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AN INTERDISCIPLINARY EXPLORATION ON CLIMATE NOTION IN DIGITAL DESIGN RESEARCH

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ABSTRACT

Research related to climate concepts has started to be more interdisciplinary with the climate change awareness. Climate action, and climate-positive design research topics are common notions among design disciplines, especially in architecture and landscape architecture. It can be said that computation, digitalization, performance-based simulations of environmental effects, and production methods in digital design are initial topics that come to the forefront concerning methodology. The reflections of these methodologies differ according to the aims and objectives. This paper aims to examine which notions and word phrases are used in the literature on climate in digital design research in a comparative way. Within this scope, The International Journal of Architectural Computing (IJAC) and The Journal of Digital Landscape Architecture (JoDLA) are chosen as academic resources indexed in the Scopus. To obtain the differentiations on climate-related concepts and their associations with other fields in an interdisciplinary manner; published research articles' titles, abstracts and keywords are defined as datasets. The examination is conducted through the data mining method as a deductive approach, using the main words are separated and associated with various phrases, and binary term occurrences. The outcomes are visualized through a map to reveal the relations of the notions that occur in the research. The findings reveal that both disciplines work on environmental issues from the context relationality stage. Although landscape architecture seems to be more related with the environment, climate and ecology trio, the binary-term occurrences show that there is not much difference in the research rates. Nevertheless, considering the close relations with environmental and climate issues in the landscape architecture discipline, the specialization is not high in terms of computational approaches regarding architecture. It is anticipated that this research may be used in future interdisciplinary literature and methodological approaches in digital design research in architecture and landscape architecture.

Keywords: Data mining, Climate, Interdisciplinary research, Digital design, Data visualization

1. INTRODUCTION

The environmental problems that started to increase in the last decade and the awareness in parallel both had a significant impact on design disciplines. Due to the sudden impact of the industrial revolution, urbanization and natural area degradation have started to arise. Current design discourses and methodologies are sourced from these environmental problems and their spatial echoes. The greenhouse effect, urban heat island, and eminent carbon footprint are fundamental grounds for global warming and climate crises [1]. Since 2015, the necessity of keeping global warming at 1.5 degrees has started to be mentioned with the significant risks that 2.0 will bring [2]. Reducing carbon emissions, which is the most crucial regulator to lower the greenhouse effect and rebinding the carbon in the atmosphere to the soil have constantly been on the agenda with the Paris agreement [2] and Cop26 [3]. Therefore, the importance of numerical methods has increased for the performative evaluation of ecological and environmental characteristics. In this regard, both indoor and outdoor sustainability studies such as surface water collection [4], enhancing micro-climate [5,6], or energy-intensive facade designs [7] were produced with simulations and analyses offered by digital technologies. In addition, social interactions and their impact on the environment opened up novel gates in spatial studies. Therefore, the spatial projections that emerge from reciprocal relations which are handled with a performative approach has pushed the designers to seek new computational methods and methodologies [8,9]. These methodologies

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vary in architecture and landscape architecture regarding the design problem and process. The foundations of the design problems are set upon space and environment, and many notions may diversify in terms of use and definition like time, movement, scale, material, etc. Therefore, design, simulation and production mediums, process, methods, and methodologies also differ accordingly.

Non resemblances can be spotted if the reciprocity of the digital and computational design methodologies, consisting of rules and procedures, are examined in design disciplines. In connection with each discipline's theoretical background, design procedures and contextualizing in digital approaches vary. Therefore, it can be deduced that the model inputs required in architectural design do not have the exact equivalent in landscape design and even fall short. The engagement of computational methodologies within the landscape design process is ongoing. While this engagement deals with various aspects in the focus of architectural design, it is also crucial to reveal its adaptation in landscape design. To ascertain the common grounds of climate notion among these disciplines, it is crucial to unfold the relations, distinctions, and collectives regarding computational backgrounds.

1.1. Computation in Design Disciplines

The innovations and developments ensued with each other pertinent to the convergence of design and computability. Particularly, with the definition of design problems in the form of graphical expressions, which began in the mid-1970s. While the emergence of object-oriented design methods in the early 1980s, the tools offered by new technologies began to evolve. Especially from the 1990s, architects tended to adapt design methods and tools to innovative visions regarding cognitive development in computation and digital design. With the origination of the first "digitally intelligent designers" [10] generation, digital design and computational methods mainly were associated with variations and non-standard forms. In conjunction with global networking systems, the idea of mass customization that stemmed from the industrialization era has been shifted to the mass collaboration known as the second digital turn [10]. With this regard, the cumulative literature of computational design theories, methods and tools reflected in design practice has become more prominent, especially in architectural discourse. This context is assumed to be informed by parametric design, topology and performance concepts and forms the basis of digital design practice [11].

Nevertheless, the fundamental changes have reshaped the architectural design mindset; similarly, landscape design has been also in a state of flux. Considering the environmental notions and the tenets that it beholds; new approaches and methods carry significant importance as in computational design development. Regarding the stages of development and impacts on the computational approaches, digitalization effects and technologically informed design methods occur in different ways. Ervin [12] proposes three modes to explain this engagement in phases: new tools, new languages, and a new design environment. The initial mode uses the software as a tool while highlighting its importance in the design process by giving an operational function. Another is creating a new language that aims to improve the design by customization via writing codes or software. Finally, he argues that the interconnectedness of all the digital devices used today creates a new environment to produce computational "interactive" and "responsive" landscape design, developed through the concept of the "Internet of Things (IoT)". It can also be argued that knowledge-based interpretation and form-finding methods create a common literature and lexicon with digital design discourse by bringing together interdisciplinary and cross-disciplinary approaches, as in scale and theoretical background. Therefore, architectural design, like urban design and landscape design, can be seen to coincide with similar approaches by using common tools and interfaces, but also to differ from each other in terms of scale and purpose.

That is to say, digitalization has created a ripple effect that forces production and design approaches to evolve and change. In particular, design practices put the way of production and the roles of designers up for discussion. Therefore, it is crucial to examine both the constraining aspects and the facilitating effects of digital tools. The engagement of digital tools and computational methods in the design has

evolved from drawing planes into coding interfaces. This development process created interchangeable characteristics for designers, from "draughtsman" identity to "scripting" capability [13]. However, reflections of these changes in designer identities varied regarding discipline purposes, congruity of digital tools, and scope. From this point of view, alignment with cross-disciplinary assessments on computational approaches and notions provides critical sight to the coherence of current digital design trajectories and overcoming the limitations of potentials.

2. METHODOLOGY

This paper aims to examine the design discourse trajectories concerning climate awareness in digital design regarding architecture and landscape architecture. Co-word analysis and data mining methods revealed the differences and gaps in related literature concerning climate crisis, climate action, and climate-positive terms. Two academic journals, the International Journal of Architectural Computing (IJAC) and the Journal of Digital Landscape Architecture (JoDLA) journals, are selected as the primary sources. Issues published in these journals were evaluated regarding concurrency, starting from 2016, the origin of JoDLA publishing, to 2021. 2016 is also the year that the Paris Agreement entered into force to reduce countries' emissions and adapt to the impacts of climate change.

The methodologies and approaches for climate responsiveness and the environmental sentience of design disciplines are the focus throughout the cross-disciplinary evaluation. Regarding this, the method of the research was structured in six stages: (1) gathering the metadata of research from the indexed database, (2) preparation of the data, including selection and assessment of data pertinent to the title, keywords, and abstracts, (3) context relationality with the environment, ecology and climate keywords using all metadata, (4) data sorting based on binary term occurrences to create relevant sub-groups, (4) goal and method sentence extraction, (5) data mining by creating word associations in RapidMiner processor and mapping (Figure 1) the extracted results as patterns with GraphCommons [14]. The evaluation of resemblances and incongruities followed the relational mapping of the data obtained from both sources. During the metadata collection phase, the data of both journals were obtained from the Scopus database by excluding the studies with missing data or inaccessibility. With this approach, an evaluation pool was created throughout Title- Abstract-Keyword (TAK) and Goal and Method Sentence (GMS) clusters.

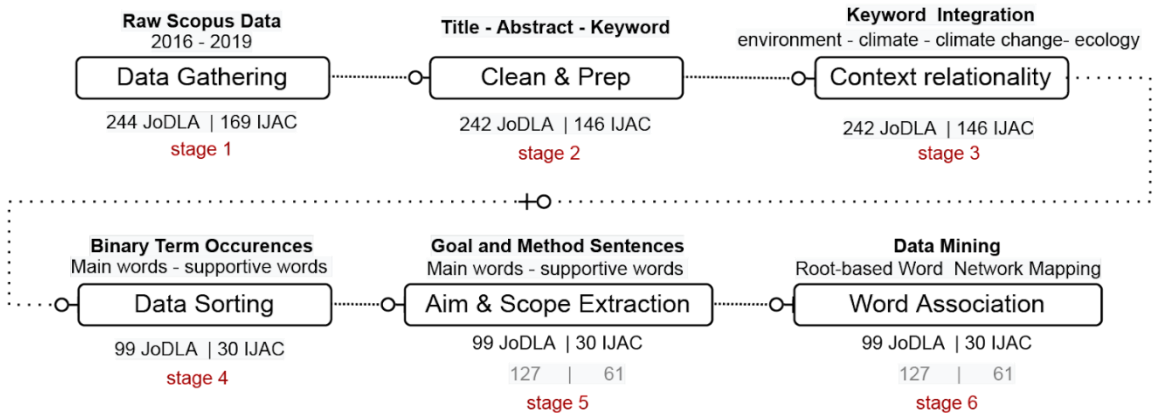

Figure 1. The main steps of the research (Source: authors)

3. MAPPING THE TRAJECTORIES

With the revolutionary creation of Sketchpad by Ivan Sutherland in the 60s, architecture became more interested in integrating the digital and computational fields into its design process. The initial interest was in tool innovation and adaptation. Afterwards, the researchers sought the potential of these in terms of mediums. Various research has expanded the deeper relations of computability in architecture, such

as theoretical backgrounds [15]. Some directed the academic research orientations toward design research [16,17,10]. Besides research on theory and practice, design education research gained importance in integrating computation and digital mediums into architecture and design education. In parallel with the connection of computational design with architecture, the Computer Aided Architectural Design (CAAD) conference series has played a vital role in broadening and deepening this new field of research [18,19,20]. These conferences have regional focuses such as the Association for CAD in Architecture in North America (ACADIA), Computer Aided Architectural Design in Europe (eCAADe), The Association for CAAD Research in Asia (CAADRIA), The Ibero-American Society of Digital Graphics (SIGraDi) and The Arab Society for CAAD (ASCAAD). On the other hand, there has been only one conference named Digital Landscape Architecture (DLA) focusing on computational design in landscape architecture since 1999. In particular, studies examining the research focus of the articles published in CAAD conferences individually [21] or across them [22] have taken an ontological approach. Seni and Hodges explain ontology as a formal conceptualization of "what exists" within the domain of science [23].

3.1. Data Gathering, Cleaning and Preparation

In information science, ontology is related to a technique that enables knowledge sharing and reuse [24]. Thus, ontological approaches coincide with data mining techniques related to bibliographic studies. In this context, there are common interests like automated classification [25] and contextual relations [26]. In this paper, ontological literature reviews of architecture and landscape architecture disciplines were conducted regarding digital and computational design domains. To this end, the bibliography was searched by going back to the publishing origin of the Journal of Digital Landscape Architecture (JoDLA). The concurrence of the International Journal of Architectural Computing (IJAC) and Journal of Digital Landscape Architecture (JoDLA) was elaborated in a time interval between 2016-2021, as aforementioned. Both journals adopt peer-reviewed and discipline-specific computational approaches. IJAC is dedicated to broadening the foundations of computer-aided architectural design, which was found by eCAADe, ACADIA, SIGraDI, CAADRIA, and CAADFutures (Acadia). On the other hand, JoDLA has a theoretical and practical focus on landscape architecture lenses, primarily in the annual international Digital Landscape Architecture conference (Gis. point). The recent articles of the specified time interval of these journals constituted the metadata of the research. Accordingly, by eliminating the null data, 146 out of 169 articles for IJAC and 242 out of 244 articles for JoDLA were obtained from the Scopus database.

3.2. Context Relationality

In this step, before moving on to the detailed word-based associative analysis, the basic relationship of both journals with the context of the research was questioned. For this purpose; all titles, keywords and abstracts were organized. In order to further infer on climate change and climate-responsive design tendencies of both disciplines, fundamental keywords were structured into two groups, main words and supportive words list. Considering the relation of climate change research between environmental science (Scopus, 2021) and its ecological solutions; ecology, environment, and climate were determined as the most related keywords with supportive words listed; awareness, change, sustainability, responsive, micro, and efficiency. Firstly, to eliminate the unrelated data and out-of-context issues, context relationality was checked by using only the main words and climate change terms. Primarily, the general contextual relations were elaborated into keywords such as "ecology (eco.)", "environment (env.)", "climate(cl.)", and "climate and change (CC.)" (Table 1). The word "environment" has been the subject of significant research in both journals. %31.5 of the research in the IJAC journal and %36.3 in the JoDLA journal contain this word. However, at this point, it should be considered that the word "environment" can also describe design environments or interactive spaces in the field of computational design. Therefore, the word “environment” in research should be evaluated in its context. While it is frequently used in climate and environmental issues research, it also creates a second context for new digital design interfaces. In

addition, in studies where the words "climate" and "ecology" can be followed, as it is expected that JoDLA has more subjects than IJAC in percentage. Considering their distribution by year, it has been consistently popular in IJAC over the years, especially when the word "environment" is taken as a basis. On the other hand, in JoDLA magazine, it is seen that this rate has drawn an increasing trajectory over the years. While the studies including the keywords "climate" and "change" were increasing over the years in JoDLA, this issue only took place in four articles in 2019 from IJAC.

Table 1. Context relationality over 5 years based on the main word list. (Source: authors)

Jour.	Env.	Cl.	Eco.	CC.	Year	Jour.	Env.	Cl.	Eco.	CC.
	11	-	1	-	2021		15	5	5	3
	7	-	3	-	2020		28	9	11	5
IJAC	9	4	-	4	2019	***JoDLA***	11	4	3	4
	4	-	2	-	2018		12	3	3	3
146	5	1	-	-	2017	**242**	10	3	2	2
	10	-	1	-	2016		12	1	1	1
	%31.5	**%3.4**	**%4.8**	**%2.7**	Total		**%36.3**	**%10.3**	**%10.3**	**%7.4**

3.3. Data Sorting and Extraction

For further inferences as a qualitative evaluation of climate responsive and environmental-oriented topics, relevant studies were extracted from metadata in two ways pertinent to the main and supportive word occurrences. Studies that involve 20 binary root-term occurrence combinations of these terms among abstracts were extracted, such as "*environ – climat*", "*ecolog – sustainab*", "*climat – micro*" etc. (Table 2). Binary terms are essential to select the more relevant studies considering the ambiguous term iterations like "environment." The presence of these word groups for both journals gives a general idea about the research trends. Articles were selected throughout the year, considering the binary term occurrences on abstracts (Table 3).

Table 2. Main and supportive word list with the root-terms and their binary combinations. (Source: authors)

Main Word List	Root-Terms	Supportive Word List	Root-Terms	Binary Combinations	
Ecology	ecology	aware	aware	1-environ - ecolog	11-ecolog - chang
Ecological		awareness		2-environ - climat	12-ecolog - sustainab
environ	environ	change	chang	3-environ - awar	13-ecolog - responsiv
environment		changing		4-environ - chang	14-ecolog - micro
environmental		sustainable	sustain	5-environ - sustainab	15-ecolog - efficien
environmentalist		sustainability		6-environ - responsiv	16-climat - awar
climate	climat	responsive	responsive	7-environ - micro	17-climat - chang
climatic		responsiveness		8-environ - efficien	18-climat – sustainab
climatically		micro-climate	micro	9-ecolog - climat	19-ecolog - responsiv
		micro-scale		10-ecolog - awar	20-climat - micro
		efficiency	efficien		21-climat – efficien
		efficient			

In that stage, using binary term occurrences shows that, the term "environ", short for the environment, is used mostly with "chang"(%67). In IJAC this rate is a primer, as opposed to the JoDLA. Even though this term heads upon among others predominantly, JoDLA has a more balanced focus on the terms including "ecolog" (%14) and "climat" (%11) to this. Similarities are distinctive for "ecolog" root term for both journals. While, in IJAC, "ecology-chang" association gains the highest share with %13 percent;"ecolog-change" (%8) and "ecolog-climat" (%7) are allied for JoDLA. However, "climat" rppt term highlights the significance of the synergy between "climat-chang" and "climat-micro". IJAC and JoDLA display similar measure as %13 and %18 respectively. On the other hand, even if the rates illustrate nearly identical numbers for both (%7 - %8) for the microclimatic issues, overall research counts of JoLA are far more than IJAC, as in for all binary occurrences.

Table 3. The chronological evaluation matrix of binary term occurrences through the root terms for both journals. (Source: authors)

	Jour.	environ								ecolog							climat						
		ecolog	climat	awar	chang	sustainab	responsiv	micro	efficien	climat	awar	chang	sustainab	responsiv	micro	efficien	awar	chang	sustainab	responsiv	micro	efficien
IJAC (30)	2021	1	0	0	4	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
	2020	3	0	1	3	2	1	1	2	0	1	3	1	0	0	0	0	0	0	0	0	0
	2019	0	4	0	6	1	1	1	2	0	0	0	0	0	0	0	0	4	1	0	1	1
	2018	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2017	0	1	0	2	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0
	2016	0	0	0	4	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Count/	4	5	1	20	3	5	4	6	0	1	4	1	0	0	1	0	4	1	1	2	1
	%	13	17	3	67	10	17	13	20	0	3	13	3	0	0	3	0	13	3	3	7	3
JoDLA (99)	2021	3	4	0	4	1	0	1	2	1	0	3	1	0	0	0	0	3	1	0	2	0
	2020	5	2	1	3	2	0	1	0	2	1	0	2	0	0	0	2	5	1	0	1	0
	2019	1	1	0	3	0	0	0	0	2	0	2	0	0	1	1	0	4	1	0	1	0
	2018	1	1	1	4	1	0	1	0	1	0	1	1	0	0	0	0	3	0	0	2	0
	2017	3	2	0	3	0	2	1	4	1	0	1	0	1	0	2	0	2	0	0	0	1
	2016	1	1	2	4	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0
	Count/	14	11	4	21	4	2	4	6	7	1	8	4	1	1	3	3	18	3	0	6	1
	%	14	11	4	21	4	2	4	6	7	1	8	4	1	1	3	3	18	3	0	6	1

3.4. Word Association and Network Mapping

After selecting the relevant research, one more step further, sentences were eliminated and attenuated. Including all kinds of goal and methodology information were selected by filtering keywords such as goal, aim, method, purpose, propose, etc. As a result of this process, 127 sentences for JoDLA and 61 sentences for IJAC were extracted. Thereafter as data mining phases, 3 main steps were structured: cleaning unnecessary information (1), grouping the most frequent words (2), and creating the associations (2). Firstly, the word groups in the basic sentence structure, such as conjunctions and prepositions, and unnecessary information such as place of publication, etc., were removed. In this way, the meaningful roots of the remaining words were obtained. Then, the most frequent words in the data set were grouped using the FP-Growth operator of RapidMiner. In these steps (Fig 2 and 3), all filtered word pools were firstly translated into text for cleaning, then binomial values (0 or 1) to acquire word occurrences for all selected sentences. Results of this step were calculated with FP-Growth operator to obtain support values regarding occurrences values. At the same time, the association rules between the words were analyzed with the association rules operator [27]. Network mappings were created for both journals, considering the association rules and supporting values of binary comparisons of words from the data set. These associations were visualized regarding color codes, link thickness, node positioning and size via a web-based network mapping interface named Graph Commons [14]. In association with rule creation, data mining was run using word stems. With this attempt, some words emerged such as comput, simul, creat, or chang sourced from various word clouds such as computerization, computability, simulation, change, creation etc. These words were illustrated as the most common meanings with association rules translated into connection forces in keyword network mappings.

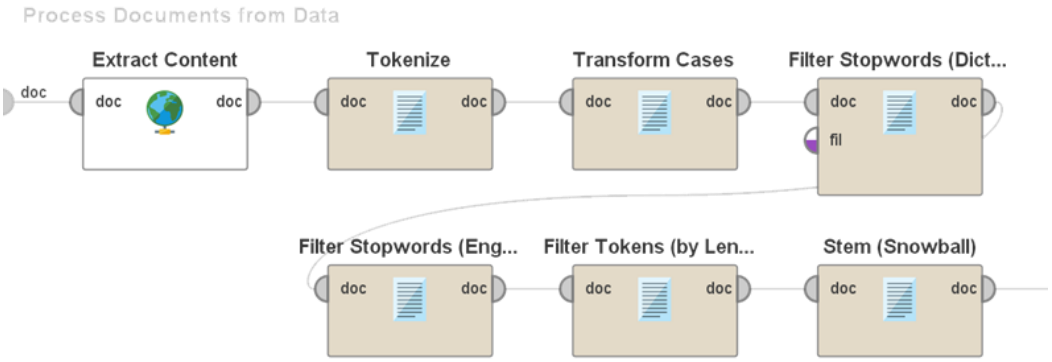

Figure 2. Cleaning the unnecessary information among word pool of all selected goal sentences. (Source: authors)

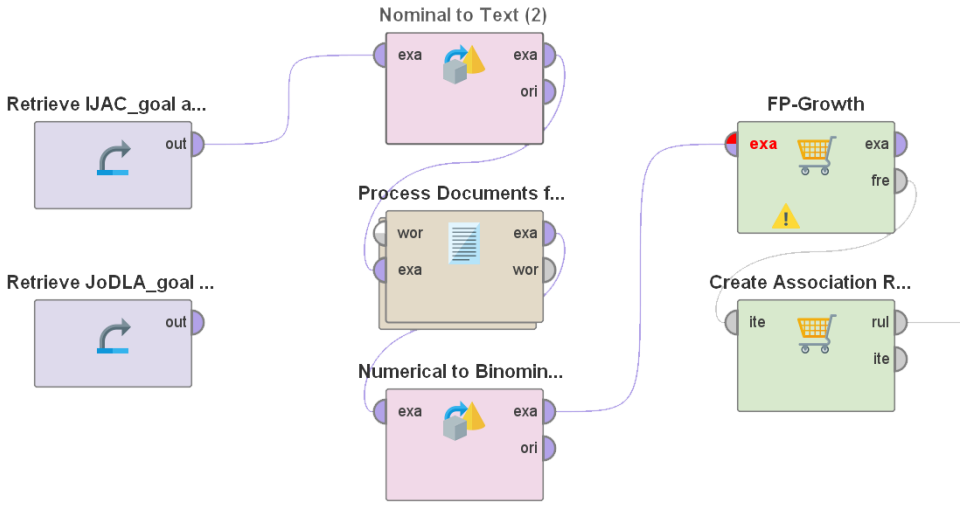

Figure 3. Overall synthesis including translations, word grouping and association rules with support values of FP-Growth. (Source: authors)

4. RESULTS

Considering both journals' depth of keyword variations and their relational graph, the main drivers which stood out were data size and variety. The proficiency in the computational approaches and environmental-focused methodologies among disciplines has significantly shaped the relations. Due to these issues, the most repeated and related notions formed the focal center. As the repetition of keywords and their relationship with the main topics decreases, it pulls out of the center of network mapping. It was observed that some concepts such as model, fabrication, and material have shaped the center. These concepts are associated with orbital concepts such as application, process, environment and project. The supporting concepts in the orbital sphere have different degrees of relationship with the other leading concepts. In association with rule creation, data mining was run using word stems.

In JoDLA, dominant words were "model", "simulate", and "environ". However, when the first data was run and illustrated according to support values, the "method" term shaped the whole network. Nevertheless, the "method" term remains ubiquitous. A manual evaluation was made to disaggregate the research to see if it introduces a method or uses a defined one. By this means, the terms that were repeated in 32 sentences, which belong to 9 different studies, were eliminated out of 127. According to the final network mapping of JoDLA (Figure 4 and 5), "model" got the highest value with 0.213, followed by "propose" with 0.164. These keywords have been repeated respectively above 21% and

%16. On the other hand, it can be seen that the highest support value of IJAC is incompatible with the network mapping trajectories. Even though the "method" keyword was ranked as the highest support value at 0.249, after the "comput" related to the computation and computing variations, it fell behind the "fabrication" and "material" in network mapping. The difference rests on the evaluation method, which focuses on the keyword repetitions and combinations of multiple occurrences in various keyword groups. Therefore, although the support values of "fabrication" for IJAC or the "environment" for JoDLA were not high, they formed important nodes in network maps due to their intense connections with various nodes. On the other hand, it can be said that the word "method," which has the highest support values in IJAC's network mapping, was overshadowed by the relations between the words "comput" and "fabrication" with other words. Even though the "method" keyword was ranked as the highest support value at 0.249, after the "comput" related to the computation and computing variations, it fell behind the "fabrication" and "material" in network mapping. The difference lay on the evaluation method which considers not only term occurrences but also combinations of various binary relations for each word. In this manner, despite the support values, specific words were highlighted as nodes like "fabrication" for IJAC, and "environment" for JoDLA.

Consequently, the scope of JoDLA is more focused on climate and environment-oriented approaches, which are heavily nourished by intertwined concepts such as "environment", "model-nature", "urban-biotop" or "simulate-hydrolog". These complex relations are shaped by the main node of "model" and supportive nodes such as "develop", "propose", "simulate", "process", and "environment". It can be deduced that the research focuses on developing a new model proposition with new tools, software, algorithms, or simulations. Especially "model" oriented research shares the links between computational and design-related innovative tools and applications. Although expected, there is no direct link between "environment" and "model". This connection was established only with the word "simulation". The critical point here is that it can be argued that the term "environ," which has only one connection with the word "ecolog", does not come close to the main focus of research. The "simulation" keyword shares a strong relation with coastal research regarding different erosion and water levels in hydrological investigations. Also, new tools and software come to the fore for urban landscape research, specifically for predicting future projections.

Figure 4. Highlighted network relations of highly valued words: Model, environ, develop. The support values are 0.213, 0.134, and 0.126, respectively. (Source: authors)

According to the word "environment" constitutes an essential node in all research regarding both repetition and multiple relationships. When examined with its sub-words, it can be said that the studies fit into two different contexts. One of these contexts is about the combination of words such as "immersive", “interact", "human", "virtual", and "augment." This combination concludes that the most

current topics, such as interactive environments as an interface, are included in the research. The other one is about "measure" and "potential." It can be said that it forms the context of environment-oriented research based on "tools" such as "space" and "data."

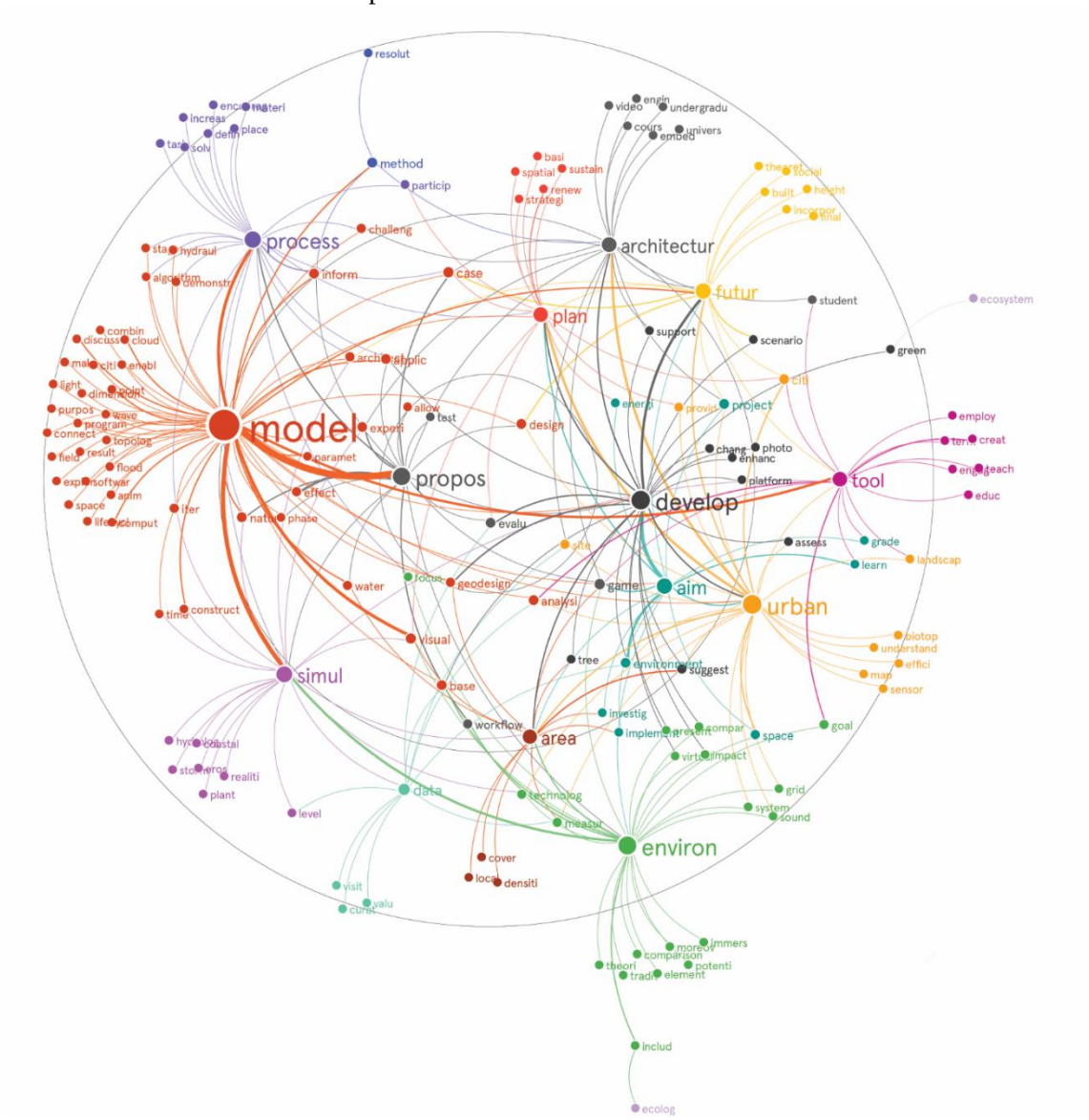

Figure 5. Keyword network mapping of JoDLA. (Source: authors)

In IJAC's network mapping (Figure 6 and 7), dominant keywords stand out as "fabrication", "compute", and "material" at first glance. Similar to the previous mapping, despite their support values and important nodes in network mapping showing a correlation, their importance varied. When the item list support values were evaluated among all keywords in IJAC, "method" got the highest value with 0.249, followed by "compute" with 0.180. Also, "fabrication" with 0.180, "material" with 0.131, and "process" with 0.098 follow after, even though they are overruled in the network mapping. In particular, it can be said that the computational approaches that focus on climate and environment-oriented research in the lense of architecture, are mainly grounded on new material production, new construction techniques, and mechanization techniques developed for this purpose. Keywords such as "robot", "fabrication-manufacture", "fabrication-structure", "material-print" and "compute-aid" form the basis of this inference. Moreover, considering the relationships of the keyword "process", which has close ties with

"fabrication" and new "material", related to words such as "novel" and "neural network", and "machine". It is seen that current methods such as artificial intelligence and machine learning are studied in specific areas. When going from the center to the orbits in the relationship map, it is seen that keywords such as "artificial" - "intelligent" and "deep" - "learn" appear in two separate groups concerning these issues. When these examples are examined on an article basis, it can be seen that studies are focusing on climate change and environment-oriented design, such as disaster-shelter design. However, similar research including words like "nature" and "environment" are used in different contexts.

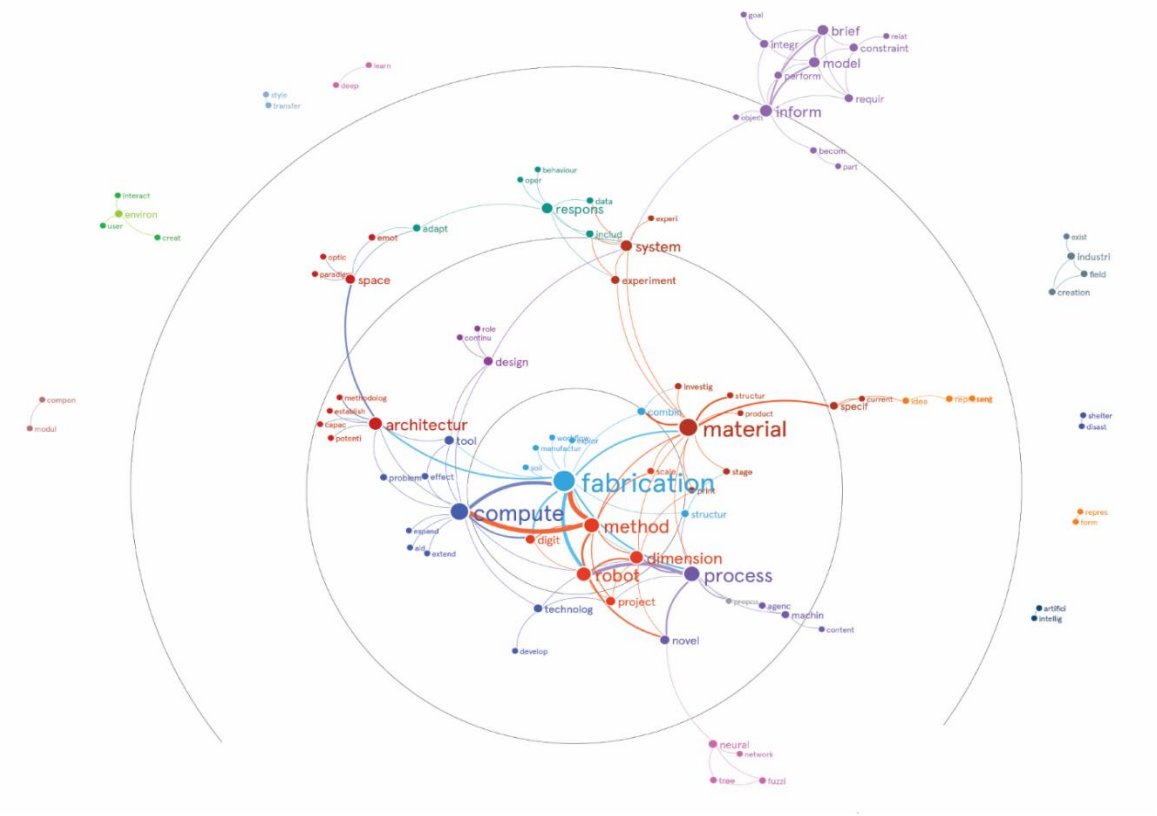

Figure 6. Keyword network mapping of IJAC. (Source: authors)

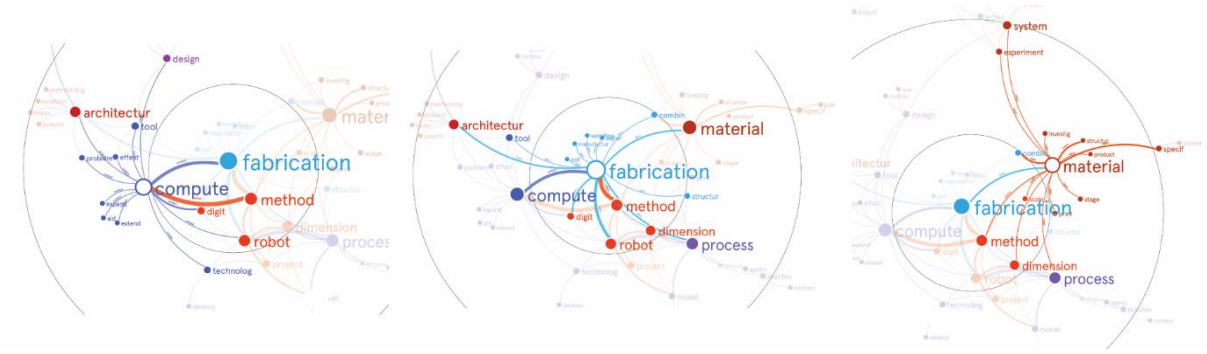

Figure 7. Highlighted network relations of high-rated words: Compute, fabrication, and material. Support values are 0.180, 0.180 and 0.131 respectively.

4. CONCLUSION

General inferences can be made for both journals when the obtained network mappings and quantitative comparisons are evaluated holistically. This evaluation discusses the correspondences and incongruities of digital approaches and notions of environment-oriented design in both disciplines. It can be said that inferences are made for both disciplines, especially in terms of digital and computational techniques and approaches to deal with climate and environmental issues. In this way, interpretations were obtained regarding how both disciplines deal with climate and environmental issues, especially through digital design and computational approaches. Although research approaches in architectural design focus much more on digital fabrication and building material, different specialized subjects have also been studied.

In landscape architecture on the other hand, it has been seen that the subjects which are encircling around new design models and simulation techniques as methods are closely related to each other. By the top-down methodology of the research, differences were obtained regarding general approaches to climate and environmental research. In particular, it has been found that both disciplines work on environmental issues from the context relationality stage. Also, the contextual query of the word "environ" was examined in terms of its relations with computational approaches in the association network mapping stage. Then, by the binary-term occurrences, even though it has been seen that the landscape discipline generally relates to these issues more than the discipline of architecture, the differences were not as high as expected. The significant point is that JoDLA's "climate-change" binary review has increased since 2017, while IJAC's special issue focused on resilient design and accordingly climate matters in 2019. Nevertheless, considering the close relations with environmental and climate issues in the landscape architecture discipline, the specialization was not high in terms of computational approaches regarding architecture.

CONFLICT OF INTEREST

The authors stated that there are no conflicts of interest regarding the publication of this article.

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