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Knowledge transfer between stakeholders in the field of urban forestry and green infrastructure: Results of a European survey

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ABSTRACT

The establishment and management of green infrastructure in cities require the involvement of a complex network of stakeholder groups, who may differ sharply from one another in their expectations and approaches. Bridging the communication gaps between them is essential for creating and maintaining urban green spaces and expressing their full potential and multi-functionality. In this research, we investigate the ways that knowledge is transferred from one stakeholder group to another, and we identify the relative strengths and weaknesses of the different modes by which these actors collaborate and interact in practice. Data obtained from this first-ever exploratory survey of public administrators, practitioners and academic researchers involved with urban green infrastructure in Italy and other European – but also some extra-European – countries indicate that there are positive attitudes toward forms of collaboration, mainly because of the need to achieve common aims such as encouraging innovation, identifying practical problem solutions and accessing sources of funding. Our analysis suggests that stakeholders need to better understand the importance of forming cohesive teams, of optimizing financial resources, and of finding a common language to bridge their diverse disciplinary backgrounds. To be effective, future models of knowledge transfer will have to consider the current needs of end users without neglecting the long-term potential of emerging communication technologies such as e-learning, and vocational training must not only be based on high-quality content, it must also include practical activities and facilitate personal contact that can lead to enhanced collaboration.

1. Introduction

Green spaces in urban and peri-urban areas provide a variety of environmental services and benefits to citizens (Nowak and Crane, 2002; Davies et al., 2011; Sanesi et al., 2011; Shashua-Bar et al., 2011; Susca et al., 2011; European Commission, 2013a; Haase et al., 2014; Petralli et al., 2014). They are also part of the city's "green infrastructure" (GI), a concept which has been elaborated in recent years under several definitions, including "*. . .the spatial structure of natural and semi-natural areas enabling citizens to benefit from its multiple services*. . ." (European Commission, 2010), and "*a strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity*. . ." (European Commission, 2013b).

Green infrastructure networks are discernible at different scales, and across urban, peri-urban and rural landscapes: they include Natura 2000 sites, multifunctional zones, and specifically urban elements such as green parks, green walls and green roofs. GI is considered to be supportive of ecological processes whilst simultaneously contributing to better human health and well-being (Lafortezza et al., 2013); in fact, an important common denominator of these diverse GI components is that they all contribute to the overall capacity of the urban region to host biodiversity and allow for ecosystems to function and deliver their essential services (European Commission, 2013b). Considering the challenges faced by urban communities in the planning and management of landscape amenities and controlling urban sprawl, the integrity of a green infrastructure network is considered vital for guaranteeing the maintenance of environmental benefits and services with respect to the needs of the local population (Maes et al., 2014).

While over the last decade there has been an upsurge of interest in urban green spaces, and even in the broader notion of urban green infrastructure, less attention has been paid to the gover-

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nance processes—i.e., the decisions of responsible organizations and the interactions between them—which are required for the establishment and maintenance of these public assets (Lawrence et al., 2013; Besse et al., 2014). Such scrutiny is essential if we are to address the widening gap between knowledge and policy in urban environmental governance, and the subsequent demand for more effective collaboration between scientists, practitioners and decision-makers.

The communication gap between academic research and the productive sectors is by now a ubiquitous and well-known phenomenon, which crosses disciplines and is rooted in our shared cultural assumptions (Folke et al., 2005). This gap has been attributed to limitations in the adaptive capacity of institutions (Smith et al., 2010), and bridging it is especially important for ensuring that researchers and industry work together to maximize the social and economic benefits of new ideas. While institutional change is undoubtedly still gradual, the European Commission has intervened to address this gap by providing operational guidelines (European Commission, 2007).

However, a recent analysis by Chapman (2013) showed that even the intensive engagement of stakeholders, which tends to catalyze relationships between scientists and other actors, does not guarantee success in terms of the actual knowledge acquired or the application of research in practice. The dynamics underlying the establishment, management and maintenance of GI can be especially complex, given the diversity of the stakeholders involved in the process. This web of actors may include administrators of green areas, landscape planners, arboriculturists, foresters, field workers, private citizens, environmentalists, volunteers, researchers and others — all of whom tend to have different points of view, goals, perspectives, skills, and means, which in many cases inhibit productive collaboration among them.

These different actors may be divided into different typological groupings, and in this research we identified three broad categories of stakeholders: 1) academicians, 2) public administrators and 3) practitioners. Thus on one side we have the academic world—generally considered to be a source of ideas and innovation, as well as a basic provider of graduates who are continually entering the work force and filling the needs of a constantly changing economy. On the other side, there are public administrators and practitioners (i.e., private professionals and associations), two groups who are, respectively, responsible for formulating and implementing policies based on the scientific results provided by academics.

However, the need for more and better science communication is continuously emphasized by organizations and programs that are dedicated to building stronger interfaces between science and society. Achieving this goal requires attention to the full range of boundary-spanning activities, such as public engagement, decision-relevant synthesis, distillation of results, and science translation and dissemination, through a variety of media to meet the needs of diverse audiences (Cash et al., 2003; Driscoll et al., 2011, 2012).

Moreover, it is clear that in order to be useful, scientific information must be salient, credible, and legitimate—and its production must relate to process, not just product (McNie, 2007). It is understood that building credibility, salience, and legitimacy with stakeholders helps to solidify long-term relationships and increases the influence of scientific research in the decision making process over time (Cash et al., 2003) – and in the sector of urban forestry, the demand for sound scientific information and public participation is particularly pronounced (Janse and Konijnendijk, 2007; Wolf and Dilley, 2008).

Historically, this gap between scientific knowledge and the public may be explained by the fact that science has been seen as an objective and value-free pursuit, which is entirely separate from political processes in society (Chilvers and Evans, 2009). Increasingly, however, science and society are becoming more closely intertwined, and politicians have concurrently started paying more attention to the need to improve the transfer of knowledge between scientists and end-users, particularly in the field of forestry (UNESC, 2004; COM, 2006). This interest has been documented in several scientific publications addressing the need to improve communication between scientists and policy-makers on environmental issues (Cortner, 2000; Mills and Clark, 2001; Shields et al., 2002; Guldin, 2003; Innes, 2003; Mayer and Rametsteiner, 2004; Spilsbury and Nasi, 2006). These studies have suggested that communication, preferably addressed to the public at large (including privates landowners and politicians), should take the form of consultation and proactive participation and should be conducted by experts such as foresters and arboriculturists—even though they may currently be lacking in the necessary communication skills (Konijnendijk, 2000, 2004; Janse and Konijnendijk, 2007; Wolf and Dilley, 2008; Wolf and Kruger, 2010; Mincey et al., 2013).

Chilvers (2012) argued that one underexplored way of improving the dialogue between scientists and users of scientific knowledge is through the intervention of expert mediators, who are increasingly recognized as an important source of 'public participation expertise'. This study revealed the emerging role of alternative forms of dialogue—including participatory and informal public debate, and events that use art, performance, or new media to catalyse discussion between stakeholders. These experimental approaches are evolving into new and diverse "ecologies of participation" that are richer, more complex and more interconnected than in the past (Wilson, 2011).

If on one hand we realize the importance of collaboration between diverse professional actors, and on the other hand recognize the difficulties involved, how may we conceive of an environment that is indeed conducive for new collaborations? Part of the answer no doubt lies with public policy-makers, and it is noteworthy that existing policies in Europe (Faehnle et al., 2014) already encourage collaborative urban governance (Forester, 1993; Campbell, 2006).

An important role can be also played by professional organisations and associations at the national or international level (e.g., International Society of Arboriculture, European Arboriculture Council, European Council on Spatial Planners, International Federation of Parks and Recreation Administration, etc.), which support research and education, certification systems, and connections between professional stakeholders in their related sectors. In fact, associations like the International Society of Arboriculture recognize the high-quality skills and competences that may be achieved by professionals through the cultivation of fruitful relationships with clients and the pursuit of successful initiatives in community education (http://www.isa-arbor.com/). These efforts make it clear that bridging the existing gaps between different stakeholders is vital for improving collaboration, and in turn facilitating the effective transfer of knowledge, between them. In particular, this requires a fundamental re-examination of the *means* that are used in the dialogue between stakeholders (Janse, 2008).

These issues are at the core of the present research—which investigates, though an exploratory survey, the nature of knowledge transfer and the state of collaboration and interaction between public, academic and professional stakeholders in the sectors of urban GI and UF. Assessing the characteristics and the effectiveness of the current situation is undertaken with the goal of gleaning useful indications of future trends, and better understanding the role of training in scientific knowledge transfer.

2. Materials and methods

In 2013, a survey was developed within the framework of the European COST Action FP1204 'GreenInUrbs' (www.greeninurbs.com), a consortium of experts focusing on the linkage between environmental and social aspects of urban forest management. The survey was exploratory in nature, and was initiated in response to a consensus opinion within the group that such a first step is needed to fill the knowledge gap that exists in this area.

Three categories were defined and targeted in order to capture indicative responses from the types of stakeholders that were deemed as playing a critical role in the management of urban forests and public green spaces. Because of the limited resources available for data acquisition, responses were solicited on a voluntary basis, by publicizing the online questionnaire through professional and academic organizations dealing with urban green infrastructure. While the lack of comprehensive inventories of entire stakeholder groups precluded the possibility of random sampling, it was possible through these channels to target a wide cross-section of actors.

Three distinct versions of web-based questionnaires, similar in their structure and content, were addressed specifically to three categories of stakeholders belonging to the spectrum of work sectors embraced by UF and GI:

1) Public administrators and policy makers (government ministry representatives; national, regional and local councillors, mayors, managers and technicians working or dealing with UF and GI).
2) Practitioners (urban planners and designers, technical consultants, technicians, plant producers, workers, arboriculturists, etc.).
3) Academicians (researchers, academics working on urban forestry and green infrastructure or related research fields, etc).

A series of pilot tests was conducted to ensure the quality of the survey, with feedback from these first respondents used to improve the clarity and functionality of the interactive questionnaire. As a first-time exploration, the survey was initially targeted to stakeholders in Italy—where dissemination of the questionnaire was supported by the major national organisations and associations representing the three categories of urban GI actors. Due to increasing interest at the European level, the survey was extended across the COST Action partner countries in Europe as well as the US, and to the most important international associations and organisations in the sectors of interest. The final version was accessible via a public web page on the COST Action site (http://www.greeninurbs.com/).

Survey responses were collected from October 2013 to February 2014, with the intent of achieving large population samples which would be distributed as randomly as possible and sufficiently varied to reflect the perspectives of the three groups of stakeholders. Detailed characteristics of the respondent sample are described in Section 3.1 below.

The questionnaires included 26 questions, divided into four parts (Table 1). The first part identified personal details (country, age, gender, work sector), the second part concerned the means, usage and effectiveness of knowledge transfer, the third part addressed collaboration between stakeholders (strong and weak points), and finally the fourth part concerned experiences on training.

Most of the questions had a response modality on a 5- or 7-point Likert scale, and responses were analyzed using the Student's *t*-test between two groups or the one-way analysis of variance (ANOVA) and Bonferroni correction method for more than two groups. This test was also used to assess the difference between target groups with respect to their geographical area. Questions having a response modality of Yes/No, or requiring a comparison of frequency (for instance the forms of collaboration between two groups), were analyzed using the Chi-squared test. The responses to some questions were also analyzed on the basis of the respondents' geographical location. In addition to the structured questions, respondents were able to add comments in an open-text format.

Table 1
Basic structure of the questionnaire administered to all respondents, with detailed versions formulated for each of the three stakeholder categories.

Section	Content
Part 1. Personal details	Country
	Gender
	Education
	Organisation (type and size)
	Work position
	Work sector in green infrastructure and urban forestry
Part 2. Scientific knowledge transfer	Aspects of knowledge transfer in need of improvement
	Usage of suggested means of scientific knowledge transfer
	Effectiveness of suggested means of knowledge transfer
	Strategic work sectors which are worthy of funding
Part 3. Collaboration between stakeholders	Experience of collaboration
	Strong and weak points of collaboration
	What is needed to start a new collaboration
	Expectations for further collaboration
Part 4. Training in green infrastructure and urban forestry	Participation in training courses
	Type of training provider
	Type of learning delivery
	Characteristics of the course

3. Results

3.1. Characteristics of the sample

The respondents were asked firstly about their personal details, including country of residence, work sector, age and gender). Among the overall sample of 477 completed questionnaires, 45% of respondents were from Italy, 36% were from other European countries and 19% were from outside Europe (mostly from the United States). Representation from the three stakeholder groups was evenly balanced, with 37% (177) of respondents self-identifying as researchers or individuals belonging to academic institutions, 34% (162) identifying as practitioners, and 29% (138) working in public administration. All three groups were also represented within each of the geographical regions, with a fairly even distribution in the extra-European group and the Italian group, and a predominance of academicians in other European countries (Table 2).

Most respondents were in the age group of 35–50 (42% of respondents) and 50–65 (34%), with younger respondents (less than 35 years old) accounting for the remainder. The public administration category was least represented by younger respondents (16% vs. about 25% for the other groups). Regarding age distribution, the share of respondents in the range of 50–65 years old (34%) is in close accordance with the 32.6% employed in "Forestry and logging" in the same age category in the overall population, as reported for 28 European countries for 2013 in the Eurostat database (http://ec.europa.eu/eurostat/web/lfs/data/database).

In terms of gender distribution, women were under-represented in all three groups: they accounted for 33% of the whole sample, comprising about 23% of practitioners, 35% of public administrators

Table 2
Distribution of respondents by category and geographical area.

	Italy	Europe (o ther)	Extra-Europe	Total sample
Practitioners	43% (91)	24% (40)	33% (31)	34% (162)
Public administrators	31% (66)	18% (31)	44% (41)	29% (138)
Academicians	27% (57)	58% (99)	23% (21)	37% (177)
Total	45% (214)	36% (170)	19% (93)	100% (477)

Table 3
Proportion of female respondents in sample, with comparative public data from Europe.

	Women (% of total)	
	Present sample	Public data
Practitioners	23	
Forestry		13[a]
Agriculture		35[a]
Public administrators	35	
Level 1 administration		30[b]
Level 2 administration		38[b]
Academicians	40	
Grade C academic staff		44[c]
Grade B academic staff		37[c]
Grade A academic staff		20[c]

[a] European Commission, 2013c. She Figures 2012. Gender in Research and Innovation.

and 40% of academicians. These proportions are highly representative of the European work force in recent years, according to data published by the European Commission (European Commission, 2013c) which show that the proportion of male researchers exceeds that of female researchers in all of the work sectors (higher education, government, and business enterprise) and nearly all of the EU countries studied. As seen in Table 3, the percentage of female academicians in the current sample (40%) is particularly reflective of academic staff in Europe at the levels of Grade B (44%) and Grade C (37%). The percentage of female practitioners, as in our sample (23%), is considerably lower—ranging from about 35% for agriculture to 13% for forestry (http://ec.europa.eu/eurostat/web/lfs/data/database). Women in public administration fall in an intermediate range, comprising 35% of the current sample and from 30% (at high level administration) to 38% (at Level 2) in Europe (http://epthinktank.eu).

Concerning the level of education, most of the respondents (79% of the practitioners, 96% of the academicians, and 81% of the public administrators) had completed higher education (bachelor's or master's degrees) – and among these, respondents with doctoral degrees were predominantly academicians (81%).

Regarding the type of employment and organization, most practitioners (75%) reported working in profit-making enterprises whereas public administrators work mainly in municipalities (66%) and regional or national government (17%). Academicians were mainly affiliated with universities (53%), with another 31% working in public research institutes.

A large majority of practitioners (71%) reported working in organizations that are very small (less than 10 employees), with another 16% employed in organizations with between 11 and 50 employees. On the other hand, public administrators and academicians mainly work in large organizations with more than 250 employees (49% and 59%, respectively) or medium-size organizations (26% and 27%, respectively).

The respondents were also asked about their main work sector. Fig. 1shows that they are mostly related to arboriculture (plant biomechanics and physiology, tree management, species selection, pathology etc.). Work connected to urban infrastructures (irrigation, light systems, etc.) is mainly typical of practitioners and public administrators. The field of urban planning and design was equally selected by respondents in all three categories. Social aspects of GI and UF are generally dealt with by academicians, whereas the economic aspects are mostly the concern of public administrators. The relatively small percentage of female respondents in the overall sample was also expressed in each of the work sectors, especially in those related to plant provision (21% females), trees (29% females), and urban infrastructure (31% females), whereas the social aspects of urban green areas were cited by the highest percentage of women

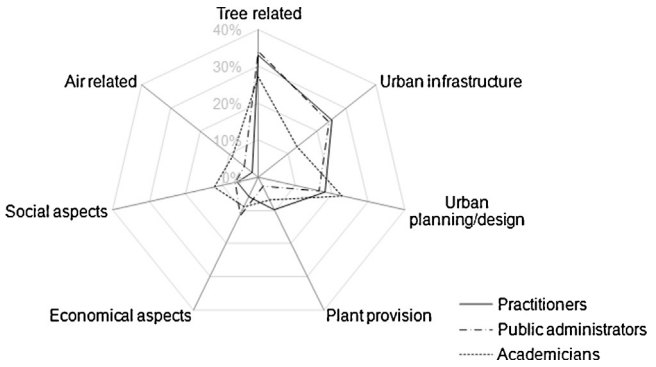

Fig. 1. Distribution of work sectors by stakeholder category.

(60%). This is reflective of the overall European work force, in which the science and engineering fields have the lowest female representation and the social sciences have a higher proportion of women in senior academic roles (European Commission, 2013c).

Respondents were then asked about the work sectors of UF and GI they would consider most important for funding. Unsurprisingly, there is a general correspondence between the work sector of the respondent and the perceived importance of funding (Fig. 2). For example, the sectors related directly to the provision of trees and other plants are seen as more worthy of support among practitioners and public administrators than they are among academicians ($p < 0.05$). In contrast, urban planning and design, and pursuits related to the social aspects of GI, are considered worthiest by academicians ($p < 0.05$). Interestingly, though, there is general agreement among all stakeholder groups regarding the funding of professional training programs —which are considered to be a high-priority goal among all types of respondents.

3.2. Scientific knowledge transfer

The second part of the survey related to scientific knowledge transfer: how it is perceived in terms of access to the latest scientific research findings, and what aspects should be enhanced (i.e., language, standardization, access, connection to societal problems, and training) in order to achieve wider exploitation.

According to respondents' self-evaluation of the extent to which they are up to date on research findings, academicians are more updated ($p < 0.001$) than public administrators and practitioners—and Italian practitioners reported feeling significantly less up to date than extra-European ones ($p = 0.02$).

It was seen that achieving a wider exploitation of scientific results depends on several variables, including the quality, accessibility and usefulness of the published material.

Respondents evaluated these different aspects and, regardless of their geographical origin, were largely (over 80%) in agreement that the most important barriers to overcome are a) enhancing the connection between scientific research and societal needs for applied knowledge and practical problem solutions, b) improving and updating their own scientific knowledge, and c) simplifying the access to scientific results. In extra-European countries, the particular challenge of enhancing access to scientific results is more important for practitioners and public administrators than for academicians ($\alpha = 0.005$), whereas the connection of scientific research to real problems is fully supported by academicians as well as practitioners ($\alpha = 0.005$).

The scientific language used to communicate research findings was largely considered to be unfriendly for the end user, and in general more than 70% of respondents agreed that this language should be enhanced for improving the transferability of scientific knowledge. Both European and extra-European practi-

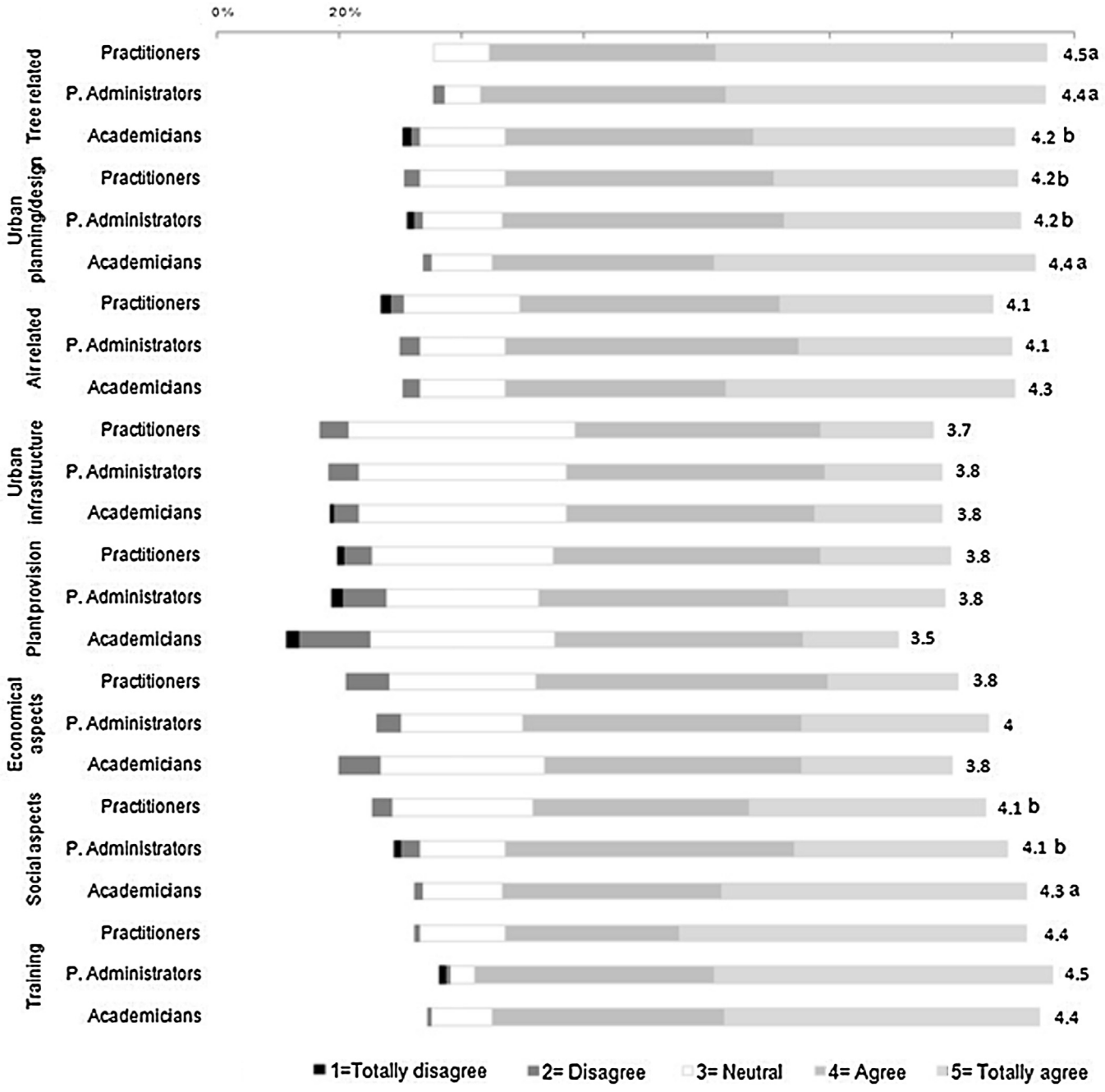

Fig. 2. Work sectors considered worthy of funding, as prioritized by stakeholder groups. Percentages of selections are shown for each grade on the Likert scale, as given by respondents in each category. Mean values are also reported. Letters indicate the statistical difference between the three categories after ANOVA followed by Bonferroni test at $p < 0.05$.

tioners are relatively sensitive to this problem, especially with respect to public administrators ($\alpha = 0.01$). One possible remedy for this is the standardization of scientific results, using terminology which is commonly understood and methodologies clearly defined (Gosling et al., 2014; Helms et al., 2003) – and support for this strategy was particularly expressed by Italian academicians ($\alpha = 0.005$).

When asked about the means of knowledge transfer they use, among those suggested (see Fig. 3), respondents revealed that online sources of information are by far the most widely used. As might be expected, scientific publications in English are mostly utilized by academicians; practitioners and public administrators use them sparingly, and even less so in Italy than in other countries ($p < 0.01$). In contrast, Italian and extra-European practitioners prefer instructional manuals more than their other European counterparts ($p < 0.01$) and more than public administrators ($p < 0.01$) and researchers ($p < 0.05$) in the same areas.

Technical meetings and seminars/conferences are more frequently attended by practitioners and public administrators, and the discrepancy between them and academicians is clear in both European and extra-European countries ($p < 0.01$) – though attendance among Italian respondents is less frequent ($p < 0.05$ vs. European, and $p < 0.01$ vs. extra-European colleagues).

With regard to alternative modes of knowledge transfer, e-learning is still very rarely used. This is clearly the case across all categories of stakeholders, though an interesting distinction may be observed when comparing the three geographical areas: Italian practitioners and public administrators report the lowest use of

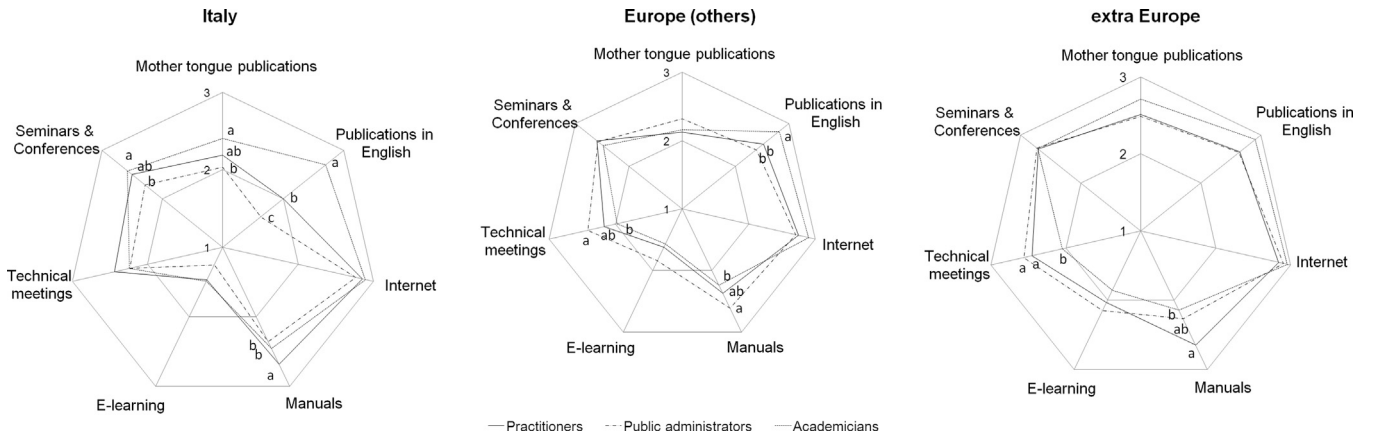

Fig. 3. Means of scientific knowledge transfer (1 = never used, 2 = at least once, 3 = frequently). Mean values of usage calculated from opinions reported by respondents in each category in each geographical area. ANOVA and Bonferroni test for comparison of means were used to find statistical differences between categories within each geographical area and between geographical areas. Small letters indicate the statistical differences between categories at $p < 0.05$. Statistical differences between geographical areas are reported in the text.

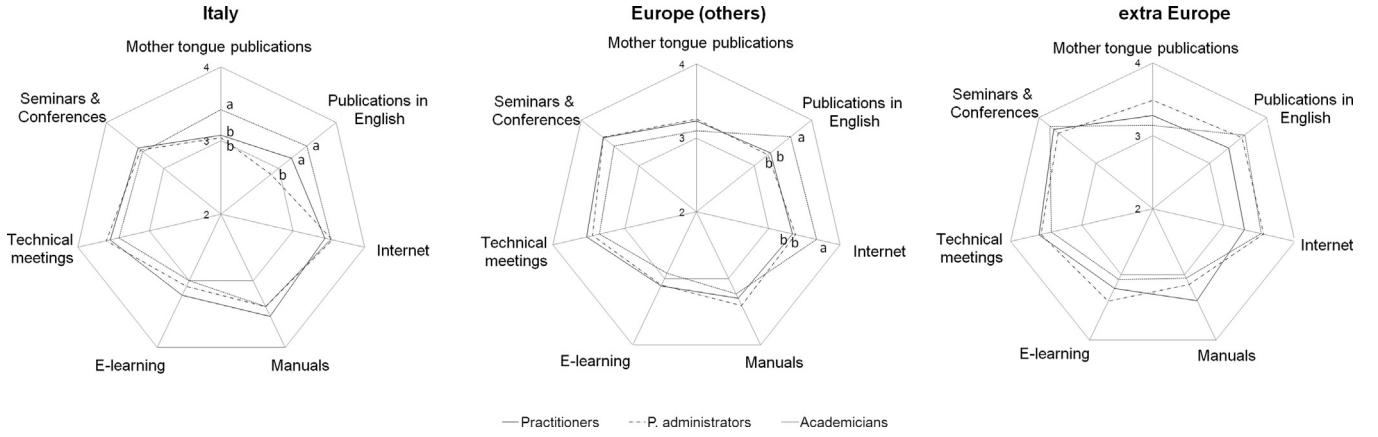

Fig. 4. Effectiveness of means of scientific knowledge transfer (4 = effective, 3 = somewhat effective, 2 = not effective). Mean values calculated from responses in each stakeholder category in each geographical area. ANOVA followed by Bonferroni test for comparison of means used to find statistical differences between categories within the geographical area and between geographical areas. Small letters indicate the statistical differences between categories at $p < 0.05$ in each geographical area. Statistical differences between geographical areas are reported in the text.

e-learning, whereas their extra-European ($p<0.01$) and European colleagues ($p < 0.05$) report using it somewhat more.

The means of knowledge transfer were also assessed for their effectiveness (Fig. 4). In Europe, academicians consider the internet more effective than practitioners do ($p < 0.05$), and a similar comparison holds for scientific publications in English ($p < 0.05$). Italian academicians prefer scientific publications in their tongue, both in comparison to the other stakeholder groups ($p < 0.05$) and to their European colleagues ($p < 0.05$), whereas Italian public administrators consider scientific publications—either in their mother tongue or in English—less effective than do their foreign colleagues ($p < 0.01$). Face-to-face meetings like seminars and conferences are still considered to be rather effective, with higher grades given by extra-European practitioners and academicians than by their European (including Italian) counterparts ($p < 0.05$ and $p < 0.01$, respectively). While the use of e-learning, as mentioned above, is relatively low overall, this new mode of knowledge transfer is considered quite effective by those who actually do use it. This is true for all stakeholder categories, although the extra-European public administrators consider it more effective than the European ones do ($p < 0.01$).

3.3. Collaboration between stakeholder groups

Each category of respondents was asked to tell about their collaboration with other groups, and to assess the strong and weak points of different types of collaboration. Most respondents have actively collaborated with members of other stakeholder groups, at least once with in the last three years (Table 4). Direct collaborations are less common between academicians and practitioners,

Table 4
Percentage of respondents who experienced any kind of collaboration with a stakeholder from a different category in the last three years.

	Collaboration experienced with scientific institutions			Collaboration experienced with public administrations			Collaboration experienced with private sector		
	Italy	Europe (Other)	extra Europe	Italy	Europe (Other)	extra Europe	Italy	Europe (Other)	extra Europe
Practitioners	54%	85%	68%	78%	75%	90%			
P. administrators	65%	65%	90%				73%	81%	93%
Academicians				89%	83%	95%	70%	46%	48%

Table 5
Type and percentage of collaborations between coupled categories: (A) practitioners and academicians; (B) public administrators and academicians; (C) practitioners and public administrators. Significant differences identified by the Chi square test. Differences between the two categories within the same geographical area are indicated by * at $\alpha < 0.05$, ** at $\alpha < 0.01$ and *** at $\alpha < 0.005$, whereas differences between geographical areas within the same category are indicated by capital letters.

	Project with public funding	Project with private funding	Funding from one of the parties	Technical consultancy	Other
A	Practitioners vs. Academicians				
Italy	59%A vs. 43%	10%B vs. 28%	12% vs. 55% ***	53%B vs. 15% ***	8% vs. 0%
Europe (other)	41%AB vs. 39%	26%A vs. 22%	9% vs. 54% ***	71%A vs. 30% ***	3% vs. 0%
Extra Europe	33%B vs. 30%	24%A vs. 40%	10% vs. 40% ***	76%A vs. 40% ***	19% vs. 10%
B	P. administrators vs. Academicians				
Italy	44%A vs. 65% ***	14%B vs. 31%A *	19% vs. 20%	51% vs. 37%	9% vs. 0%
Europe (other)	20%B vs. 51% ***	30%A vs. 12%B *	30% vs. 20%	55% vs. 38%	10% vs. 5%
Extra Europe	51%A vs. 60%	27%A vs. 30%A	24% vs. 20%	49% vs. 50%	8% vs. 10%
C	Practitioners vs. P. administrators				
Italy	55%A vs. 44%	17% vs. 6%B	58% vs. 19%B ***	21% b vs. 75%A ***	8% vs. 2%
Europe (other)	30%B vs. 48%	13% vs. 20%A	53% vs. 60%A	53% a vs. 52%B	0% vs. 8%
Extra Europe	43%AB vs. 63% *	21% vs. 26%A	43% vs. 63%A *	39% ab vs. 37%B	7% vs. 0%

though, compared to those between public administrators and either academicians or practitioners, both of which were reported in a large majority (around 80%) of cases.

In all geographical areas, practitioners have mostly engaged in technical consultancies with academicians ($\alpha < 0.005$). Italian practitioners, as compared to extra-European ones, report that most of their collaborations with scientific institutions are supported by public funding ($\alpha << 0.005$) – and that they are financed only to a lesser extent by private bodies such as foundations and lending agencies ($\alpha << 0.05$). As a rule, collaboration between public administration and scientific institutions is mainly funded by public entities (EU, government ministries, regions, municipalities etc.), and it often takes the form of technical consultancies. Such consultancies are also common between public administrations and practitioners in Italy, where most projects are funded by public bodies—in contrast to Europe and extra-European countries, where public administrators declare more projects funded by private bodies ($\alpha << 0.025$) (Table 5).

All of the suggested strong points of collaboration (transferability of results/problem solutions, opinion exchange, professionalism, identification of strategies, and innovation) are considered very important by all stakeholder groups (Fig. 5). Transferability of results and problem solutions are considered rather important within each coupled collaboration and within geographical areas, with a significant difference observed only between Italians practitioners and academicians ($p = 0.016$). For Italian academicians the identification of strategies is especially important when the collaboration is with public administrators ($p = 0.0057$). Public administrators emphasize the exchange of opinions as an important aspect of collaboration with academicians, but also with practitioners. Italian administrators in particular ($p < 0.01$) judge this to be important in their dealings with academicians, and for their part, academicians consider it valuable in collaborations with practitioners – though more so within Europe than in other places ($p < 0.05$).

Professionalism, defined as high-quality skills and competences that contribute to a betterment of the profession, is considered less important for practitioners in European and extra European countries, either in their collaboration with academicians or with public administrators ($p < 0.05$). In contrast, Italian practitioners consider professionalism somewhat more important than their foreign colleagues ($p < 0.01$), especially in their collaborations with academicians. Innovation is seen to be an issue which is very important for both practitioners and public administrators when they collaborate with academicians – but only of moderate importance for collaborations between those two groups.

Regarding the weak points in collaboration (scarcity of resources, diversity of interests, conflicting project schedules, and problems concerning royalties and bureaucracy), the most commonly reported obstacle to effective collaboration is a lack of resources (Fig. 6). For practitioners, this problem varies by country and is more important for Italians and non-Europeans than for their European colleagues – either when they collaborate with academicians ($p < 0.05$) or with public administrators ($p < 0.01$).

Another perceived barrier is bureaucracy, especially for academicians and practitioners in their collaboration with public administration. In Italy, this is seen as a more important problem by practitioners than by their counterparts in coupled collaborations, either with public administrators ($p < 0.05$) or with academicians ($p = 0.036$).

More subtle weak points in collaboration include the perceived diversity of interests and approaches among different stakeholders. Italian practitioners rate the importance of this higher than their Europeans colleagues do ($p < 0.05$), in collaborations with both public administration and scientific institutions.

Even meeting project deadlines is considered an obstacle to productive collaboration, especially for academicians. This is also the case for public administrators collaborating with one another, though more so for Italians and extra-Europeans than for other Europeans ($p < 0.01$). Practitioners are more sensitive to the issue in Italy then elsewhere in Europe ($p < 0.01$) our outside of Europe ($p < 0.05$), when they collaborate with either public administrators or academicians.

Another important issue is how to initiate collaboration between different stakeholders, and what one may offer to another in order to be attractive for a collaboration. Having direct contact seems to be very important for European and extra European respondents (more than 80% of practitioners, and some 70% of academicians and public administrators). Practitioners tend to value this contact more than academicians, both in Italy ($\alpha << 0.05$) and outside Europe ($\alpha << 0.01$), when the collaboration is with public administrators.

What the different categories of stakeholders can offer each other in any form of collaboration is expressed by the word clouds

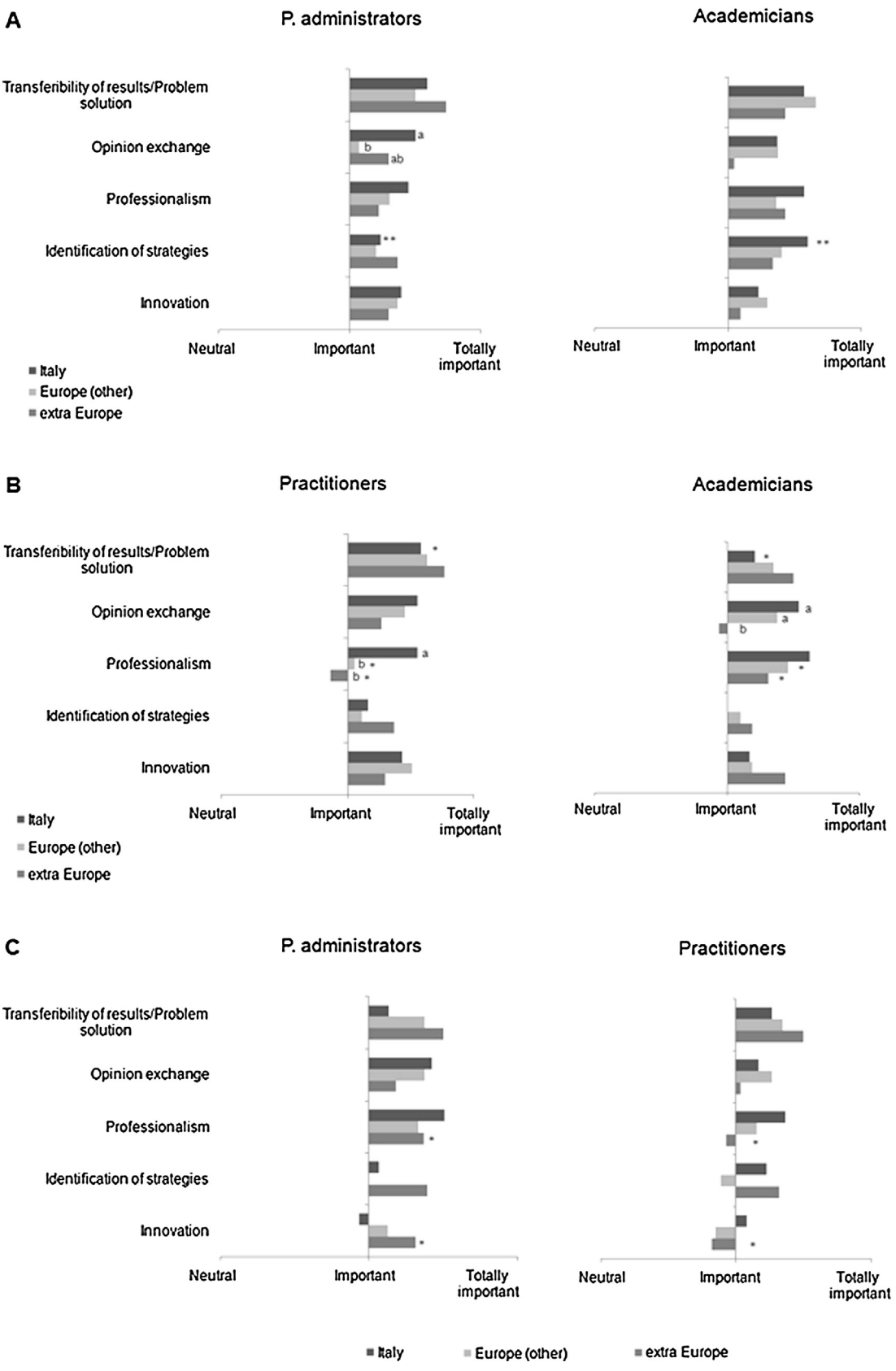

Fig. 5. Evaluation of strong points in the collaboration between coupled categories: (A) between public administrators and academicians; (B) between practitioners and academicians; (C) between public administrations and practitioners. Significant differences between the two categories, found by the Student's *t*-test at $p < 0.05$, are indicated by * at $p < 0.05$ and by ** at $p < 0.01$. Significant differences between geographical areas within the same category, found by ANOVA followed by Bonferroni test at $p < 0.05$, are indicated by small letters.

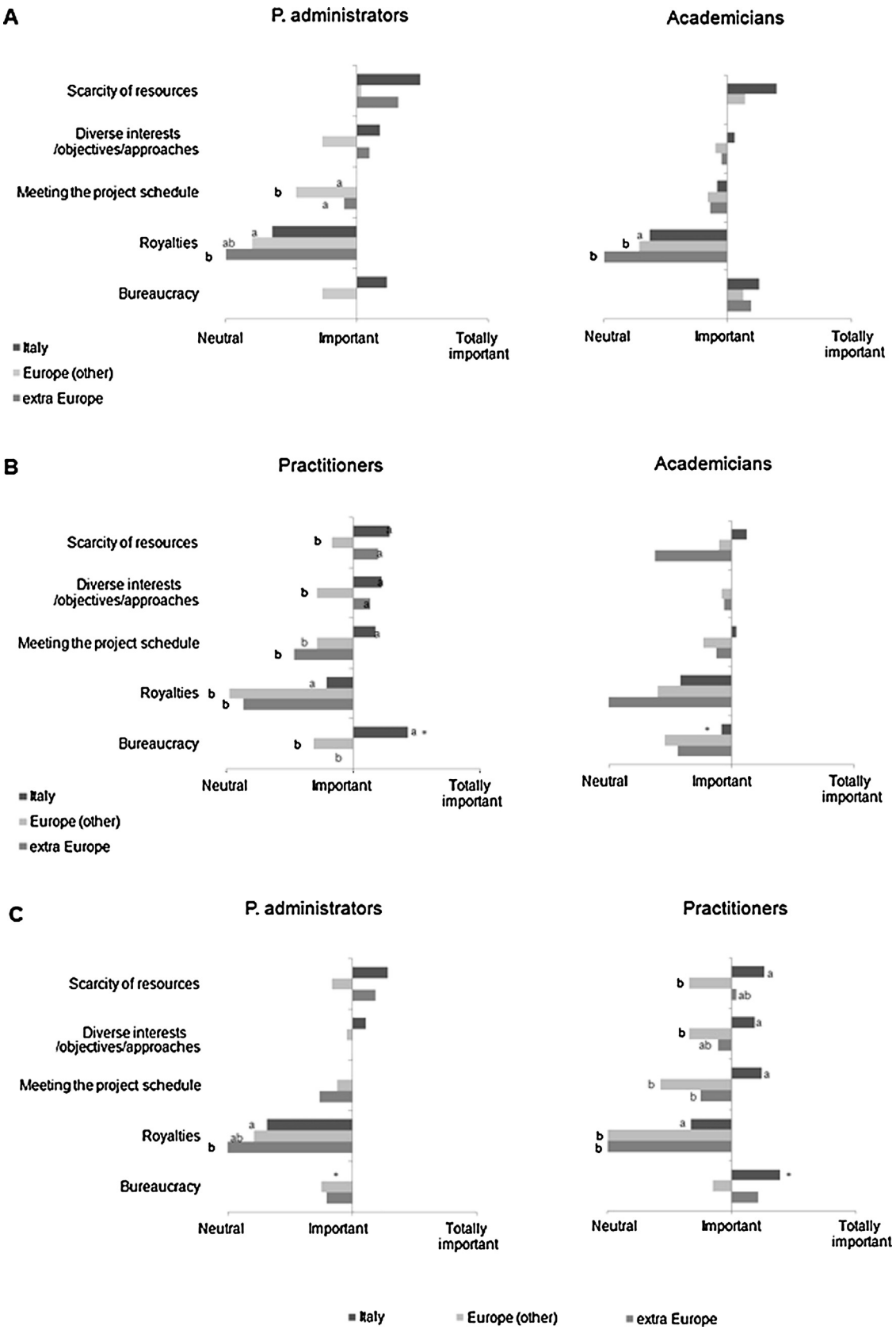

Fig. 6. Evaluation of weak points in the collaboration between coupled categories: (A) between public administrators and academicians; (B) between practitioners and academicians; (C) between public administrations and practitioners. Significant differences between the two categories, found by the Student's *t*-test at $p < 0.05$, are indicated by * at $p < 0.05$ and by ** at $p < 0.01$. Significant differences between geographical areas within the same category, found by ANOVA followed by Bonferroni test at $p < 0.05$, are indicated by small letters.

Fig. 7. Word clouds indicating what each group of stakeholders can offer to the others. Terms most frequently used by respondents appear largest.

in Fig. 7, which illustrate the words most used by respondents. As indicated by the most prominent terms in each of these diagrams, practitioners can offer practical experience and professionalism to the other groups; academicians can offer scientific knowledge, research experience, expertise and problem solutions; whereas public administrators can offer field experience and data but they can also introduce new problematics.

When respondents were asked if they expect further collaborations for the future with other stakeholders, respondents generally expressed high expectations for productive collaboration. This is especially true for Italian practitioners, who expect more collaboration with research institutions (a 24% average increase above the level of collaboration already experienced) than their European and extra-European colleagues, who feel that they already have such strong ties. Positive expectations are also expressed for future collaboration with public administrators, by more than 80% of practitioners in Europe and 94% outside Europe.

European (including Italian) public administrators are also positive regarding their collaboration with scientific institutions or practitioners, whereas the extra-European ones do not expect more from either category (−7% and −10%, respectively). On the other hand, academicians are very optimistic: more than 95% of them in all geographical areas expect further collaborations with public administration, and enhanced collaboration with the private sector is expected in both European (+39%) and extra-Europe (+42%) countries.

Several motivations are considered important for initiating new collaborations (Fig. 8). The "achievement of problem solutions" is an important goal for all categories of stakeholders, and the "awareness of reciprocal need" was deemed an important motivator by academicians—more so than by public administrators ($p = 0.028$) or practitioners. Collaborations may also bring potential advantages in "obtaining funding," especially for European academicians and public administrators – though Italian ones seem more skeptical ($p = 0.012$ and $p = 0.016$, respectively)—when the collaboration is with practitioners.

3.4. Training

The last section of the questionnaire addressed respondents' experience with training in UF and GI during the last three years (2010–2013), considering the means of knowledge transfer and interaction between stakeholders, as well as the provider of the training and learning delivery tools used.

Practitioners are clearly seen to be the most frequent attendees of specialized training courses. Extra-European respondents generally show the highest rate of attendance, reaching a full 100% of practitioners (compared to about 70% in Europe). Similar comparisons are seen for public administrators (82% vs. 45%) and academicians (69% vs. 32%), though in the latter case Italian attendance in particular is somewhat higher (48%).

Practitioners seem to mostly attend courses organized by professional organizations like Chambers of Commerce or professional associations, which on average represent over 40% of responses. Slight differences are seen, however, between regions—with significant roles played by certified providers in extra-European

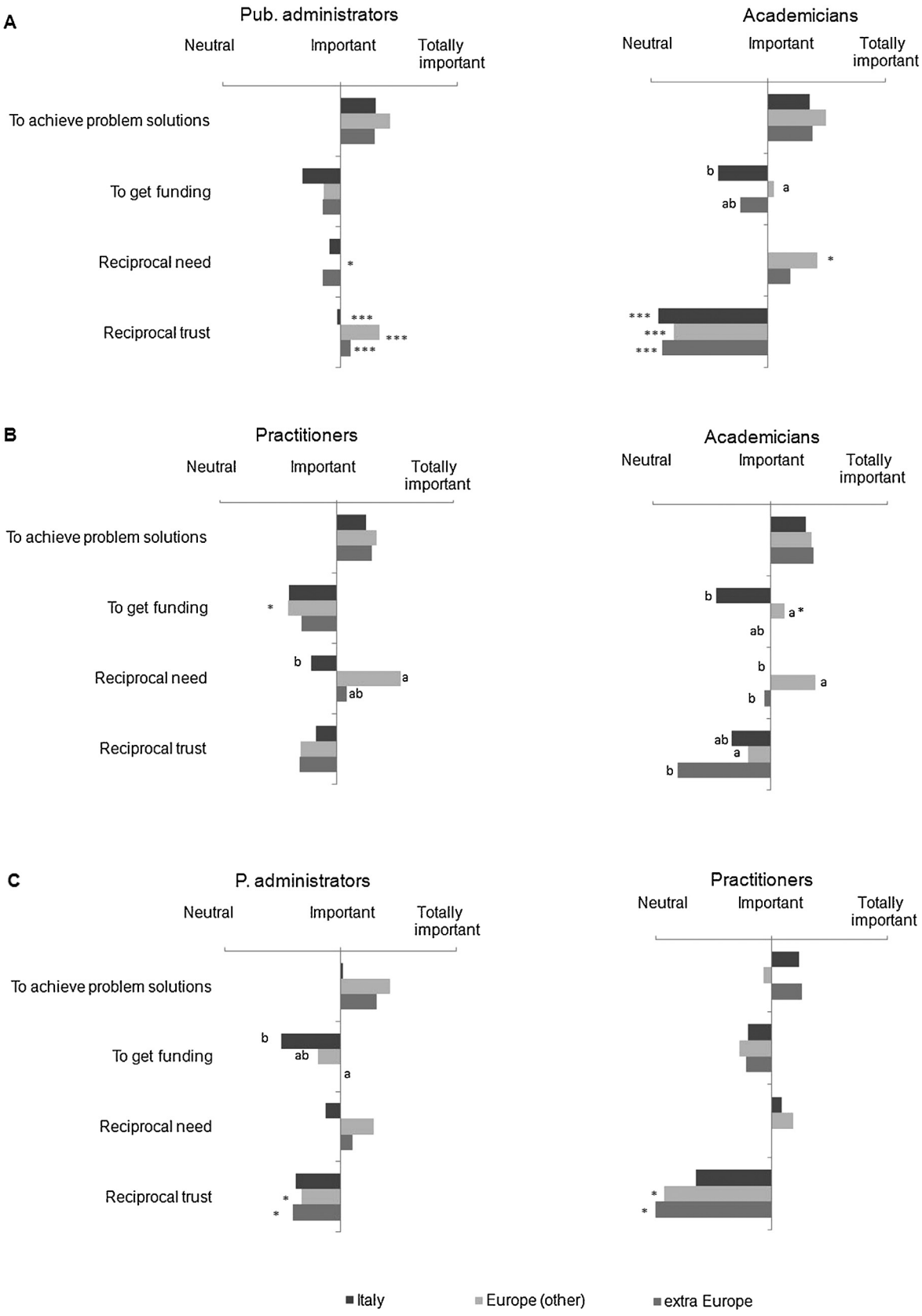

Fig. 8. Reasons given by respondents for starting a new collaboration with members of other stakeholder categories. Significant differences between the two categories, given by the Student's *t*-test at $p < 0.05$, are indicated by * at $p < 0.05$, by ** at $p < 0.01$ and by *** at $p < 0.005$. Significant differences between geographical areas within the category, given by ANOVA followed by Bonferroni test at $p < 0.05$, are indicated by small letters.

Table 6
Mode of learning delivery. Percentages of selections given by respondents in each stakeholder category, in each geographical area. As determined using the Chi-squared test, significant differences between geographical areas are indicated by capital letters whereas significant differences between categories are indicated by small letters.

		Italy	Europe (other)	extra Europe
Plenary presentations	Practitioners	76%	65%	78%b
	Public administrations	76%	60%	71%b
	Academicians	74%B	71%A	100%aA
Practical activities	Practitioners	59%a	61%	61%
	Public administrations	67%a	70%	64%
	Academicians	37%bB	57%A	56%A
Blended e-learning	Practitioners	22%aB	17%B	39%A
	Public administrations	5%bB	20%AB	36%A
	Academicians	11%abB	14%AB	25%A
E-learning	Practitioners	0%B	4%AB	9%bA
	Public administrations	0%C	10%B	29%aA
	Academicians	0%B	7%A	6%bA
Networking	Practitioners	25%aB	22%B	43%aA
	Public administrations	10%b	30%	32%ab
	Academicians	19%ab	26%	19%b

countries (57%), and by academic institutions in Europe (48%) and specifically within Italy (51%).

Public administrators and academicians mostly attend courses organized by academic institutions (about 50% and 60%, respectively), although participation in courses delivered by professional organizations is significant for public administrators (43% in Europe and 57% elsewhere) and for academicians outside Europe (about 60%).

Regarding the tools, or methods used to deliver content (Table 6), face-to-face presentations in a classroom and practical activities are reported to be the most widely-used learning delivery mechanisms. This is in contrast to e-learning (i.e., remote communication by electronic means), which even in a blended form (combining both direct and virtual presentation) has not been experienced to a large extent. However, there are some differences between regions in this regard, with a lower rate of usage for Italian respondents of any category than the parallel extra-European group. Networking in training courses has rarely been undertaken by academicians or public administrators, whereas among practitioners the practice is somewhat more adopted outside of Europe.

Respondents were also asked to assess the extent to which positive aspects of participation in specialized training courses are realized in practice (Fig. 9). Results indicate that in attending these courses, respondents do in fact benefit from a range of positive aspects: stakeholders in all the three categories say that such training has "enhanced their professional knowledge," and has been "useful for meeting the requirements" of their job. The "discussion moments" during the training experience were effective for European academicians (less for Italian ones – $p < 0.05$), indicating that effective interaction does indeed take place among participants. Academicians more than others ($p < 0.05$) – and especially Europeans ($p < 0.01$ with respect to Italians) – have also "been included in mailing lists of participants, which allowed for ongoing communications. However, it seems that actual collaboration between participants after the end of the course has been negligible. The courses attended have been judged to be relatively inexpensive, but they rarely included the granting of any official form of professional or academic certification.

Finally, respondents were asked to assess a number of possible suggestions for improving the level of these training courses (Fig. 10). Broad agreement was expressed on the need to increase practical activities, enrich the quality of learning delivery, and strengthen the connection between the content of the training and the needs of the labor market. The latter point was especially pronounced for practitioners ($p < 0.05$), and for Italians in general compared to their foreign colleagues ($p < 0.05$). Also networking among participants is recommended, especially by academicians ($p = 0.021$ with respect to practitioners). Extra-European practitioners and public administrators expressed more awareness about the usefulness of networking than their Italian counterparts ($p < 0.05$, $p < 0.01$, respectively). Given their lack of acquaintance with e-learning, most respondents did not emphasize the need for increased utilization of electronic technologies—nor did they prioritize the need for offering inclusive learning to those with difficult access. The cost of education is seen as one of the aspects to improve, though more so for public administrators than for academicians ($p = 0.045$) or practitioners ($p < 0.05$).

4. Discussion

Because of the diverse issues that must be addressed for the preservation and enhancement of a city's GI, a complex network of relevant stakeholders is inevitably involved, directly or indirectly including public administrators of parks and roadways, designers of buildings and neighborhoods, practical foresters and gardeners, and academic researchers.

This study has identified an array of obstacles which contribute to the lack of effective knowledge transfer among different stakeholders dealing with urban forestry and green infrastructure, as well as some of the factors which can be conducive to collaboration among them.

Even considering that the scope of this survey is limited—since a statistically representative sample of the entire targeted population would have required a much higher number of respondents, and a much larger campaign—the results which were obtained expose some interesting patterns which are worthy to consider as reflection points and which can be the basis for broader and more complete future research.

The samples of different respondent groups, which were shown to closely parallel the European labor force even in terms of their gender composition, reflect a persistent gender imbalance in nearly all fields except in the attainment of tertiary education (OECD, 2012). Our sample shows females outnumbering males only in the social sciences in higher education, which clearly reflects the existing situation portrayed through publicly available data (European Commission, 2013c). In this regard, it is important to consider the ongoing efforts by the European Commission to foster gender balance in science education and encourage more integrative decision making—so that in the future, we might expect a higher presence of women in these work sectors as part of a more general transition regarding their role in the society.

The educational level of respondents in each of the categories is quite high, with about 80% of respondents having completed a bachelor's degree and more than 50% of academicians holding a PhD. Despite the high level of education, there is a consensus among all stakeholders that ongoing professional training, beyond

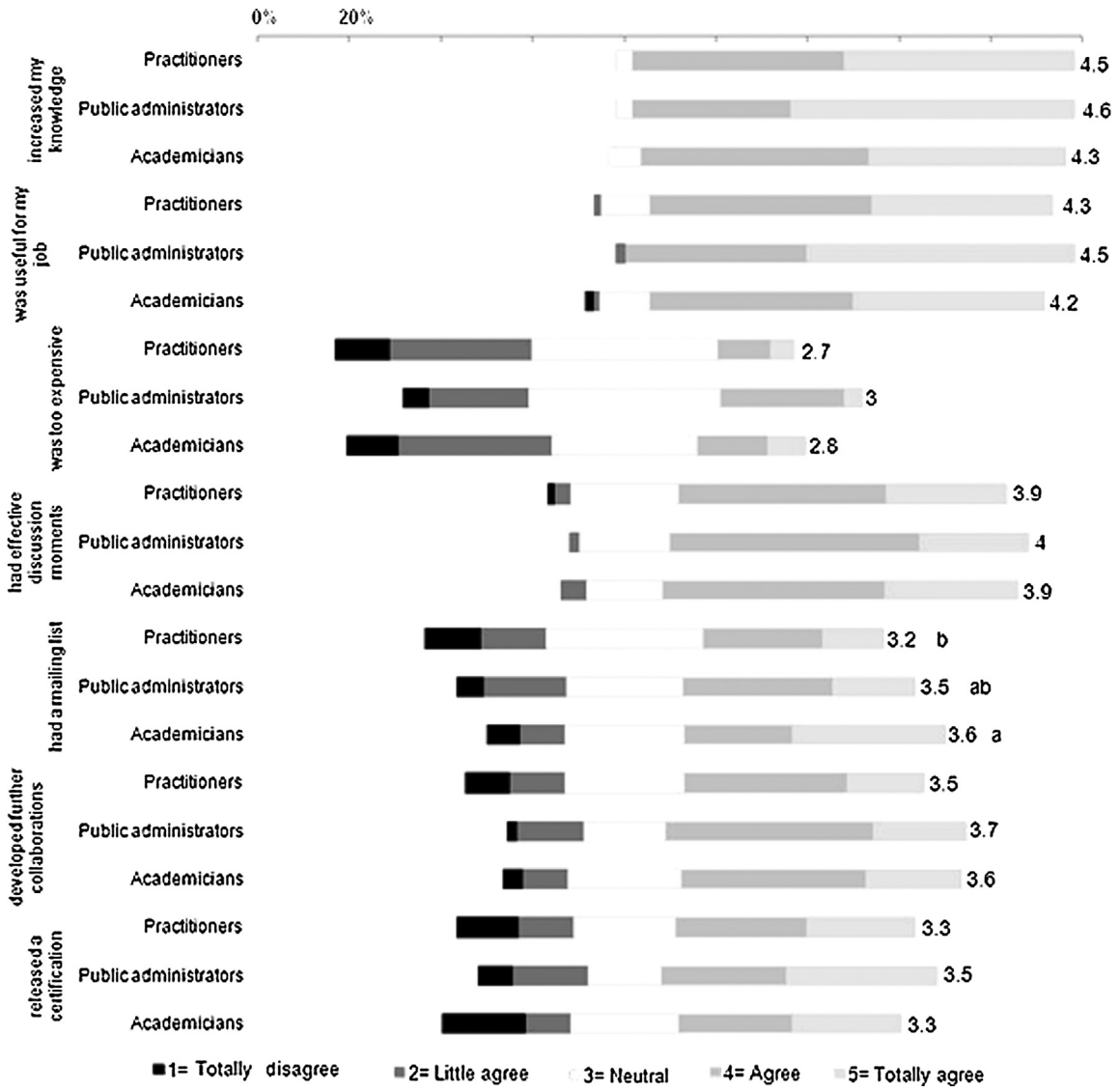

Fig. 9. Distribution of responses of the three categories on aspects concerning training. Mean values of the level of agreement are also reported. Small letters indicate the significant difference between the three categories given by ANOVA followed by Bonferroni test at $p < 0.05$.

own sectoral interest, has an important role and should receive additional funding.

Academicians and researchers are the actors who feel most up-to-date on the latest scientific results, likely thanks to their easy access to a wide range of information sources (journals, proceedings of meetings and conferences, direct contact with scientific communities, etc.). Keeping updated through reading, exchanging opinions, and experimenting is crucial for finding new solutions and bringing further innovation to socie—which, we would argue, should be the basic mission. In contrast, public administrators and practitioners feel less updated, possibly because of time pressure and constraints on their access to the various means of knowledge transfer. From this study we found that scientific information and knowledge transfer become particularly fruitful when they are connected to real-world problems, and access is easy.

Scientists and policy makers make use of traditional modes of communication, including emails, telephone calls and face-to-face meetings (Janse, 2008), which are considered the most effective channels to communicate and exchange knowledge. However, we are also facing dramatic changes connected to the introduction, in our everyday life, of new devices like smartphones and tablets, and the modes of communication which they enable (i.e., texting, chat, social media etc.).

It is not surprising, then, that the internet is the most heavily used tool for knowledge access by all categories of stakeholders and audiences who are distributed over a wide geographical area and who include an array of individuals with diverse interests and technical backgrounds (McKinley et al., 2012). As a rule, technology is a key factor for improving the general functioning and processes of learning (Choudhary, 2013) – and many well-known organizations dealing with forestry and agriculture have already started offering e-learning content targeting practitioners and policy makers (Alm and Byrne, 2010).

Scientific publications, which are considered the most reliable sources of knowledge thanks to the peer-review process through which they pass (Dumon, 2013), still are not widely exploited by practitioners and public administrators—especially in Italy, and also in some countries outside Europe. Certainly one of the reasons might be the language barrier, though only a few respondents ranked the lack of scientific articles in their mother tongue as an important obstacle to knowledge transfer.

Still, accessibility may play a key role—because on one hand, practitioners do not necessarily have subscriptions to costly scien-

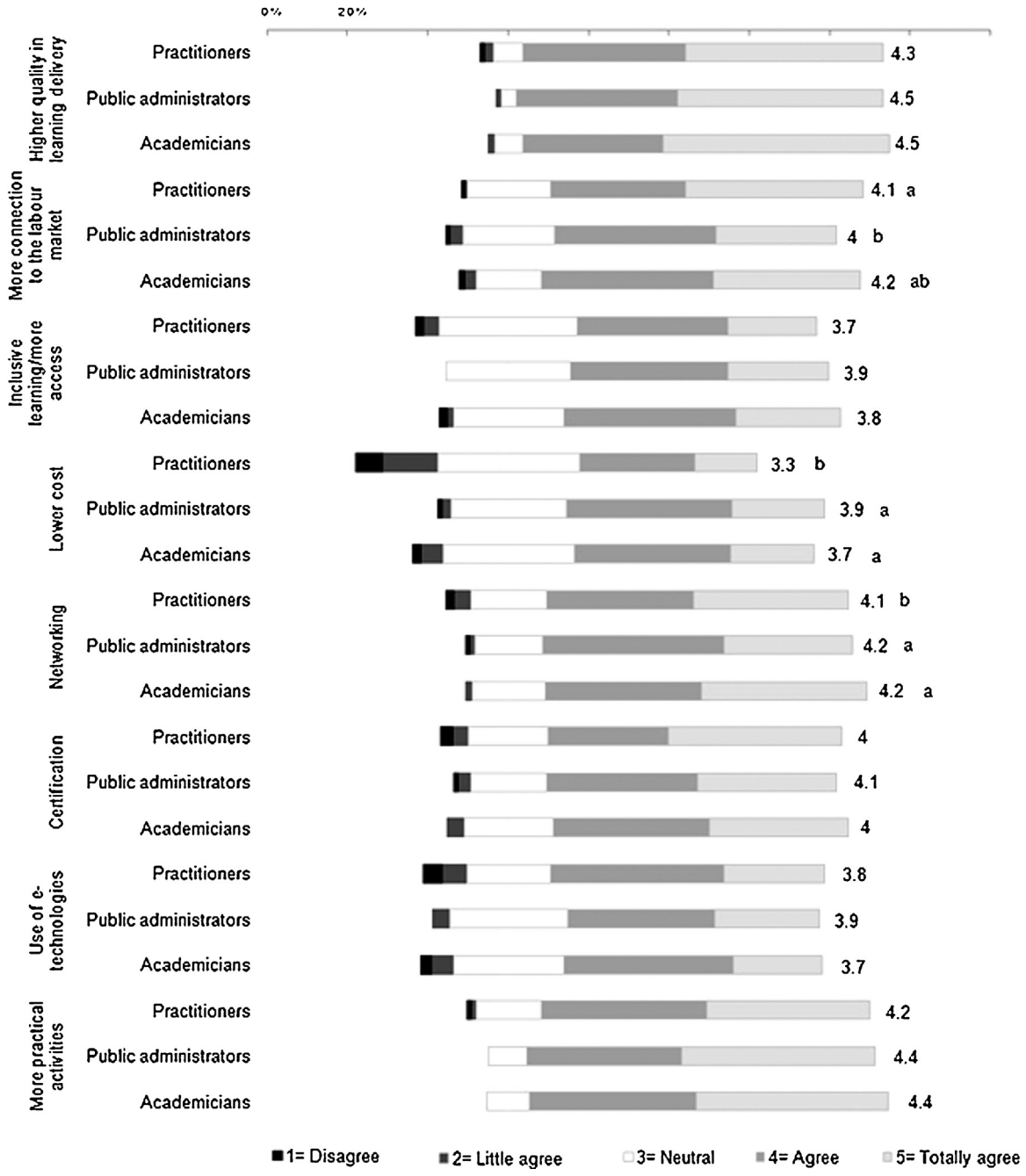

Fig. 10. Distribution of respondents' recommendations for improvement in professional training. Mean values of the level of agreement with each statement are also reported. Small letters indicate the significant difference between the three categories, given by ANOVA followed by Bonferroni test at $p < 0.05$.

tific publications, and on the other hand, open access publication may still be too expensive for academic researchers. Therefore, the scientific community should reflect more on the role it plays in civil society, and how best to facilitate the exploitation of scientific results in the face of these present-day challenges. Ultimately, this means developing a stronger and more coherent "common language" – that is, a conceptual framework for connecting the ideas and accumulated wisdom of people who come from different professional worlds. Proposals for the development of such a language have been elaborated in the past as a means of promoting sustainable solutions to multi-faceted problems in the built environment (Pearlmutter and Meir, 1999; Pearlmutter, 2007) – and they are certainly worth revisiting within the more specific context of urban green infrastructure.

Another important mode of knowledge transfer is ICT. Despite the indications that face-to-face encounters are still widely preferred over remote "e-learning" platforms, the latter seem to have gained more traction in extra-European countries, especially the United States, and its effectiveness was recognized in comments by those who are indeed familiar with it first-hand. It was also suggested, in open-text comments, that the success of training depends less on the nature of its methods than on the quality of its content—a sign that the low value placed on remote learning is more a reflection of a lack of familiarity then an adverse reaction. As such, we might expect these methods to spread more widely as the technology matures and becomes more intuitive. Obviously, achieving a greater exploitation of e-learning implies the need for policy measures which will encourage the development of infrastructures

and skills related to information and communication technologies.

Another core concern of the survey is the collaboration between stakeholders. The most frequent form of collaboration between the three groups is the technical consultancy, especially when practitioners are involved. Direct collaboration between practitioners and academicians is less common—though this state of affairs is liable to change in the future, given the strong emphasis which the European Commission has placed on fostering partnerships between researchers, entrepreneurs and policy makers through public funding programs like Horizon 2020, INTERRREG and COST. Italian practitioners and public administrators show a higher capacity to obtain public funding for collaborative projects (from municipalities, regions, government ministries or the European Union), while their European and extra-European counterparts appear to be more adept at soliciting private funding (grants and loans from banks, foundations etc.).

Regardless of the particular circumstances, collaborative experiences are considered very important for the achievement of several core aims, including the identification of solutions to practical problems, the transfer of practical research findings, and the open exchange of opinions (with the latter especially important for European academicians).

The value of these benefits is clearly acknowledged, despite the familiar stumbling blocks to collaboration, involving resource scarcity, bureaucracy, and the divergent interests of different stakeholders. Regarding resources, it is crucial to remember that new collaborations can be also an opportunity for attracting funding and investments which are otherwise unavailable—though it seems that only academicians are aware of this possibility, and only at the European level.

Having direct contacts is obviously an important motivator, especially for initiating collaborations with public administrations. Recognized certification is highly valued in a potential partnership, particularly for Italian academicians, as is the ability to offer innovation— and outside of Europe this is particularly expected when academicians are involved.

There are reasons to be optimistic about the prospects for future collaboration between stakeholders. The recent debate on policy-making assigns more importance to knowledge deriving from a variety of stakeholders, including citizens (Jasanoff, 2004), and to public engagement, which increases the diversity of collaborators who would otherwise not interact (European Commission, 2013d). Such endeavours are being promoted through the allocation of public funding in Europe (Castellani, 2014), aiming to improve the inclusion of science in society and possibly also pushing the labour market to become more competitive and innovative. The interest shown by practitioners in collaborating with scientific institutions (and vice versa) is therefore particularly expected to increase. The recognition of this reciprocal need is a promising indication that the valuable experience accumulated by practitioners can be combined fruitfully with the theoretical understanding of academic researchers, to develop innovative techniques and solutions for meeting the most consequential challenges.

However, the debate is complicated by additional concerns related to the relationship between these very different actors. These include the mechanisms and infrastructures needed for integrating scientific knowledge in the political decision-making process, the political pressures placed on evidence-based decision making, the possible conflicts of interest in the relationship between research and industry, and the status of the academic profession—in terms of both individual academic freedom and institutional autonomy, in the face of intensifying assessments and rankings based on standardized metrics (Mejlgaard et al., 2012).

Training plays a role not only in knowledge transfer, but also in profession development and collaboration opportunities—putting together the actors most interested in innovation or updating their knowledge. As this survey has revealed, professional training is universally recognized as a strategy that is worthy of increased funding. While universities may be the primary institutions providing specialization training in UF and GI, other organizations (like professional associations and technical high schools) are recognized for their commitment to this type of knowledge transfer. The International Society of Arboriculture and the European Arboriculture Council are prominent examples in the field of forestry, including urban forestry, offering certification recognized at the international level.

From this study, it seems that there is generally a high level of satisfaction with existing training courses, and that they are often considered effective for increasing knowledge and stimulating professional collaboration. Nevertheless, there are still primary aspects of learning delivery which need to be enhanced—including the quality of content, the inclusion of practical experience in the learning process, the effectiveness of networking and the connection between training and the needs of the labour market.

At another level, we may view such training within a broader context, as places to establish informal connections and as catalysts for networking—which clearly plays an important social role through the facilitation of direct interaction. Here, the cultural aspects of collaboration are significant, as we have seen that the importance of exchanging opinions is more highly valued by academicians and researchers than by other groups, and more by European (including Italian) respondents than by those in other regions.

5. Conclusions

Urban green infrastructure is increasingly seen as an essential component of a city, whose establishment and ongoing management involves a complexity of individuals and institutional actors. Communication gaps between these stakeholders – particularly between academicians and professionals—are nearly inevitable, and they can prevent urban green amenities from fully expressing their potential value and multi-functionality.

The international survey presented here has highlighted a number of key themes that characterize the interactions between three main categories of stakeholders, and highlighted key concerns regarding knowledge transfer and collaboration. From our analysis, we may conclude that scientific knowledge transfer, and in turn training, is of utmost importance and the ways it is achieved should foster a common language and ease of access to the latest knowledge. However what appears to matter most is not the specifics of the educational tool, but rather the quality of the educational content—and the practical experiences and contacts which the tools can facilitate. While interactive web-based tools and online databases for e-learning are emerging and expanding at a dizzying pace, our findings show that the internet is still an underutilized tool which has yet to fulfil its considerable potential.

We see positive attitudes toward those forms of collaboration which can achieve particular common aims: fostering innovation, developing generalized solutions to practical problems, and leveraging partnerships to attain funding. Moreover, what emerges from the survey is that stakeholders need to better capitalize on the opportunities offered by collaborative work once contact has been established; this means understanding the importance of forming a team, of optimizing financial resources, and perhaps above all, of finding a "common language" that can channel a diversity of knowledge into concerted efforts. We would argue that the ground is fertile, then, for a fresh look at how collaborations may be initiated and effectively maintained in the field of urban green infrastructure.

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