Identification of Competencies and Teaching Models for the Governance of Smart Sustainable Cities in the South American Context

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Abstract. This study is developed in the context of the Strengthening Governance Capacity for Smart Sustainable Cities (CAP4CITY) Project, part of the Erasmus + Programme. The study aims to support the design of teaching materials to address the human-capacity related needs for the governance of Smart Sustainable Cities (SSC) in South America. This article identifies the competencies and instructional design for the design of smart sustainable cities courses adapted to the South American context. Applying a scenario-building approach and the CAP4CITY roadmap for smart sustainable city initiatives, we conducted two workshops in Chile and two in Argentina attended by representatives from academia, NGOs, government agencies, and private companies. Using the data about competencies and teaching models gathered during these events, the study clustered the data and identified the major areas of competences and instructional methods. Lastly, we compared the results from both countries.

Keywords: Smart cities · Sustainable cities · Governance · Human-capacity · South America

1 Introduction

The use of innovative digital technologies to improve the quality of life of residents in urban contexts has been a goal for many local-level governments around the world and it is known as smart city efforts. However, the concept, that has gained popularity in the academic and practitioner world during the last decade, is still at an infancy stage in terms of current governance capabilities of urban centres [1] and available education programmes. Many frameworks, rankings, and technical standards have been conceived

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to assess the level of smartness of cities but, a uniform approach or a single recipe that can fit for all cases is difficult to be envisioned, in part due to the multidisciplinary nature of the field and the uniqueness of different countries and cities [2–8]. Many cities in developed countries are transiting towards being considered smart and sustainable in those rankings. Yet, cities in the Global South, and in particular, in South American countries, face a completely different reality compared with the former, mainly considering the technological, cultural and geographical perspectives [9].

The design of smart sustainable cities (SSC) training modules contextualized to the Latin American region is one of the main goals of the CAP4CITY Project. To address the problem, several workshops were conducted in Argentina, Brazil, Chile, and Colombia to assess the training needs for each country. In this research, we identified the main competences and training needs concerning planning, development and management of smart sustainable cities in Chile and Argentina. This article therefore describes and discusses the main competences and teaching methods identified as most relevant during the workshops with stakeholders from government, academia, private companies, and third sector, conducted in Chile and Argentina.

The rest of this article has the following structure. Section 2 presents some background concepts in SSC and discusses related work. Section 3 explains the methodology applied to conduct the workshops and to gather data. Section 4 discusses the major findings of the workshops in Chile and Argentina as well as lessons learned. Finally, Sect. 5 summarizes conclusions and future work.

2 Literature Review

2.1 Smart Sustainable Cities (SSC)

The term ‘smart city’ has become trendy to distinguish or promote cities that are considered advanced in the deployment and use of digital technology, and many cities are currently developing long term plans to become one. However, the concept of a ‘smart city’ is still ambiguous and complex since efforts for its development have to integrate multiple disciplines behind the city and the smartness dimensions, ranging from the urban and social related issues, through economic and environmental, to the technological areas. Additionally, we need to see the need to adapt it to cultural, social and geographical differences [10, 11]. Some commonly used definitions are the following:

- A smart city is one that utilizes Information and Communication Technologies (ICT) to meet the demands of the market (residents of the city), and to promote community involvement in the process. Thus, a smart city would be a city that not only possesses ICT technology in particular areas, but has also implemented this technology in a manner that positively impacts the local community [12].
- A smart city promotes regional competitiveness, transport and ICT economics, natural resources, human and social capital, quality of life, and participation of citizens in the governance of the city [5].
- A smart city brings together technology, government and society to enable the following characteristics: smart economy, smart mobility, smart environment, smart people,

smart living, smart governance (Institute of Electrical and Electronics Engineers Smart Cities Community)[1].

- A city can be defined as 'smart' when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life, with a wise management of natural resources, through participatory action and engagement [10].
- A developed urban area that creates sustainable economic development and high quality of life by excelling in multiple key areas: economy, mobility, environment, people, living, and government. Excelling in these critical areas can be done so through strong human capital, social capital, and/or ICT infrastructure[2].

The CAP4CITY Project, part of the Erasmus + Programme of the European Union, defines Smart Sustainable Cities (SSC) as a progression of how cities apply digital technology to serve their populations, pursue sustainable socio-economic development, and transform themselves. The urban development that leads SSC requires a growing number of roles and competencies to work together in order to plan, design, implement and manage the ongoing transformations of the city, enabled by technological innovation. A large number of competencies are needed for pursuing SSC efforts, mainly related to areas such as Business Administration, ICT, Computer Science, Engineering, Architecture and Urbanism, Urban Planning, Law, Political Science, Sociology, and Communication, among others. In addition, although the SSC concept has gained considerable attention in Latin America, there is a need for improving old and developing new teaching and learning tools, as well as curricula in all levels of higher and continuous education to build the needed qualified human resources able to develop SSC in the region.

The smart city concept integrates ICT, and various physical devices connected to the IoT (Internet of Things) network to optimize the efficiency of city operations and services and to connect citizens [13]. Such infrastructure enables to integrate data collected from citizens, devices, and assets. This data is processed and analyzed to monitor and manage traffic and transportation systems, power plants, utilities, water supply net-works, waste management, crime detection, information systems, schools, libraries, hospitals, and other community services [14]. Technology deployed in a smart city allows city officials to interact directly with both community and city infrastructure and to monitor what is happening in the city and how operations and daily activities in the city evolve. ICT is used to enhance the quality, performance, and interactivity of urban services, to reduce costs and resource consumption, and to enhance interactions between citizens and government. Smart city applications are developed to manage urban flows and allow for real-time responses [15]. Therefore, a smart city is more prepared to respond to challenges than one with a simple "transactional" relationship with its citizens [16]. Yet, the term itself remains unclear to its specifics and therefore, open to many interpretations [17]. When considering the sustainable dimension to the smart city concept, we could see that there is no general consensus since most frameworks are not integrating all the

[1] https://www.ieee.org/membership-catalog/productdetail/showProductDetailPage.html?product=CMYSC764.

[2] http://www.businessdictionary.com/definition/smart-city.html.

areas that should be assessed. Ahvenniemi, Huovila, Pinto-Seppä and Airaksinen [18] compared the frameworks and standards to assess smart sustainable cities and suggested that the initial target of sustainability of a city is not sufficiently addressed in some of the smart city frameworks with environmental indicators clearly underrepresented and a large variety of indicators considering economic and social aspects of a city.

2.2 Competencies and Massive Online Open Courses (MOOCs)

Researchers in many fields agreed about the importance of identifying competencies in the development of new curriculums rather than only focus on the knowledge itself. This change in perspective is characterized by a change in emphasis from teaching to student learning [19]. Then the words competencies, competence and competent become relevant when talking about learning and performance in education. These words mainly refer to a perso's state or quality of being able and fit. Katane and Selvi [20] defined competencies as "the set of knowledge, skills, and experience necessary for future, which manifests in activities" (pp. 44). Although Selvi [21] proposed the existence of various competencies for teachers, most researchers grouped the competencies in only three main areas: field competencies, pedagogical competencies and cultural competencies. Field competencies are related to the question of "what should school teach." In the past, field competencies were considered as the most important ones based on the concept that teachers were the only actor responsible for transmitting the content. However, today, other competencies, such as pedagogical competencies, are also necessary. The UK Training Agency [22] defines competence as a broad concept which embodies the ability to transfer skills and knowledge to new situations within the occupational area. It includes those qualities of personal effectiveness that are required in the workplace to deal with co-workers, managers, and customers.

Elam [23] sustained that under the Performance-Based Teacher Education program the main characteristics for the assessment of the student's competency should include i) using performance as the primary source of evidence, ii) taking into account evidence of the student's knowledge relevant to planning for, analyzing, interpreting, or evaluating situations or behavior, and iii) striving for objectivity. Another relevant approach to the understanding of design learning was made by Bloom [24] who proposed a taxonomy of cognitive domains that has been extensively used in competence-based learning. Bloom's taxonomy structured educational goals into the 'cognitive', 'affective' and 'psychomotor' domains, a structure which is closely related to the contemporary concept of competency as made up of knowledge, attitude and skill components.

The massive adoption of technology in education has given birth to various approaches, including Massive Open Online Courses (MOOCs), who materialize the interest in providing tools to support distance education and company training. Kalz [25] acknowledges the importance of technological advancements in MOOCs to remove existing barriers in lifelong learning. Castaño-Muñoz, Kreijns, Kalz and Punie [26] emphasize the importance of MOOCs to provide access to education for people who could not access to this opportunity for financial reasons or because they lack the necessary qualifications. Most MOOCs today are free and open to any interested participant. They provide the opportunity to numerous students to access simultaneously to online educational resources, without charge, in highly recognized institutions such as

MIT Open Courseware, Stanford Engineering Everywhere, Khan Academy, and others. MOOCs are based on the principles of open learning with the student at the center and a strong focus on learning rather than teaching. MOOCs provide students with flexibility and choice in meeting their educational goals. They comprise various non-traditional learning opportunities, from short courses to degrees.

3 Methodology

The main purpose of the study documented in this paper was to identify the perception of main stakeholders in the South American community about knowledge, skills, and competencies that should be present in courses building human capital for SSC. Such courses include elective courses at the undergraduate level, at the postgraduate level, including a Specialization and a Master degree programs, as well as MOOCs for continuous education. Applying the roadmap for SSC developed by the CAP4CITY Project, the study collected data and information through eight workshops conducted in the region – particularly in Argentina, Brazil, Chile, and Colombia. In this paper, we focus on the four workshops conducted in Chile and Argentina with representatives from government, NGOs, private companies, and academia. The study collected quantitative and qualitative data. Quantitate data was analyzed using IBM SPSS, and qualitative data was analyzed using logical tools and a computer-aided word-driven analysis with the software KH Coder. KH Coder recognizes patterns in word co-occurrence [27].

3.1 Workshop Activities

To conduct the workshops in Argentina and Chile, we apply the same methodology comprising the following three activities:

1) *Raising awareness* – delivering presentations about results of preliminary work explaining the state of the art on educational programs related to SSC
2) *Identifying knowledge areas and competencies* – conducting group discussions about knowledge areas and type of competencies to be delivered by new courses.
3) *Proposing pedagogical models* – conducting group discussions to identify innovative pedagogical models suitable to deliver the proposed competencies.

The workshops conducted in Chile took place in Antofagasta and Valparaiso, while the ones in Argentina, in La Plata and Bahia Blanca. All workshops were conducted in Spanish, and one researcher from the CAP4CITY Project presented the "Raising awareness" activity, explaining the partial results of the project and the methodology for the workshop. Following, participants were divided into groups to have team discussions. At the end of this activity, each group presented and discussed in plenary sessions the knowledge areas and competencies that they found necessary to be included in SSC courses. The third activity was conducted following the same approach previously used for the second one, but the theme to discuss and present was the pedagogical models most suitable for delivering the knowledge and developing the already identified competencies. The workshops followed the same methodology to allow for a combined analysis of the results.

3.2 Population and Sample

In total, 113 participants attended the workshops in Chile and Argentina. In Chile, there were twenty-eight representatives from academia (58%), fourteen from the private sector (29%), and six from the government (13%); while in Argentina, fifty-four representatives from academia (83%), five from the private sector (8%), and six from the government (9%). Figure 1 shows the number of workshop participants per sector. In each workshop, the organizers requested participants to assemble into teams, each of them constituting round tables with 6 to 8 attendees.

4 Results

Based on their experience and understanding, participants identified knowledge areas and competencies needed to develop SSC in their cities. The study classified the competencies based on the participants´ contributions respecting their main ideas but syntactically rephrased them. The researchers used the conventional style for defining competencies, i.e., starting with a verb in the infinitive. The identified competencies were organized according to the knowledge areas that appeared in the group presentations. In both countries, a total of 270 SSC competencies classified in 14 knowledge areas were identified by participants as relevant for SSC. Table 1 summarizes the identified knowledge areas and, for each country, the number of competencies per area. Similarities in the results of each country include the relevance of three topics: 1) *Technology and Apps*, ranked second in Argentina and first in Chile; 2) *Urban and Territorial Development*, fourth in Argentina and second in Chile; and 3) *Governance and Citizens*, third in Argentina and fifth in Chile. Some differences refer to: 1) the high position of the knowledge area *Management and Projects* in Argentina, ranked first, and the lower level in Chile, ranked seventh; 2) the high relevance of *Communication and Ethics* in Chile, ranked third, and the lower appearance in Argentina, ninth; and 3) the high relevance that Argentina gives to Society and People, ranked sixth, and the low level in Chile, eleventh.

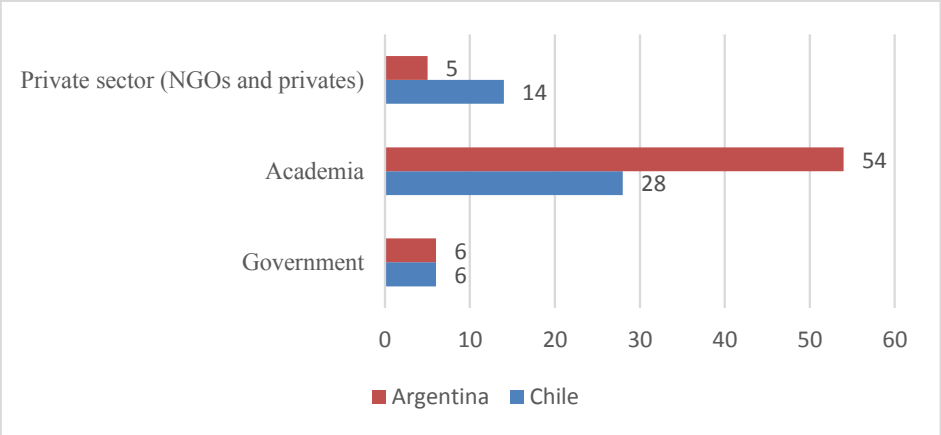

Fig. 1. Participants attending the workshop in Chile and Argentina

Table 1. Number of competences by area of knowledge

Knowledge areas	Chile	Argentina
Urban and territorial development	23	9
Laws and regulations	15	6
Entrepreneurship and innovation	7	1
Technology and apps	28	10
Data	18	5
Environment and sustainability	16	8
Governance and citizen participation	17	10
Management and project	16	14
Security and privacy	5	3
Social media and marketing	9	0
Communication and ethic	20	5
Society and people issues	6	8
Education	2	5
Information	0	4
Total	182	88

The CAP4CITY project team grouped the competencies in nine major themes according to their similarities. Figure 2 shows the percentage of competencies mentioned by the workshop participants in the nine themes by country. We could see that Argentina mainly mentioned competencies in the following themes: Governance (20.5% of the total competencies), Urban Studies and Sustainability (19.3%), and Public Administration and Management (15.9%). Meanwhile, in Chile, the themes in which more competencies were identified include Urban Studies and Sustainability (21.4%), Socio Technical ICT (15.4%), and Public Administration/Management" (13.7%).

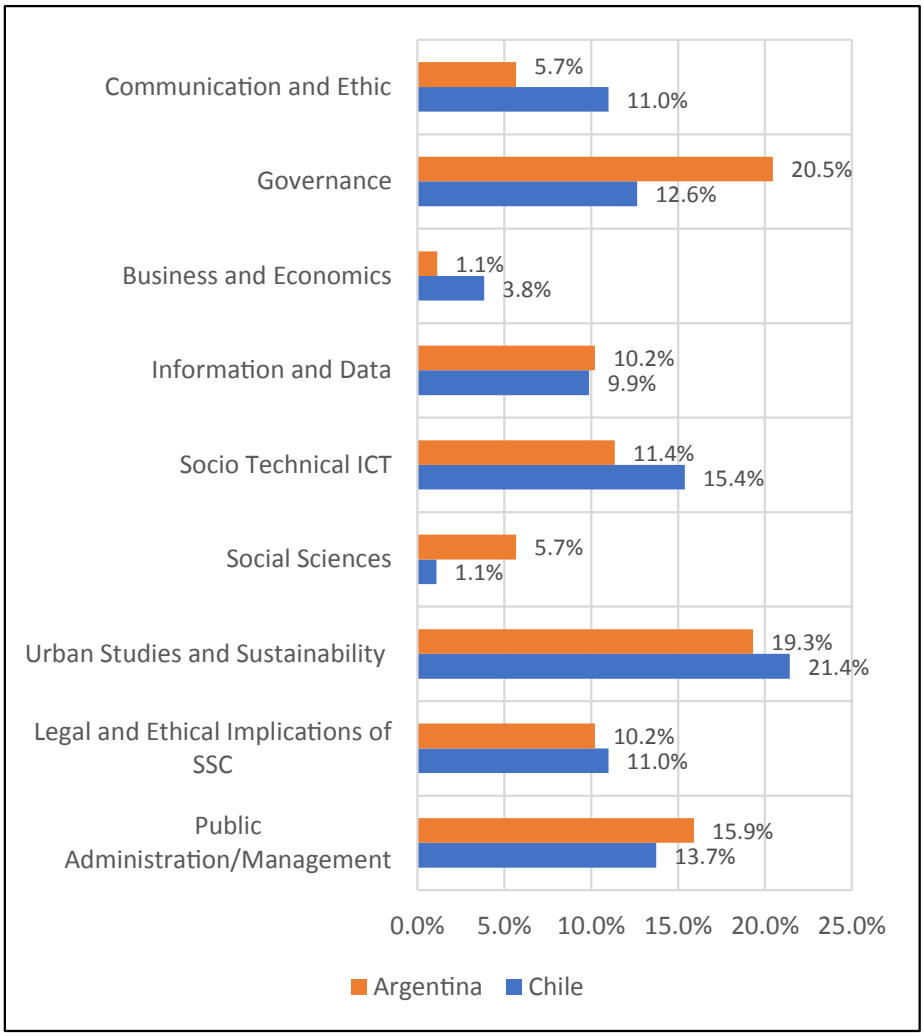

Fig. 2. Percentage of competencies identified by SSC theme

4.1 Comparison of Knowledge Areas Using Co-occurrence Analysis

This part of the study analyzes similarities and differences among the knowledge areas and competencies mentioned during the workshops conducted in Argentina and Chile.

Initially, we clustered the competencies identified by the workshop participants and coded them in the fourteen knowledge areas enumerated in Table 1. Later, a word analysis using the KH Coder software was performed to analyze and conceptualize the text. This software analyzes the structure of a text using statistical tools [27]. We applied the co-occurrence network [28] to analyze the similarities and differences among the competencies mentioned by the workshop's participants. This analysis showed that even though both countries share some competencies, many others were different, as we see in Fig. 3.

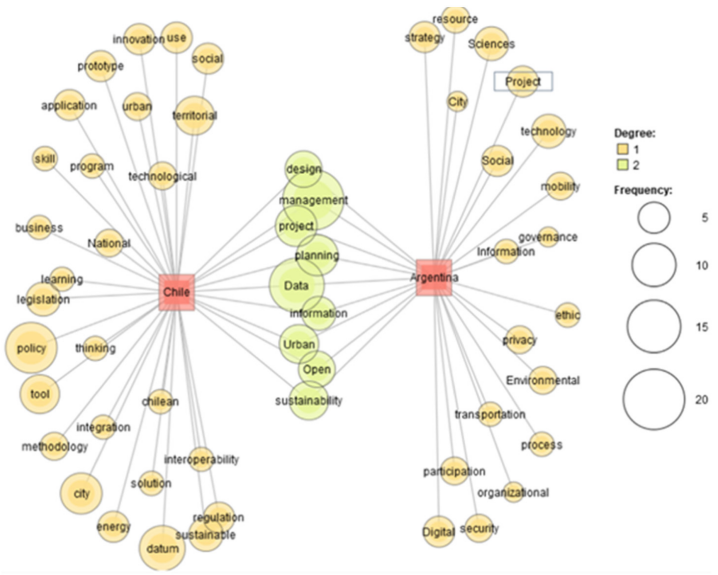

Fig. 3. Co-Occurrence Network between competencies in Chile and Argentina

Participants in both countries mentioned the competencies with the words design, management, project, planning, data, information, urban, open, and sustainability. The words governance, participation, strategy, social, organizational, and environmental stood out in the Argentina's workshops, but they were barely mentioned in the Chilean workshops. Chile, individually, mentioned the words policy, datum, interoperability, tool, legislation, and regulations, among others. The analysis of pedagogical models are shown in Fig. 4, which also shows similarities and differences between the models identified in the workshops conducted in the four cities.

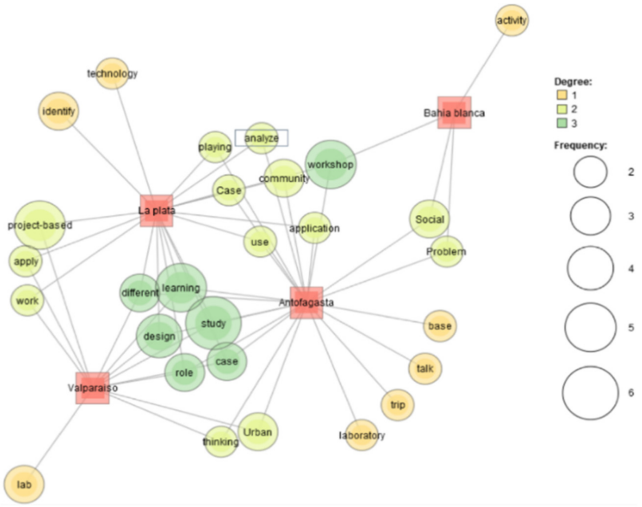

Fig. 4. Co-Occurrence Network between pedagogical models identified in Chile and Argentina.

The analysis clearly identified more similarities than differences in the suggested pedagogical models.

5 Discussion

The workshops organized in Chile and Argentina, aimed at identifying competencies and teaching models for the governance of smart sustainable cities in the South American context, enabled to collect more than two hundred competencies in various knowledge areas. The four workshops were conducted applying the same methodology and attracted a wide variety of participants from government, private companies, and academia. One essential requirement related to the participants was to include professionals from different areas of expertise – e.g. lawyers, IT professionals, urban planners, economists, and sociologists, among others, to cover the multiple dimensions and views needed for governing SSC efforts.

Results showed that even both countries being geographically close; their perception of the competencies needed for SSC development is not similar. The main differences between both countries can be summarized as follows. The Argentinian community emphasizes Governance and Social Sciences more than the Chilean community, but the Chilean community emphasizes Communication and Ethics, Socio Technical ICT, and Business and Economics more than the Argentinian community. Despite the differences, some similarities we found is the shared interest in areas such as Information and Data; Urban Studies and Sustainability; Legal and Ethical Implications of SCC; and Public Administration/Management. In addition, the pedagogical models identified by the participants were very similar in both countries. For instance, in the workshops conducted in the cities of La Plata, in Argentina, Valparaiso, and Antofagasta in Chile, participants identified the use of case studies and project-based learning as suitable learning methods for building competencies for SSC. Workshop's results were the first stage for the envisioned implementation of the courses – elective undergraduate courses, postgraduate courses and postgraduate programs – Specialization and Master, and MOOCs. Currently, the consortium defined a portfolio of 31 courses to develop the total set of the identified competencies. The usage of such courses will be open to the community. Moreover, acknowledging that each city has its own values, and one recipe does not fit all cases, we argue that each university, government or actor willing to use the courses, will need to select those that best fulfills the need of the local context.

6 Conclusions

Cities around the world are rapidly evolving, and they need to become smart and sustainable, adapting to the technological changes and the new demands of their citizens. Policymakers at the country and city level in South America need SSC programs that are adapted to their geographical and cultural condition. The series of workshops in South America, in the context of the CAP4CITY project, provided insights for developing a suite of courses that any city can adopt, customize, and use depending on their training needs. The successful implementation of such workshops allowed the researchers to identify the competencies and pedagogical models that could be both general but

adapted to the South American context. This approach can be repeated to assess the training needs in a city. The findings of this study are of key importance for government, private companies, and academia to drive towards finding a balance between knowledge areas, pedagogical models, and SSC programs adapted to their environment.

The study has some limitation. We were able to consider only two cities per country, and a limited number of participants. Therefore, the methodology used in the workshops can be replicated by other cities to identify their specific training needs before implementing an educational programme in SSC. In this sense, the contribution of this study is mainly oriented to present a methodological approach that any city can adopt rather that claiming any generalization of the results.

Future work includes completing the design and content development for the courses, designing the most appropriate implementation mode of the curricula, and designing and establishing postgraduate programs based on the courses. We believe that this work may lead to new approaches for training city leaders to better govern their cities, addressing the challenges of the South American cities in the 21st century.

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