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The usefulness of a Web-based Participatory Planning Support System in Wuhan, China

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ABSTRACT

Public participation in urban planning has become a legal requirement in China since the 2008 Urban and Rural Planning Law prescribed to collect the opinions of the public in preparing plans. The way in which this participation is organized is left to local governments and current practices are still in a stage of experimentation. Drawing on Western experience various participatory tools have been explored, including in some instances Web-based planning support systems (PSS). The current literature has identified several potentials and shortcomings in the performance of PSS that define their usefulness. However, these have been identified in the context of democratic societies and communicative planning paradigms. To what extent do these potentials and shortcomings also pertain to the emerging practice in China? This paper aims to widen the understanding of the usefulness of Web-based PSS when these are applied in a Chinese context. To do so, the paper first presents a conceptual framework that divides usefulness into utility and usability, and thereafter, it analyzes the "East Lake greenway planning project" in Wuhan. The results show that the Wuhan PSS provides new functionalities in eliciting ideas from independent citizens in the early stage of the planning process. In terms of usability, the system meets many of the criteria, but requires a high level of computer experience and domain knowledge restricting its use to "professional citizens". From the point of view of western planners this would seriously limit the usefulness as a participatory tool, but it is legitimate in China. Given the low level of computer literacy, limited access to the internet and a lacking tradition of public involvement in state affairs, it is nevertheless clear that there is a need to improve Web-based PSS and combine them with other participatory methods, both online and offline, to facilitate the participation of a diverse group of target users.

1. Introduction

In 2008 the Chinese Urban and Rural Planning Law was changed to include the requirement to collect the opinions of the public (The Central People's Government of China, 2007). As a consequence, Chinese urban planning professionals started to involve the public actively or passively in planning processes to maintain the legitimacy of the planning procedure. The law did not specify specific requirements for participation, but left those to the discretion of local governments, which often transfered the responsibility to their planning bureaus. Chinese planners are aware that traditional tools for participatory planning have received criticism, such as that they are limited in same-place and same-time settings and cannot sophisticatedly display information (Al-Kodmany, 2002). And many are also aware of the potential of PSS, knowing that urban planning practice is mostly map based, and the most efficient way to acquire useful local knowledge would be through a map-based application enabling strong communication between planners and stakeholders (Narooie, 2014). The first time that computers were used in urban planning in China was to analyze the data of 76,000 questionnaires in the "Residents' travel research in Tianjin" program of the China Academy of Urban Planning and Design in the 1980s (Chen, 1995). Thereafter, planning professionals began to adopt more modern computer technologies to support their work, such as computer-aided design (CAD) and geographic information systems (GIS). However, these types of tools are designed explicitly for experts, rendering them difficult to be used by the general public. "Planning support systems" (PSS) are usually defined as a subset of geo-information technologies that aim to support those involved in planning to manage plan-related problems (Batty, 1995). PSS were introduced in China in 2003, when an English paper "Planning Support

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System as an Innovative Blend of Computer Tools" (Piracha & Kammeier, 2002) was translated into Chinese and published. In 2005, Du and Li (2005) described the working of the "WHAT IF!" PSS and presented a case to illustrate its working in supporting decision-making during the planning process. Thereafter, so-called Web-based PSS entered the scene.

Several studies have shown that Web-based PSS can be useful for planning practice by exhibiting information in forms that are easy to understand by non-specialist users, by facilitating interpersonal communication, by displaying relevant scenarios, and by helping the public to express their interests (Kingston, Carver, Evans, & Turton, 2000; Mansourian, Taleai, & Fasihi, 2011; Shifter, 1995; Wong & Chua, 2001). So, PSS are expected to enjoy a warm welcome, but their uptake in planning practice remains low (Pelzer, Geertman, & van der Heijden, 2016; Russo, Lanzilotti, Costabile, & Pettit, 2018; te Brömmelstroet, 2013). The reasons for the low level of uptake are manifold (see Vonk, Geertman, & Schot, 2005) but the overarching one is that there is a continuing mismatch between the supply of and demand for PSS (Biermann, 2011;Vonk et al., 2005; Vonk, Geertman, & Schot, 2007). Whether a computer system can satisfy the needs of the users and other potential stakeholders, such as the users' clients and managers, is basically about the acceptability of a computer system (Nielsen, 1994). Usefulness is an important dimension of acceptability (Nielsen, 1994). Therefore, the usefulness of PSS warrants special attention in order to increase the level of uptake. When it comes to the specific purpose of PSS as participatory tools, Kahila-Tani, Broberg, Kyttä, and Tyger (2016) used five criteria in evaluating the performance of a PSS in Helsinki: participants should be representative of the target population, they should be selected independently, be involved at an early stage of the planning process, their contributions are taken seriously and it is clear how the process proceeds with the input. It turns out that many conditions and design criteria have to be met for a PSS to be useful to the task at hand. This raises the question whether these conditions are also met in the Chinese context and whether design criteria can be applied in the same manner. In a first attempt to answer this question, the East Lake greenway planning project in Wuhan, China was investigated. Therein, we first introduce a conceptual framework concerning the concept of usefulness in Section 2. Thereafter, in Section 3, the involved Web-based PSS application is described. Section 4 describes the research methods, while Section 5 presents the analyses. In Section 6, conclusions are drawn, and the main findings and their consequences are discussed.

2. Conceptual framework

Human-computer interaction (HCI) is the discipline of designing, implementing and evaluating interactive computer systems for human use (Preece et al., 1994). Web-based participatory PSS form an exemplar of these interactive computer systems. Based on Nielsen's (1994) theory on HCI, this research applied an adapted conceptual HCI framework for evaluating the usefulness and in particular the usability of participatory PSS in a specific Chinese planning practice, the "East Lake greenway planning project" in Wuhan. The concept of usefulness refers to the issue of whether the computer system can be used to achieve desired goals (Nielsen, 1994). Nielsen (1994) broke down "usefulness" into "utility" and "usability", where utility is the question of whether the functionality of the system in principle can do what is needed, and usability is the question of how well users can use that functionality to perform their task (Fig. 1).

2.1. Utility

As stated, utility concerns the question of whether the functionality of a computer system in principle can do what is needed (Nielsen, 1994). What is needed (the task), is defined exogenous to the system. In Nielsen's words, "educational software has high utility if students learn from it" (Nielsen, 1994). Utility of a participatory PSS refers to whether the functionalities of a participatory PSS can meet the needs of all participants, both the planners and the public. In the European context two goals are identified with public participation. The normative goal of a more direct democracy in which multiple voices are being heard; and the more procedural goal of providing better plans by taking in experience-based knowledge and by recognizing different values of various actors (Kahila-Tani et al., 2016). The two are not necessarily at odds, as long as participation is effective. Kahila-Tani et al. (2016) use the framework developed by Rowe and Frewer (2000) to evaluate this using the criteria: (1) representativeness, (2) independence, (3) early involvement, (4) influence and (5) transparency. They criticize current participation methods in that they are often dominated by a self-selected elite that participates from a specific affiliation which might be shared with the planners. Participation at an early stage is often dissuaded by planners because it slows down the planning process, but in the later stages value-judgements have often been made already. Participation is often used to placate, rather than to provide influence on the outcome and it is not clear to the public how the input provided will be weighed in the decision making.

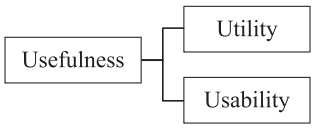

Fig. 1. The categories of system usefulness (Nielsen, 1994).

Planning support systems potentially contribute to improving the participation process as these can be accessed by different users at a place and time that suits them, and through their information functions (visualization of the project, gathering ideas from participants, storing and retrieving this information for processing), their communications functions (report back the results, have follow-up response, provide insight into decision making) and analytical functions (show what if effects, integration of inputs) (Pelzer, Arciniegas, Geertman, & Lenferink, 2015; Vonk, 2006). The utility of the system is therefore also dependent on the quality of the technology to perform these tasks.

The normative framing is different in China. Urban Planning involves many levels of government: central, provincial, municipal, district, sub-district and even neighborhood level. The neighborhood committee is the lowest level and consists of appointed officials that are responsible for the implementation of higher-level policies and to maintain social stability in their community. The municipality has the pivot role in urban land-use planning. The authority over the land resides with the municipality and cities have professional planning bureaus (at municipal and district level) that take responsibility in preparing plans and involving stakeholders. From the political angle, participation is driven mostly by the need to maintain social stability (He & Warren, 2011). From the professional angle, participation might help to come up with better plans. The task in developing and applying a PSS in China is therefore different from the European context, but the functionalities might still overlap to a large extent. The evaluation of the utility however will differ as this is defined by the task.

2.2. Usability

Usability refers to the question of how well users can make use of this functionality of the computer system (Nielsen, 1994). Since in participatory planning the public is the end user of PSS, the usability refers to the question of how the public can make use of the functionality of the PSS. Usability is typically measured by having users test a computer system to handle pre-specified tasks or by having real users in the field to handle whatever tasks they would otherwise be doing (Nielsen, 1994). In either case, an important point is that usability is measured relative to certain users and certain tasks. The same system

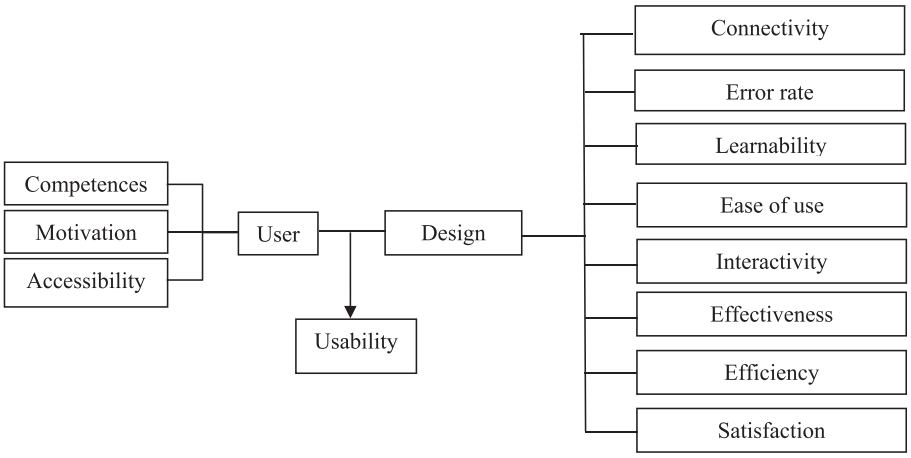

Fig. 2. A user-design fit model for assessing the usability of the Web-based PPSS.

would be measured as having different usability characteristics if used by different users for different tasks. In other words, the degree of usability is user- and task dependent. The distinctive characteristics of the users (Fig. 2) concern their specific competences, their motivations for using the system, and their degree of accessibility to the system (e.g., the availability of the means to access the system; the availability of sufficient time). In terms of competences Nielsen (1994) identifies three dimensions: Knowledge about computers in general, expertise in using the specific system and understanding of the task domain. To function as a participation tool, the intended users will have to be defined explicitly before starting the design. The motivation is important because users might self-select in using the system and use it to other than the intended ends. Accessibility also depends on the local contexts and refers to both physical and financial barriers to using the system. The fundamental question is: who can use the system for what purpose. Utility and usability are two sides of the same coin, inseparable as dimensions of usefulness.

The mentioned task-dependency relates in this case to the degree of the system's support of the participation process. As a consequence, in addition to fitting the characteristics of particular users, the usability of a system is also dependent on the design of the system. In that, for the measurement of the usability of a system, several performance criteria can be found in the literature, and for the specific field of participatory planning, the next eight criteria stand out (Fig. 2).

2.2.1. Connectivity

"Connectivity" refers to how easy it is for users to access the Web-based PSS (Sidlar & Rinner, 2007). The online participatory planning process becomes ineffective in case the public cannot access the Web-based PSS easily, e.g., because of failures or restrictions in Internet access. In principle, Web-based participatory planning approaches can maximize public involvement and can be extremely valid in areas in which it is difficult to participate in planning at a particular time or place (Kingston et al., 2000).

2.2.2. Error rate

An error is defined as any action that does not accomplish the desired goal, and the system's "error rate" is measured by counting the number of such actions by users while performing some specified task (Nielsen, 1994). The system should have a low error rate, indicating that users make few errors while using the system, and in case they do make errors, they can easily recover from them (Nielsen, 1994).

2.2.3. Learnability

"Learnability" refers to how easy it is for users to learn about how to use the application (Nielsen, 1994). Learnability is in some sense the most fundamental performance criterion: the first experience most people have with a new system is that of learning how to use it (Nielsen, 1994). Sidlar and Rinner (2007) adopted users' self-rated learning time to evaluate learnability.

2.2.4. Ease of use

"Ease of use" refers to whether users find the system sufficiently easy to use (Zhao & Coleman, 2007). Web-based PSS should be designed in a manner that they are easy to use for the diverse range of computer literacy levels, world views, cultural backgrounds and knowledge levels of the public (Haklay & Tobón, 2003). Even if the application developers believe that they have created something that is easy to use, only testing will show whether the design is successful in meeting users' needs (Haklay & Tobón, 2003).

2.2.5. Interactivity

"Interactivity" is at the heart of all modern interfaces and is important on many levels (Dix, 2009). In most cases, the interactivity of a system restricts itself to the interaction between a user and a system (e.g., Dix, 2009; Lewis, 1995; Sidlar & Rinner, 2007). In participatory planning, the interactivity of the system also concerns the facilitation of the interaction between the people involved.

2.2.6. Effectiveness

"Effectiveness" refers to the accuracy and completeness with which specified users can achieve specified goals in particular environments (Dix, 2009). According to Meng and Malczewski (2010), "the system effectiveness has a strong influence on the users' duration on the website and interactions with each other".

2.2.7. Efficiency

"Efficiency" refers to the resources (time and effort) expended in relation to the accuracy and completeness of the goals achieved (Dix, 2009). The system should be efficient to use so that, once the user has learned the system, a high level of productivity is possible (Nielsen, 1994).

2.2.8. Satisfaction

"Satisfaction" refers to how pleasant it is to use the Web-based PSS application (Nielsen, 1994). The system should be pleasant to use so that users are subjectively satisfied when using it.

The usability of the system eventually does not only depend on whether these criteria have been met, but whether they match with the competences, motivations and resources of the users. Again, this context might be different in China than in Europe or the US. Despite the impressive rise of a middle-class in China the level of household wealth

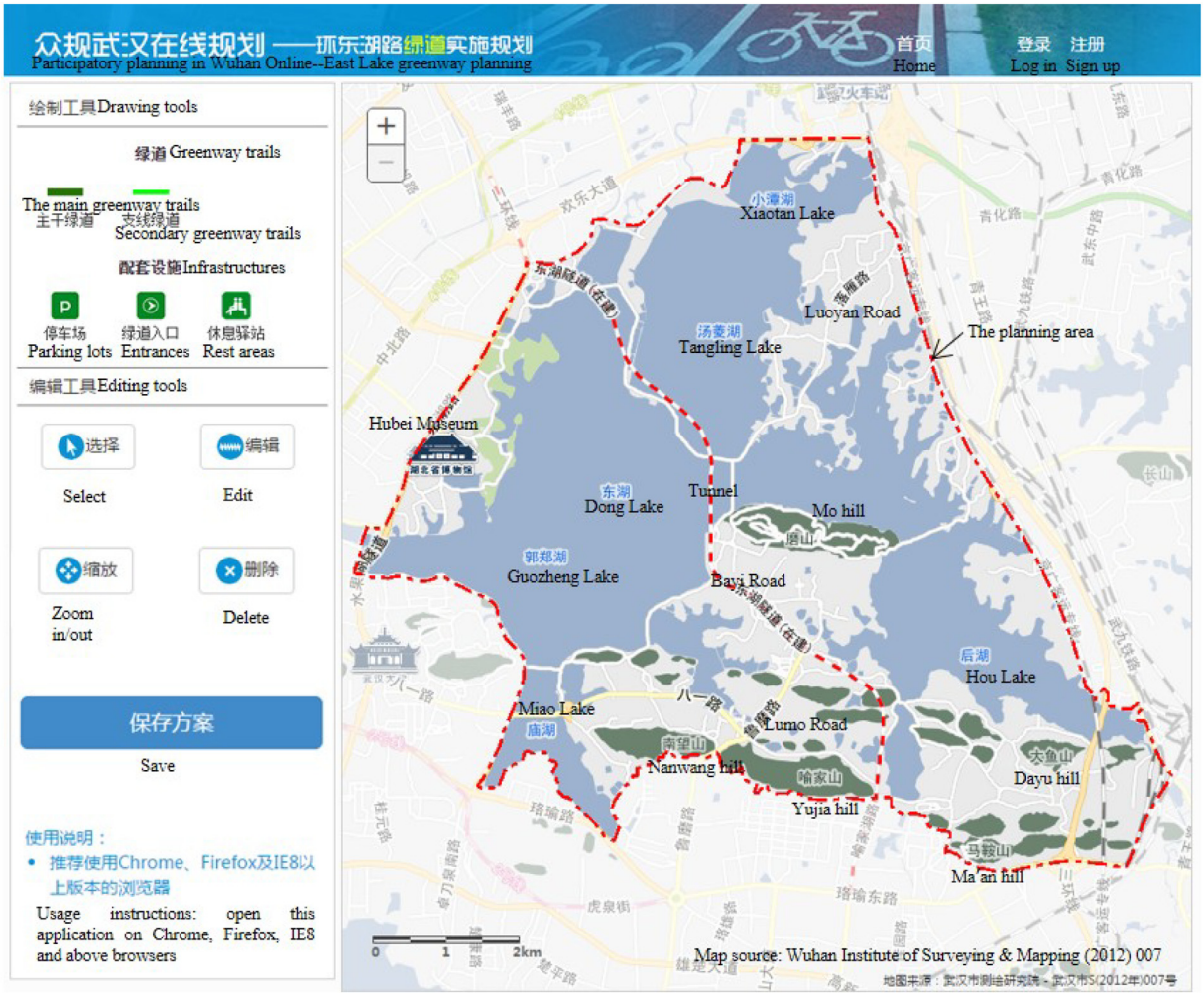

Fig. 3. The Web-based PSS application in the East Lake greenway planning project (http://zg1.wpdi.cn/gis/).

is still lagging behind the developed countries. The percentage of people having access to internet is clearly lower and a tradition that citizens actively participate in governmental decisions is only developing recently.

3. The East Lake greenway planning project

The East Lake greenway planning project in Wuhan was selected to analyze the usefulness of a Web-based PSS (Fig. 3) that was applied in the local planning process. In general, one can state that the adoption of PSS in planning practice remains relatively limited and access to empirical investigations in practice is not very easy (Pelzer et al., 2016). The specific reasons for selecting this case were that it is one of the very few participatory planning practices in China that has adopted a Web-based PSS application. Furthermore, the contact information of all of the users is potentially available (Changjiang Daily News, 2015). The East Lake was cut off from the Yangtze River in 1957 and is now a popular recreational site within the metropolitan boundaries of Wuhan (Du, 1998). The East Lake greenway planning project was initiated by the Wuhan municipal government and was undertaken by Wuhan Municipal Bureau of Land Resources and Planning (WBLRP). In 2015, WBLRP decided to involve the public in this project. This project aimed to develop the main greenway trails, secondary greenway trails, and infrastructures (parking lots, greenway entrances, and rest areas) in the East Lake area. To facilitate public participation, WBLRP opened an online participation platform, called “Participatory planning in Wuhan”, on January 8, 2015. The platform includes an online bulletin board which issues the newest information, a 3D street view map of the East Lake, related texts (including the Wuhan urban master plan, Greenway construction plan in Wuhan, the definition of the greenway, etc.), the links to the three participatory stages of the project, experts' comments on this project, and comments of the public on this project. To inform citizens, WBLRP opened an official Wechat account on January 10, 2015, which published the main information about the online participation platform.

The East Lake greenway planning project was initiated in January 2015 and was finalized in December 2016, there were three participatory stages before planners made the final plan in this project. To encourage citizens to participate in the project, WBLRP offered monetary incentives at the three participatory stages (Table 1): the online questionnaire survey stage, the online planning stage, and the online submitting nodes' plans stage (Xiong, 2015). In the first online questionnaire survey stage, a lottery was provided to increase response. There were two questionnaire surveys on the platform for this project in this stage (January 8 to January 20, 2015 and since March 30, 2015[1]). In the second online planning stage, a Web-based PSS application was provided. In this stage, the plans made by citizens through the Web-based PSS were integrated in ArcGIS. Winners at this stage were selected according to the degree of similarity between participants' plans and the final integrated plan. The lists of winners of the lottery in the first questionnaire survey stage and of the second online planning stage

[1] The deadline is unavailable.

Table 1
the three participatory stages of the planning project.

Stage	Period	Activity/activities	Participatory tools
1	Jan. 8 - Jan. 20, 2015 March 30, 2015-unavailable	Online questionnaire surveys	Online questionnaires
2	Jan. 15 - Jan. 30, 2015	Online planning	**A Web-based participatory PSS**
3	Jan. 25 - Feb. 5, 2015	Online submitting nodes' plans	None

were published in 2015.

3.1. The application of a Web-based participatory PSS

WBLRP launched the "participatory planning in Wuhan-East Lake greenway online planning" application in the Wuhan Urban Planning Exhibition Hall in January 2015. The main goals of the launch were to introduce a Web-based PSS application (Fig. 3) and to encourage citizens to make plans about greenway trails and infrastructure using this application. The application has five panels (from top to down and from left to right), namely, the drawing tools, the editing tools, the save button, the instruction panel, and the mapping panel. The public can draw the main greenway trails and secondary greenway trails on the map and locate infrastructure (parking lots, greenway entrances, and rest areas) on the map by using the drawing tools. The public can select its own plans, edit its own plans, zoom in/out the map, and delete its own plans by using the editing tools. The "save" button can be used to save the plans of the public.

This Web-based planning application only can be used on computers. The functionality of it entailed all of the earlier mentioned components. "Informing" included defining the planning area, indicating the required data, explaining what the greenway trails and infrastructure were, and providing the recommended browsers for this application. "Information visualization" was performed by representing the geographic information of the planning area on a 2D map. The "information gathering" functionality of the application collected plans for greenway trails and infrastructure. The mapping tools enabled participants to draw the main greenway trails and secondary greenway trails on the map and to locate infrastructure (parking lots, greenway entrances, and rest areas) on the map. In fact, the public can draw the main greenway trails (or secondary greenway trails) by clicking on the main greenway trails (or secondary greenway trails) button on the drawing tools panel, moving the mouse pointer over the mapping panel, and clicking a set of points to make a line as a trail. Furthermore, the public can locate infrastructures (parking lots, greenway entrances, and rest areas) by clicking on the corresponding infrastructure button on the drawing tools panel, moving the mouse pointer over the mapping panel, and clicking the selected point on the mapping panel to locate the infrastructure. When a participant clicks on his/her own plan, a window will pop up to collect textual information. The textual information can be seen only by its creator, but plans for greenway trails and infrastructure on the map are available to everyone. The editing tools enable participants to select, edit, zoom in/out, and delete their own plans on the map. The "information storage" functionality of the application saves the participants' plans. The "information retrieval" functionality is provided only partly in the sense that participants can retrieve their own plans and textual information after registering and logging into the platform. The "communication" functionality includes one direct information flow from participants to the planning institution as participants submit their plans. Furthermore, the participants can see each other's plans.

The Web-based PSS application did not have an "analysis and modeling" functionality, so the original plans (Fig. 4 left and Fig. 5 upper) provided by the 138 participants were analyzed with the help of ArcGIS (the integrate tool). Fig. 4 (left) shows the greenway trails plans created by citizens, and Fig. 5 (upper) shows the parking lots, greenway entrances, and greenway rest areas created by citizens. Fig. 4 (right) shows the integrated plan of the greenway trails, and Fig. 5 (lower) shows the corresponding integrated plans. Subsequently, the integrated plans (Fig. 4 right and Fig. 5 lower) were provided to six professional design groups of WBLRP with distinctive specialties. Each group was asked to consider the citizens' plans explicitly and to devise a complete plan. The resulting six plans were combined into a composite final plan, which was published on the platform in May 2015.

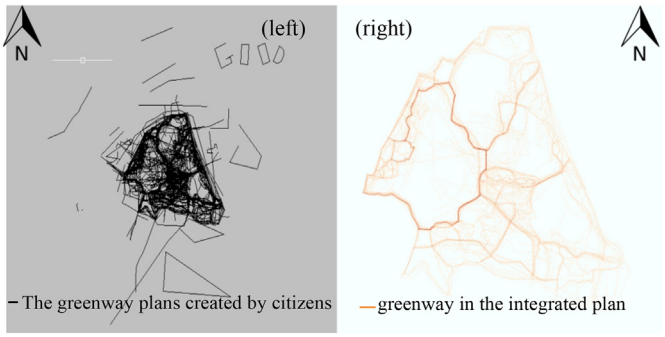

Fig. 4. The greenway trails plans created by citizens (left) and the integrated plan (right) (Xiong, 2015).

4. Research methods

The East Lake greenway planning project was initiated in January 2015 and was finalized in December 2016; the Web-based PSS was open for use from January 2015 onward. It sounds reasonable to measure usefulness immediately after usage, but this plan turned out to be impossible. To reduce recall errors in this retrospective survey, in the fieldwork, we provided as much relevant textual and visual information as possible. The evaluators' understanding of usability items is crucial for success (Steinmann, Krek, & Blaschke, 2004). Therefore, different types of citizens were consulted before our survey to resolve to some extent the ambiguity of respondents' understanding of questionnaire items.

4.1. Utility

To measure the utility of the Web-based PSS, semi-structured interviews were conducted with the project manager and the software developer[2] (both of them were employees of Wuhan Planning and Design Institute, a subordinate unit of WBLRP) in November 2016. The project manager was also the manager of "participatory planning in Wuhan". We provided to the interviewees Fig. 3 and a paper with the tasks and functionalities of the Web-based PSS. Contacts were made in advance by e-mail, and each interview lasted approximately one hour. The key questions concerned why they adopted the Web-based PSS in the planning process, which functionalities the application possesses, in what sense the application matched their goals, and which functionalities were considered to need improvement?

[2] The software developer was interviewed to better understand the functionalities of the application.

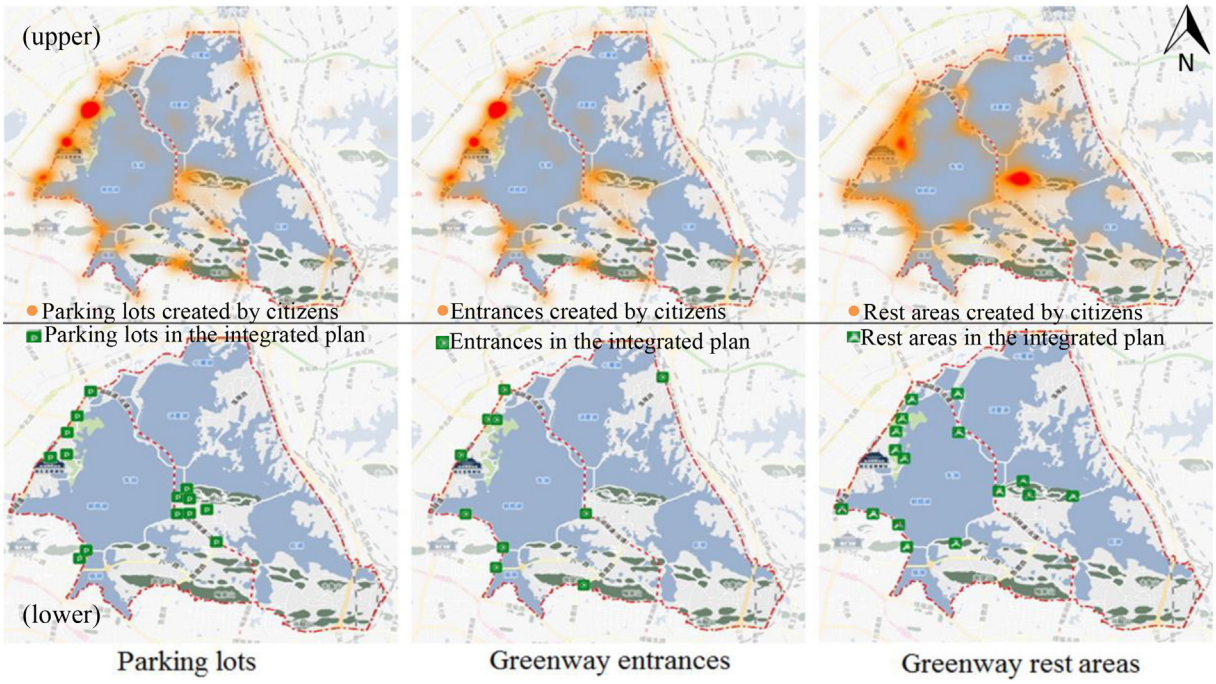

Fig. 5. The infrastructure plans created by citizens (upper) and the integrated plan (lower) (Xiong, 2015).

4.2. Usability

To measure the usability of the Web-based PSS, an online questionnaire survey of users was conducted from April 7 to May 6, 2017. Questionnaires were sent to users' e-mail addresses. Monetary incentives were provided to stimulate the response rate. The questionnaire consisted of three parts. Part one concerned questions about users' attitudes toward the 21 performance criteria (see Appendix), which were selected from the literature (i.e., Perlman, n.d.; Davis, 1989; Lewis, 1995) and thereafter were modified to fit the context of Web-based PSS in participatory planning. The respondents used a 5-point Likert scale to rate their degree of agreement with each criterion, and this step was considered sufficient to perform a reasonably reliable assessment of respondents' attitudes (Bradburn, Sudman, & Wansink, 2004).

Several criteria were negatively worded to alleviate acquiescence bias (i.e., the tendency to agree/disagree with all of the criteria regardless of content) (Marsh, Barnes, Cairns, & Tidman, 1984). Cronbach's α, the most commonly used reliability index (Field, 2013), was computed in SPSS software to test the reliability of the questionnaire.

Part two of the questionnaire concerned additional usability-related information, such as "please provide any further comments about this application", "please indicate the relative importance of the eight performance criteria (from 1-most important to 8-most unimportant)", and "have you ever participated in urban planning processes before?". Part three of the questionnaire concerned questions about users' individual characteristics, such as their levels of formal education, ages, etc.

5. Results

To determine the usefulness of the Web-based PSS, one should keep in mind that utility and usability are the two sides of one coin, in the final evaluation they should be weighed together. However we measured each separately. The decision on the task and related functionality was made within the planning bureau as part of the planning process and did not include the users, and the question whether the application fit the needs of the users should not be answered by the ones in charge of the development of the PSS. In the following paragraphs, the outcomes of the measurements are presented.

5.1. Utility

We first asked the project manager about the background of this project. According to him, the WBLRP planned to use the internet to help them solve the problems they met when developing and administering urban plans around 2015. Therefore, they created a "participatory planning in Wuhan" platform online. They selected the "East Lake greenway planning project" as their first participatory project in order to benefit the public within a short term. The East Lake area was a popular open sight in Wuhan city, and this project was expected to be completed within 1.5–2 years. Here are the dialogues:

What is the origin of the "participatory planning in Wuhan" platform?

We (WBLRP) organized 4–5 brainstorming sessions from the end of 2014 to the beginning of 2015. During the sessions, we talked about how to use the Internet when we developed and administered urban plans, and then we decided to create a "participatory planning in Wuhan" platform. The primary purpose of the platform is to collect the knowledge of planners and people with professional knowledge to solve planning problems because urban planning is still a specific disciplinary area. (However, in the Greenway project the general public was consulted.) Yes, it is our first project.

Why did "participatory planning in Wuhan" select the "East Lake greenway planning project" as its first project?

We started to develop the greenway plan in early 2015, and at the time, we decided to create the "participatory planning in Wuhan" platform. The greenway planning met the two selection criteria of the platform: "the public is happy with this project" and "it can be finished within a short timeframe". We all love to go to the East Lake, and this project was planned to be completed within 1.5–2 years. Therefore, the East Lake greenway planning project was selected for participatory planning.

Then, we asked the project manager three questions about the utility. As the project manager stated, the task of the web-based PSS was to collect the public's plans on the project before planning professionals made the final plan. The PSS developer provided the appropriate utility, which included "informing and information visualization",

"information gathering", and "information storage" functionalities. Here are the dialogues:

Why did the "participatory planning in Wuhan—East Lake greenway planning project" adopt this Web-based PSS application?

We decided to collect citizens' knowledge about the greenway planning project but did not know how to achieve this goal. This application became the tool for this goal. Normally, we went to the planning area and talked with citizens about the final plan. So the public passively participated in urban planning when plans had been finalized. Now, we decided to involve the public before the final plan had been finalized. Therefore, we launched the application to attract the public. Local mainstream media, such as Hubei daily newspapers and Hubei TV, were invited to the launch. Monetary incentives were provided as well.

What were the functionalities of this application? Did these match your goal?

The fruitful functionalities of this application included "informing and information visualization", "information gathering", and "information storage". These functionalities can achieve my goal. But I also think that the additional functionalities of "communication" and "analysis and modeling" need to be improved.

We also interviewed the software developer to gain his opinion on the utility of the application. The questions were the same as we had asked to the project manager, we also asked extra questions about the application developing process. From the software developer's perspective, this application has utility too, as he stated:

The goal of this application was to collect citizens' plans. The functionalities of this application included "informing and information visualization", "information gathering", and "information storage". … These functionalities can achieve this goal. … We invited some citizens to use the application in its launch, and then I improved it according to my observations during the launch. Now, I think the functionality of "information visualization" needs to be improved; for instance, the roads can be more vivid.

It is clear from the answers that the main goal of the operation was to provide a better plan and also that several of the five criteria from the Rowe and Frewer (2000) framework were considered. It was an open platform and was widely published in the local media and the motivation of the potential users was stimulated by choosing a project citizen could easy relate to and financial rewards were introduced. it was deliberate decision to apply this PSS in an early phase of the planning process. It was also communicated that input from the public would be used to draw-up the final plan. Yet how the decision making worked was not transparent. Perhaps the most remarkably finding is the preference to gather the knowledge of people with professional knowledge, rather than those of the general public. This is clearly at odds with the idea of setting up a participatory tool that would also provide experience-based knowledge from the actual users of the greenway. A clear strategy, other than advertising, to meet the competences of the users was lacking. Both the principal and the designer were very much aware of the required functionalities in a technical sense, but less aware of the potential users of the system. The matter of representativeness was clearly not a main issue in setting up the system.

5.2. Usability

5.2.1. The respondents

The highly selective nature of the participation is substantiated by the results of our survey. In total, there were 138 users, of whom 134 were available and provided a valid e-mail address. Of the 134 potential respondents, 33 (25%) complete the online questionnaire afterward, from which we could distill reflective information. The respondents were primarily male, young, local (Wuhan inhabitants), well educated, and middle class (Table 2).

We are aware that this entails a double selection process, first to participate in using the application, second to also participate in our survey. However we have the idea that the burden of our survey is not greater than the requirements to participate in the first stage and that the respondents will not systematically differ from the total group. Although not explicitly stated, yet confirmed by the project manager, the participation platform was developed mainly to collect relevant input from planners and people with equivalent professional knowledge. Most respondents belong to these target users because they had relevant knowledge/skills (Table 2): 13 (39.4%) respondents had a major in urban planning, urban design, or architecture, the majors of 7 (21.2%) respondents were transportation planning or transportation engineering, and the major of 1 (3.0%) respondent was GIS. However, of the 33 respondents, 12 (36.3%) had never participated before in an urban planning practice. The goal of collecting relevant knowledge might not be fully achieved: only 13 (39.4%) respondents chose "the greenway planning project itself" as the prime reason to participate in this project, 14 (42.4%) respondents did so for the Web-based PSS application", 4 (12.1%) respondents chose "the online questionnaire, the online forum", and 2 (6.1%) respondents chose "others suggested that I participate". The respondents who were not attracted by the project itself might have participated simply to gain experience with platform tools.

Table 2
Characteristics of respondents (N = 33).

Characteristic	n	%
Gender		
Male	23	69.7
Female	10	30.3
Age		
18–40	30	90.9
41–65	3	9.1
Address		
Wuhan	29	87.9
Other cities in China	3	9.1
Europe	1	3.0
Education		
High school (or high school equivalent)	1	3.0
Junior college degrees or bachelor's degrees	18	54.5
Master's degrees or doctoral degrees	14	42.4
Income[a]		
Higher (more than $46,000)	2	6.1
Middle ($10,001–$46,000)	20	60.6
Lower (less than $10,001)	11	33.3
Major		
Urban planning, urban design, or architecture	13	39.4
Transportation planning or transportation engineering	7	21.2
GIS	1	3.0

[a] This classification is made by BCG and AliResearch according to the annual disposable income of a household. https://www.bcgperspectives.com/content/articles/globalization-growth-new-china-playbook-young-affluent-e-savvy-consumers/?chapter=3.

Nearly all of the respondents considered the Web-based PSS to be acceptable: of the 33 respondents, 32 (97.0%) respondents were willing to use the Web-based PSS in the future, and 30 (90.9%) respondents were willing to recommend the Web-based PSS to others. Although 27 (81.8%) respondents reported that their most favorite participatory method was the Web-based PSS because it enabled them to "express ideas clearer" or "save time and effort", 3 (9.1%) respondents still favored offline participatory methods, and 2 (6.1%) respondents favored common online participatory methods (e.g., online questionnaires and online forums), and only 1 (3.0%) respondent believed that there was no difference.

5.2.2. The usability of the Web-based PSS

Before analyzing the data, the negatively worded items were reverse-scored so that a high score on a performance criterion indicated a high level of usability. The value of Cronbach's α was 0.848, indicating sufficient reliability of the test scores. The mean score (M) and the standard deviation (SD) of each performance criterion were calculated to evaluate the usability of the Web-based PSS application (See

Table 3
Respondents' perceived relative importance of performance criteria.

Criterion	Score (mean)	Ranking
Error rate	3.88	1
Satisfaction	4.27	2
Learnability	4.30	3
Interactivity	4.61	4
Ease of use	4.73	5
Connectivity	4.91	6
Efficiency	4.91	7
Effectiveness	5.30	8

Note. 1 - extremely important, …, 8 - extremely unimportant5.

Appendix). The M of the performance criteria ranged from 3.17 to 4.15 (on a scale of 1–5), indicating that respondents perceived the application as usable but believed that each criterion could be improved to some extent. Only three SD values exceeded 1, indicating those respondents' attitudes toward most performance criteria varied only slightly. In addition to measuring the usability of the Web-based PSS by scoring each of the performance criteria, their relative importance was also scored on a scale of 1–8 (Table 3).

The performance criterion “error rate” is considered the most important criterion in measuring the usability of Web-based PSS applications (Table 3). In general, the respondents tended to agree that there were still some problems with the application, particularly with drawing infrastructure objects. Respondents considered “satisfaction” to be the second most important performance criterion. In general, its M (3.63) indicated a quite satisfactory position (See Appendix), despite there still being some errors to overcome in the Web-based PSS application to increase its usability. “Learnability” ranked third in importance, although it was very close to the second rank, and it overall showed a fair position (M = 3.17). However, the SD of each of the “learnability” questions was quite high, indicating that the respondents' attitudes toward this performance criterion varied widely. From this outcome, we can assume that respondents possess very different levels of background knowledge and experience with this type of application, with some needing much more support information and relatively longer learning times than others to use the application properly.

The importance scores for the next four performance criteria were very close: “interactivity”, “ease of use”, “connectivity”, and “efficiency”. The “interactivity” criterion was considered satisfactory (M = 3.57), but one should consider that the application was not aimed to support communication with the planning institute or the interactions between users but foremost to support the development of new planning ideas. The respondents also scored quite positively the performance criterion “easy to use” (M = 3.43), which is a crucial feature not least because the Web-based PSS was built for citizens' participation and was not designed for planning professionals. However, one should consider here that the respondents of the enquiry were a group of highly educated people. The performance criterion “connectivity” received the highest M (4.15) with a relatively low SD (0.83), indicating that respondents were quite uniform in their agreement with this criterion that they all possessed the resources to be able to use the Web-based PSS application. In fact, the Web-based feature of the application facilitated online participation, not least among people for whom it was inconvenient to participate onsite. The related “efficiency” criterion received a relatively high score also (M = 4.03), indicating that the respondents were quite satisfied with the efficiency of the Web-based PSS, compared to traditional participatory channels. Nevertheless, the respondents did not consider this criterion to have very much importance.

Finally, the “effectiveness” criterion was considered the least important performance criterion (Table 3), although the M of this criterion was relatively high (3.97), indicating that the application enabled respondents to accomplish their goals quite effectively, compared to traditional participatory channels (e.g., public hearings, questionnaires, bulletin boards, and weblogs). However, its very low position in the ranking of the importance of performance criteria emphasized that respondents did not consider this performance criterion to truly be important.

In short, the Web-based PSS was considered to be usable in general, although different users attached different values to different performance criteria, and more importantly were probably a highly selective group. Many of them were not motivated by the intrinsic planning problem at hand but were attracted by the form in which it was presented.

6. Discussion and conclusions

This paper attempts to understand the usefulness of a Web-based PSS application in a Chinese planning practice. The crucial question is whether technologies originating from Western countries are also useful when applied in China, with a fully distinctive political system and where participatory planning is an emerging practice and still is in an experimental phase. Can the potentials of the online systems also be realized in China and are the shortcomings shared or context specific?

Starting with the seminal framework of Nielsen (1994) we identify utility (=systems' functionality needed) and usability (=how well users can use that functionality to perform their task) as the two closely intertwined dimensions to evaluate the performance of human-computer interaction systems. In particular when it comes to participatory tools, the two cannot be separated. If the task is to enable citizens to participate in planning processes, then this would clearly fail if the intended users could not access or operate the system. The definition of the task and its concomitant functionalities is the starting point for the evaluation of the utility and this is where the contexts differ. In Europe, Participatory PSS are either developed as a means of more direct democracy in a system of representative government (normative) or as a means to come up with better plans by integrating experience-based knowledge and recognizing values from outside the planning community (procedural) (Kahila-Tani et al., 2016). The two overlap considerably, but differ in their normative underpinnings. In the Chinese context the normative approach is radically different. The system of representation is defined as a “social contract” between the citizens and their government at all levels that the leaders will serve the best interest of their constituency. Violation of this contract can lead to vehement protests and many conflicts over urban (re)development have been recorded in recent years. The emphasis on participatory measures to maintain social stability should be understood from this context: it's the outcome that counts, the procedures are left to local government. From a more procedural point of view one could still argue that making better plans would also serve the Chinese normative stance and that the Rowe and Frewer (2000) framework of: (1) representativeness, (2) independence, (3) early involvement, (4) influence and (5) transparency can be applied in both cases.

Our results are to some extent in line with this argument. The interview with the project manager that commissioned the Web-based PSS application for the Wuhan East Lake greenway project confirmed that he identified the potential of the application to elicit plans from independent citizens at an early stage of the planning process, over traditional methods of collecting responses by citizens to a designed plan in physical meetings. He also showed a clear intention to have his design teams use the input to come up with a final plan, and communicated the results on the website. He was aware of the appropriate functionalities like “informing and information visualization”, “information gathering”, and “information storage” to achieve the goal and thought “information retrieval” and “communication” functionalities should be improved. Yet he was not concerned with the fact that only “professional citizens” used the application. His priority was not to include the general public and assure representativeness, but to come up with a better plan that the people would like. To understand the

utility of the system in a Chinese context one should be aware that participation is not a goal in itself, like in Europe, but a means to maintain social stability and is considered legitimate without the need for representativeness.

One of the criticism of participatory planning methods in Europe is that participation is often dominated by a self-selected elite that uses the process to further their interest (Kahila-Tani et al., 2016). Indeed Web-based participatory tools are seen as a possible solution as they open up the process to those that do not have the time or other resources to become involved in the inner-circle. Our results showed that this process of self-selection also occurred with the web-based tool in Wuhan, although for a different reason. Among the respondents to our survey only one (out of 33) did not have at least a college degree and the majority had majored in either urban planning, design or architecture, transportation planning and engineering or geo-information science. Half of them were not motivated by the intrinsic quality of the East Lake project, but were attracted by tool itself. In terms of usability this is at odds with the requirement that the system should enable both novice and experience users, given the task at hand. Even within this experienced group, respondents' attitudes toward two of the three learnability items varied significantly. The system was not only selective in its use, but also failed to deal with different levels of knowledge and experience with PSS, in which some respondents needed much more support information and relatively longer learning time than others in using this specific application properly. The respondents perceived this application in general to be usable, as expressed in the overall sufficient scores on the performance criteria that varied only slightly.

Web-based PSS is a double-edged sword for participatory planning. On the one hand, it can attract and help people (even outside Wuhan city) to participate in planning. In this research, four respondents participated in the urban planning process for the first time, due to the "inconvenient time or place" of onsite planning practices, which appeared to be a more general burden of participation in planning processes in China (Hu, de Roo, & Lu, 2013). On the other hand, participatory tools that fail to comply with competences, motivations and resources of their potential users are not very useful. Our research shows that technologies are easily transferable from Western countries and that the application did have most of the required functionalities and met most of the design criteria on usability. However, assuming that the tools would perform the same task as in Western countries is clearly mistaken, as the normative planning context is very different and the system will be used for other ends.

This research confirmed the conclusions of earlier research by Narooie (2014), who argued that a Web-based PPGIS application could complement, instead of replace, traditional participatory methods (e.g., roundtables and sticker map methods) based on the contextual barriers such as the attitudes of participants. According to our empirical study, the barriers in the Chinese context have three aspects. First, those who miss the resources to access the Web-based PSS will be marginalized by just providing online tools to participate. A large proportion of people in China still cannot connect to the Internet easily, considering the Internet penetration rate of only 53.2% in 2016 (CNNIC, 2017). Second, learning how to use Web-based PSS is a challenge for the general public. This research showed that the usability and, in particular, the scores for "learnability" were quite diverse for different users of the Web-based PSS application. Half of the respondents asked for much more information to be able to handle the PSS application in a proper manner, although 21 of the 33 respondents already had relevant knowledge/skills (e.g., ArcGIS). Third, people with low levels of computer literacy might be marginalized as well. Current research on Chinese participatory/collaborative planning found that online platforms exclude some important stakeholders (e.g., affected residents in local communities) who are not familiar with the information and communications technology (Zhao, Lin, & Derudder, 2017). Therefore, we emphasize the need for complementarity of online participatory methods (e.g., Web-based PSS, online questionnaires and online forums) and offline/traditional participatory methods (e.g., face-to-face meetings, public hearings and citizen surveys). And furthermore, we ask for more attention to the identified differences in normative planning context between China and the western world, which influences for what purpose the participatory system is applied for.

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Appendix A

Usability of the Web-based PSS application in the Wuhan greenway planning project ($N = 33$).

Performance criteria	M	SD
Connectivity	4.15	
I had resources (e.g., laptop and network) to access this online application quickly and easily	4.15	0.83
Error rate[-]	3.66	
I made errors when I drew greenways because of errors in this application	3.70	0.81
I made errors when I located infrastructure because of the errors in this application	3.52	0.87
I made errors when I added comments to a discussion forum because of the errors in this application	3.82	0.81
I made errors when I used this application (except for the abovementioned three operations) because of the errors in this application	3.61	1.09
Learnability	3.17	
I did not need support information (e.g., online guidance) when using this application[#]	2.76	1.12
I felt the functions of this application were easy to understand	3.52	0.97
I did not need exploratory learning time to become familiar with the application	3.24	1.06
Ease of Use	3.43	
I found it was easy to draw greenways in this application[#]	3.36	0.93
I found it was easy to locate infrastructure in this application[#]	3.21	0.99
It was easy to read characters on the screen[#]	3.52	1.06
The visual information was clear enough for me to complete the task	3.64	0.96
Interactivity	3.57	
I was satisfied with the function of interacting with the planning bureau	3.48	0.83
I was satisfied with the function of interacting with other users (please select disagree if there was not this function)	3.52	0.94
I was satisfied with the interactive functions of this application in general	3.70	0.85

Effectiveness	3.97	
Compared with traditional participatory channels (e.g., public hearings, questionnaires, bulletin boards, and weblogs), this application enabled me to accomplish my goals more effectively	3.97	0.92
Efficiency	4.03	
Compared with traditional participatory channels, this application enabled me to accomplish my goals in less time	4.03	0.85
Compared with traditional participatory channels, this application enabled me to accomplish my goals with less effort	4.03	0.73
Satisfaction	3.63	
I was satisfied with the look and feel of this application (e.g., design, layout)	3.79	0.74
I was satisfied with the amount of time it took to achieve my goal in this application	3.58	0.83
The application was pleasant to use	3.52	0.91

Note. 1-strongly disagree, 2-disagree, 3-neutral, 4-agree, 5-strongly agree.

* 1-always, …, 5-never.

The scores and items have been reversed in this table.

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