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Research Article

An empirical study of interdisciplinary crime research

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Abstract

This research was designed to test the effectiveness of interdisciplinary scientific research in the field of crime. A survey was conducted using an online questionnaire to assess the hypotheses and evaluate the adequacy of statistical and text analysis tools. The sample consisted of scientists from various disciplines. The results of the data analysis showed that there is a lack of effective interdisciplinary cooperation and knowledge synthesis among the different types of sciences. Interdisciplinarity in science involves the synthesis and application of knowledge from different scientific fields. In the field of crime research, there is a lack of organized interdisciplinary approaches due to the relative isolation of various scientific disciplines and their focus on traditional research subjects. This means that crime is often not a priority for these disciplines. The discussion chapter examined the factors contributing to the less effective interdisciplinary research in the field of crime, as well as explored the potential for achieving a more effective synthesis of knowledge in criminology.

Keywords: crime; interdisciplinarity; data analysis knowledge synthesis; opinion research.

1. Introduction

The research involved 200 scientists from various disciplines in Slovenia, including the humanities, social sciences, intermediate sciences, natural sciences, applied sciences, and marginal sciences. Invitations to participate in an online questionnaire on crime and cosmic impacts were sent to various faculties and research institutes in Slovenia, resulting in a total of 634 respondents (12.37% of the total). Of these, 200 (31.55%) completed the questionnaire. Data collection took place from June 21st to July 21st, 2020.

This paper presents data on research and cooperation in the field of crime among scientists in Slovenia and their descriptive opinions on crime in a broader sense.

Scientists were classified into the following categories: humanities (including philosophy, theology, linguistics, librarianship, and pedagogy), social sciences (such as sociology, law, economics, public administration, political science, demography, statistics, and history), natural sciences (including mathematics, astronomy, physics, chemistry, geology, biology, and physical anthropology), applied sciences (such as computer science and informatics, construction, mechanical engineering, electrical engineering, and medicine), intermediate sciences (such as management, organizational science, psychology, cybernetics, kinesthesiology, geography, and ecology), and marginal sciences.

The largest number of respondents came from the field of applied sciences (28%), followed by natural sciences (22.5%), social sciences (18.5%), humanities (17%), intermediate sciences (12.5%), and marginal sciences (1.5%).

1.1 **Work objective**

The main objectives of the research were to identify interdisciplinary cooperation on crime among various scientific disciplines in Slovenia and to gather opinions to determine the attitudes of scientists towards interdisciplinary research in the field of crime. The disciplines included the humanities, social sciences, intermediate sciences, natural sciences, applied sciences, and marginal sciences.

1.2 **Research presumptions**

(1) There is very little interdisciplinary cooperation among the humanities, social sciences, intermediate sciences, natural sciences, applied sciences, and marginal sciences in the field of crime research in Slovenia.

(2) The attitudes of scientists from different disciplines towards the concept of crime are relatively narrow, making it a less favorable starting point for interdisciplinary research in the field.

1.3 **Research questions**

(1) Which scientific disciplines have contributed the most research on crime in Slovenia?

(2) What is the strength and intensity of interdisciplinary cooperation among various scientific disciplines in Slovenia regarding crime?

(3) What are the attitudes of scientists from different disciplines towards the concept of crime?

(4) Is the perspective of scientists in the field of crime research sufficiently wide and favorable for interdisciplinary research?

1.4 **Methodology**

The research sample consisted of scientists from various disciplines in Slovenia, mainly from various faculties, research institutes, libraries, and ministries. The sample also included the opinions of scientists from marginal sciences (the sample size was 200 usable respondents). An online survey questionnaire was used to test the hypotheses.

1.5 **Methodological tools**

Various software tools for data analysis were used. These include:

(1) AntConc for importing opinions and word analysis (Anthony, 2019).

(2) JigSaw for importing .TXT files and visual analysis of notable opinions from scientists of various disciplines (Stasko, Görg, & Liu 2008).
(3) Orange Canvas for importing, analyzing, and visualizing composite data (Demsar, et al. 2013).
(4) Ora Casos for importing composite data and conducting conceptual network analysis (Carley, et al. 2011).
2 Statistical data analysis and interpretation
This paper will present analyses of interdisciplinary research on crime by scientists from various disciplines and their attitudes towards the concept of crime. The results of the analyses will be interpreted and discussed.

Table 1: Scientists who have already researched or participated in any crime research

Scientists	Frequency	Percentage
Yes	22	11
NO	178	89
Total	200	100

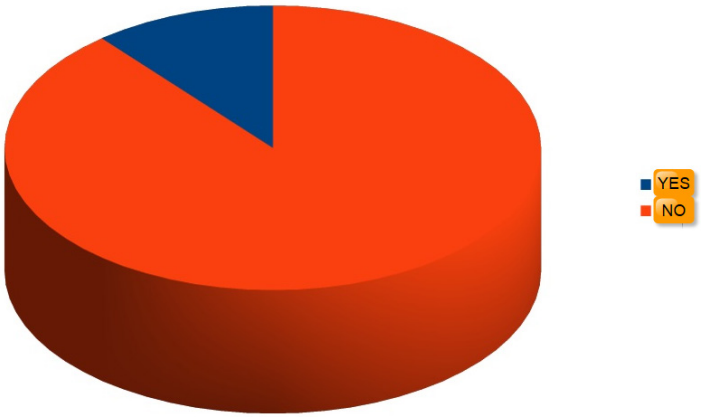

Figure 1: Scientists who have already researched or participated in any crime research
Table 1 and Figure 1 show the frequencies and percentages of scientists who have conducted or participated in any crime research. Of the 200 scientists, only 22 (11%) reported that they have researched or participated in crime research, while 178 (89%) have never been active in this field. Based on the responses from scientists of various disciplines, it can be concluded that there is a lack of interdisciplinary cooperation among the sciences in the field of crime research. This conclusion can be further supported by composite data.

Table 2: Representatives of sciences in connection with crime research

Sciences representatives	Frequency	Percentage
Humanities	1	0.5
Social sciences	13	6.5
Intermediate sciences	2	1
Natural sciences	1	0.5
Applied sciences	5	2.5
Marginal sciences	0	0
Sample size	200	11

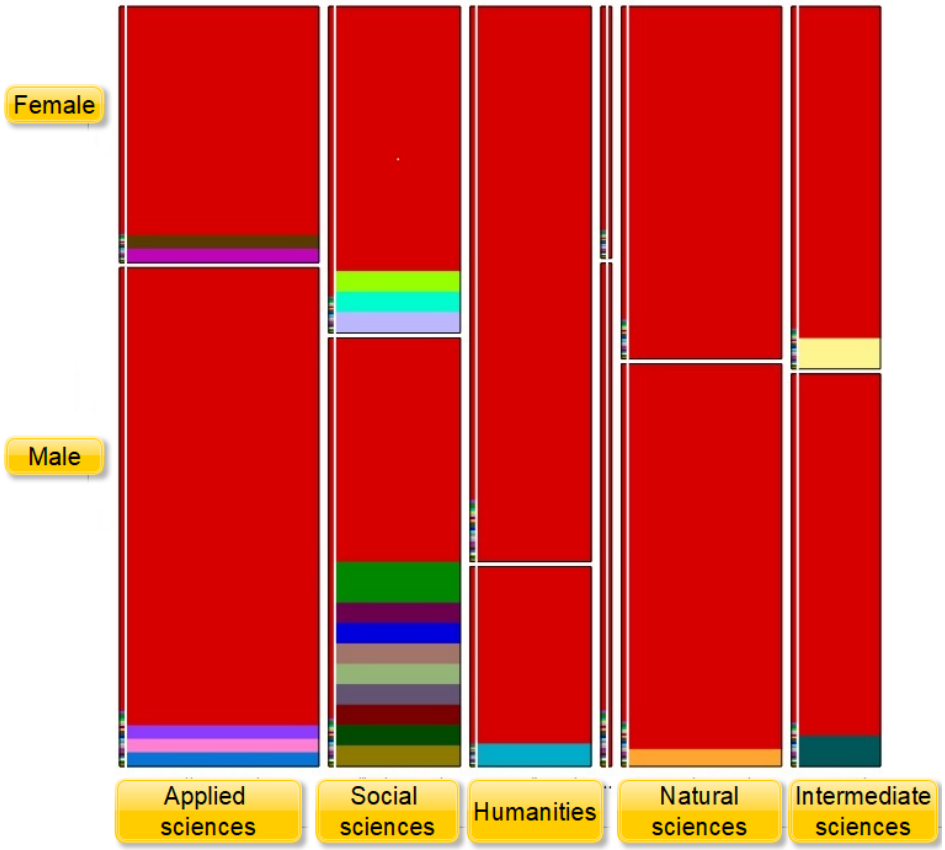

Figure 2: A mosaic diagram of crime research by science and gender

Table 2 presents statistical data on crime research by scientific discipline, while Figure 2 shows a mosaic diagram of crime research by scientific discipline and gender. Based on the responses of 200 respondents, it can be concluded that outside of criminology, criminal law, and police science (13 respondents, 6.5%), there were few research

activities on crime by other disciplines (9 respondents, 4.5%). This suggests a lack of knowledge synthesis or a more organized interdisciplinary approach to crime research in Slovenia. It should be noted that a larger sample size would provide a more comprehensive picture, so the results should be interpreted with caution. These results address the first and second research questions and support the hypothesis that there is very little interdisciplinary cooperation among the humanities, social sciences, intermediate sciences, natural sciences, applied sciences, and marginal sciences in the field of crime research in Slovenia. The following analysis will focus on the attitudes of scientists towards the concept of crime.

3. Verbal analysis of opinions

Before analyzing the opinions, the data preparation, processing, and cleaning process was carried out. Responses without opinions were excluded (47 responses). The remaining 153 opinions were copied and saved in a .txt file. A list of unnecessary words and different forms of words (e.g., education -> upbringing, educating, breeding) and semantic fields of words (e.g., words related to content were grouped into appropriate conceptual categories, e.g., education -> school, teaching, learning) were compiled. After preparing the data, it was processed using the AntConc software tool. The .txt file with the 153 opinions was imported, and the list of unnecessary words and different forms and semantic fields of words was imported using the word list option. When the "Start" command was activated, AntConc calculated the frequency of words within the 153 opinions. The results were then cleaned and organized by combining different forms and semantic fields of words and eliminating unnecessary words. The "Start" command was activated again after the data had been cleaned and organized. A small portion of the results of the verbal analysis of the 153 opinions is shown in the following figure.

Table 3: Word analysis showing the frequency of occurrence of a certain word or word category

Rank	Frequency	Word	Word form / Word category
1	140	sociality	society, societies, social …
2	139	crime	criminal, collar, illegally …
3	95	influence	influences, influential, affect …
4	50	people	peoples, human, humans …
5	48	factor	factors, driver, agent …
6	45	parenting	upbringing, foster, childcare …

Table 3 presents a snapshot of the AntConc software tool showing the ranks and frequencies of a particular word or word category within 153 opinions. The most used word category is 'sociality' and related words (rank 1, frequency 140), followed

by 'crime' and related words (rank 2, frequency 139), which was the central topic of the final question in the questionnaire. After preparing the data for analysis, the author used their own universal classification system for verbal and non-verbal symbols/words, slightly modified, to classify the words. More details on the results are provided below.

Table 4: Universal classification of verbal and non-verbal symbols / words

Classification	Short description	Examples
UKBS 1	attentive physical property	heat, cold, odors, noise, energy, etc.
UKBS 2	performance property	action, education, effort, work, etc.
UKBS 3	individual psychological property	anxiety, personality, emotions, etc.
UKBS 4	social property	sociability, crime, family, etc.
UKBS 5	non-living natural property	celestial bodies, stone, earth, etc.
UKBS 6	living natural property	living beings, legs, eyes, body organs, etc.
UKBS 7	health biological property	health, disease, genes, infections, wounds, etc.
UKBS 8	products of people (material, intellect)	machines, applications, laws, books, etc.
UKBS 9	institutions and their parts	ministries, municipalities, departments, traffic, etc.
UKBS 10	periods	time, spring, history, etc.
UKBS 11	open or universal group	influences, phenomena, causes, mesocosm, etc.

Table 4 presents a small selection of examples for the classification system. After classifying the words or word categories, the connections strengths (rated on a scale from 1 to 10, with 1 representing the weakest link and 10 the strongest) between the central topic of crime and words were determined based on the frequency of occurrence. This resulted in a table of data, a small excerpt of which is shown in the following figure.

Table 5: Part of composite data for word analysis

CT	LS	F	W	UCW
crime	10	140	sociality	4
crime	10	139	crime	4
crime	9	95	influence	11

crime	8	48	factor	11
crime	7	37	individuality	3
crime	8	50	people	6

Table 5 shows a portion of the composite data for word analysis, where the central topic (PR: crime) is listed in the leftmost column. The second column (MP - link strength) includes assessments of the connection strength between crime and words or word categories based on the responses of 153 respondents. The third column shows the frequency of occurrence of a particular word or word category. The fourth column lists the words (UKB), and the fifth column includes the classification of words or word categories (UKBS 1 to 11). The data in the form of a .txt file was then imported into the Ora Casos software tool for the analysis of social and conceptual networks using the command "Create a meta network from table data". The column headers were then labeled according to the type of data. The central theme was defined as a resource, the link strength as an assessment (belief), the frequency of occurrence of a particular word as an assessment (belief), the words were defined as knowledge, and the classification of words was defined as organization. Links were then created between the different categories (PR, UKB, and UKBS) and attributes (MP, F) from the table. After creating the links, the command to visualize the conceptual network was activated. In the case of the conceptual network, the color and link strength, as well as the color and size of the nodes, were also determined. The size and colors of the nodes were based on the occurrence frequency attribute of a particular word, while the color and link strength were determined using the link strength attribute (MP). The result is shown in the following figure.

Figure 3: Conceptual network of crime and classified words with a filter

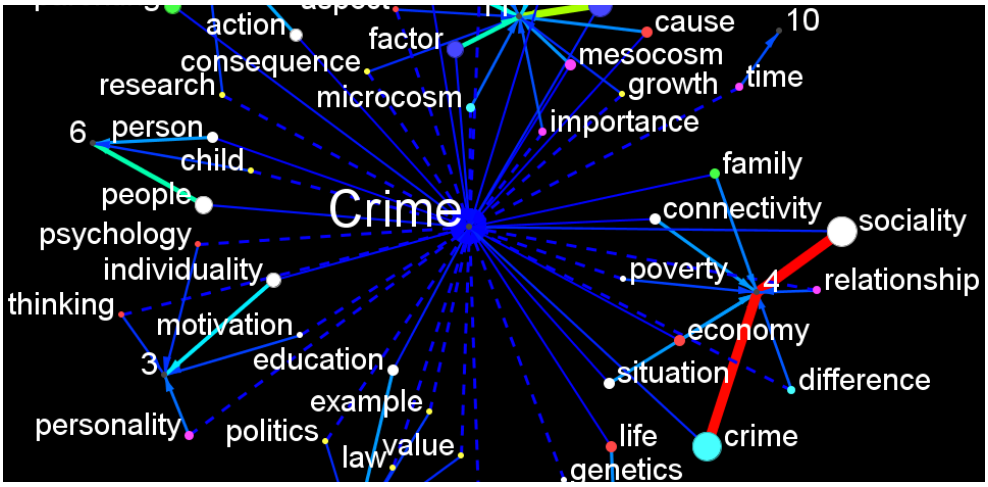

Figure 3 shows a conceptual network of crime and classified words with a filter that includes all words with a node size of less than 5.0. The filter also includes a range of

node sizes from less than 6.1 to less than 5.1, which are shown within the conceptual network by dashed links from the central crime theme to smaller nodes (e.g., the central crime theme and dashed links to the words motivation, personality, genetics, differences, relationships, research, etc.).

These words have a weaker connection to the central theme of crime according to the content link strength. The respondents focused less on these words or the concepts they represent in their responses. The final question was open-ended and allowed respondents to express their own opinions on the causes, influences, links, consequences, effects, preventive measures, or future visions related to the central theme of crime. They could also provide complex answers that addressed the causes, effects, and preventive measures of crime. Few respondents chose the composite answer option. Additionally, some respondents (27 out of 153, or 17.65%) adopted the 3M cosmic levels model when describing crime in their responses. They were more likely to write about the impacts of crime and focused less on the causes and preventive measures. Word categories within classification groups such as UKBS 1 and UBKS 5 were not shortlisted for analysis due to the set filter.

1.1 Analysis of the density and diversity of opinions by representatives of different sciences

The analysis of the density and diversity of opinions by representatives of different sciences will allow us to identify the most productive and diverse representatives of a particular science. The counting of words within the responses of individual representatives of the sciences, as well as the frequency of various words, will be performed using the Antconc software tool. To do this, five .txt files were prepared containing the responses of representatives of the humanities, social sciences, intermediate, natural sciences, and applied sciences. Due to the insufficient number of responses from representatives of marginal sciences, this group will be excluded from further analysis. The results of these analyses are shown in the following table.

Table 6: Statistical data on density and diversity of opinions

Representatives of the sciences	Fb	Fm	B/m	Rb	Rb/Fm
Humanities	1004	34	29.52	390	11.47
Social sciences	870	37	23.51	360	9.7
Intermediate sciences	816	25	32.64	351	14.04
Natural sciences	1267	45	28.16	492	10.9
Applied sciences	1276	56	22.79	525	9.4
Averages	1046.6	39.4	27.3	423.6	11.1

Table 6 shows statistical data on the density and diversity of opinions. The largest

number of words (see average 1046.6) according to the submitted opinions was contributed by representatives of applied sciences (see value 1276), followed by natural sciences (see value 1267), then humanities (see value 1004), social sciences (see value 870) and the last place was taken by representatives of intermediate sciences (see value 816).

The maximum number of words did not yet mean the highest density of opinions, which was why the values of the number of words (Fb) were divided by the number of opinions by representatives of different sciences (Fm). Based on this, we obtained values for word density per number of opinions (B/m). The highest word density was calculated for representatives of intermediate sciences (see value 32.64 words / opinion), followed by representatives of humanities (see value 29.52 words / opinion), followed by representatives of natural sciences (see value 28.16 words) / opinion), representatives of social sciences (see value 23.51 words / opinion) and last place went to representatives of applied sciences (see value 22.79 words / opinion).

As a result of considering the number of words and opinions by individual sciences, we obtained a different classification. The values for the use of various words within opinions (Rb/Fm) were calculated. A simple calculation procedure was used to divide the values of the number of diverse words (Rb) by the number of opinions (Fm) for representatives of individual sciences.

Based on the calculated values, it was determined that representatives of intermediate sciences had the most diverse opinions, with an average of 14.04 diverse words per opinion. Representatives of humanities had an average of 11.47 diverse words per opinion, followed by representatives of natural sciences with an average of 10.9 diverse words per opinion. Representatives of social sciences had an average of 9.7 diverse words per opinion, and representatives of applied sciences had the least diverse opinions, with an average of 9.4 diverse words per opinion. The number of different words does not provide much information about the significance of these words or categories of words. In the next part of this analysis, words or categories of words that appeared fewer than three times were excluded. After excluding these words or categories, the following values for each individual science were obtained:

(1) Representatives of humanities: 35 words or categories of words
(2) Representatives of social sciences: 40 words or categories of words
(3) Representatives of intermediate sciences: 31 words or categories of words
(4) Representatives of natural sciences: 53 words or categories of words
(5) Representatives of applied sciences: 56 words or categories of words

Next, we need to calculate the ratios of frequent words or categories of words to the number of opinions for each individual science. Based on these calculated ratios, we can determine which sciences had the highest value of important words or categories of words. The results show that representatives of intermediate sciences had a ratio of 1.24 important words or categories of words per opinion, followed by representatives of natural sciences with a ratio of 1.18. Representatives of social sciences had a ratio of 1.08 per opinion, representatives of humanities had a ratio of 1.03 per opinion, and representatives of applied sciences had the lowest ratio, with

a value of 1.0 per opinion. It can be concluded that representatives of intermediate sciences had the highest density of words or categories of words per opinion, the highest diversity of words or categories of words per opinion, and also the highest density of important words or categories of words per opinion. Representatives of social sciences are in the second to last place based on all the obtained values, while representatives of applied sciences have the lowest values. The ranking is less clear for representatives of humanities and natural sciences. To clarify the ranking for these sciences, we will perform a simple calculation to sum the scope, diversity, and strength of the opinions. The sum of the corresponding values for each individual science gives the following result:

1st place: Intermediate sciences (sum of densities) $\Sigma\varrho = 47.92$
2nd place: Humanities (sum of densities) $\Sigma\varrho = 42.02$
3rd place: Natural sciences (sum of densities) $\Sigma\varrho = 40.24$
4th place: Social sciences (sum of densities) $\Sigma\varrho = 34.29$
5th place: Applied sciences (sum of densities) $\Sigma\varrho = 33.19$

Based on the results, we can more clearly identify the sciences that contributed a relatively larger share compared to the number of opinions provided. There is a clear gap in intermediate sciences, while the difference between natural sciences and humanities is very small and statistically insignificant. There would be greater statistical significance in terms of differences if we compared the first three sciences to social sciences and applied sciences. When comparing the values between social sciences and applied sciences, we can again emphasize the extremely small difference and consequently the very small statistical significance. To help clarify this information, it can be visualized with a model of circles.

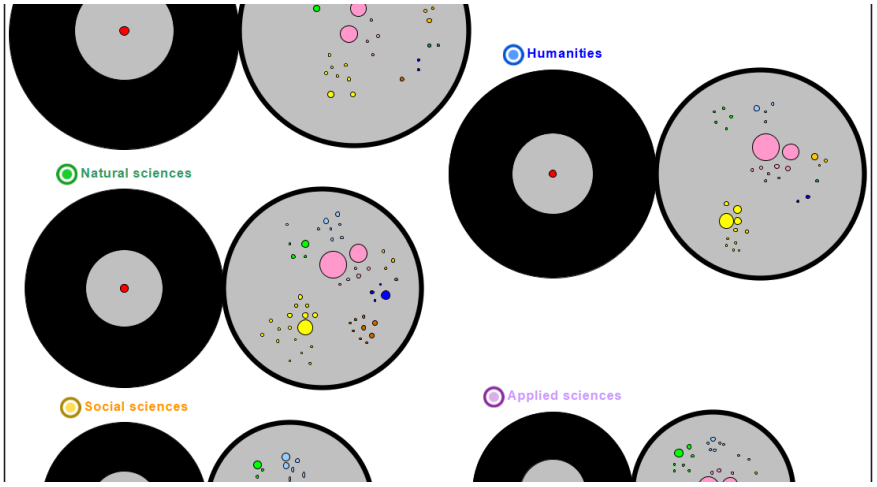

Figure 4: A model of circles representing the scope, diversity, and strength of opinions

Figure 4, in the form of a circle model, illustrates the important contribution of individual sciences to the submitted opinions.

This model shows the size ratios of the previously calculated values very clearly. It also includes circles with colored bubbles (e.g. pink bubbles belong to the UKBS 4 group, yellow bubbles belong to the UKBS 11 group) representing more important UKBS-classified words or categories of words. The size of these bubbles is based on the occurrence frequency of a particular classified word or category of words.

We can see that words or category of words from the UKBS 4 classification group (such as those related to social characteristics, crime, sociality, connection, economy, and conditions) and UKBS 11 (universal words or categories of words such as factor, influence, microcosm, macrocosm, mesocosm, consequence, importance, phenomenon, form, level, pattern, type, etc.) are more frequently used.

Words or categories of words from the UKBS 2 classification group (performance properties) are used less often, but this group includes some stronger words or categories of words such as "education and action." All other classification groups are less expressive within the opinions and therefore have less influence on the main substantive emphases highlighted by representatives of various sciences. These main substantive emphases form the main substantive concept regarding the notion of crime, which emphasizes social/sociological factors described using universal words or categories of words.

Within the main substantive concept of the crime notion, performance factors such as upbringing and actions could be included. The main substantive concept regarding the concept of crime is very clearly illustrated by the model of circles (see pink, yellow, and green bubbles).

Verbal analysis with a statistical emphasis showed that there was no significant difference between the sciences regarding the main substantive concept on the crime notion. Crime is mainly understood due to social influences and causes, to which other less pronounced influences and causes from the point of view of performance and psychological factors are added based on the obtained results. Even less emphasis is placed on environmental (in terms of climate change, ecological disasters), media, technological, institutional, and biological factors (such as the genetic basis, viral diseases, cooperation between intestinal bacteriological networks and nerve cells in our brains, and cooperation between genes and bacteria). The aspect of preventing crime occurrence is likewise extremely weakly represented, which is not surprising given the main substantial concept by representatives of various sciences. This is because it is well known that large social realities can be extremely rigid and even resistant to positive changes.

The individual, as a more mobile part of society, can propose ways to prevent various negative phenomena, but they are constantly aware that as an individual they are helpless against the power and rigidity of society, which often only follows crude interests of positional and material profitability. The word analysis with statistical emphasis has effectively illustrated the main substantial concept of representatives of different sciences and allowed us to determine the ranking scale in terms of the sum of the scope, diversity, and strength of opinions by representatives of different sciences.

It is not accurate to claim that representatives of applied and social sciences were the least original and productive based on this analysis. The verbal analysis of opinions with statistical emphasis cannot show this. Upon intellectual review of opinions by individual sciences, we can identify original and quality opinions by representatives of all sciences. For this reason, we also analyzed the deviation of opinions by representatives of various sciences from a strict sociological interpretation regarding the notion of crime. To do this, we prepared six .txt files (for the humanities, social sciences, intermediate, natural sciences, applied, and marginal sciences) containing opinions by each science and imported them into the JigSaw software tool for analyzing various texts.

Within each text or opinion by representatives of various sciences, we intellectually determined the entities of exposed opinions from the main substantial concept. These entities were determined as the humanities, social sciences, intermediate sciences, natural sciences, applied, and marginal sciences. To help clarify this information, a snapshot of the JigSaw software environment should be included.

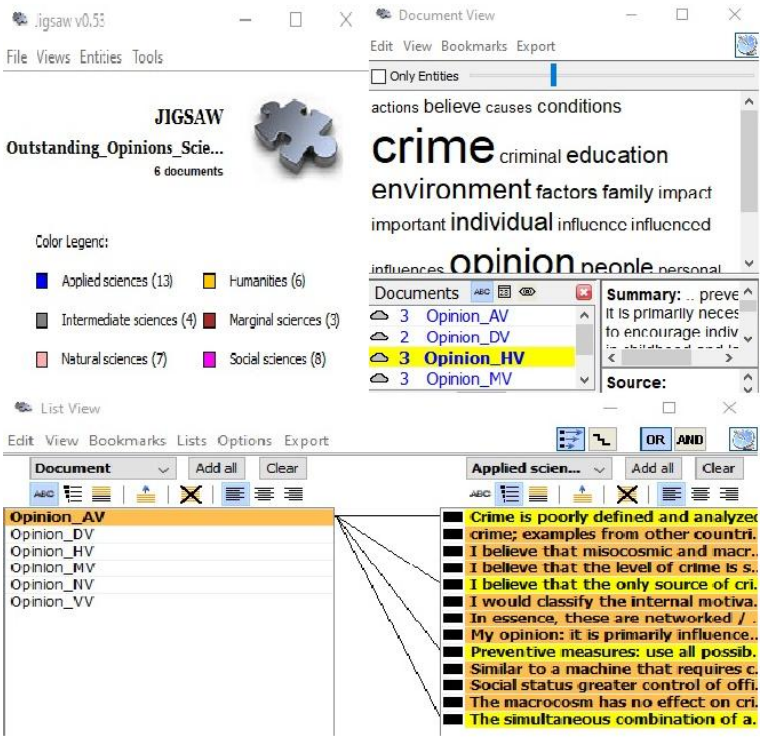

Figure 5: Snapshot of the JigSaw software environment

Figure 5 shows a snapshot of the JigSaw programming environment, in which opinions deviating from the emphasized sociological substantial concept by representatives of various sciences have been revealed. The results are shown in the upper left part of the figure with numerical values for each individual science.

The number of exposed opinions had to be recalculated based on the number of opinions contributed by representatives of different sciences. For transparency, a table was created with appropriate data for the number of outstanding opinions, the number of opinions by each individual science, and the calculated percentages of deviation from the main substantial concept. Figure 5 also shows a part of the opinions by representatives of the applied sciences using the documentary review technique and a visual column list. The same visualizations were also made for the humanities, social sciences, intermediate, natural sciences, and marginal sciences, which this snapshot does not show.

Table 7: Results of exposed opinions according to the main substantial concept

Representatives of sciences	Fim	Fm	Percentage of exposed opinions
Humanities	6	34	17.6
Social sciences	8	37	21.62
Intermediate sciences	4	25	16
Natural sciences	7	45	15.6
Applied sciences	13	56	23.2
Marginal sciences	3	3	100

Table 7 shows data on the number of exposed opinions, the number of opinions, and the calculated percentages of exposed opinions by individual sciences according to the main substantial concept. The largest percentage of the main substantial concept of exposed opinions can be observed in representatives of applied sciences (13 or 23.2%), followed by representatives of social sciences (8 or 21.62%), then representatives of humanities (6 or 17.6%), then intermediate sciences (4 or 16%), and finally natural sciences (7 or 15.6%).

Due to the insufficient number of representatives from the marginal sciences and consequently also opinions, they were excluded from this ranking list. If a larger number of representatives of marginal sciences were included in this research, we could expect a much greater departure from the main substantial concept, which was relatively strictly sociologically and anthropocentrically oriented.

In short, stable, and firm positions are generally welcomed because they provide a certain effective orientation in life and relative social stability. On the other hand, these views can block innovative scientific ideas and make it difficult to communicate and collaborate with groups of people who represent other views. This orientation is not conducive to interdisciplinary collaboration among the sciences in various research subjects, including crime.

The opinions of the included scientists/researchers have been largely firmly rooted in a relatively strict mesocosmic and anthropocentric mindset. It is difficult to be open to areas that are not a part of this mindset. We know that crime is extremely complex in terms of content, and it is impossible to explain it only in sociological, psychological, environmental, biological, media, etc. terms. As a rule, a multidisciplinary and/or interdisciplinary approach is used to research extremely complex fields, including crime research.

Based on the sample of scientists/researchers and the analysis of data from the questionnaire, we can reliably say that there is no effective interdisciplinary cooperation among different types of sciences in Slovenia. We can also interpret the obtained results to mean that representatives of different sciences have an extremely narrow substantial or mental range in terms of the concept of crime, which is an unfavorable starting point for any interdisciplinary scientific research activity. This finding answered the third and fourth research questions and confirmed the second research hypothesis.

4 Discussion

This research was specifically designed to test interdisciplinary scientific research in the field of crime research and the current range of thought among representatives of diverse scientific disciplines. The results concerning organized interdisciplinary research in the field of crime were quite clear. What are the reasons for the lack of a real organized interdisciplinary approach in the field of crime research in Slovenia? The main reason for the lack of organized interdisciplinary research in the field of crime can be attributed to Slovenia's small population, which means fewer scientists are available. However, this reason alone does not fully justify the situation since small populations can be more organized, cohesive, and less dispersed. An analysis of bibliographic networks in Slovenia from 1991 to 2012 revealed that authors in the field of criminality research and related topics, such as migration and traffic accidents, have very little connection with one another (X, 2013). The highest number of connections between authors was observed in the field of criminal law. The range of interest or thought among Slovenian authors in relation to the studied fields was narrow, as the majority of authors were highly specialized. This makes it challenging for authors with different interests to cooperate with each other. The collaborative network analysis revealed that the main nodes essentially represent scholarly authorities in a particular specialized area of criminal law. The excessive focus on criminal law is also the primary reason for the lack of research in the field of crime prevention. Preventing crime necessitates an organized, interdisciplinary approach. Most scientific authorities in Slovenia from various fields of science, who have a fairly specialized range of expertise, attract younger scientists. These younger scientists mainly follow the lines of thought of these scientific authorities. It is precisely this mindset that significantly reduces the potential for true organized interdisciplinary thinking. However, organized interdisciplinary thinking requires a

broad base of knowledge and, therefore, a greater level of mental openness.
This raises the question of the scientific research contributions of criminology in the field of interdisciplinary scientific research. Crime can be studied by sciences and professions such as criminology, police science and profession, sociology, psychology, cultural anthropology, forensic sciences, medicine, especially psychiatry, ethnographers/ethnologists, legal sciences, political sciences, economic sciences (e.g., economic crime), statistics, among others. Many other sciences and applied sciences can also contribute to understanding crime. Other fields that can contribute to understanding crime include natural sciences (e.g. astronomy, meteorology, physics, biology, chemistry), applied sciences (e.g. computer science and informatics, communication sciences), social sciences (e.g. history, economics, ethnography), humanities (e.g. philosophy, linguistics, librarianship, pedagogy), intermediate sciences (e.g. geography, management, organizational science) as well as marginal sciences (e.g. astrology, hieromancy, radiosthesia).
This is not an exhaustive list of all the scientific and professional representatives who could help in studying crime. The complexity of crime is also reflected in the definition of crime, which can have a multidisciplinary or interdisciplinary approach (Brown, Esbensen, & Geis 2013). Explanations for the causes of crime can be biological, psychological, and sociological, but none of these theories provide a comprehensive view of crime (Marsh 2006).
With the advancement of neuroscience and molecular genetics, researchers have discovered that nerve cells in the brain have a significant impact on both normal and criminal behavior. They have also found that the interactions between nerve cells in the brain are heavily influenced by hormones and neurotransmitters. Additionally, they have studied various types of brain damage, such as damage to the temporal and/or frontal cortex, as well as diseases like tumors, Alzheimer's disease, and psychosis, which can alter the functioning of a person's personality and potentially lead them towards criminal behavior.
Many have also studied the impact of harmful substances such as drugs and narcotics on human behavior, which can significantly impact the formation of a criminal personality and, as a result, crime. The causes of crime and criminal personalities are, on the one hand, psychologically conditioned. People may have the power to decide their actions and thoughts, but there are factors over which an individual has little or no influence.
These factors can greatly affect an individual's personality and even that of crowds of people (e.g., genetic makeup, international agreements, climate, viruses, bacteria, movements of celestial bodies). In short, both the internal and external environment contain several factors that are beyond the control of each individual and even the entire human species. This can be broken down into three dimensions: the microcosm, the mesocosm, and the macrocosm.
Within the intertwining of these three dimensions, we can find stronger and weaker connections that result in certain relationships and point to the most likely causes for both the emergence of criminal personalities and crime. Within the microcosm,

we can take as an example certain bacteria that congregate in large microbiological networks and influence certain human behavioral patterns such as eating habits, smoking, and so on. In particularly unfavorable social conditions, the bacterium "latent Toxoplasmosis" can influence violent behavioral patterns in humans (Ren, & Lotfipour, 2020; Cheung, 2019; Ignatova, 2019; Brookshire, 2018; Fernandez, et al. 2015; Shotar, Alzyoud, & AlKhatib, 2015).

Certain types of bacteria may have an impact on the development of criminal personalities and could potentially contribute to the occurrence of crime. However, there is currently limited research and evidence in this area on the effect of bacteria on delinquent and criminal behavior in humans (Meckel, & Kiraly, 2019; Johnson, & Foster, 2018; M Berryessa, 2014; Zai, 2012).

Science, and therefore scientists in any field, contribute pieces of the truth to the bigger puzzle, but the outcome is unknown. As humanity continues to develop, scientific theories and models will evolve based on existing knowledge and discovered shortcomings of the past and will offer new insights or added value. It seems that the puzzle of scientific theories and models will only be fully completed when the human species is no longer around. The causes of various types of crime can be more comprehensively understood through the three interconnected concepts of microcosm, mesocosm, and macrocosm. These main concepts can also include various biological, sociological, psychological, environmental, etc. explanations, which can be emphasized and connected in different ways. It is known that crime investigators are more familiar with factors at the mesocosmic level, so this emphasis is primary. However, the mesocosmic reality of science is not enough on its own and requires the other two realities. Factors at the micro and macrocosmic levels often require highly precise instruments to detect certain events, as our natural senses are not sensitive enough to perceive them.

This is also true for electromagnetic, gravitational, and nuclear energy fields and the movement of celestial bodies. It is challenging to prioritize micro and macrocosmic factors in explaining the causes of criminal personalities and crime. There is a hierarchical rule in which mesocosmic factors are given the most attention, as crime occurs within the mesocosm through actors and actions.

However, a mesocosmic perspective can be distorted as it may neglect more important factors at the micro and macrocosmic levels. Stronger electromagnetic fields can have significant effects to disrupt the proper functioning of body organs and brain cells (Lavanya, 2003). They have already proven the influence of the full moon on humans is very strong, but is there no real evidence that a full moon could cause co-killings or a car accident, because in all probability we cannot measure it more accurately (Kmetty, Tomasovszky, & Bozsonyi, 2018)? The logical consequence of this is reflected in a more intense focus on phenomena or factors at the mesocosmic level. What processes take place at the macrocosmic level, which in the concluding stage always yield as a result certain ordered patterns and chaos? Can such formations create such strong energy fields that could be responsible for the emergence of crime and criminal personalities, or that they contribute merely indirectly to a certain

share, which can lead to the emergence of both criminal personalities and crime? Astrology as a frontier science has apparently dealt with this in the distant past (e.g., patterns of celestial bodies give a guarantee of fertility, setting a favorable date for military conflict) (Thakur, & Sharma, 1984). On the other hand, natural sciences like physics and astronomy have already discovered many natural principles of the macrocosm, which we do not until now know how to explain in connection with the meso and microcosm.

Briefly, the synthesis of knowledge is still lacking from the point of view of all three worlds of our reality, because certain possible solutions already exist, but we do not yet know how to translate them, which consequently leads in relation to crime (also in relation to other social phenomena) into hidden unconscious knowledge. The more closed off the sciences become, the more they rely on abstractions expressed in models and theories. This, in turn, distances them further from the truth. An organized interdisciplinary mindset, on the other hand, promotes the synthesis of knowledge and can bring us closer to a more realistic understanding of the world.

Criminology and related sciences (e.g. police science) are expected to be even more open and linked to other sciences in the future, as crime remains a very complex social phenomenon that can be present within all activities carried out by organized communities at local, national and international levels. Existing biological, neurobiological, psychological, social, media, feminist, environmental, etc. crime theories are not comprehensive and effective enough to better understand, predict, and prevent crime. The already present specific serious forms of crime, which may flourish in the future, will be difficult to understand and even more difficult to investigate without intensive and strong interdisciplinary efforts, and thus less effective in preventing them.

Individual scientists are relatively confined in certain thought cages and have difficulty or no control over different perspectives, which is not the case for diverse interdisciplinary scientific groups. These can broaden the mental horizon and enable better efficiency in the synthesis of knowledge in the field of crime as well as in many other research subjects. Therefore, the interdisciplinary paradigm of crime research in criminology is more than important.

What has been done so far in this area? The software tool Publish or Perish was used to perform composite queries on Google Scholar without time constraints (Harzing, 2007). The results were relatively modest, with fewer than 300 publications published between 1975 and 2022 and cited 5845 times. To a greater degree, many of these publications could be excluded in terms of relevance. Next, an assessment of the authors' bibliographic network was carried out using the VOSviewer software tool (van Eck, & Waltman, 2010).

In terms of interdisciplinarity in relation to crime research, we can report on a modest bibliographic network of authors, numbering only 420 authors. With the strict condition of at least two publications on the topic, the number of authors is only 46 and there are very few links between the identified authors. There are only few publications which are more or less dealing with interdisciplinary crime research

(Allum, & Gilmour, 2022; Bleakley & Kehoe, 2021; Bussmann, et al., 2021; Bussmann, 2004; Boratto, & Gibbs, 2019; Loff, et al., 2019; McGregor, 2021; Peter, 2018; Ryder, 2018; Ryder, et al., 2016; Brooks, 2016; Jung, et al., 2017; Butler, et al., 2012; Gibbs, et al., 2009; Weber, 1993; Abu-Laban, 1980). This assessment primarily means that we do not possess an explicit scientific authority regarding interdisciplinary research in the field of crime within criminology.

In essence, we first need a flexible mindset of scientists to achieve holistic interdisciplinary well-organized scientific groups working permanently in the field of crime research. It should be more intimately linked at least to the contents of other social anomalies such as negative stress, mental illness and addiction, stigma, poverty, conspiracies (political, economic) and environmental pollution. The mentioned contents are also supposed to be related to the physicochemical conditions, climate change, electromagnetic fields, microbiology, and the reduction of biomass on our planet. The big picture of crime research is still contained in relatively disconnected small pictures.

5. Conclusion

Interdisciplinarity in science essentially means the ability to synthesize and apply knowledge from different scientific branches. In our world, there is a lack of a fuller and more effective interdisciplinary approach in the field of crime research, because various scientific branches are relatively closed and focused on their own traditional research subjects, making crime seem very remote to them. This social climate prevents the useful synthesis and application of knowledge from various fields of science. Based on the great need to better understand crime, there is a need for a social scientific climate that is not excessively closed to another knowledge and thinking. It can often happen that a certain scientific branch already has a solution to burning social and environmental problems, of which they are not explicitly aware. In this case, we can talk about hidden, unconscious clusters of knowledge that do not find their way to the right person or scientist, which is prevented in advance by a relatively closed scientific social climate.

A robust and well-organized interdisciplinary approach is necessary in the study of crime. Only through this method can there be a more effective integration of knowledge from various scientific research fields. Furthermore, there is a greater likelihood of discovering hidden knowledge, which can facilitate the synthesis or enhancement of existing knowledge, leading to a deeper comprehension of crime and potentially improved prevention strategies. The production of knowledge from various fields of science multiplies exponentially and no scientist in this world can have even a partial overview of new cognition from various fields of science. It is not a shame that criminologists have difficulty or do not follow publications that deal with crime in a slightly different way. The problem can be alleviated by actively collaborating with specialized libraries, information centers, or soon, through the use of artificially intelligent robots. These robots could extract or uncover hidden

knowledge from publications and even facilitate synthesis. Through an even more efficient synthesis of knowledge, both criminology and substantially oriented sciences (e.g., police science) could develop new views that could, for example, increase efficiency in predicting and forecasting crime, thus preventing many bad things and improving the world. Regarding the review of human knowledge, it is not just criminology in the role of David vs. Goliath (e.g., geneticists find it difficult to keep up with novelties in the field of bacteriology and vice versa).

In future research related to interdisciplinary crime studies, Slovenia could be compared to other countries in similar research environments to determine whether the lack of interdisciplinarity is unique to Slovenia or common across many countries.

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