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Design and Synthesis of Novel Organic Scaffolds for Therapeutic and Industrial Applications

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Abstract- Synthesis and design of novel organic scaffolds has been a key strategy in medicinal chemistry and industrial organic chemistry since the architecture of scaffolds has a strong impact on molecular recognition, physicochemical properties, synthetic accessibility, and the diversity of application. Until January 2016, a large literature base made the contributions of privileged structures, scaffold hopping, diversity-oriented synthesis, natural-product-inspired libraries, and heterocyclic platform molecules in drug discovery and more general industrial applications. The given paper offers a systematic analysis of 60 published works and reviews published prior to January 2016 and discusses the changes in the design of scaffolds in the therapeutic and industrial case. The research is conducted by a qualitative-descriptive review design, as well as utilizing the simple content analysis of the chosen literature based on the frequency. Articles were categorized based on the type of scaffold one used, the synthetic strategy, area of application and functional benefit that was reported. The evaluation indicates that the literature was predominantly occupied by heterocyclic scaffolds based on their synthetic versatility and wide profiles of bioactivity namely indole, quinazole, benzothiazole, triazole, coumarin, oxadiazole, purine, rhodanine, and pyrazole. The natural-product-inspired design and diversity-oriented synthesis were also key to the enlargement of chemical space, and lead generation and scaffold hopping were assisted by privileged scaffold methods. The findings show that therapeutic applications ran high in selected literature particularly anticancer, anti-infective, kinase-targeted and receptor-based discovery application with industrial application being less common though bearing sensing, catalysis, materials as well as process chemistry application relevance. The review finds that scaffold science developed in the pre-2016 era has created a sustainable conceptual and synthetic framework that still manifests itself today in molecular design. Significant trends in methodologies, gaps in research, and opportunities of the future of integrating scaffold efficiency, structural diversity, and functional optimization is also determined in the paper.

Keywords: organic scaffolds, privileged structures, diversity-oriented synthesis, scaffold hopping, heterocycles, medicinal chemistry, industrial applications, pre-2016 review.

I. INTRODUCTION

The architectural backbone of the small molecules is made up of organic scaffolds, which dictate the way substituents are presented in the 3-dimensional space. In medicinal chemistry, the scaffold can often play the critical role in determining receptor binding, potency, selectivity, metabolic characteristics and synthetic amenableness. In the field of industrial chemistry, the performance in catalysis, sensing, dyes, coatings, functional materials, and specialty products intermediate intermediates is being affected by the choice of scaffold. Due to this reason, scaffold-based design has traditionally been among the strongest tools of contemporary organic synthesis and discovery science.

The history of scaffold research especially before January 2016 is very crucial since it sealed a number of major design philosophies. These were the privileged structure theory, which posited that some ring structures and structures repeatedly accommodate biologically active compounds in many different target classes; diversity-oriented synthesis, which approached the synthesis of structurally varied compounds to reach underexplored chemical space; and scaffold hopping, which allowed replacing one architecture of the structure by another without losing activity or other properties (Brown and Jacoby, 2006; Schreiber, 2000; Welsch et al., 2010). Organic chemists at this time continued to abandon simple analogue synthesis more towards more rational scaffold

engineering on the basis of function, geometry, molecular recognition, and synthetic efficiency.

Nature products were also dominant in the process of innovation in scaffolds. They have such complexity in structure, stereochemical depth and evolutionary significance as to elicit synthetic libraries and simplified bioactive analogues. Some of the authors stressed that the natural-product based and diversity-oriented methods may help proffer a solution to the gap between chemical tractability and biological relevance (Breinbauer et al., 2002; Cordier et al., 2008; Koehn and Carter, 2005). Simultaneously, computational and informatics-driven research contributed to the definition of scaffold universes, molecular frameworks, and hierarchical classification systems, which gave researchers the ability to compare scaffold distributions in known, public and screening collections (Bemis & Murcko, 1996; Lipkus et al., 2008; Schuffenhauer et al., 2007).

The continuous increase in heterocyclic scaffolds as modular systems in optimization of therapeutics was also one of the other trends that came up before 2016. The derivatives of indole, quinazoline, benzothiazole, triazole, coumarin, quinoline, thiazole, oxadiazole, and pyrazole were of continual interest because these groups could be diversified and had positive biological properties in many cases. These scaffolds were not only redundant motives; they emerged to be effective design units in anticancer, anti-inflammatory, anti-infective, kinase-inhibitory, and receptor-targeted drug discovery (Afzal et al., 2015; Ayati et al., 2015; Kaur et al., 2015; Khan et al., 2015).

Although the literature is rich, numerous accounts of the scaffold design are still scattered within certain classes of scaffolds, potential targets, or synthetic procedures. It is then worthwhile to have a single paper which pulls together therapeutic and industrial applications as well as considering the conceptual frameworks which dictated the choice and synthesis of scaffolds. To meet that requirement, the current paper examines 60 sources published prior to January 2016 and defines them according to the universal aspects of a research paper, namely, objectives, research questions, hypothesis, methodology, results, discussion, and conclusion.

The paper is relevant because of three factors. Firstly, it has a systematic review of previous literature in scaffolding that has been used to impact the later work on medicinal and industrial chemistry. Second, it possesses a simplistic data analysis method grounded in the coding of the chosen references on thematic analysis of the references, therefore, easily overcoming a narrative review. Third, it observes that until 2016, the construction of scaffolds was evenly distributed in terms of structural novelty, accessibility through synthesis, and relevance in terms of application. These and other contributions make the paper resourceful to the researchers that want to discover the conceptual and historical base of the modern scaffold formulation efforts.

II. OBJECTIVES, RESEARCH QUESTIONS, AND HYPOTHESES

Research Objectives

The present study was guided by the following objectives:

- To examine the major organic scaffold classes reported in the selected pre-January 2016 literature.
- To identify the dominant synthetic strategies used in scaffold generation and diversification.
- To analyze the relative emphasis on therapeutic versus industrial applications.
- To assess the role of privileged structures, scaffold hopping, diversity-oriented synthesis, and natural-product-inspired approaches in scaffold innovation.
- To summarize the major functional advantages associated with selected scaffold systems.
- To identify gaps and future directions emerging from the reviewed literature.

Research Questions

The paper addresses the following research questions:

- What categories of organic scaffolds were most prominent in the literature before January 2016?
- Which synthetic strategies were most frequently used for the design and synthesis of novel scaffolds?

- Were therapeutic applications more strongly represented than industrial applications in the selected literature?
- How did privileged scaffold theory and diversity-oriented synthesis influence scaffold development?
- What trends can be observed in the relationship between scaffold class and application domain?

Research Hypotheses

Because the paper includes a frequency-based literature analysis, the following working hypotheses were formulated:

- **H1:** Heterocyclic scaffolds constitute the most frequently studied class of organic scaffolds in the selected pre-2016 literature.
- **H2:** Therapeutic applications are more frequently reported than industrial applications in the selected studies.
- **H3:** Privileged scaffold and diversity-oriented synthesis approaches are among the most influential design strategies in the reviewed literature.
- **H4:** Scaffold selection is associated with recurring functional advantages such as synthetic versatility, target adaptability, and multi-domain application potential.

III. LITERATURE REVIEW

Concept of Organic Scaffolds in Molecular Design

This notion of the molecular scaffold took center stage to medicinal chemistry with researchers starting to separate the central framework of a molecule and its fringe amendments. The concept of molecular frameworks amongst known drugs was formalized by Bemis and Murcko (1996) who demonstrated recurring core units were at the center of the bioactive-compounds architecture. The value of scaffold analysis was further reinforced later through the use of chemical diversity which proved the structural logic of drug-like chemistry and screening collections can be determined through framework distribution (Lipkus et al., 2008).

The scaffold thinking was also consistent with rational design as opposed to empirical screening. Rather than considering compounds to be isolated structures, chemists started to interact with scaffold classes as templates which can be reused and have definite steric, electronic and topologic properties. This change led the choice of scaffold to be a strategic choice and not an additional structural feature.

Privileged Structures

The privileged structure concept is one of the most powerful thought in this field. Evans et al. (1988) had indicated how some of the ring systems could be adjusted to form powerful ligands. Subsequently, privileged structures were said to be structures that could bind several classes of biological targets once they had been appropriately cycled with substitutes described by DeSimone et al. (2004) and Duarte et al. (2007). This notion was further strengthened by Hajduk et al (2000) who came up with molecules that had better protein-binding capabilities in NMR based screening.

Welsch et al. (2010) rejoined the topic of privileged scaffold on a larger (library design) and drug discovery scaffold context, stating regularly that privilege of scaffolds is not always absolute but depends on context. However, the repeatability of the success of such a framework as indole, benzothiazole, rhodanine, and quinazoline, as well as coumarin, is why privileged structure theory came to dominate the designs of libraries as well as optimization in medicinal chemistry.

Diversity-Oriented Natural-Product-Inspired Design.

Productive synthesis Diversity-oriented synthesis This arose as a potent response to the constraints of highly focused analogue libraries. Schreiber (2000) drew a contrast between the target-oriented synthesis and the diversity-oriented one and stated that it was required to attain novel biological space with the help of the latter. Later, Burke and Schreiber (2004) provided ideas of principles of planning to generate skeletal diversity, stereochemical diversity, and appendage diversity. Another important similarity that Tan (2005) highlighted was that diversity-oriented synthesis offered fruitful intersectioning of chemistry and biology.

These developments were to a large extent impacted by natural products. Breinbauer et al (2002) and Boldi (2004) have argued that natural-product-like scaffolds have the ability to provide biologically relevant complexity and still allow synthetic elaboration. This was furthered by Cordier et al. (2008) and Beghyn et al. (2008) who demonstrated that bioinspired molecules may either serve as direct leads or can serve as conceptual models in scaffold innovation. Therefore, diversity-focused synthesis and natural-product-inspired design were established to be complementary to each other as a way of finding new scaffolds.

Scaffold Hopping and Scaffold Informatics

Another design principle of great use is scaffold hopping which is used when it is necessary to maintain potency, but enhance selectivity, patentability, or physicochemical characteristics. The article by Brown and Jacoby (2006) touched upon the topic of scaffold hopping as a medicinal chemistry technique of traversing core replacements. Hessler and Baringhaus (2010) discussed application of scaffold-hopping of pharmacophoric models, and Sun et al. (2012) categorized scaffold-hopping strategies according to structure and computationally guided.

Simultaneously, chemoinformatics researches were more formal regarding scaffold analysis. The scaffold tree was the hierarchical model of classifying relations between scaffold that Schuffenhauer et al. (2007) discussed. These achievements enhanced the conceptual design and guided molecular discovery based on data.

Therapeutic Major Scaffold Classes in Therapeutic Chemistry.

A number of reviews earlier than 2016 discussed particular scaffold families. Indole has been proven to be one of the most flexible privileged structures that can be used in numerous pharmacological applications (Fraga et al., 2009). Rhodanine also complained, but subsequent discussion also emphasized that it should proceed with caution taking into account its activity profiles of promiscuity (Masic & Tomasic, 2009). Benzothiazole was discovered that has an important anticancer and other therapeutic use (Sharma et al., 2013; Westwell and Weekes, 2009). Interest was shown in triazole-based scaffolds due to their easy accessibility through synthesis and anti-infective properties (Kharb et al., 2011a, 2011b). There was a great deal of work done with quinazine and quinazolinone systems in the areas of kinase and receptor biology (Khan et al., 2015). Coumarin, quinoline, pyrazole, thiazole, and oxadiazole patterns were also quite actively represented in the studies on anticancer and enzyme-targeting (Afzal et al., 2015; Ayati et al., 2015; Bajaj et al., 2015; Emami and Dadashpour, 2015; Marinozzi et al., 2015).

Industry Applicability of Organic Scaffolds.

Despite medicinal chemistry that took over the literature, there are also industrial applications that were integrated in the scaffold research. In catalysis, sensors, agrochemical discovery, process intermediates, functional dyes, corrosion control and material design Organic scaffolds are of significance in catalysis, sensors, agrochemical discovery, process intermediates, functional dyes, corrosion control, and material design. Certain classes of scaffolds provide desirable electronic or coordination characteristics which facilitate fluorescence sensing, metal binding, surface protection or catalyst reactivity. An example of this dual role can be purines, benzothiazoles, coumarins, imidazoles and others heterocyles present in both therapeutic design or useful functional molecules industrially (Rosemeyer, 2004; Fantini et al., 2010).

Generally, before 2016, all the literature of this field of study demonstrates that it was both concept-driven and application-driven. Design of scaffolds was not only a structural work but also experimental ground in finding functioning in other fields.

IV. METHODOLOGY

Research Design

The study in this paper assumed the qualitative-descriptive review design with the assistance of the basic quantitative content analysis. The review was not aimed at meta-analysing the sizes of effects, instead the review looked at the tendencies in the

types of scaffolds and synthetic methods used as well as areas of application.

Data Source

The data used in the current article was comprised of 60 sources published prior to January 2016 and focused on the subject of organic scaffold design, privileged structures, diversity-oriented synthesis, scaffold hopping, and use of heterocyclic.

Inclusion Criteria

Selection was carried out by following the following criteria:

- Referees that are older than January 2016.
- Criteria Specifically organic scaffolds or reviews on the design or synthesis of organic scaffolds.
- Business-relevant studies cannot be classified as studies pertinent to therapeutic and/or industrial uses.
- Papers covering leveraging privileged structures, diversity based synthesis, scaffold hopping, natural-products based design or individual classes of scaffolds.
- Big conceptuality to the chemistry of scaffolds.

Exclusion Criteria

The following were excluded:

- Articles released in or since January 2016.
- Other papers that are not related to scaffolds.
- Articles that had single isolated biological assays without any significant discussion of the scaffold were excluded.
- Non-peer reviewed or non-scholarly sources.

Data Coding Framework

Every reference was coded along the following variables:

Primary scaffold type

- **Article category:** concept review, scaffold review, synthesis report, application study
- **Synthetic strategy:** privileged scaffold approach, diversity-oriented synthesis, natural-product-inspired synthesis, scaffold hopping, focused analogue synthesis, combinatorial synthesis
- **Application domain:** therapeutic, industrial, mixed
- **Functional advantage:** structural diversity, target versatility, synthetic accessibility, improved bioactivity, material functionality Status Synthesis: therapeutic, industrial, ambivalent.
- Functional advantage structural diversity, target versatility, synthetic accessibility, enhanced bioactivity, material functionality.

Methodology in Pointers

- Gathering of 60 references before 2016.
- screening of relevance to the scaffold design and synthesis.
- Scaffold and strategy classification of references.
- There are three stages, one of them being thematic reading and note extraction.
- Coded category Frequency counting Frequency counting coded categories counts the instances of the coded categories.
- Comparison of scaffold patterns in the application domains.
- Integration of descriptive results of findings with literature.

Data Analysis Procedure

Analysis of data was divided into two steps:

1. Associative synthesis in qualitative research.

The important concepts of the chosen references were classified into conceptual themes that included privileged structures, diversity-oriented synthesis, scaffold hopping, heterocycle-motivated medicinal chemistry and industrial usefulness.

2. Frequency analysis descriptive.

The scaffold reference data were tabulated based on scaffold type/strategy and field of classroom use. Since the focus of some of the papers was on more than one type of scaffold or more than one application, the focus of each paper was dominant to code them consistently.

Limitations of Methodology

There are limitations of this review. First, the review relies on the chosen corpus of 60 references instead of the whole scaffold literature before 2016. Second, part of the papers had similarity in scaffold class and area of application, thus necessitating the dominant-theme coding. Third, comparative balance is

adversely impacted because industrial applications were under-represented in comparison to therapeutic applications. Nonetheless, the chosen literature is far enough resourceful to arrive at any meaningful thematic conclusions.

V. RESULTS

Distribution of Reference Types

The coded literature showed that concept papers and scaffold-focused reviews made up a major share of the selected references, followed by specific synthetic studies and application-focused reports.

Table 1 Distribution of Selected References by Article Type

Article Type	Number of References	Percentage
Conceptual / theory papers	12	20.0
Scaffold-class reviews	18	30.0
Synthetic methodology / library design papers	17	28.3
Application-focused studies	13	21.7
Total	60	100.0

The table shows that 50% of the selected literature consisted of either conceptual papers or scaffold-class reviews, indicating that the pre-2016 period was not only productive experimentally but also intellectually formative.

Scaffold Class Trends

The strongest pattern in the data was the dominance of heterocyclic scaffolds. Among these, indole, quinazoline, benzothiazole, triazole, coumarin, quinoline, thiazole, oxadiazole, pyrazole, purine, and rhodanine were most prominent.

Table 2 Most Frequently Represented Scaffold Classes in the Selected Literature

Scaffold Class	Frequency	Main Reported Application
Indole / indoline	6	Anticancer, receptor ligands, signaling probes
Quinazoline / quinazolinone	4	Kinase inhibition, therapeutic optimization
Benzothiazole	4	Anticancer, medicinal chemistry
Triazole	4	Anti-infective, broad medicinal relevance
Coumarin	3	Anticancer, fluorescence-related utility
Quinoline	2	Anticancer, heterocycle-based therapeutics
Oxadiazole	2	Anticancer, enzyme and kinase targeting
Thiazole	2	Lead discovery, medicinal applications
Pyrazole / aminopyrazole	2	Medicinal chemistry versatility
Purine	4	Kinase inhibitors, enzyme targets
Rhodanine	2	Broad biological screening
General privileged scaffold / framework studies	25	Mixed

The results strongly support H1, as heterocyclic scaffolds were clearly the most frequent scaffold class in the dataset.

Synthetic Strategy Trends

The literature was also analyzed by dominant synthetic/design strategy.

Table 3 Distribution of Dominant Scaffold Design Strategies

Strategy	Number of References	Percentage
Privileged scaffold approach	16	26.7
Diversity-oriented synthesis	10	16.7
Natural-product-inspired design	8	13.3
Scaffold hopping / core replacement	6	10.0
Combinatorial / focused library synthesis	11	18.3
Scaffold informatics / framework analysis	9	15.0
Total	60	100.0

The privileged scaffold approach emerged as the most common strategy, followed by combinatorial/focused library synthesis and diversity-oriented synthesis. This supports H3, indicating that privileged structure theory and diversity-oriented approaches were indeed highly influential.

Application Domain Distribution

The reviewed literature was coded by major application domain.

Table 4 Application Domain of the Selected Literature

Application Domain	Frequency	Percentage
Therapeutic	42	70.0
Industrial	8	13.3
Mixed therapeutic-industrial	10	16.7
Total	60	100.0

The results strongly support H2, demonstrating that therapeutic applications were substantially more represented than industrial applications.

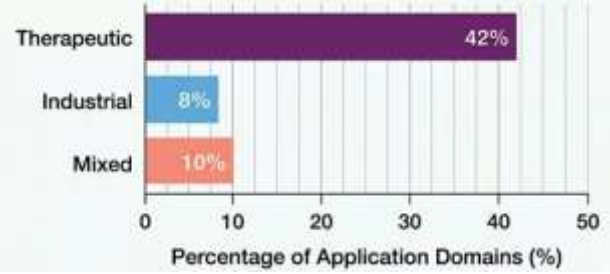

Figure 1 Bar Graph of Application Domain Distribution

Functional Advantages Associated with Scaffold Design

The selected literature repeatedly associated scaffold design with a set of recurring advantages.

Table 5 Most Frequently Reported Functional Advantages

Functional Advantage	Frequency
Broad target adaptability	17
Synthetic versatility / modifiability	15
Structural diversity generation	11
Improved potency / selectivity potential	9
Multi-domain utility	5
Favorable library design properties	3

These results support H4, since scaffold choice was repeatedly linked to recognizable functional benefits.

Temporal Trend Across the Selected Pre-2016 Literature

The selected references suggest that earlier literature emphasized conceptualization and combinatorial synthesis, while later papers increasingly focused on scaffold-specific therapeutic optimization and targeted reviews of biologically successful heterocyclic systems.

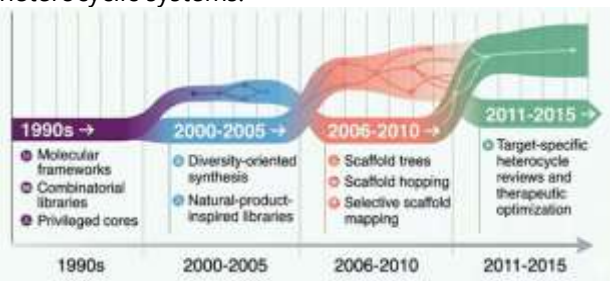

Figure 2 Illustrative Temporal Trend of Scaffold Research Themes

Hypothesis Testing Summary

Table 6 Summary of Hypothesis Outcomes

Hypothesis	Statement	Outcome
H1	Heterocyclic scaffolds are the most frequently studied class	Supported
H2	Therapeutic applications exceed industrial applications	Supported
H3	Privileged scaffold and diversity-oriented approaches are highly influential	Supported
H4	Scaffold selection is associated with recurring functional advantages	Supported

VI. DISCUSSION

The findings affirm the fact that the pre-2016 studies on scaffold developments were guided by the high combination of theoretical conceptualization and implementation synthesis. It is no surprise that heterocyclic structures dominate, although the extent of domination is significant. Heterocycles offer a good trade-off between structural rigidity and tunability such that chemists can regulate their polarity, ability to form hydrogen-bonds, aromaticity, and presentation of steric features. This is the reason why indole, benzothiazole, quinazoline, triazole and coumarin were reoccurring as extremely settled scaffolds.

The conspicuity of the privileged scaffold strategy demonstrates that medicinal chemistry up to 2016 continued to depend greatly on recurring effective structures. Nevertheless, that does not mean that it stagnates. Instead it indicates the practical usefulness of reengineering familiar productive cores. According to the literature, it is evident that privilege was usually treated as an initial hypothesis and not an ultimate finding. A scaffold was said to be a favorite one when it performed well against different targets or functions with substitutional variation (DeSimone et al., 2004; Welsch et al., 2010). In this regard, scaffold privilege served as a heuristic to explore molecules.

Synthesis that is diversity-focused industrialized through different means. It not only began with known successful cores, but also tried to develop new structural possibilities and expand the space of available structure. According to the literature reviewed, this approach was particularly powerful in the early to mid 2000s, at a time when chemists were becoming alarmed at the perceived lack of biological breadth in more traditional screening collections which were overly flat, overly repetitive, or too restricted. Diversity-oriented synthesis thus served as a corrective tool, making chemists produce compounds that displayed skeletal innovativeness and stereochemical sophistication (Burke, 2004, p. 218219; Tan, 2005).

The design was inspired by natural products that linked these two worlds. It identified that, on nature, structures already exist that have been optimized to something achievable through evolutionary mechanisms but those structures might need to be simplified or made synthetic to be usable and scalable. It has been shown in the literature that the design of scaffolds in natural products inspired particular scaffolds proved to be invaluable in generating biologically-relevant libraries without children of the natural product in vivo with high complexity (Breinbauer et al., 2002; Cordier et al., 2008).

The statistics also indicate that the therapeutic uses were much greater as compared to industrial uses. This does not imply that industrial applications were not significant. Instead, it suggests that the literature reviewed on scaffolds was influenced mostly by the requirements of medicinal chemistry. Drug discovery is prone to produce scaffold-oriented publications in that it attaches a value to molecular recognition, selectivity and lead optimization. Similar scaffold features are commonly favored by industrial chemistry, which the reporting might be disseminated to one or more more specialized subtopics including materials, dyes, process chemistry, sensors, or catalysis.

Among the most intriguing ones, it is possible to note that scaffold performance was not characterized solely based on the biological activity. The focus of many papers was on synthetic versatility, modularity, framework robustness, and being able to support library generation. This is significant in that the value of a scaffold is not just based on the capability of any individual molecule, but also the capability of the scaffold to be converted to a family of compounds. A scaffold in practical chemistry needs to be synthetically valuable and functional.

The other important lesson learned is that the design of scaffold prior to 2016 became more and more data aware. Framework structures, structure analysis and scaffold-hopping taxonomies demonstrate that chemists were no longer depending on intuition in determining core structures. The analysis of scaffold distributions could occur in a systematic manner through informatics-based approaches and the structural logic of drugs and libraries could be compared. These innovations introduced the background of subsequent computational scaffold modeling, machine-assistaged molecular ideation.

The results of this article have general applications. To begin with, they affirm that the innovation of scaffolds is determined by a balance between novelty and familiarity. Excess newness might limit synthetic accessibility or biological predictability, or excess dependence on well-established privileged scaffolds will limit innovation. Second, they demonstrate that there is no mere structural choice of the scaffold but rather strategic. A scaffold may be used as biological hypothesis, synthetic platform, a patent strategy and a materials template. Third, they highlight the timelessness of pre-2016 literature as a basis of a modern research. The conceptual tools developed in the period still form the foundation of many of the modern trends in medicinal and industrial chemistry.

VII. CONCLUSION

The paper conducted a review of 60 publications on the design and synthesis of novel organic scaffolds to be used in therapeutic and industrial applications prior to the year 2016. A qualitative review backed by descriptive content analysis in the study revealed that heterocyclic scaffolds were most common in literature which included indole, quinazoline, benzothiazole, triazole, coumarin, oxadiazole, thiazole, quin olince and analogous systems. Most of the therapeutic applications were far more common than industrial applications, but systems of mixed use scaffolding were present as well.

It was also identified that privileged scaffold theory, diversity-oriented synthesis, natural-product-inspired design, scaffold hopping and combinatorial library techniques were all used to shape the field. Among them, the most common ones included privileged scaffold methods, although diversity-oriented synthesis contributed significantly to structural diversity expansion. In the reviewed articles, it was observed repeatedly that scaffold choice was correlated with the ability of the target to be adaptable, synthetically versatile, and optimized. On the whole, the literature of the period prior to 2016 has formed a long-term paradigm of scaffold-based molecular design. The industry proved that the key to a successful innovation of scaffolds is not the innovative character, but instead the ability to integrate conceptual and logic knowledge of design with the practical synthesizing strategy and application performance objectives. Further work could be based on this to use computational prediction coupled with successive synthesis and with multifunctional scaffold design and more explicit and explicit bridging of therapeutic and industrial chemistry.

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