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Conceptualisation of the Regulatory Framework of Green Infrastructure for Urban Development: Identifying Barriers and Drivers

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Abstract: Urban green infrastructure plays a crucial role in sustainable city development by offering a multitude of benefits, including improved environmental quality, increased social well-being, and enhanced economic prosperity. Evaluation and monitoring of regulatory implementation stand as essential components in the advancement of urban green infrastructure (GI) as they indicate the efficacy of regulatory acts and enable the assessment of their implementation success and adaptability to identified needs. This study identifies barriers and drivers based on the views of 352 professionals surveyed between 2018 and 2023 in Serbia. The primary data collection method employed questionnaire surveys. This study identified a range of barriers within existing legal frameworks, foremost of which include the lack of coordination and coherence between relevant ministries and governmental agencies, insufficient financial and human resources, the lack of transparency in the regulation development process, the need for strengthening technical capacities, and the absence of an adequate urban GI strategy. This research serves as a foundation for conceptualising GI regulatory elements that enhance urban GI development. Addressing these barriers necessitates efforts to improve coordination and collaboration among stakeholders, increase public participation, and enhance transparency in the regulatory process.

Keywords: green infrastructure; conceptual framework; institutional innovation; green infrastructure regulation; ecosystem services

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1. Introduction

1.1. Theoretical Background

Rapid urbanisation across the planet has left a significant ecological footprint, resulting in profound changes to landscape patterns and ecosystem structures and functions. This trend ultimately leads to the degradation and fragmentation of natural and nature-like elements, undermining the integrity of landscapes. Moreover, it contributes to the emergence of urban heat islands, increased greenhouse gas emissions, and reduced biodiversity. Concurrently, there is an evident decline in health and well-being, which, combined with the effects of intense climate change, adversely affect the quality of life of residents of modern cities [1–4].

As the key driver of changes in the quality and integrity of environmental elements, urbanisation necessitates the adaptation of urban landscape planning models towards greater sustainability [5,6]. The concept of sustainability should primarily respect existing natural values within urban settings to determine new planning models based on landscape ecology principles that will enable the preservation of existing and the creation of new nature-like elements in the urban structure [7]. The planning model should, by no means, be viewed as a static instrument but be based on emerging knowledge regarding climate

change and innovative approaches to sustainable planning; it should create a dynamic representation of the city as an adaptable organism that can provide space for the coexistence of nature and city residents [8]. Of course, planning the metropolitan areas of landscapes at the regional and global levels requires more than just having models based on scientific hypotheses that have been validated in local practice. It also requires having a sufficient regulatory framework to allow the process to be applied.

Green infrastructure has been identified as an effective measure to address many of the negative consequences of urbanisation and climate change and to improve the sustainability of urban development [9–11]. Urban landscapes are saturated with non-porous surfaces, which serve as the foundation for urban processes and functions. In this context, natural and nature-like elements fail to provide ecosystem services adequately and effectively. Green infrastructure is a concept that unites elements of different forms and spatial levels into a system that represents a conglomerate of ecosystem services capable of responding to the challenges posed by climate change, improving the environment, and ensuring the quality of life of city residents [12]. In addition, the efficient planning of GI elements, such as parks, tree-lined streets, blue–green corridors, recreational spaces, and individual trees, forms a resilient network that, through ecosystem services, promotes sustainable cities and provides an environmental platform for creating a smart city [13,14].

In light of the recognised value of the green infrastructure concept, governments worldwide are dedicating considerable efforts to integrate GI into their policy programs and planning guidelines [15]. This process is particularly aided by the emergence of the United Nations Sustainable Development Goals [16] set for 2030, underscoring the role of green infrastructure in achieving the goals related to conserving life on land (SDG 14), ensuring clean water (SDG 6), and adapting to climate change (SDG 13) [17]. However, research has confirmed the uneven presence and distribution of GI elements within the regulatory framework because of various factors. These include historical context, state policies aimed at increasing property value, financial constraints for GI maintenance and development, top-down political decisions and their implementation, and limited public involvement [8,18,19].

1.2. Development of the Conceptual Framework for Green Infrastructure

The concept of green infrastructure has been seeking its place within the regulatory framework of planning institutions and practices worldwide for decades. Presently, three informal phases of this process have been delineated [20]: the exploration phase, which occurred during the 1990s and primarily focused on uncoordinated scientific research on the ecological functions of green infrastructure to a limited extent; the expansion phase, which took place during the 2000s and initiated a broader discussion on the principles and values of green infrastructure; and the consolidation phase, which started around 2014, with earnest efforts to integrate green infrastructure into policy.

In the USA, this concept primarily materialised as blue–green infrastructure, serving the function of natural resource protection and water management, particularly at the urban scale [21]. Although larger cities, such as Boston, New York, and Philadelphia, as pioneers in this process, recognised the value of urban green spaces and integrated them into conservation efforts, this approach did not systematically influence other cities [22]. In recent decades, countries in Asia and the Global South have also been actively engaged in researching the impact of green infrastructure on the quality of urban landscapes and exploring modalities for the development of planning guidelines [23]. Within Europe, green infrastructure is embraced as both a spatial and functional concept, extensively covered in numerous reports and strategies. The presence of the ecological network concept rendered Europe as being fertile ground for the adoption of this new approach, with particular significance attributed to the EU Green Infrastructure Strategy. This strategy identifies green infrastructure as an integrated network of natural features that enhance the status and perception of ecosystem services across various sectors, including biodiversity preservation; climate adaptation; forestry, soil, and water protection; and the circular economy [24].

The advancement of the application of the concept of green infrastructure in the UK is particularly significant, given the long tradition of landscape and green area planning. Key principles supporting green infrastructure planning, along with proven methodologies, have been identified [25].

In previous research, green infrastructure has consistently demonstrated its capacity to address the challenges posed by modern city development and climate change across various scales, from global to local. It operates on principles such as multifunctionality, connectivity, diversity, and identity. However, one of the challenges lies in the comprehensive regulation of green infrastructure, as its spatial and functional coverage is vast and intertwined with geographical contexts [24,26].

Countries in transition, such as Serbia, face similar challenges stemming from territorial irregularities and uneven urban systems. For instance, Belgrade, Serbia's capital, hosts more than 15% of the country's urban population and serves as the centre for most urban functions, including finances, education, and culture [27]. In addition, the metropolitan area of Belgrade, along with other cities, accommodates more than half of Serbia's population but comprises less than 2% of all the settlements [28]. Consequently, Belgrade grapples with numerous environmental issues related to air quality, urban heat islands, flood occurrences, soil erosion, and the loss of biodiversity [29,30]. To address these challenges and integrate green infrastructure into urban development for a more sustainable, resilient, and healthier city, a systemic regulatory approach becomes imperative. Given its development, Belgrade serves as an ideal testing ground for the application of green infrastructure concepts, contributing to more effective protection, management, and restoration of urban ecosystems. Although Belgrade has a certain tradition regarding the city's natural values, dating back to the first urban plan in the late nineteenth century and the concept of the green belt introduced in the thirties of the twentieth century, a systemic framework for regulating green infrastructure has been notably absent until now.

The dogmatic approach represented in land use planning regulations reflects a specific law system influenced by traditional and cultural attitudes towards urban open spaces and their resources. Consequently, identifying a universal and inclusive approach to the development of green infrastructure regulations proves to be challenging. Moreover, decision-makers and planners crucial to regulation development often employ incoherent and uncoordinated strategies because of the abundance of literature and examples on green infrastructure models, coupled with the lack of clarity on regulatory development approaches and instruments [31]. The methodological framework of our study was established through the formation of a conceptual framework aimed at identifying barriers and drivers within a comprehensive scope. It is essential to form a consensus around the establishment of an organisational strategy capable for addressing all the questions regarding the treatment of green infrastructure elements. The initial construction of the applied approach relied on the models that were used and proved during the analysis of the modalities of the formation and success of the regulatory framework. These models relied on determining the viewpoints of professionals dealing with green infrastructure from different aspects and at different scales [32]. It is crucial to identify all the barriers, recognised by active professionals in the field, impeding the transformation of the spatial planning system and obstructing the institutionalisation of the green infrastructure concept [33]. To address this, a list of pertinent questions was formulated to highlight potential drivers identified by professionals directly or indirectly during their work [34].

This conceptual framework serves as the interconnection of different concepts and provides a comprehensive understanding of the integral role each concept plays within the network [35]. Detailed data collection and aggregation were essential for developing this framework. The conceptual framework, depicted in Figure 1, is based on knowledge derived from both theory and practice. These findings will contribute to the scientific discourse on green infrastructure and aid practitioners seeking to understand appropriate planning and design processes.

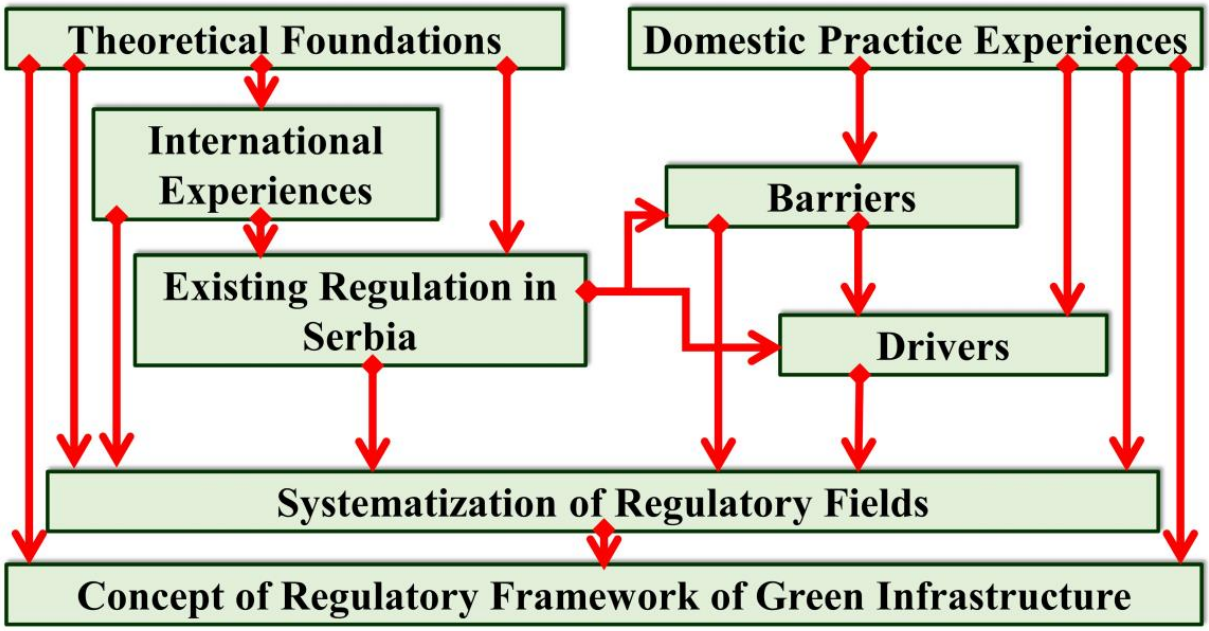


Figure 1. Dual approach in the study: theoretical foundations and practice.

Consequently, research conducted between 2018 and 2023 in Serbia surveyed 352 professionals and representatives of 33 city and state organisations relevant to GI. The aim was to identify barriers and drivers within a broad conceptual framework in the following areas: (1) formulating a legal framework for GI; (2) regulating the conservation of existing GI elements; (3) improving GI planning regulation; (4) improving regulation in the fields of design and construction; (5) enhancing regulation for green infrastructure maintenance; (6) regulating GI management; and (7) enhancing awareness, knowledge, and information dissemination about GI.

Drawing from both theoretical foundations and practical applications, green infrastructure (GI) can serve as the missing link between people, nature, and the built environment. It offers a cost-effective and efficient solution for addressing multiple challenges simultaneously [36], achieved through the integration of interdisciplinary factors such as pollution mitigation, habitat and biodiversity conservation, improvement in the quality of life, provision of food and energy, facilitation of recreation, and enhancement of landscape values.

2. Method

To conceptualise the regulation of green infrastructure (RGI) in Serbia, the viewpoints of professionals directly or indirectly involved in green infrastructure (GI) were explored. An examination and analysis of the scientific literature facilitated the thematic mapping and categorisation of these viewpoints [37] to facilitate the selection and direction of the survey [38]. The selection criteria for respondents were based on their understanding and expertise related to assessment tools and other evaluation methodologies, as well as their professional interest in GI development. Therefore, the study did not encompass the viewpoints of citizens, as knowledge and experience were considered as being necessary for the systemic approach to GI regulation. Questionnaires were distributed among landscape architects, urban planners, spatial planners, architects, civil engineers, forestry engineers, horticulture engineers, and ecologists, as well as professionals in law, culture, tourism, environmental and nature protection, transportation, technical infrastructure, economics, and others employed in institutions with experience in GI.

Professionals employed in urban secretariats (departments for environmental protection, urban planning and construction, communal and residential affairs, culture, economy, transportation, etc.); government institutions (construction, transportation, infrastructure, environmental protection, etc.); state and city public enterprises engaged in the planning,

management, and maintenance of green infrastructure elements (public green spaces, forests, watercourses, etc.); as well as non-governmental organisations focused on enhancing urban quality were surveyed.

The total number of professionals surveyed amounted to 352. The study made use of data collected from surveys conducted between 2018 and 2023 (Table 1).

Table 1. Summary of surveys conducted among professionals from 2018 to 2023.

Survey	Number of Participants	Participant Type	Number of Questions in the Questionnaire
Legal Regulation as a Mechanism for Green Space Sustainability (2018)	47	Individuals—professionals	31
Green Infrastructure in Serbia (2019)	167	Individuals—professionals	24
Green Infrastructure Strategy (2020)	96	Individuals—professionals	8
Green Infrastructure Strategy of Belgrade (2023)	42	Representatives of 32 city and state organisations relevant to GI	45

Before conducting the survey in 2018, pilot interviews were conducted with experts from national professional associations, with the support of the Ministry of Environmental Protection of the Republic of Serbia. The aim was to define the questions to be answered in a larger sample. Pilot interviews, serving as trial surveys in this research, were conducted with a sample of 10 respondents to identify and rectify any errors before broader data collection. Additionally, they helped to identify any ambiguities enabling surveyors to seek clarification from respondents [39]. The questionnaires were structured to encompass various types of questions, including closed-ended questions with a predefined set of responses, open-ended questions, and open-ended questions allowing for additional responses. Questions were classified based on different aspects related to which professionals' attitudes were assessed. During a workshop held on 31 October 2018, participants responded to questions related to the preservation of existing greenery and green spaces (9 questions); planning, designing, and constructing new green spaces (10 questions); and using and maintaining green spaces (12 questions). The questions were open-ended to avoid bias in the research (Supplementary Material S1).

The responses partly confirmed the emphasis on problems that had already been identified as being significant, but there were also entirely new topics based on which the questionnaire (Supplementary Material S2) was compiled for the subsequent year of the research. This questionnaire included both closed- and open-ended questions.

An electronic survey was conducted in September and October 2019, containing the following question groups: general information about the respondents (4 questions); understanding of the concept of GI (2 questions); assessment of the state of GI in Serbia (12 questions); suggestions for improving the state (5 questions); and additional comments (open-ended responses).

In the third year of the research, based on the surveys conducted in 2018 and 2019, a questionnaire was structured comprising both closed- and open-ended questions (Supplementary Material S3). In October 2020, an electronic survey was conducted on the possibilities for implementing the European Green Infrastructure Strategy in Serbia. The questionnaire consisted of general information about the respondents (2 questions) and questions about the European GI Strategy and its implementation in Serbia (5 questions). With knowledge obtained from literature reviews and three conducted surveys, a questionnaire (Supplementary Material S4) with open-ended questions was structured in 2023. The qualitative research method of "in-depth" interviews was utilised, where the interviewer engaged respondents in dialogue and posed additional questions to clarify their responses. This survey was implemented as a part of the "Belgrade Green Infrastructure Strategy" project, and a survey was conducted with questions related to the legal framework of

GI (4 questions); organisation, management, and procedures in the context of GI (9 questions); preservation of existing GI elements (3 questions); GI planning (11 questions); GI design and construction (8 questions); GI maintenance (4 questions); and awareness and knowledge of GI (6 questions).

For the purpose of this study, all the questionnaires were transcribed and coded, with repetitions and digressions omitted beforehand. The most frequent and relevant responses were utilised and systematised into areas that could be parts of GI regulation. The number of responses to individual questions varies because participants did not respond to every question that was posed.

The surveys were analysed using text analysis techniques [40]. Microsoft Excel 2016 (KB5002454) 64 was used for creating graphical illustrations.

3. Results

3.1. Legal Regulation as a Mechanism for Green Space Sustainability

In the survey on legal regulation as a mechanism for the sustainability of green spaces (2018), participants were presented with a total of 31 questions. From the first group focusing on the "Preservation of Existing Greenery and Green Spaces", a total of 9 questions were aimed at gathering ideas to be incorporated into regulations to preserve existing green spaces as being the most developed and, therefore, most valuable for the environment. The key responses are presented in Table 2.

Table 2. Selected suggestions from respondents for the preservation of existing greenery and green spaces.

Preservation of Existing Greenery and Green Spaces
➢ Green spaces should be a public good (public interest).
➢ A new law or sublegal act should be developed to regulate greenery.
➢ Existing green spaces should benefit from a certain level of protection.
➢ There should be a cadastre of greenery as a part of the spatial database.
➢ The conversion of green areas should be prohibited.
➢ Mandatory fieldwork should be introduced for planners and designers, and the existing one should be valorised.
➢ Participation of landscape architects in planning commissions should be made mandatory.
➢ Penalties and compensation for destroyed greenery should be introduced.
➢ Tax incentives for investors to protect existing greenery should be provided.
➢ Plans and projects should be adapted to existing vegetation.
➢ Technical standards for protecting existing greenery during construction should be developed.
➢ Preference should be given to existing trees over installations.

The second group of questions, totalling 10, focused on "Planning, Designing, and Building New Green Spaces". The questions aimed to generate ideas for improving regulations in the spatial planning process for the more efficient creation of new green spaces. The key responses are presented in Table 3.

The third group of questions, totalling 12, focused on the "Utilisation and Maintenance of Green Spaces". This group of questions aimed to propose measures that would standardise construction works, the initial maintenance after the establishment of green spaces, and mandatory maintenance and offer solutions to ensure the issues of green space survival. The most valuable suggestions are presented in Table 4.

Table 3. Selected suggestions from respondents for planning, designing, and building new green spaces.

Planning, Designing, and Building New Green Spaces
➢ Defining a protocol for green space planning;
➢ Incorporating the protection of existing greenery within the planning framework;
➢ Introducing new parameters for evaluating greenery, such as ambience, cultural values, and ecosystem services;
➢ Introducing standards to the planning process;
➢ Planning structured greenery (at all levels, not just lawns);
➢ Introducing subsidies for new green spaces;
➢ Ensuring equal treatment for biotechnical objects as for buildings;
➢ Planning and designing in line with contemporary needs, such as water conservation, soil porosity preservation, connectivity, green roofs, green facades, and using plants resilient to altered microclimates;
➢ Planning the unity of blue–green corridors;
➢ Protecting greenery on private property through planning;
➢ Implementing clearer control mechanisms.

Table 4. Selected suggestions from respondents for the utilisation and maintenance of green spaces.

Utilisation and Maintenance of Green Spaces
➢ Developing standards for design and construction works;
➢ Standardising descriptions and norms of works;
➢ Creating regulations defining initial maintenance works after the establishment of green spaces, specifying types of works, warranties, calculation methods, etc.;
➢ Providing conditions to increase the self-sustainability of green spaces;
➢ Defining mandatory maintenance requirements;
➢ Inciting the maintenance of private spaces and offering them expert maintenance guidance;
➢ Including a professional, such as a landscape architect, as a member of the urban planning team;
➢ Establishing a centre for processing plant waste;
➢ Introducing irrigation systems, combined with the use of atmospheric water;
➢ Preventing encroachment on green spaces;
➢ Prohibiting the unplanned planting of Christmas trees.

3.2. Green Infrastructure in Serbia

In the second, electronic survey (2019), general information about the respondents covered questions regarding their profession, area of work, level of education, work experience, and gender (Figure S1 in the Supplementary Material).

This group of questions concerning "Understanding the Concept and Importance of GI" aimed to examine experts' attitudes regarding the importance and impacts of various elements of GI. In response to the question, "Evaluate to what extent the following terms relate to the concept of 'green infrastructure'", nine options were provided to discover which elements professionals considered to be the most valuable in GI within urban environments and surroundings. The responses are presented in Figure 2.

Of the nine provided terms, all the elements of green infrastructure were rated as being significant. However, experts considered parks, tree rows, and urban fringe forests to be the most important elements of green infrastructure. The importance of roadways, zones of individual housing, and agricultural land was rated the lowest.

Responses to the question "Evaluate the importance of green infrastructure for the quality of life in urban environments". are presented in Figure 3.

Of the 11 provided responses, experts assessed that GI was very significant for all 11 contributions but mostly for its impacts on the climate, air quality, biodiversity, and ambience. Respondents less commonly perceived the importance of GI for residents' education and soil quality.

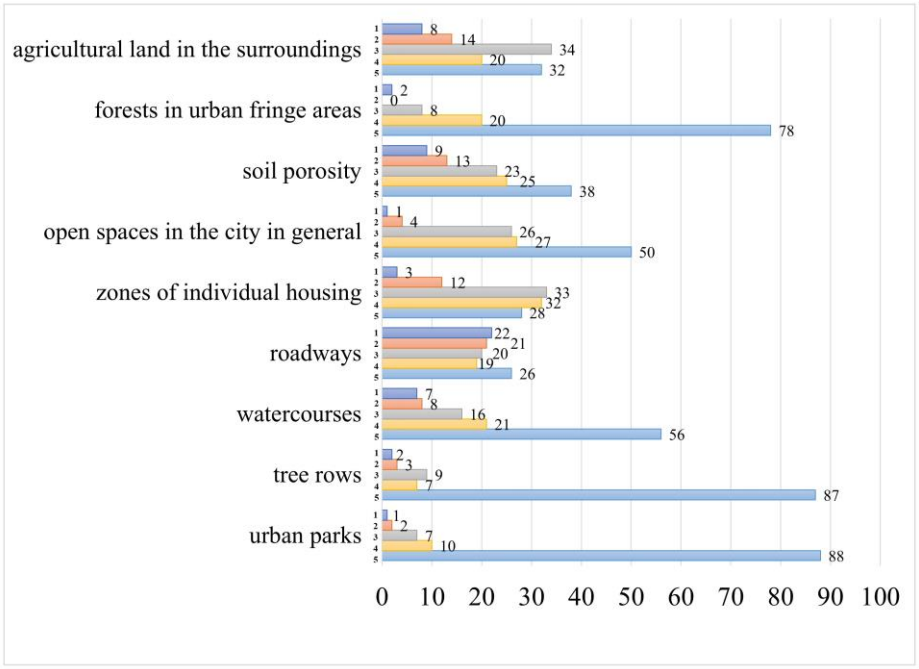


Figure 2. Summarised responses to the question "Evaluate to what extent the following terms relate to the concept of 'Green Infrastructure'".

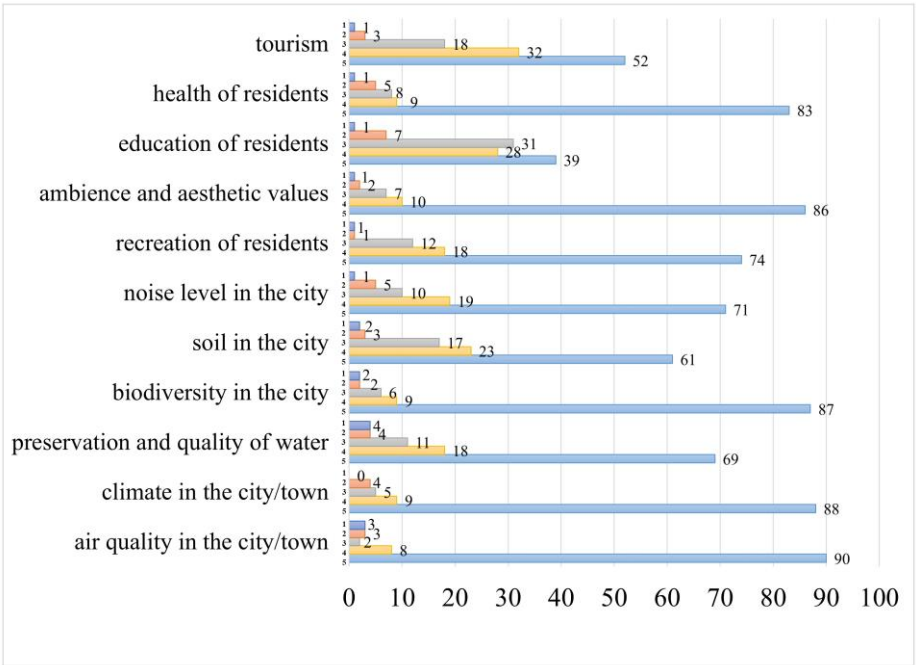


Figure 3. Summarised responses to the question "Evaluate the importance of green infrastructure".

Within the group of questions concerning the "Assessment of the Current Situation in Serbian Cities", respondents were tasked with evaluating how GI is treated in practice in Serbia based on 12 indicators. In response to the question, "Based on your own experience and observations in your environment, assess the current state of the relationship to green infrastructure, considering the listed evaluation elements", they were offered 12 elements to assess the relationship to GI. These elements were aimed to reveal the general relationship to green spaces, e.g., whether experts check the situation in the field, whether documents contain all the necessary information, whether plans include conditions for nature protection, whether responsibilities are defined, and what is the position of experts. Elements

were rated from poor treatment (rating 1) to the best treatment (rating 5) and are presented in Figure 4.

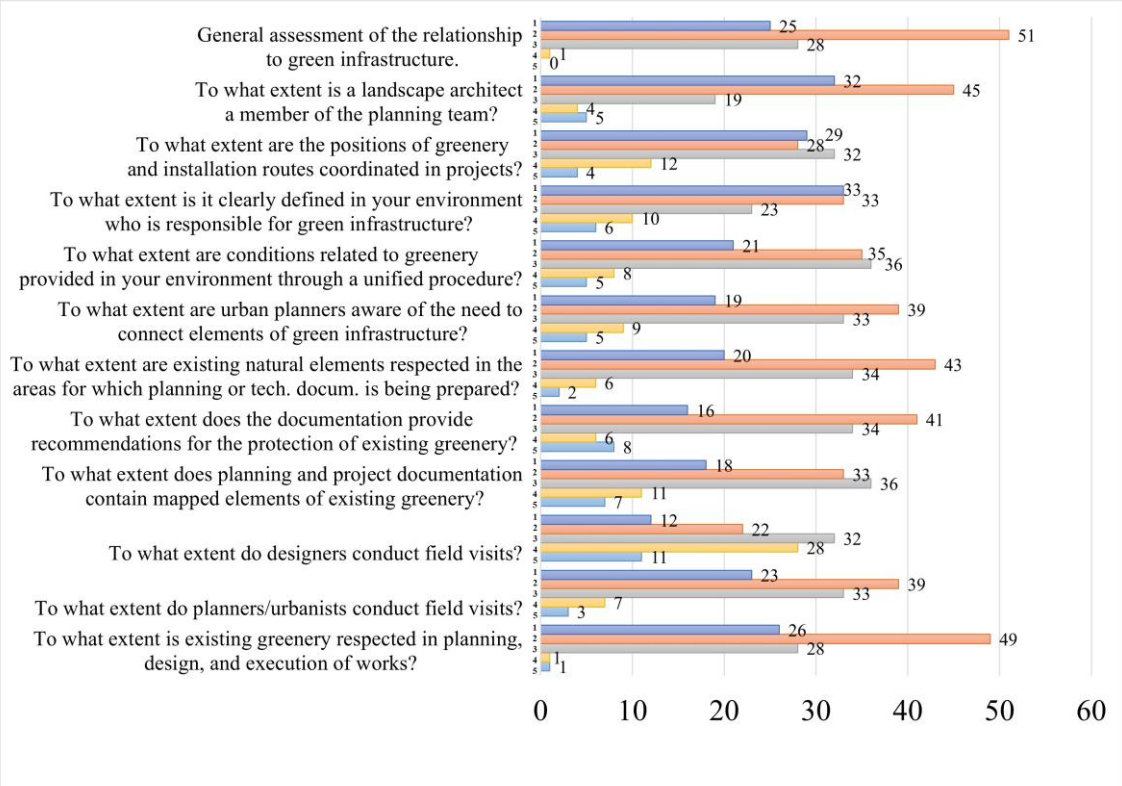


Figure 4. Summarised responses to the question "Evaluate the relationship to green infrastructure in Serbia".

Ratings for all the elements fell between 2 and 3, indicating that surveyed experts assessed the treatment of GI as being very unfavourable. The lowest-rated aspect referred to the respect for existing greenery during planning, design, and construction. This rating of the relationship to GI was unfavourable.

In response to open-ended questions, various measures were proposed to enhance the development of GI in Serbian cities through legislative regulation, rules, organisation, standards, etc.

In response to the question "Suggest measures for preserving existing elements of green infrastructure", the following measures emphasising the preservation of existing elements of GI were underscored: drafting a specific law, prescribing the prohibition of tree destruction and imposing penalties for offenders, broadening the responsibilities of expert commissions for tree assessment, mapping and documenting the existing condition, creating a cadastre, education and awareness raising, defining a responsible manager (director), and declaring greenery as public property.

Regarding the development of the cadastre, the majority of the respondents, when asked to "Suggest measures for implementing the green infrastructure cadastre", proposed the following: allocation of financial resources from the state and municipalities, engagement of experts for cadastre-related tasks, organising training for professionals and municipal authorities, and digitalisation in the field of green infrastructure and the development of a GIS (geographic information system) for these purposes.

In response to the question "Propose measures in the field of planning aimed at improving and developing green infrastructure in the cities of Serbia for the needs of GI planning", the following answers were highlighted: the establishment of a cadastre as a basis for planning, the development of a preliminary strategy, team collaboration among

various experts, mandatory involvement of landscape architects in plan development, the development of regulations, the establishment of planning standards and norms, and the implementation of special measures for preserving green corridors.

In the sphere of the design, in response to the question "Suggest measures for improving green infrastructure", the following proposals were made: introducing an obligation to carry out projects, mandating the preparation of a bioecological plan and an assessment of the existing state, clarifying the conditions of urban plans, formulating new regulations, developing standards in design, and utilising native species.

Answers to the question of how to organise or manage green infrastructure in Serbian cities demonstrate great diversity and opposition among experts' opinions. It was proposed that organisations, such as public utility companies, public urban planning enterprises, city secretariats, city landscape architects, nature conservation institutes, municipal administrations in collaboration with municipal police, and even private organisations, should take over the management of GI. However, there were opposing proposals suggesting that public utility or urban planning enterprises should not be managers because of conflicts of interest. Instead, these respondents proposed the establishment of a special organisation—a directorate for GI.

Some of the surveyed professionals had additional comments. In these additional, as well as other written, responses, the following points were emphasised: the needs to organise professional conferences; raise awareness among residents; ensure greater involvement of landscape architects in spatial planning; allocate more funds; adopt strategies, laws, rules, and standards; and combat corruption. There was also a highlighted need to abolish the monopoly of urban public utility companies for greenery to create healthier competition and higher-quality and more-affordable services.

3.3. Implementation of Green Infrastructure Strategy

In the third, electronic survey (2020), general data on the respondents included questions regarding their gender, level of education, and field of professional engagement (Figure S2 in the Supplementary Material).

The second set of questions aimed to examine the opinions of the professional community regarding the European Green Infrastructure Strategy, its significance, the need for it, and the potential opportunities for its application in domestic regulations. The questions and answers are presented in Figure 5.

In 2020, half of the surveyed professionals were only partially familiar with the European GI Strategy (2013). Professionals believed that GI should definitely be established in the legislation of the Republic of Serbia, either through a new law or by inclusion in existing ones. The most prevalent opinion among surveyed experts was that GI should be integrated within the framework of all the relevant laws. The majority of the respondents believed that a potential GI Strategy in Serbia should be defined at both the national and local levels. Over 80% of the surveyed professionals thought that GI should be planned synchronously both as a separate theme and within sectoral themes.

Considering the state of practice in Serbia and the year of conducting the survey (2020), even the partial familiarity of the professional community with the existence of the European GI strategy can be considered as being acceptable awareness. Over time, this awareness undoubtedly increases. The multidisciplinary perspective of all the professionals on the GI issue is particularly valuable. This survey shows the strong determination of the respondents that it is necessary to legislate in the area of GI. In this regard, it can be concluded that working on a systematic approach to regulation is a logical step towards forming a regulatory framework for GI.

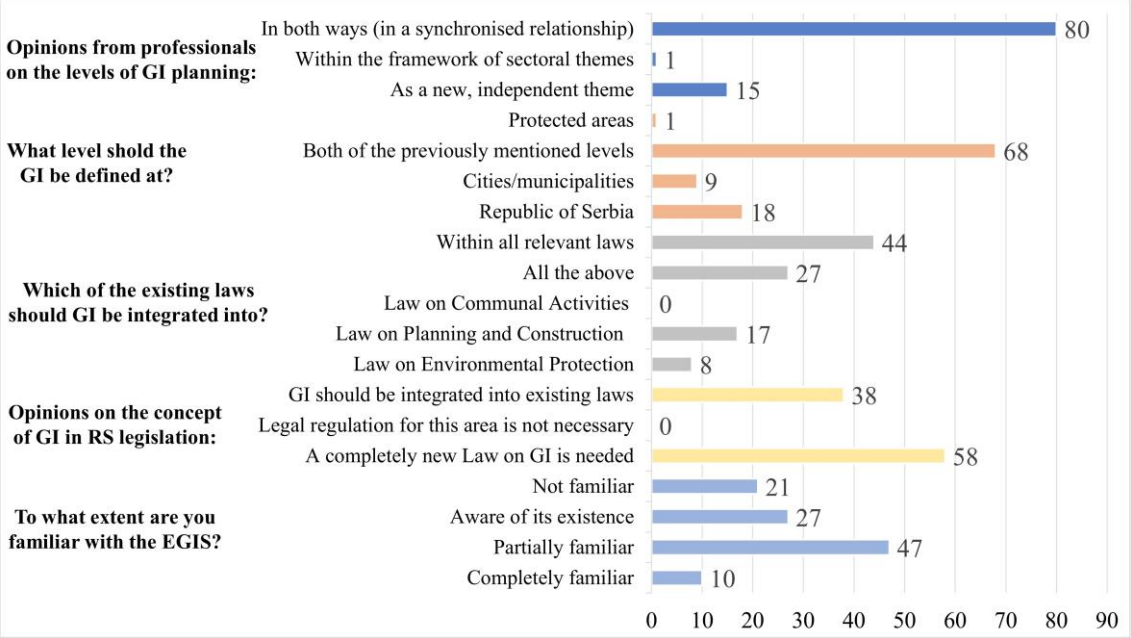


Figure 5. Summarised responses to the set of questions aimed to examine the opinions of the professional community regarding the European Green Infrastructure Strategy.

3.4. Green Infrastructure Strategy of Belgrade

After identifying and systematising issues, the development of the Green Infrastructure Strategy of Belgrade (2023) included 820 ideas submitted as proposals. The proposals were classified as responses to the registered problems. The highest number of proposed ideas fell within the Planning of Green Infrastructure (166), while the least was related to the Preservation of Existing GI Elements (64). Based on the questionnaire from the Belgrade GI Strategy survey, problems were systematised and classified into 8 groups, and the most frequent responses were singled out (Table 5).

Table 5. Systematisation of issues and most frequent responses.

1. General issues regarding GI:
➢ The lack of a systematic approach towards GI; ➢ Unequal treatment of GI compared to other urban structures; ➢ Failure to recognise the link between GI and ecosystem services; ➢ Insufficient recognition and application of GI in climate change adaptation; ➢ The lack of knowledge and awareness about GI as a public interest and general natural and cultural asset.
2. Legal framework issues of GI:
➢ The absence of a legal framework in the field of GI at all levels; ➢ Inadequate implementation of existing legal and planning regulations in areas related to GI elements; ➢ Inadequate prescribing of sanctions in the field of GI; ➢ Inadequate inspection control.
3. Issues of organisation, management, and procedures in the context of GI:
➢ The existing organisational structure is insufficient for the development of GI; ➢ Poor intersectoral collaboration; ➢ Incomplete and imprecise conditions of public authorities for planning and developing technical documentation; ➢ The lack of incentive measures for the development of GI; ➢ Jurisdictional issues over GI elements; ➢ Owners and/or users of certain GI elements lack the capacity for their maintenance and improvement (schools, hospitals, residential blocks, etc.);

Table 5. *Cont.*

➢ The absence of models enabling the maintenance of public GI elements by the private sector; ➢ Inadequate collaboration established between citizens and public authorities; ➢ "Shifting responsibilities" to managers who lack the capacity to solve specific problems (e.g., illegal construction on GI surfaces).
4. Issues for preserving existing GI elements:
➢ Degradation and usurpation of GI elements (often viewed as spatial resources and space available for construction); ➢ Vulnerability of GI elements not formally protected but valuable in terms of biodiversity conservation, cultural heritage, and/or spatial identity; ➢ Insufficient recognition of GI elements in private ownership.
5. Problems for GI planning:
➢ Insufficient number and surface area of GI elements, poor spatial distribution, and lack of connectivity; ➢ Inadequate space reserved for new GI elements during the planning process; ➢ Ignoring the potential for addressing environmental issues resulting from climate change through GI planning; ➢ The lack of a multidisciplinary approach for planning, in which spaces of different purposes are planned integrally with GI elements; ➢ Inconsistent regulative norms for preserving existing and constructing new GI elements; ➢ The absence of a planning approach that improves conditions and addresses problems by respecting ecosystem services; ➢ Failure to conduct evaluations for planning solutions through levels of ecosystem service provision; ➢ Inconsistent typology of GI within the city territory; ➢ Incomplete geographic information system (GIS) for GI; ➢ A tendency to plan public GI not accessible to everyone; ➢ Unresolved property–legal relationships affecting existing and planned GI elements.
6. Issues with designing and constructing GI:
➢ Designing and building without assessing and integrating existing GI elements into the solution; ➢ Underutilisation of the potential for forming GI structures, such as roofs, walls, and facades, of public and private buildings; ➢ Conflict between technical infrastructures and GI; ➢ Neglecting the multifunctional (environmental and aesthetic) significance of GI elements during GI feature design; ➢ Overlooking the multifunctionality of GI elements during feature design (impacts on its aesthetics, microclimate influence, noise reduction, etc.); ➢ Inadequate equipment for public green infrastructure elements; ➢ The lack of a wide range of plant materials in the domestic market, especially those suitable for extreme conditions in urban environments and changing climate conditions; ➢ The absence of an approach designed to enhance biodiversity in project solutions; ➢ The lack of data on GI elements within location information (construction possibilities and restrictions).
7. Maintenance issues of GI:
➢ Inadequate financial resources for the regular maintenance of GI; ➢ Insufficient staffing capacities; ➢ Inadequate maintenance of green areas adjacent to multi-family (collective) residential buildings; ➢ The presence of invasive species in GI elements and the lack of a systemic solution for their permanent elimination.
8. Awareness and knowledge about GI:
➢ Insufficient education of stakeholders in the decision-making, planning, and design processes regarding the significance of GI; ➢ Inadequate understanding of the importance of the multifunctionality of GI and its synergistic effects with other activities; ➢ Limited media promotion of the importance of GI; ➢ Limited knowledge about the use of available and innovative solutions; ➢ Investors do not recognise the potential for investing in GI; ➢ Insufficient involvement of citizens in the GI planning and design process.

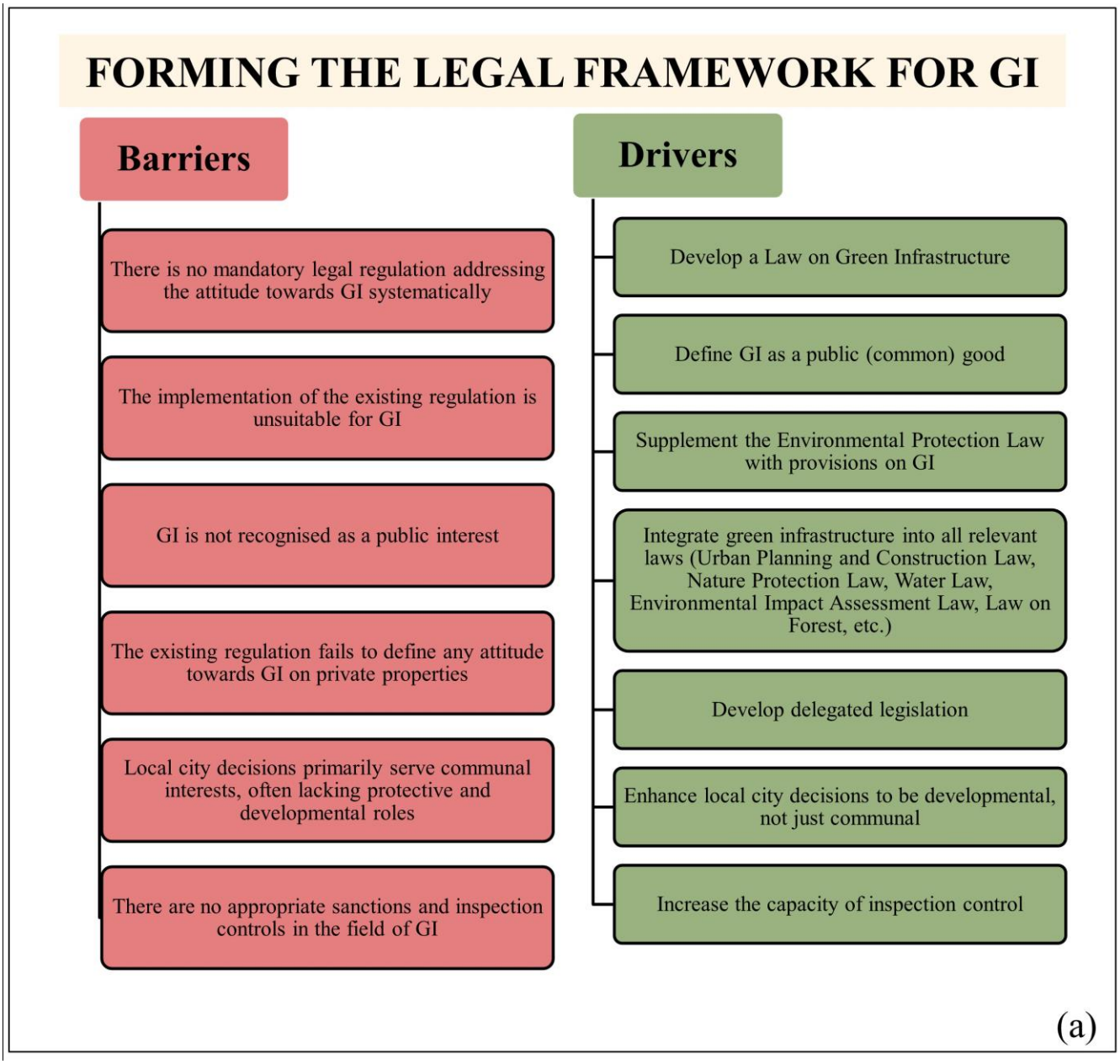
4. Discussion

Structured and semi-structured questionnaires were applied to identify barriers and drivers in conceptualising elements of green infrastructure regulation for the needs of local and regional urban development. The importance for researching these attitudes lies in the following characteristics of professionals: theoretical knowledge of the concept of green infrastructure; practical experience in working with green infrastructure; experience gained in organisations and institutions responsible for planning, designing, constructing,

maintaining, or managing green infrastructure; and practical experience in procedures that are important for implementing the concept of green infrastructure.

By analysing and coding responses, seven areas were identified in which key barriers and drivers were registered (Figure 6a–g):

(1) formation of the legal framework for green infrastructure;
(2) regulation of the preservation of existing green infrastructure elements;
(3) improvement of the regulation for green infrastructure planning;
(4) improvement of the regulation in the field of design and construction;
(5) improvement of the regulation for the maintenance of green infrastructure;
(6) regulation of green infrastructure management;
(7) awareness, knowledge, and information about green infrastructure.



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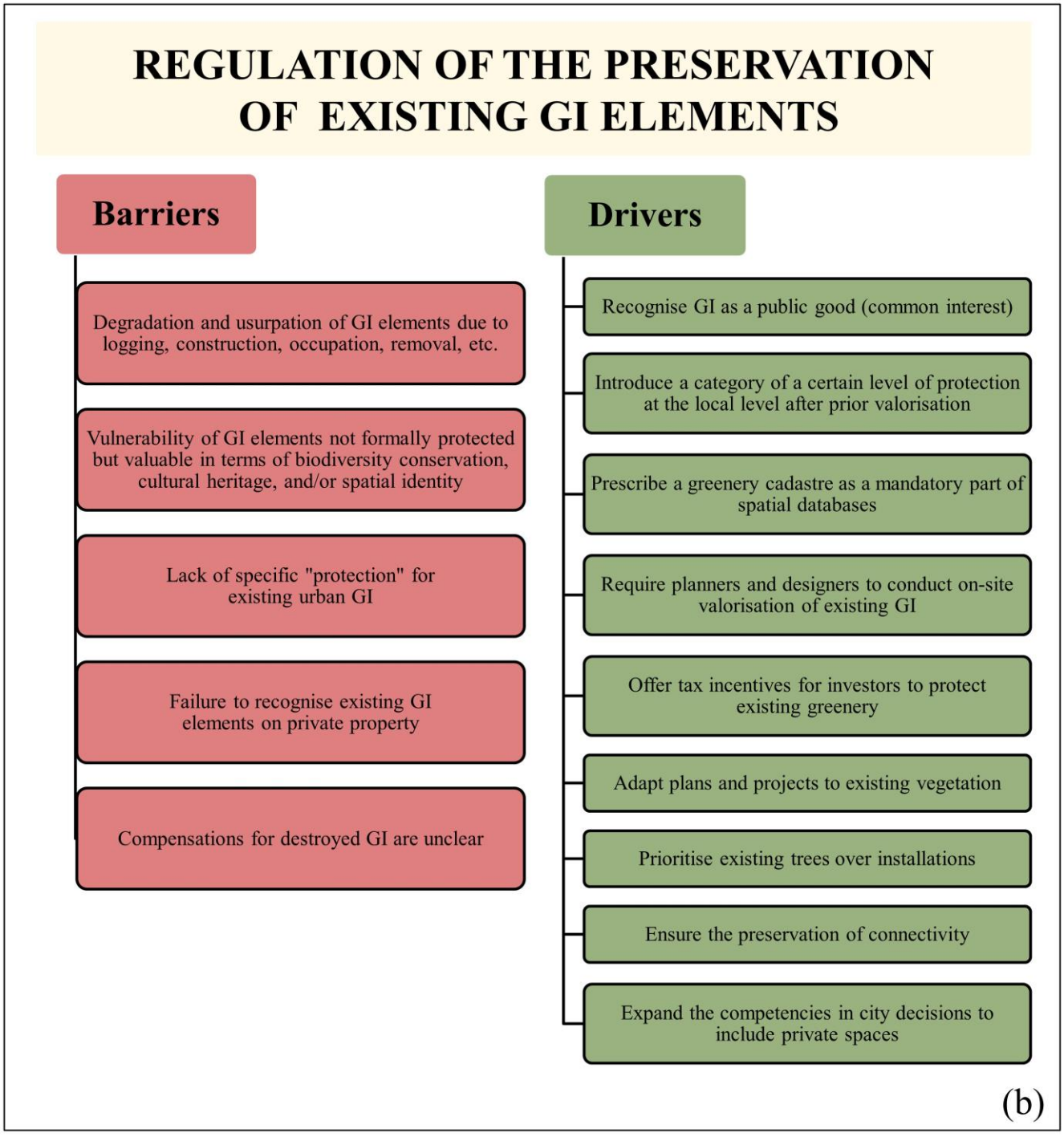

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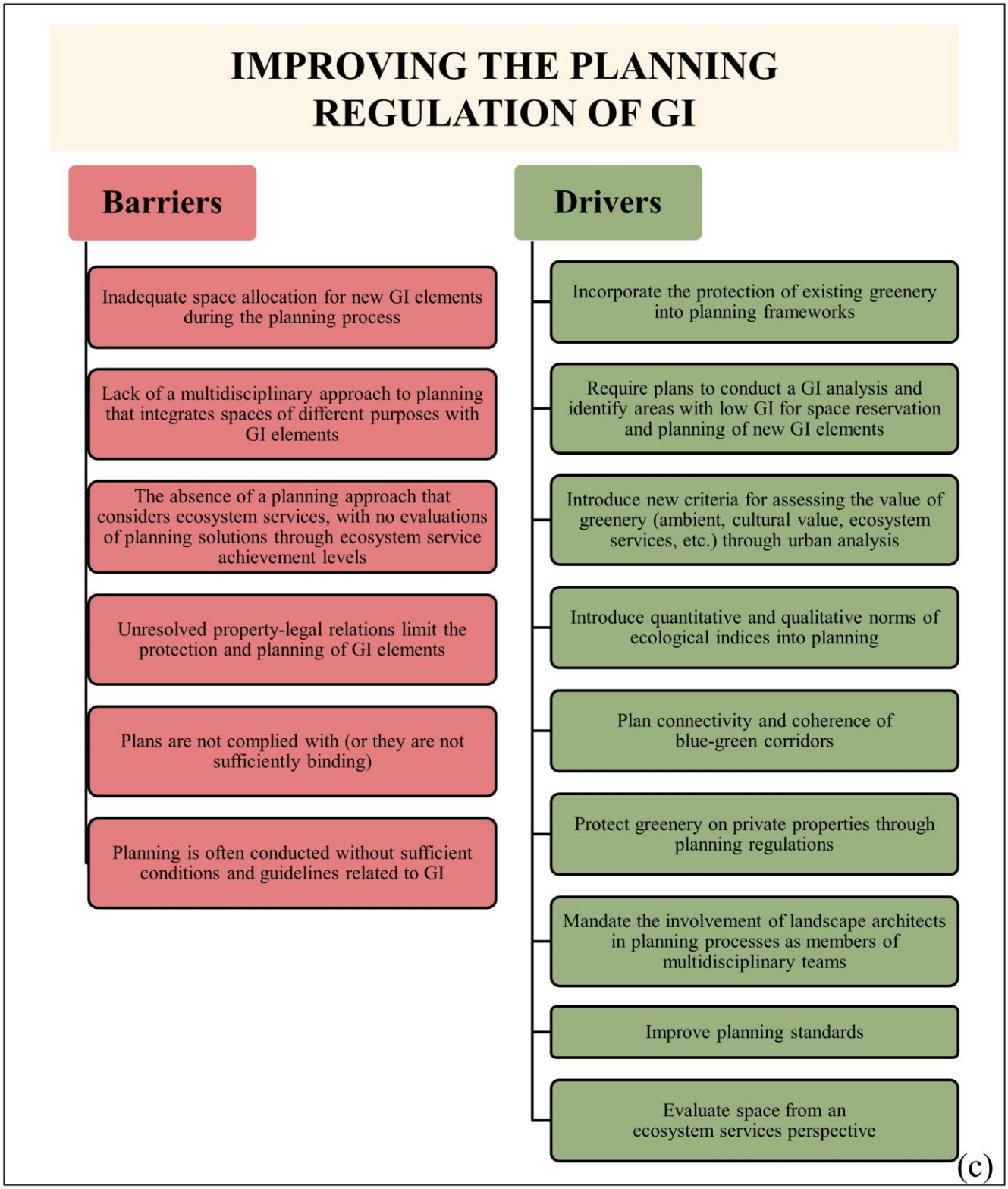

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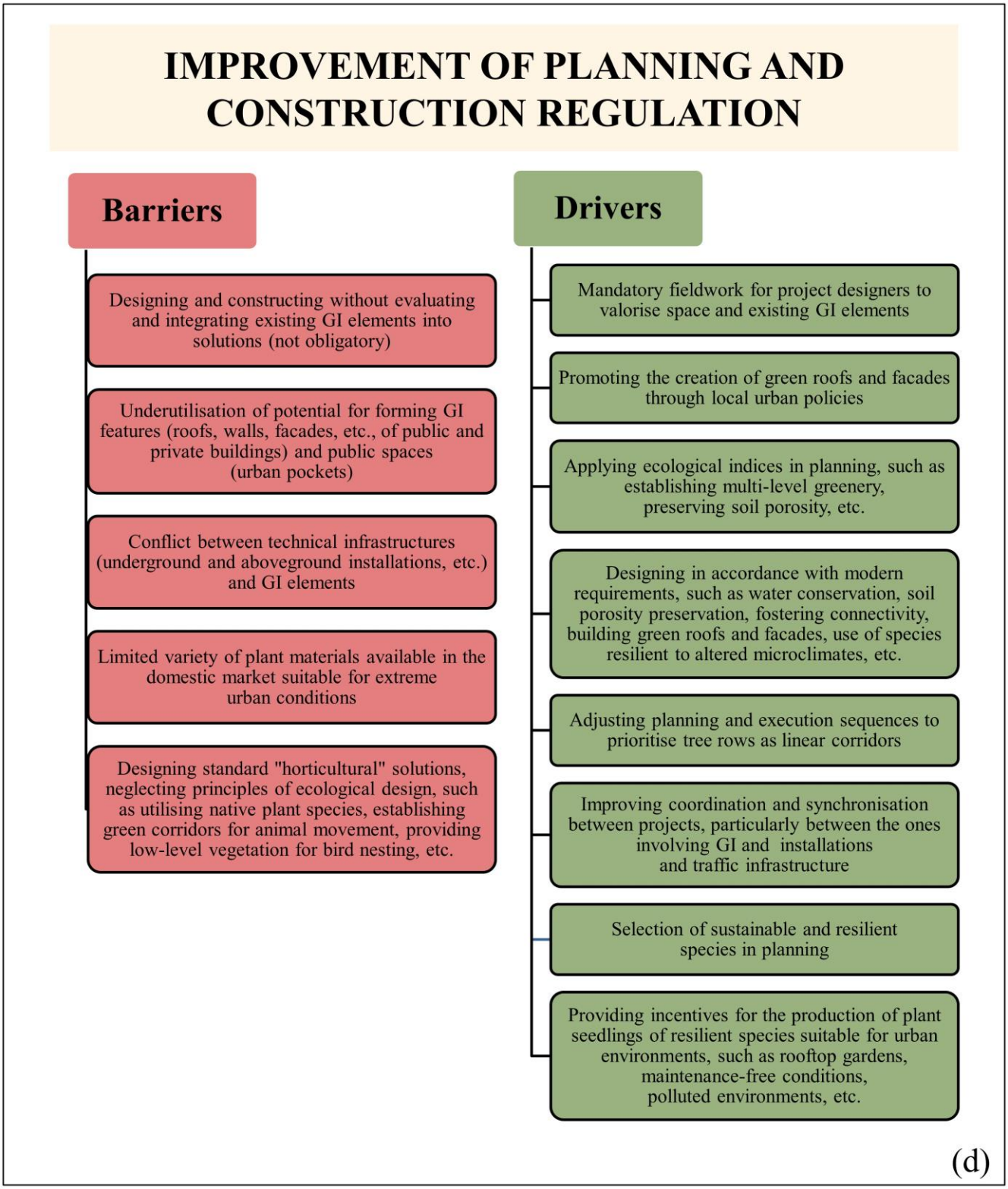

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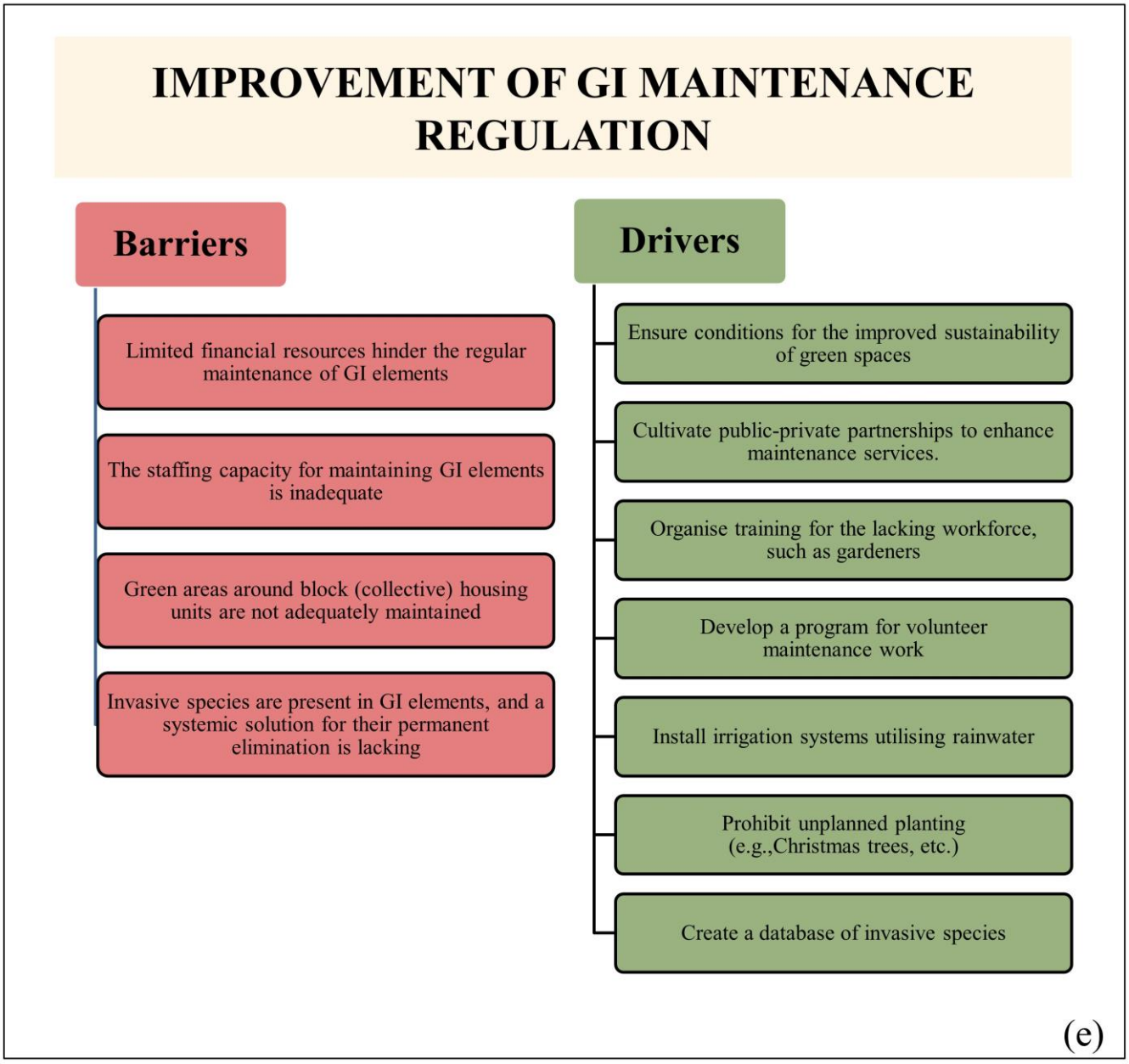

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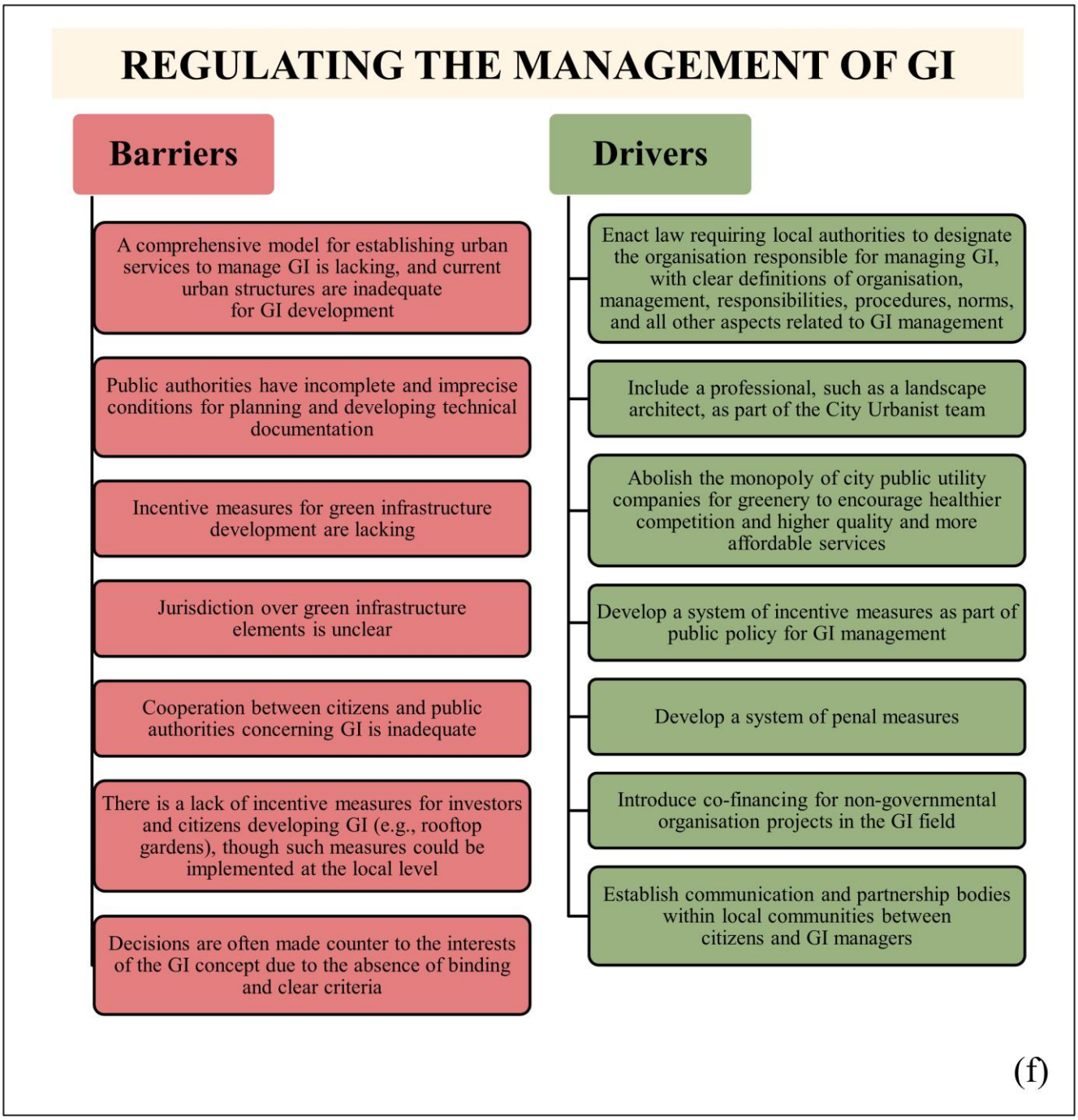

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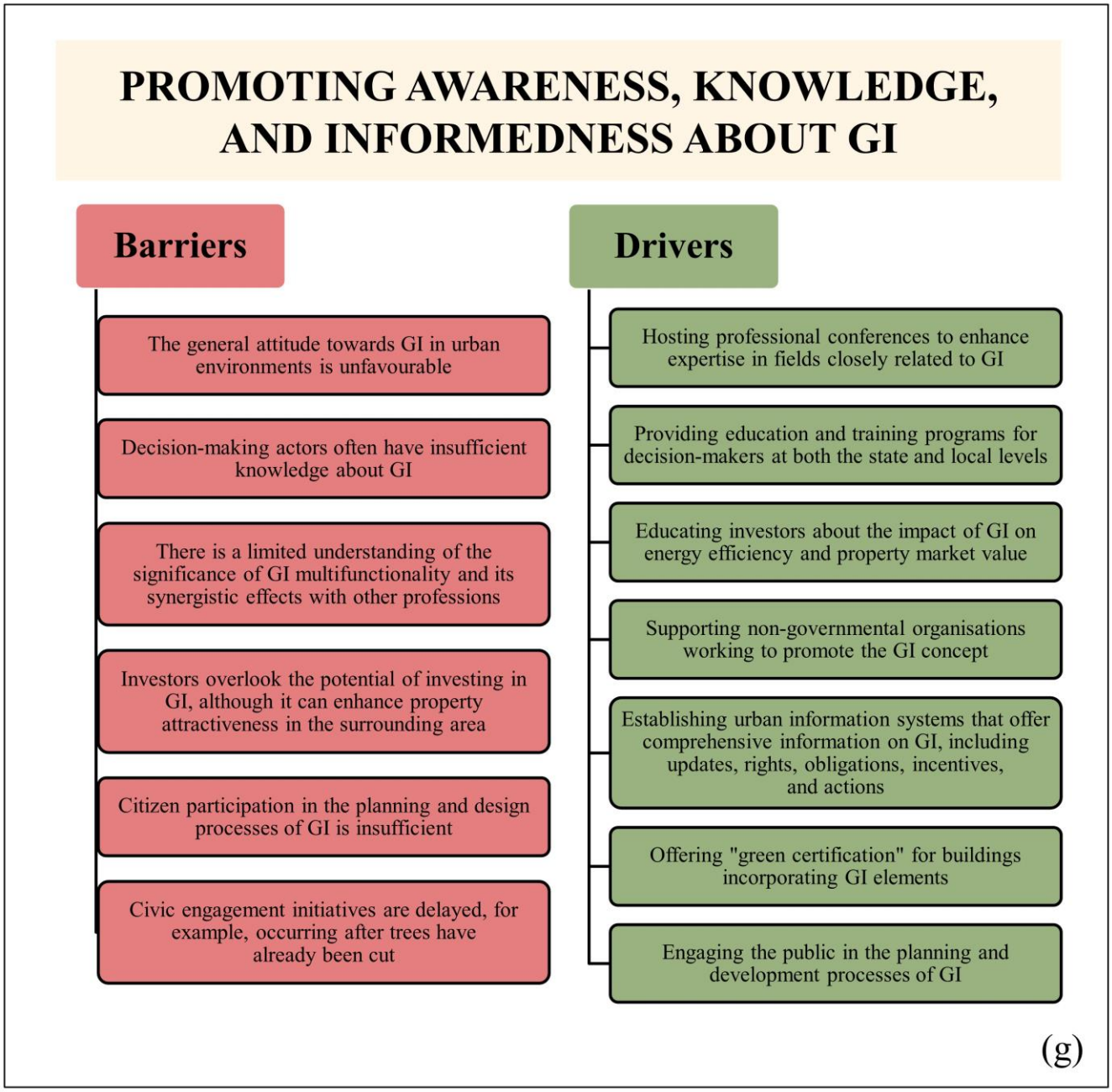

Figure 6. Systematised attitudes of professionals: (**a**) legal framework of GI, (**b**) regulation of preservation of existing GI elements, (**c**) planning of GI, (**d**) regulation of design and construction, (**e**) regulation of GI maintenance, (**f**) management of GI, and (**g**) ways to enhance awareness and understanding of GI.

The development of green urban infrastructure and its management in urban centres are facilitated and strengthened by policies, strategies, and other legal instruments. At the national level, several documents have been developed in recent years; however, they have little connection with the development and management of green urban infrastructure. Additionally, experts, government officials, and the public do not interpret these documents in the same way, which aligns with the findings of Keita and Kourouma [41]. Urban GI is a strategically developed network of green spaces that can improve the quality of the environment and provide significant economic benefits [17]. It is in line with the Sustainable Development Goal [42], which calls for resilient, safe, sustainable, and inclusive cities. However, the primary barrier for creating and managing urban green infrastructure is the

lack of commitment, competent workforces, financing, and public participation. This study aims to identify existing research and policy gaps and complement the limited empirical literature on RGI. The identified barriers and drivers (Figure 6a–g) serve as a database for institutions involved in the development and management of GI, including legislators, planners, managers, and other interested groups.

Our five-year research on the segment concerning the formation of the legal framework for green infrastructure (Figure 6a) aligns with findings [43,44] indicating that national organisations should take the lead in finding the most suitable solution, within the national context, to integrate appropriate instruments into the legal framework. Furthermore, it is crucial to encourage national municipalities to continue their efforts towards the development and implementation of indicators, as recommended by Bläser et al. [45] for Germany and Antoszewski et al. [46] for Poland. Presently, building standards do not enforce strict ecological solutions; instead, laws and regulations are yet to adopt a purposefully oriented, holistic, and interdisciplinary approach to facilitate legal evolution contributing to the progress of green infrastructure [47].

The preservation of existing green infrastructure (GI) elements (Figure 6b) requires an assessment of the effectiveness of ecological safety patterns and green space systems in urban areas, as well as the efficiency of the GI network [48], alongside an evaluation of current conditions for implementation. Our research highlights historical and cultural landscape features, as well as linear elements that can enhance connectivity within and to urban spaces, promoting more sustainable GI, as also observed by [49] for Ankara. Wei et al. [15] stress the importance for identifying existing structural GI elements and suggest incorporating morphological variables, such as "connectivity value", "degree of integration", and "value of understanding", which serve as quantitative parameters of spatial structure. These proposals closely align with the findings of our research regarding the regulation of existing GI elements.

Based on the identified drivers in our study, it is evident that enhancing GI planning regulations (Figure 6c) requires the implementation of strategies as tools for nurturing and revitalising the quality of urban life. Given its multifunctional impact, GI as a network generates greater benefits than the sum of its individual parts, all of which contribute to ecological, social, and economic advantages [50]. However, the planning and execution of the GI concept in urban environments necessitate the collaboration of all the relevant stakeholders towards supporting long-term objectives. This can be achieved through strategic framing and the delineation of operationalised tasks for all levels of governance in a collaborative process [51,52]. Additionally, it is essential to disseminate knowledge about ecosystem services to stakeholders, along with adopting new planning approaches that consider the qualitative aspect of public action based on performance standards, aiming to provide multiple benefits in terms of regulation, support, and cultural services [53]. In light of the current dynamic global landscape, GI is gaining prominence in planning policies, primarily because of its ecological, economic, and social components, which contribute to the sustainable and resilient planning and design of smart cities and spaces [51,54]. The issue of GI is contextualised within the conceptual frameworks of sustainability and resilience, which are described through an examination of their shared characteristics and disparities, with a specific emphasis on planning elements [55].

The rationale for enhancing the regulatory framework for designing and constructing sustainable, resilient, and smart cities and GI networks (Figure 6d) stems from the 2030 Agenda for Sustainable Development and current European strategies: the EU GI Strategy, EU Climate Adaptation Strategy, EU Biodiversity Strategy for 2030, and other strategic documents [56–58], which recognise GI and nature-based solutions as being critical approaches and tools for design and implementation in urban environments and landscapes. Our research identifies drivers for GI design and construction at both holistic and specific levels. Specifically, the experiences and empirical findings of national professionals underscore the importance of public involvement and engagement, as well as the wide array of ecosystem services provided by GI and its elements, including some potential ecosystem disservices.

Our findings in this regard partially align with results cited by Hanna and Comín [17], Tzoulas et al. [59], the Forestry Commission [60], Toth and Timpe [61], Williams [62], and Pochodyła et al. [63].

To enhance the maintenance regulation for GI (Figure 6e), several prior studies have underscored the significance and benefits achievable through GI maintenance [64–67]. From the viewpoint of national professionals, the maintenance requirements for various types of GI vary considerably depending on their specific type and design, requiring not only adequate financial resources but also a thorough understanding of maintenance practices to ensure effective upkeep. This encompasses responsibility and maintenance planning through monitoring and comprehensive documentation, training and education on GI maintenance, mechanisms for compliance, and ensuring dedicated funding sources. In addition to pursuing the primary goals of GI maintenance, there are multiple other objectives associated with the optimisation process. When optimising GI maintenance, all these factors must be taken into account to ensure the optimal maintenance with the maximum benefits and minimal costs. This study emphasises the importance for systematically optimising GI maintenance through the engagement of multidisciplinary stakeholders, similar to the approach by Hansen and Pauleit [68].

Based on research on the regulation of GI management (Figure 6f), it has been established that the current GI management models in Serbia are insufficient for addressing contemporary issues related to sustainable development and GI protection, a situation similar to that in Italy [69]. Throughout our five-year study, professionals have underscored the importance for adopting new approaches that integrate the benefits of ecosystem services provided by GI into traditional management frameworks, thereby achieving a higher level of ecological performance essential for enhancing quality of life. Both in Serbia and Italy, there are no mandatory planning tools for the design and management of GI, and they are now a part of traditional land use plans [69]. Moreover, the lack of financial resources allocated towards the development of "green standards" presents a challenge for the majority of the public administrations in Serbia as well as in other countries [69–71]. Therefore, it is proposed to abolish the monopolies held by public utility companies for green spaces to foster competition, deliver higher-quality services at more-affordable rates, and establish a cohesive management strategy.

The perspectives of professionals regarding the enhancement of awareness, knowledge, and information about GI (Figure 6g) are consistent not only with each other but also with the findings of Inzunza-Acedo [72], asserting that despite the prevailing influence of social media globally, there is still a need for arranging professional conferences and educational programs for decision-makers, investors, and the general public. A particular emphasis is placed on promoting the GI concept across social media platforms. Our research findings partially align with the study conducted by Metastasio et al. [73], which explored the role of social media and the outcomes derived from posts shared on two widely used platforms (Facebook and TikTok) during 2022 and 2023. Their results validate the significance of social media as indicators of current trends in the evolution of information dissemination.

This study investigates variable policies and legal frameworks for green infrastructure development in Serbia from the perspective of urban development, aiming to enhance the contributions of local experts rather than consulting foreign experts who may not be familiar with urban landscapes. The expressed views of these professionals, systematically categorised into appropriate groups, provide a valuable and rich source of information about barriers existing in Serbia's practice as well as initiatives to be applied in future GI regulation. The obtained results partially align with those obtained by Pakzad and Osmond [74], who utilised conceptual foundations to establish a framework for assessing the sustainability of GI elements. Their framework consists of 30 indicators classified into four categories, including ecological, health, socio-cultural, and economic indicators.

5. Conclusions

This paper thoroughly examines the challenges facing green infrastructure (GI) in both policy and practice, identifying barriers and drivers crucial for a systemic approach to GI regulation. By integrating the experiences and views of professionals, tools for assessing existing GI policies at the national level were identified. These selected tools can be applied across various dimensions in the revision of existing laws and planning documents or the development of new strategies.

The findings drawn from the research enable the identification of barriers and drivers aimed at integrating processes and enhancing the utilisation and adoption of natural solutions for many key challenges in urban development, which link GI performance with ecosystem services, health, and human well-being. The systemic approach to GI regulation in Serbia is still in its infancy and is not fully accepted by decision-makers in a proper manner. However, the results of this research suggest that professionals, government agencies, and academic researchers should consider and propose methods to establish GI regulation and evaluate its performance. Furthermore, this research has demonstrated that over several years (2018–2023), there have been progress and increased understanding among professionals regarding the need to enhance the concept of green infrastructure, indicating a higher level of comprehension of the issues. The conceptualisation of GI regulatory elements provides a purposeful cognitive platform for establishing a composite model based on tangible indicators to evaluate GI performance.

After five years of thorough research, we conclude that this study surpasses national significance as GIS planning and design manifest in various dimensions and environments as strategic concepts integrated into international policies of the world and the EU as well as regional, national, and local concepts. This study introduces a novel framework (concept) compared to previous research endeavours. This framework, based on professionals' perspectives, comprises seven key indicator areas: formulating a legal framework for GI, regulating the conservation of existing GI elements, improving GI planning regulation, improving regulation in the fields of design and construction, enhancing regulation for green infrastructure maintenance, regulating GI management, and enhancing awareness, knowledge, and information dissemination about GI. This study provides detailed descriptions of drivers used to overcome identified GI barriers, among which the most significant ones are the drafting of GI legislation; the designation of GI as a common good; the integration of GI principles into all the relevant laws, sublegal acts, and local city decisions; expanding regulatory oversight over private spaces; increasing inspection controls; introducing compensation mechanisms for greenery destruction; mandating greenery cadastres within spatial databases; the prohibition of green space conversions; obliging planners and designers to valorise the existing GI while respecting the interconnectedness and unity of blue–green corridors; offering tax incentives for biodiversity conservation; raising awareness and educating decision-makers, governmental bodies, investors, and the public; supporting projects and non-governmental organisations advocating for GI; implementing "green certification" for facilities incorporating GI features; and introducing ecological index norms in planning in line with contemporary needs for water conservation, soil porosity, connectivity, green roofs, green facades, etc. This study establishes a globally and regionally applicable framework that can be replicated to fulfil broader objectives of sustainable urban revitalisation.

Gaining insight into the limitations and weaknesses of this proposed framework will necessitate evidence gathered through case-study testing. Future research will encompass identifying parameters and subindicators for each indicator, along with the calibration, validation, and assessment of the weaknesses and limitations inherent in the proposed concept. Ultimately, sustainable space is not a local or regional but a global issue that requires diverse transdisciplinary interactions. Our intentions are to persist in research efforts and to establish a composite model based on indicators for assessing RGI performance through conceptualising GI elements as its foundation.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/land13050692/s1: Figure S1: Summarised general information about the respondents (2019); Figure S2: Summarised general information about the respondents (2020); Supplementary Material S1: Questionnaire 1 (2018); Supplementary Material S2: Questionnaire 2 (2019); Supplementary Material S3: Questionnaire 3 (2020); Supplementary Material S4: Questionnaire 4 (2023).

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