio-cultural factors, the main ones being related to trust, adequate communication (including face-to-face), motivation and culture for sharing knowledge (overcoming the stereotype of knowledge ownership as a source of competitive advantages).

Building adequate mechanisms for the transfer of tacit knowledge involved creating specialized communication channels based on symmetrical relationships, chains of trust and job shadowing thereby strengthening the participants' teamwork, trust, expertise and individual skills. There are rich opportunities for further research in the chosen research topic. An example of such directions is establishing the capabilities of modern social network analysis methods in quantitative analysis of established networks of researchers and research organizations to determine and exploit their network characteristics, such as centrality, transitivity, and modularity.

It is of significant interest to carry out a comparative analysis of the efficiency, speed and volume of the transfer of tacit knowledge in different branches of the economy, as well as to track regional differences, especially between territories with different levels of economic development. The use of different methods and models for sharing tacit knowledge and its gradual transformation into a codified one focused on the effectiveness of the various mechanisms, the possibilities for their combination and adaptation to the specifics of innovation networks, especially in the context of the internationalization of knowledge.

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REFERENCES

- [1] Abu Bakar, A.H., Yusof, M.N., Tufail, M.A., Virgiyanti, W., 2016, Effect of knowledge management on growth performance in construction industry," *Management Decision*, Vol. 54(3), 735–749.
- [2] Addis, M., 2016, Tacit and explicit knowledge in construction management, *Construction Management and Economics*, Vol. 34(7-8), 439–445.
- [3] Amar, A.D., Juneja, J.A., 2008, A descriptive model of innovation and creativity in organizations: A synthesis of research and practice, *Knowledge Management Research & Practice*, Vol. 6(4), 298–311.
- [4] Aria, M., Cuccurullo, C., 2017, Bibliometrix: An R-tool for comprehensive science mapping analysis, *Journal of Informetrics*, Vol. 11(4), 959–975.
- [5] Ball, R., 2018, *An Introduction to Bibliometrics*. New Development and Trends, CP Elsevier.
- [6] Bathelt, H., Glückler, J., 2011, *The Relational Economy: Geographies of Knowing and Learning*, Oxford: Oxford University Press.
- [7] Bathelt, H., Henn, S., 2014, The geographies of knowledge transfers over distance: toward a typology, *Environment and Planning A*, Vol. 46(6), 1403–1424.
- [8] Benfell, A., 2021, Modeling functional requirements using tacit knowledge: a design science research methodology informed approach, *Requirements Engineering*, Vol. 26, 25–42.
- [9] Bonesso, S.C.A., Pizzi, C., 2014, Open innovation at project level: Key issues and future research agenda, in *Project-based knowledge in organizing open innovation*, London, Springer, p. 85–95.
- [10] Büyükkidik, S., 2022, A Bibliometric Analysis: A Tutorial for the Bibliometrix Package in R Using IRT Literature, *Journal of Measurement and Evaluation in Education and Psychology*, Vol. 13(3), 164–193.
- [11] Cho, S., Happa, J., Creese, S., 2020, Capturing Tacit Knowledge in Security Operation Centres, *IEEE Access*, Vol. 8, 42021–42041.
- [12] Clarivate, "Support," 9 June 2022. https://support.clarivate.com/ScientificandAcademicResearch/s/article/KeyWords-Plus-generation-creation-and-changes?language=en_US. Accessed on 9 June, 2022.
- [13] Cowan, R., Jonard, J., Zimmermann, J.-B., 2007, Bilateral Collaboration and the Emergence of Innovation Networks" *Management Science*, Vol. 53(7), 1051–1067.
- [14] Dekkers, R., Carey, L., Langhorne, P., 2022, *Making Literature Reviews Work: A Multidisciplinary Guide to Systematic Approaches*, Springer.
- [15] Dima, A., Vasilache, S., 2013, *Social Network Analysis for Tacit Knowledge Management in*

Universities, *Journal of the Knowledge Economy*, Vol. 6, 856 - 864.

[16]Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., Lim, V.M., 2021, How to conduct a bibliometric analysis: An overview and guidelines, *Journal of Business Research*, Vol. 133, pp. 285-296.

[17]Elsevier, 2024, What is a Good H-index?, 19 September 2024. <https://scientific-publishing.webshop.elsevier.com/publication-recognition/what-good-h-index/>. Accessed on 19 September 2024.

[18]Eraut, M., 2000, Non-formal learning and tacit knowledge in professional work, *British Journal of Educational Psychology*, Vol. 70(1), 113–136.

[19]Goffin, K., Koners, U., 2011, Tacit Knowledge, Lessons Learnt, and New Product Development, *Journal of Product Innovation Management*, Vol. 28(2), 300-318.

[20]Hofmann, F.H., Lehner, F., 2001, Requirements engineering as a success factor in software projects, *IEEE Software*, Vol. 18(4), 58–66.

[21]Isik, C., Aydin, E., Dogru, T., Rehman, A., Alvarado, R., Ahmad, M., Irfan, M., 2021, The Nexus between team culture, innovative work behaviour and tacit knowledge sharing: Theory and evidence, *Sustainability*, Vol. 13, p. 4333.

[22]Jeck, T., Baláz, V., 2020, Geographies of tacit knowledge transfer: Evidence from the European co-authorship network, *Moravian Geographical Reports*, Vol. 28(2), 98-111.

[23]Jennissen, R., 2007, Causality Chains in the International Migration Systems Approach, *Population Research and Policy Review*, Vol. 26(4), 411–436.

[24]Leonard, D., Barton, M. K., 2015, Knowledge and the management of creativity and innovation, in *The Oxford handbook of innovation management*, Oxford, Oxford University Press, p. 121–138.

[25]Li, Y., Song, Y., Wang, J., Li, C., 2019, Intellectual capital, knowledge sharing, and innovation performance: Evidence from the Chinese construction industry, *Sustainability*, Vol. 11(9), p. 2713.

[26]Nonaka, I., 1994, A Dynamic Theory of Organizational Knowledge Creation, *Organization Science*, Vol. 5(1), 14–37.

[27]Pathirage, C.P., Amaratunga, D.G., Haigh, R.P., 2007, Tacit knowledge and organizational performance: construction industry perspective," *Journal of Knowledge Management*, Vol. 11(1), 115–126.

[28]Soewin, E., Chinda, T., 2018, Factors affecting construction performance: Exploratory factor analysis, *IOP Conference Series: Earth and Environmental Science*, Vol. 140(1), p. 012102.

[29]Sundaramurthy, S.C., McHugh, J., Ou, X.S., Rajagopalan, S.R., Wesch, M., 2014, An anthropological approach to studying CSIR.Ts, *IEEE Security & Privacy*, Vol. 12, 52–60.

[30]Supanitchaisiri, M., Natakutoong, O., Sinthupinyo, S., 2020, The innovative model for extracting tacit knowledge in organisations,

International Journal of Knowledge Management Studies, Vol. 11(1), 81-101.

[31]Tahir, M.B., Khan, K.I.A., Nasir, A.R., 2021, Tacit knowledge sharing in construction: a system dynamics approach, *Asian Journal of Civil Engineering*, Vol. 22, p. 605–625, 2021.

[32]Terhorst, A., Lusher, D., Bolton, D., Elsum, I., Wang, P., 2018, Tacit Knowledge Sharing in Open Innovation Projects, *Project Management Journal*, Vol. 49(4), 5-19.

[33]Tran, Y., Mahnke, V., Ambos, B., 2010, The Effect of Quantity, Quality and Timing of Headquarters-initiated Knowledge Flows on Subsidiary Performance, *Management International Review*, Vol. 50(4), 493–511.

[34]University of Pittsburgh, Course & Subject Guides, <https://pitt.libguides.com/bibliometricIndicators/AuthorMetrics>. Accessed on 19 September 2024.

[35]Xu, J., Wu, H., Zhang, J., 2022, Innovation Research on Symbiotic Relationship of Organization's Tacit Knowledge Transfer Network, *Sustainability*, vol. 14, p. 3094.

[36]Yu, D., Yang, J., 2018, Knowledge management research in the construction industry: A review, *Journal of the Knowledge Economy*, Vol. 9(3), 782–803.

[37]Yu-Jing, W., 2012, Application of System Dynamics in Construction Project Planning and Control, in *IEEE 2012 2nd International Conference on Business Computing and Global Informatization (BCGIN)*, 51-54.

[38]Zimble, J.A., 2024, Learning Resource Center, Uniformed Services University, 12 June 2024. <https://usuhs.libguides.com/c.php?g=184957&p=2506307>. Accessed on 12 June 2024.

[39]***Biblioshiny application website, <https://www.bibliometrix.org/home/index.php/layout/biblioshiny>, Accessed on 19 September 2024.

[40]***Web of Science, Clarivate, <https://clarivate.com/academia-government/scientific-and-academic-research/research-discovery-and-referencing/web-of-science/>, Accessed on 19 September 2024