Greening the Scientific Conferences

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Abstract*—Today we are facing an increasing number of scientific conferences that play an important role in the exchange of information for academia and researchers. In order to attend a conference, attendees travel to the conference city from all over the world and for bigger meetings this will produce a significant amount of carbon dioxide and other greenhouse gasses. In sustainable urban environments, various mobility solutions such as public transport, car sharing, and ride sharing are offered to enable seamless multimodality and reducing the urban pollution. However, the urban impact of the academic events needs to be addressed on a larger spatial scale. In scientific conferences, the conference location is decided during the early stages of conference planning and is announced by way of a Call For Papers. To this end, the conference location is merely decided based on economic, political, or city-attractiveness concerns. In this paper, we will first articulate the importance of the conference location by analyzing the real world data of some past conferences. Next, we show that there is a strong correlation between the emission rate per capita of the contributing authors and the final attendees of the conference. Based on this finding, we will then propose the idea of variable conference location that suggests deferring the selection of conference city to the paper submission deadline. As a result, it would be possible to make an informed and environmental-friendly decision about the conference location.

Keywords - greenhouse gasses; emission; conference management; green events

I. INTRODUCTION

Scientific conferences are an integral part of the science and academic life. Every year millions of scientists and researchers around the world attend a meeting or conference for presenting their works, receiving feedback, and doing face-to-face interaction and networking. The meetings have also emerged as a significant contributor to national economies. According to a 2009 UNEP green meeting guideline, every year over 80 million people around the world attend a meeting or conference and even more attend trade shows or exhibitions [1][2]. Another study states that in 2012, there have been 284,600 conventions/conferences/trade shows in the US alone, with a total of 87 million attendees [3]. Also, according to the U.S. Bureau of Labor Statistics, conventions and events sector is the fastest growing occupation and is expected to expand by 43.7 percent from 2010 to 2020 [4].

Over the past several years, the number of conferences and scientific papers has increased significantly. For instance, according to one of the proceedings databases [5], which contain listings of thousands of conference

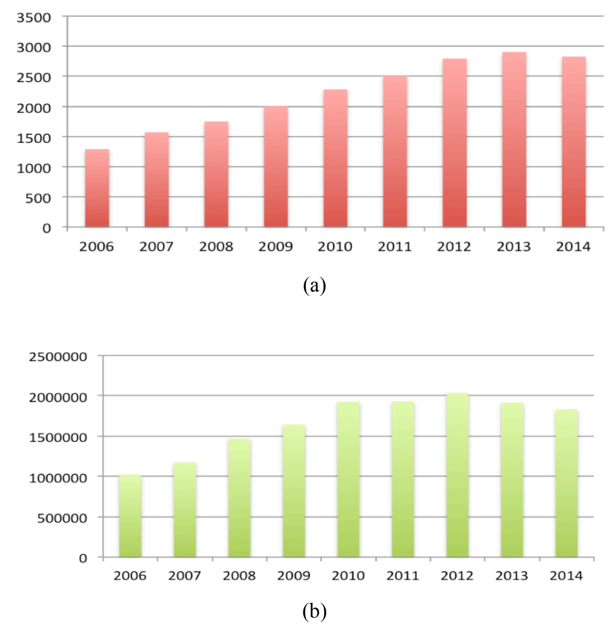

Figure 1. Number of conferences (a) and procedings' pages (b) between 2006 and 2014

publications, the number of conferences, as well as the proceedings' volumes, are two-folded. Figure 1 shows the increasing rate of scientific conferences and their proceedings volume between 2006 and 2014.

There are a number of arguments that might explain this phenomenon. One reason could be the broad acceptance of academic publications and citations as the evidence of research impact of scientists. This puts much pressure on scientific communities to sustain their career and academic promotion via publishing more papers and attending many scientific conferences. Besides, the recent advances in virtual meetings, digital communication, and webinars have not impacted the value of face-to-face communication and in-person meetings. Accordingly, it seems that the widespread adoption of such technologies may be years away [6][7].

This global rise of conferences and meetings imposes a bigger number of travels and consequently causes a significant amount of carbon dioxide (CO2) and other greenhouse gasses. The transportation and especially the long-haul travels of attendees are the major source of conference-related emissions. So, minimizing the travel path to the attendees' home country and city would significantly reduce the carbon footprint of the conference.

In order to reduce the contribution of transportation to urban pollution, the city designers try to shorten the paths to daily living destinations and make them accessible within a walkable distance. In the case of academic events, we are dealing with the same optimization problem on a larger spatial scale. However, neither the conference location nor the attendee location is flexible which hinders the optimization of the traveling distances and reduction of the urban pollution. Consequently, little attention is paid to the environmental impact of the conference location. The conference location is usually decided based on administrative or city-attractiveness factors. As such, the conference location is predetermined and the volume of emissions can be calculated only after the conference registration phase when the participation list is completed. Supposing that the conference location could be variable, it would be possible to calculate the optimal conference location based on the participants' list and their travel path to the conference location. Although the post-determination of conference city may reduce the emission, but in practice, this does not seem to be feasible. One of the major problems of this approach is the narrow timeframe for the participants and the conference organizers. This issue will not allow participants to plan the travel and address the formal requirements such as submitting the travel request to their organization or applying for the visa of the target country. Also, the conference organizers will not have enough time to plan the conference tasks and organize the local chairs and local staff competently.

In the present work, we first articulate the importance of the conference location by analyzing the real world data of some past conferences. Next, we show that there is a strong correlation between the emission rate per capita of the contributing authors and the final attendees of the conference. Finally, as depicted in Figure 2, we suggest a data-driven approach for selecting an environmental-friendly conference location.

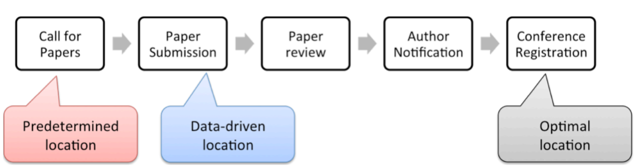

Figure 2. Determining the conference location at various phases of a scientific conference

The major contribution of this paper is to establish a data-driven approach to approximate the emission per capita of conferences based on the submitted papers and their prospective presenters. As such, the conference location can be determined as early as the paper submission phase. This will give enough time to the conference organizers to plan the logistic and organizational tasks, as well as attendees to plan their travel accordingly.

The rest of this paper is organized as follows. Section 2 reviews the state of the art. Section 3 introduces the data resources and the semantic data integration process for enriching the data and filling the missing values. Section 4 presents the emission calculation method for determining the emission per capita of conference participants. The proposed approach of this work is presented and discussed in Sections 5 and 6. Finally, Section 7 describes the future work and concludes the paper.

II. State of the Art

According to United Nations Environment Programme (UNEP), "a meeting or conference can be considered climate neutral when all possible efforts have been made to reduce the greenhouse gas (GHG) emissions arising from the organization of the meeting and when carbon offsets have been purchased to compensate for the unavoidable emissions" [1]. Since a significant part of the conferences' emission is associated with participants' travel activities, the conference location plays a significant role. There are a few guidelines for greening the meetings and the most common recommendation about the location of meetings is to minimize the local and long distance transportation needs for participants and products. However, in the specific case of scientific conferences attendees and their origin countries are unknown at the early stages of the conference planning and as a result optimizing the distances for long-haul travels is not possible.

Another proposed option for reducing the emission is to restrict meetings to major cities because holding them in outlying areas will require more connecting flights and subsequently more emissions [8]. There are also a few other proposals that suggest organizing fewer meetings or restricting the number of attendees but as discussed in the previous section, these suggestions are already neglected and overridden by the scientific community.

Other options are the virtual meetings [8] and the amplified conferences [9] that use ICT and networked technologies in order to extend the reach of the conference and liberate the participants from traveling to the conference location [10]. Although the virtual meetings are a great alternative to physical conferences in order to reduce emissions, but the trade-off is the limitation in social and networking activities.

III. Data Resources

The dataset of this study is taken from an integrated conference management system that offers various modules for paper management and conference registration. The selected dataset contains the paper submission and

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registration records of seven international conferences between 2010 and 2015. Each conference comprises a collection of co-located conferences and workshops. The attendees of these conferences range between 300 to 600 and the conferences have various acceptance rates. Figure 3 shows conference cities as well as the number of paper contributors, accepted authors, and attendees of these conferences.

Selection of paper contributors and accepted authors is based on the contact author of submitted papers during the paper submission phase. Each contact author may contribute one or more papers and will be considered as accepted author if at least one of the submissions is accepted.

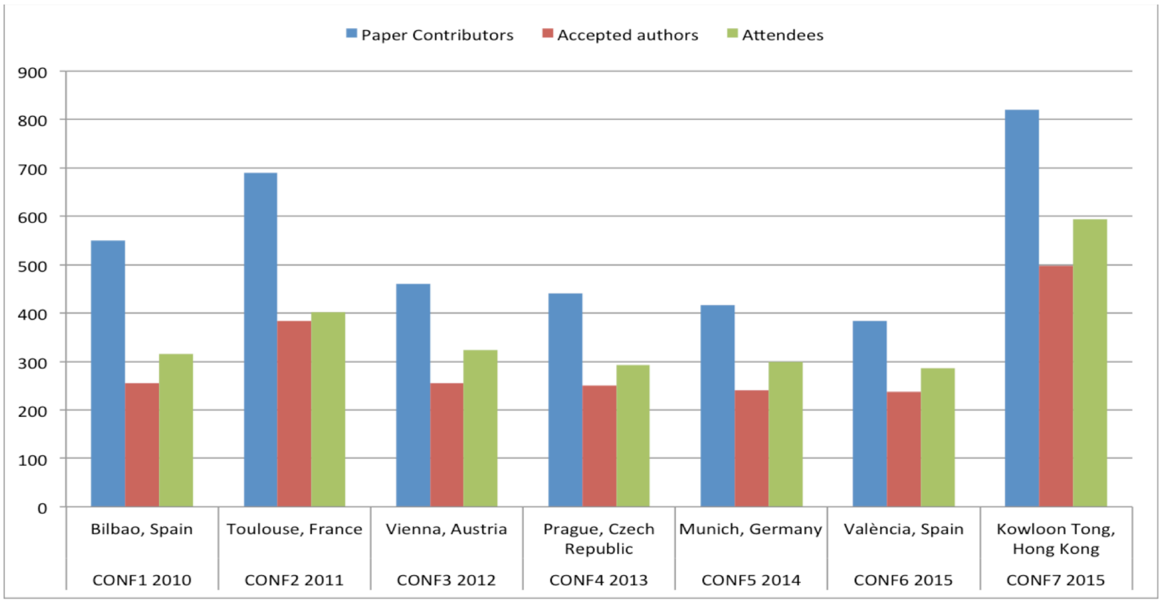

Figure 3. number of paper contributors, accepted authors, and attendees of selected conferences

Usually, conference organizers require at least one registration per accepted paper in order to include the papers in the conference proceedings and urge the authors of accepted papers to register and present their work in person.

In order to calculate the emission rates, we would need to identify the city and country of the contributing authors. Since the dataset of conference management system contains only the author's affiliation, we used the open data to acquire their city and country names. To this end, we first used the DBPedia lookup service [11] to disambiguate the affiliations and match them with the DBpedia resources. To increase the precision of results, the queries were limited to the "Organization" class of DBPedia ontology and the affiliations were annotated with their DBPedia URIs. For instance, the lookup service assigns the DBPedia resource [12] to the affiliations containing text "MIT" or "Massachusetts Institute of technology".

After this step, we used the DBPedia SPARQL endpoint to extract the city and country name of each affiliation by using the specific property names of DBPedia ontology as shown in Figure 4.

We used the OpenRefine tool [13] to automate the above-mentioned steps and could disambiguate and reconcile a big portion of the data. For the remaining part, which was not recognized by the DBPedia, we made an intensive data cleaning and manual matching to create a complete and concise dataset for our analysis.
As the final step, we used an online API [14] to calculate the distance between the conference location and the corresponding cities of the contributors and participants.

```
SELECT str(?city_name) str(?country_name) WHERE
{
  OPTIONAL {
<http://dbpedia.org/page/Massachusetts_Institute_of_Tech
nology> dbp:city ?city
<http://dbpedia.org/page/Massachusetts_Institute_of_Tech
nology> dbo:city ?city }

   ?city rdfs:label ?city_name .
   ?city dbo:country ?country .
   ?country rdfs:label ?country_name

   FILTER (lang(?city_name) = 'en')
   FILTER (lang(?country_name) = 'en')
}
```

Figure 4. SPARQL query for extracting city and country names based on affiliation

IV. EMISSION CALCULATION

For estimation of CO_2 and other greenhouse gasses, we have used an adapted version of the emission factor calculation proposed by UK Department for Environment Food & Rural Affairs [15]. This method uses a simple model to calculate the carbon dioxide equivalent (CO2e) of the travel emissions, which includes CO2, CH4, and N2O weighted according to their global warming potentials.

For specifying the emission conversion factor, we suppose that all participants within a reasonable short distance to the conference location use train and others with longer distances take a flight. To this end, we define three distance categories for domestic rail transport, short-haul flight, and long-haul flight as shown in Table I.

TABLE I. DISTANCE CATEGORIES AND THEIR EMISSION FACTORS

Transportation Type	Distance Range	Emission Factor (kg CO2/pkm)
Domestic (rail)	Less than 785km	0.01205
Short-haul flight	Between 785km and 3,700km	0.0831
Long-haul flight	Greater than 3,700km	0.097

The amount of carbon dioxide equivalent for each conference participant, is then calculated as follows:

Emission = Round-trip Distance * Emission Factor * Uplift Factor

where the emission factor for each transportation type comes from the recent report of [16] and the uplift factor is an adjustment factor to consider non-direct routes, delays, and circling of flights. For rail transport, it will be set to one and for flights, it comes from the IPCC Aviation and the global Atmosphere 8.2.2.3 [17]. Although the uplift factors for short-haul and long-haul distances are different (higher for short-haul flights and lower for long-haul flights), but currently only a uniform value of 1.09 is used by the airline industry which seems to be good enough for the purposes of this paper.

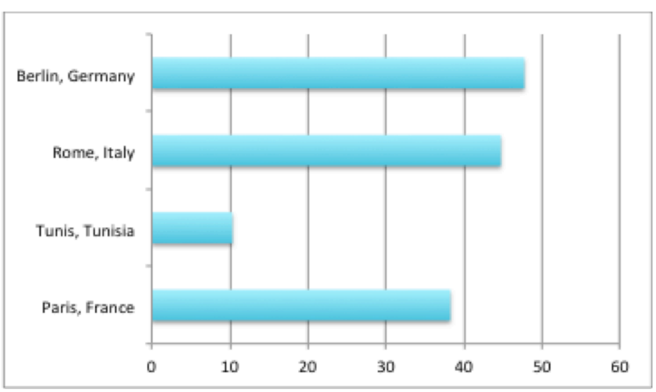

Figure 5. Emission saving per person for Conf 6 in Valencia Spain (kg CO2e)

V. APPROACH

Using the dataset of the conference management system and the above-mentioned emission calculation method, we have assessed the emission per capita for registered participants, contributing authors, and the accepted authors.

The registration dataset includes city and country information of each participant, which makes it possible to make a near-real calculation of conference emission caused by participant's travel. It is important to note that this value could be calculated only after the finalization of the registration process. Therefore, it can be only considered as an informative/evaluation indicator and cannot be used in a proactive way to reduce the conference emissions. In order to highlight the decisive role of conference location in causing emissions and as a demonstrative example, consider the case of CONF-6, which took place in Valencia, Spain. The calculation of carbon emissions shows that by relocating the conference to other cities, a reasonable fraction of the carbon emission will be reduced. Figure 6 shows the amount of emission savings per capita by relocating the CONF-6 to Berlin, Rome, Tunis, or Paris.

If we consider the number of submitted papers per country and compare it with the emission savings (Table II), we find that the host countries with a higher number of submissions do not necessarily provide a higher rate of emission saving. For instance, in the case of the CONF-6, the top three countries namely France, Tunisia, and Italy are not the optimal location for organizing the conference. Furthermore, a country like Brazil with a high number of submissions will cause a huge amount of emission per capita.

TABLE II. SUBMITTED PAPERS VS. EMISSION SAVING

City, Country	Submitted Papers	Emission Saving
Paris, France	31	38.26
Tunis, Tunisia	31	10.33
Rome, Italy	29	44.72
Berlin, Germany	21	47.72
Brasília, Brazil	20	-1262.77

We now extended the emission calculations to the other two groups namely the contributing and accepted authors. In the dataset of conference management system, each submitted paper has a contact author who upon acceptance of the paper, will register for the paper and attend the conference. Each contact author might have also multiple paper submissions but will be counted only once in the emission calculation lists. This is in line with the economic and budget considerations of the participating organizations that usually prefer to reduce the size of their delegates to the conferences and ask a single author to present multiple papers.

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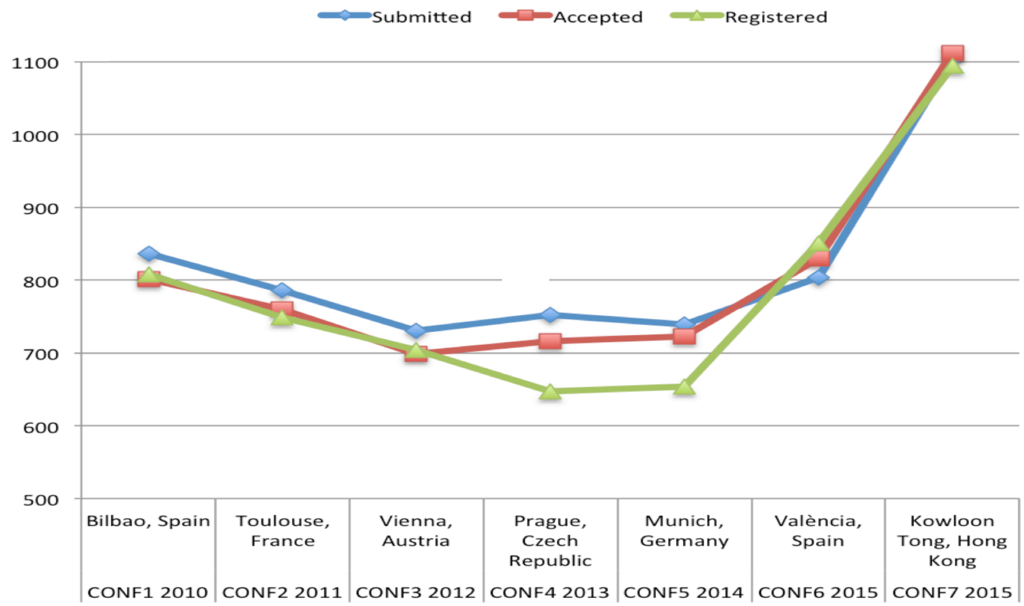

Figure 6. Emission per capita for selected groups and cities (kg CO2e)

In the case of contributing authors, the dataset does not contain the city information of authors and instead we used the distance between the conference location and centroid of author's country for calculating the emissions.

Figure 6 shows the emission per capita for the selected target groups and cities. This empirical result shows a correlation of 0.97 between accepted-registered authors and a correlation of 0.95 between submitted-registered authors. The latter correlation is especially interesting because the list of contributing authors is typically known at the early stages of the conference lifecycle. So, independent of the review and evaluation processes, it can be used as an effective indicator to decide about conference locations.

VI. DISCUSSION

With the current trend in the scientific conferences, it seems to be improbable that the alternative communication models such as virtual conferences replace the physical conferences. So, it makes sense to make the conferences as green as possible.

The preliminary results of this research show that at the early phases of conferences and with a rather good accuracy, the carbon emission of a conference can be estimated. As such, the conference-positioning problem will turn into a well-known 1-center problem [18], where the cost between nodes will be the carbon emission of travel between those nodes. This process will result in a short list of candidate nodes (cities) that produce a lower amount of CO_2 emission. As such, the conference organizers will be able to consider the candidate cities as well as other organizational policies to make a data-driven and environmental-friendly decision about the conference location.

Due to the absence of some required data in our dataset, we have made some simplifications to our emission calculation method. These include restricting the transportation vehicle to the railway for short distances (less than 785 km) and considering the country centroids for distance calculation. But, comparing the emission of registered participant and contributing authors shows that these simplifications do not have significant impacts on the estimation of travels' emission. Furthermore, the data preparation for the simplified model requires less effort and as a result, it would be more convenient for the conference organizers to apply it in practice.

Despite proof of feasibility and environmental benefits of the proposed approach, acceptance of variable conference location by the academic community might need a longer time. Nevertheless, compared to other proposed options such as virtual meetings, less frequent meetings, or limiting number of attendance, the proposed solution does not restrain the quality of participants' communication and networking activities.

VII. CONCLUSION AND FUTURE WORK

Our analysis shows that there is a big potential for emission reduction of scientific conferences. The existing options for emission reduction are typically decreasing the quality of social interaction and face-to-face.

The proposed idea of "*variable conference location*" suggests deferring the selection of conference city to the paper submission deadline. The empirical results show a rather strong correlation between the emission per capita of contributing authors and the conference attendees. As a result, it would be possible to make an informed and environmental-friendly decision about the conference location when the paper submission is over. This will give enough time to both attendees and organizers to accomplish the conference preparation tasks.

In order to realize the concept of variable conference location, we would need datasets and services that take the

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environmental concerns into account. For instance, instead of restricting the transportation method to railway or flight, we may be able to plan multimodal trips that consider the environmental concerns provided that the required datasets and services are available. Currently, there are a growing number of cities that promote the multimodality transportation at the urban level. As such, people will be able to plan their transport based on a network of transit option or even combine them to address the individual needs. Unfortunately, the multimodality concept is not yet well established for the case of international trips and the existing trip planning services usually support only a single mode of transportation. This problem is mainly because of the disconnected information resources in transportation domain and lack of standards for data exchange between them. Furthermore, we would need information services that are capable of examining the alternative travel itineraries in order to identify the environmental-friendly variant. So, future work should aim to refine the proposed approach by considering various factors, such as alternative modes of transportation, multi-stop flights, and multimodal trips.

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