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Explorer la perception sociale des systèmes de drainage durables : points de vue de praticiens et d'universitaires

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RÉSUMÉ

Les SuDS sont devenus une infrastructure verte populaire pour les eaux pluviales, développant une grande variété de recherches et de pratiques à l'échelle internationale. Néanmoins, la perception des SuDS par les praticiens d'un point de vue technique et social est encore un domaine inexploré dans le domaine. Il y a eu plusieurs tentatives pour décrire l'état actuel des SuDS dans plusieurs pays, soulignant la nécessité d'enquêtes internationales pour établir le niveau de mise en œuvre et de connaissance des SuDS à l'échelle internationale, tandis que de nouvelles méthodologies sont nécessaires pour conférer une robustesse mathématique à ces questionnaires. Cette recherche propose l'utilisation du modèle des moindres carrés partiels et des équations structurelles (PLS-SEM) en utilisant la méthodologie SmartPLS pour explorer la perception sociale des praticiens et des universitaires sur les connaissances SuDS et comment les variables latentes telles que les coûts-avantages, les obstacles et les opportunités de mise en œuvre se rapportent à cette connaissance. L'enquête a été complétée par 232 experts. Les résultats ont montré que la zone géographique influençait de manière significative la perception du niveau de connaissance des stratégies de mise en œuvre du SuDS, notant l'absence générale d'activités de maintenance et de suivi. Les chaussées perméables et les jardins pluviaux ont été décrits comme les techniques SuDS les plus utilisées. Le modèle structurel proposé a été validé dans l'enquête, permettant l'acceptation des hypothèses, devenant une méthode transférable à n'importe quel territoire.

ABSTRACT

Sustainable Drainage Systems (SuDS) have arisen as popular green stormwater infrastructure, developing a wide variety of research and practice internationally. Nevertheless, the perception from practitioners and academics about SuDS from a technical and social viewpoint still is an unexplored area in the field. There have been several attempts to describe the current state of SuDS in several countries, highlighting the need for international surveys to establish the level of implementation and knowledge about SuDS internationally, whilst new methodologies are required to confer mathematical robustness to these questionnaires and their hypotheses. This research proposes the use of the partial least square and structural equations model (PLS-SEM) using the SmartPLS methodology to explore the social perception from practitioners and academics about SuDS knowledge and how latent variables such as cost-benefit, barriers and opportunities for implementation relate to that knowledge. The survey was completed by 232 experts across the world. Results exhibited that the geographical area significantly influenced the perception of the level of knowledge about SuDS implementation strategies, noting the general absence of maintenance and monitoring activities. Permeable pavements, swales and raingardens were outlined as the most utilised SuDS techniques. The structural model proposed was validated in the survey, checking its goodness-of-fit, allowing the acceptation of the hypotheses, becoming a method that could be transferred to any territory.

KEYWORDS

Amenity, BMP, PLS-SEM methods, SCM, WSUD.

1 INTRODUCTION

Sustainable Drainage Systems (SuDS) or Stormwater Best Management Practices (BMP) have become a commonly implemented stormwater infrastructure across Australia, China, Northern-Europe, and North America, beginning their growth in Latin America and Southern Europe over the last two decades. However, the understanding of SuDS from a technical perspective when it comes to the perception of practitioners is still an area for further development. Previous research by Morison (2011) and Melville-Shreeve (2018) opened the field for further understanding and uptake of WSUD and SuDS, respectively. Sañudo-Fontaneda and Robina-Ramírez (2019) highlighted the need for the application of social perception methodologies that support mathematically the surveys.

The main goal of this research was to identify the perception from practitioners and academics internationally about SuDS implementation through the understanding on how they embrace SuDS considering their awareness of cost-benefit, barriers, and opportunities for implementation. With this aim, an international survey was developed following the partial least square and structural equation modelling (PLS-SEM) methods.

2 EXPERIMENTAL METHODOLOGY

2.1 Hypotheses, model, and questionnaire development

The targeted population for this survey were practitioners and academics working closely to SuDS internationally. Six hypotheses were designed following the main aim from this research and considering the four pillars of SuDS design (Woods Ballard et al. 2015), testing latent variables (constructs or factors) that cannot be observed directly such as “Knowledge Level” (KL), “Cost-Benefit” (CB), “Barriers” (B) and “Identification of Opportunities for Implementation (IOI). The hypotheses can be observed in Figure 1.

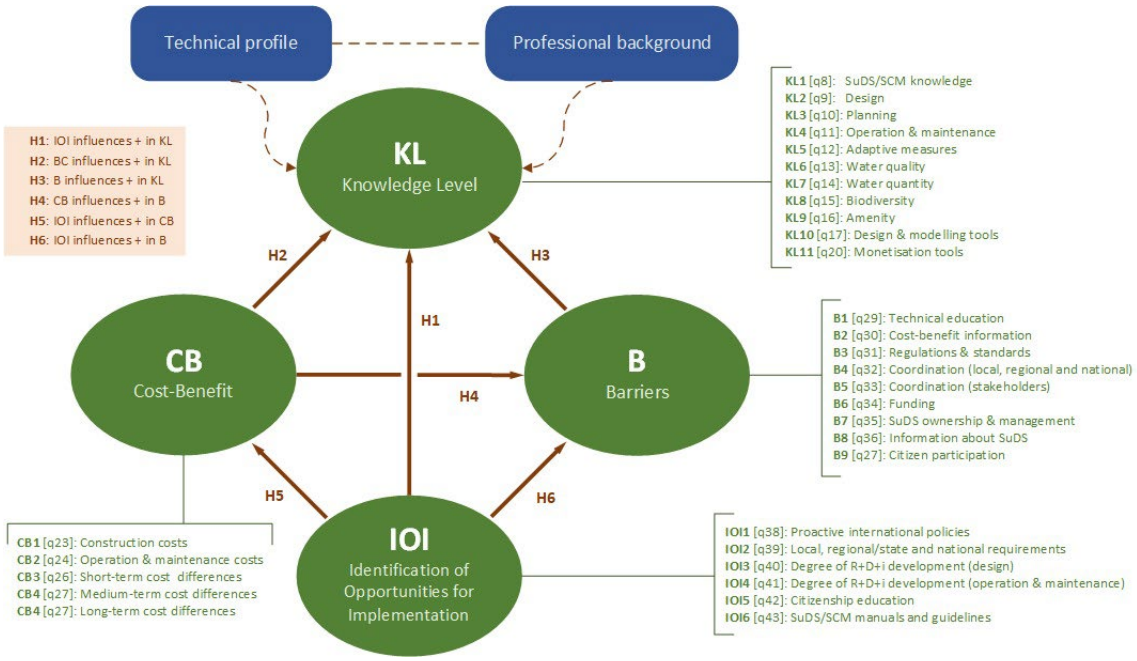

Figure 1. Model to value technical perception in SuDS based in the knowledge level.

Once the model was built, the indicators associated to any construct were developed alongside their questions included in the survey. With this aim, a focus group was created including 10 international experts. This group discussed the first draft of the questionnaire and provided comments while suggesting modifications. Finally, once the questions were agreed, the final survey was launched in Spanish-Castilian and English.

2.2 Methodology for the analyses of the results from the questionnaire

The data were analysed using the PLS-SEM methodology using the SmartPLS proposed by Sañudo-Fontaneda and Robina-Ramírez (2019) to analyse the social perception of SuDS, putting the topics of this research through indicator reliability, internal consistency variability, convergent validity, discriminant validity, check of the structural path and significance in bootstrapping. All questions linked to the PLS-SEM method were developed using Likert’s scale for each indicator.

3 RESULTS AND DISCUSSION

3.1 Descriptive and statistical analyses

3.1.1 Respondents' demographic and technical profile

A total of 232 participants completed the survey internationally. The first approach to a descriptive analysis is to find out about the demographic profile from the respondents, looking at the gender (34% female, 63% male, <1% non-binary and 2% did not provided and answer) and the age range (36%, 40-50; 25%, 30-40; 22%, 50-60; 10%, 20-30; 7%, 60-70).

The academic background and qualifications from the practitioners and academics surveyed depicted a high percentage of professionals with a master's degree (57%), which shows the degree of specialisation required to work in SuDS. In addition, 19% held a PhD in the scientific areas surrounding the topic. Finally, 22% of the interviewees had a bachelor's degree while 3% corresponded to practitioners with no higher academic education. The academic qualifications were significantly dominated by those coming from civil engineering and their different branches. However, there are a wide range of qualifications between the interviewees, noting the engineering disciplines such as environmental, industrial, electrical, agronomy, forestry. Furthermore, architecture, landscaping, chemistry, business management, health, parasitology, and geology, were depicted in the list.

The geographical origin of the respondents was quite varying, highlighting the participation from the Hispanic World (76%), which has been usually overlooked in the international analyses such as in Fletcher et al. (2015), where there is no mention to their concepts and developments over the years. Respondents from Spain represented 52% of the people surveyed, Colombia reached 17% and the UK up to 11% with interviewees from another 22 countries across the world (i.e., Andorra, Australia, Brazil, Canada, France, Germany, Netherlands, Sweden, Portugal, and USA, amongst others).

The respondents' profiles were completed by their professional backgrounds, noting the following ones: project consultancy (22%), academic (19%), local government (18%), specialised companies in urban water management (15%), regional government (7%), national government (4%), drainage products developer or distributors (4%). Other professionals from construction companies, government agencies, professional associations, constructions, environmental and water clusters, and operation and maintenance companies represented percentages below 2% each one of them. The professionals surveyed described their role in relation with SuDS selecting several options, highlighting design (46%), planning (35%), R+D+I (25%), operation and maintenance (19%), monitoring (18%), construction (15%), and SuDS approval bodies (13%).

3.1.2 Relation between the respondent's profile and their knowledge about implementation strategies

Statistical analyses unravelled significant and non-significant relationships between the respondent's profile and their perception of their knowledge about implementation strategies and approval policies. The geographical area and the area of work significantly influences (Kruskal-Wallis test) the perception of the level of knowledge about SuDS implementation strategies and approval policies. On the other hand, the gender (Mann-Whitney test) and the age range (Kruskal-Wallis test) did not significantly influence the perception of the level of knowledge about SuDS implementation strategies and approval policies.

3.1.3 Perception about the implementation of SuDS

The perception of the implementation of SuDS was obtained through the experience of the respondents, highlighting the following outcomes below:

- The primary application of SuDS was identified to take place in new development and urban retrofits, considering the following land uses as the preferred ones: green/blue corridors, consolidated urban land, industrial or commercial areas, developable areas, sports and recreational areas and unconsolidated land. Other uses such as transport infrastructures (e.g., drainage in road, railway, airports, and ports) received lower attention.
- The main reasons for SuDS implementations were noted as following: attenuation of the disruption of the natural water cycle, insufficient service provided by the stormwater network, and climate change adaptive measure in infrastructures. At a second level of importance, the respondents pointed out the external funding for their implementation, requirement introduced by any local, regional/state, or national standard, and the provision of amenity and biodiversity.

- The most utilised SuDS techniques were permeable pavements (n=98). In a second level, swales (n=54), raingardens (n=47), detention ponds/basins (n=47), infiltration trenches (n=45), green roofs (n=43), filter drains (n=38), bioretention areas (n=37), street trees (n=36), infiltration ponds/basins (n=35), constructed wetlands (n=35), appeared as quite popular choices. Finally, tank modules/plastic units (n=24) and storage tanks (n=22). In addition, new technologies for stormwater management (e.g., hydrodynamic separators) usually combined with SuDS were identified by 13 respondents, whilst treatment trains were utilised by 26 respondents. These results differ from those obtained from the analysis of the scientific literature in SuDS techniques carried out by Jato-Espino et al. (2018), exhibiting relevant differences between a combined approach between practice and academia, and a sole academic consideration.
- Most of the respondents had never monitored their SuDS schemes or had done so in less than 25% of their experience, showing a need for further monitoring in real cases in order to get real data and adequate understanding of SuDS performance. In addition, maintenance was never carried out by 41% of the respondents, while 33% carried out maintenance operations during the whole operational life of the SuDS. The remaining respondents only carried out some maintenance activities until the first 5 years of practice. The most important issue encountered by practitioners was identified to be the lack of maintenance budget, followed by a lack of planning for maintenance and vagueness in the maintenance tasks descriptions.

3.2 Structural model results

After examining the measurement model, the relationships between the constructs were analysed. The trajectory coefficients of the hypotheses were studied and the explained variance (R^2) of the endogenous latent variables and the p-value of the regression coefficients (t-test) were used as indicators of the explanatory power of the model. The results obtained allow to accept all the hypotheses established in the model, since there were no statistically significant differences in the relationships between the variables. The goodness-of-fit for the model was carried out using the standard root mean square residual (SRMR) indicator, obtaining R^2 values obtained in this investigation between 0.380 and 0.632 that can be considered substantial based on Chin (1998).

4 CONCLUSIONS AND FUTURE RESEARCH LINES

This research presents a survey with numerous responses from the SuDS community internationally, providing useful information about the current state of the perception of academics and practitioners about the technical level of knowledge around SuDS, as well as their implementation. The geographical area and the area of work significantly influenced the perception of the level of knowledge about SuDS implementation strategies. SuDS are perceived as key infrastructure elements within climate change adaptive measures, whilst standards and manuals are required in Southern Europe and Latin America (LATAM). Finally, the absence of maintenance and monitoring due to lack of planning and short budgets in SuDS schemes are identified as barriers.

The main limitation of the international outreach of this research is the large influence from the Hispanic world (Spain and LATAM) respondents. Future research lines have been identified as follows: specific analysis of the Spanish case within the Spanish-LATAM region, and the extension of this research to other countries by increasing their participation in the survey.

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