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Embedding planning support systems in spatial planning practice: the role of drift in implementing the Spatial Development Framework methodology

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ABSTRACT

Planning Support Systems (PSS) research has explored ways to improve PSS use and embeddedness. However, there is little knowledge of how unplanned changes during implementation impact outcomes. This paper answers the question, 'How can drift influence PSS implementation and use?' It applies the concept of drift (changes in new technology, user behaviour, and/or existing practice during ICT implementation) to explain how PSS users (GIS specialists, planners) initiate unplanned changes during implementation and use. Following a qualitative approach, we investigate a PSS implementation case study in Rwanda – the Spatial Development Framework (SDF) methodology – to establish the role of drift in PSS use and embeddedness. Our study reveals that a) user understanding and perception of PSS can initiate drift during implementation and use, and b) drift can influence outcomes of PSS use or embeddedness. This study confirms the role of drift in PSS use and embeddedness in Rwanda's spatial planning process.

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Planning support systems (PSS); spatial planning practice; Spatial Development Framework (SDF) methodology; drift; technology acceptance model (TAM)

Introduction

Planning Support Systems (PSS) are a type of information and communications technology (ICT) that evolved as a framework of systems, methods and tools for data management, communication and collaborative decision-making in spatial planning processes (Geertman 2002, 2006; Geertman and Stillwell 2004, 2009; Pelzer et al. 2014; te Brömmelstroet 2010). PSS is also a scientific field that investigates how ICT, geospatial information systems, tools and methods can support decision-making processes in planning practice (Geertman 2013; Geertman and Stillwell 2004, 2020b; Geertman, Toppen, and Stillwell 2013). The achievements of Planning Support Science include providing knowledge to support PSS implementation for specific tasks and strategic spatial planning processes at the local and national levels (Geertman and Stillwell 2020a; Geertman, Toppen, and Stillwell 2013). Another achievement is its integration of ICT advancements in geospatial technologies or methodologies for PSS development, to enhance communicative and collaborative planning processes (Geertman and Stillwell 2020a; Geertman, Toppen, and Stillwell 2013).

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The continuous integration of ICT with geospatial technologies and methodologies allows PSS prototypes to become fully developed systems that support various planning activities. However, with the persistent limited use of PSS, identified almost two decades ago (Geertman 2017; Geertman and Stillwell 2004; Vonk, Geertman, and Schot 2005), there is continuous interest in research to understand better the challenges of PSS use and embeddedness in the spatial planning practice (Geertman 2013, 2017; Geertman and Stillwell 2020b; Pelzer 2017; te Brömmelstroet 2013). PSS use refers to a one-time implementation of a PSS for a planning activity or a repeated use in different planning contexts and activities. PSS embeddedness happens when the PSS becomes part of the formal decision-making process for the respective types of planning activities.

Geertman and Stillwell (2009) categorize three approaches to studying PSS use. The *instrument approach* investigates how PSS quality for task achievements and user-friendliness affect PSS use (Geertman 2006; Geertman and Stillwell 2004; Goodspeed 2016; McEvoy et al. 2019; Pelzer 2017; Russo et al. 2018b; te Brömmelstroet 2013; Vonk, Geertman, and Schot 2007a; Vonk and Ligtenberg 2009). The *transfer approach* investigates how PSS evolved from the developers' ideas to the users' choice for usage (Goodspeed and Hackel 2019; Pelzer 2017; Russo et al. 2018a; te Brömmelstroet 2013, 2017; Vonk, Geertman, and Schot 2005, 2007a). The *user approach* investigates actual PSS use based on how user perceptions influence PSS acceptance and usage (Pelzer and Geertman 2014; Russo et al. 2018b; te Brömmelstroet 2017; Vonk 2006; Vonk and Geertman 2008). These three approaches improved our understanding of how technology quality, task compatibilities and user perceptions contribute to PSS use. However, PSS research is yet to explore how *unplanned changes* in new technology, user behaviour, and/or existing practice during PSS implementation, and the sources of these changes, explain PSS outcomes, which appeared to be a productive research about the institutionalization of information systems.

Information systems studies identified a vital characteristic of technology adoption that affects its use and embeddedness– the concept of *drift* (Ciborra 1997). Drift was adopted to investigate unplanned changes in new technology, user behaviour, and/or existing practice and how these influence actual use and embeddedness in organizational practice (Ciborra 2002; Ciborra et al. 2000; Ciborra and Lanzara 1994; Elbanna 2008; Nandhakumar, Rossi, and Talvinen 2003). Ciborra (2002, 85) defined drift as, 'a slight, or sometimes significant, shift of role and function in the actual situation of usage, compared to the planned, pre-defined, and assigned objectives and requirements that the technology is called upon to perform'. Previous ICT studies built on the concept of drift, highlighting the crucial contribution of unplanned changes during ICT implementation, which reveal surprises, deviations, mediations and improvisations that contribute to actual use and embeddedness in organizational practice (Ciborra 1996, 2002; Orlikowski and Hofman 1997). The concept of drift investigates changes in characteristics of technology, user, established process, or organizational structure to explain implementation outcomes. The user's understanding and perception of PSS has never been considered as sources of drift that might explain PSS embeddedness in practice. For example, drift might refer to a change in institutional structure and routines or developing new ones for collaboration and coordination within planning practice. PSS research has neither considered drift in PSS implementation or its technology nor their effect on PSS use or embeddedness. The limited knowledge of the role of drift in PSS outcomes is a research gap. The gap can be explored from different perspectives - technology, user, established process, or organizational structure. In this article, we explored the user perspective to explain how users contribute to changes during PSS implementation and the impact on outcomes. This study assumes that investigating drift will help reveal what contributes to PSS use or embeddedness, drawing on insights from drift in information systems studies. Recognizing the need to investigate the role of drift in PSS implementation as another perspective to enhance adoption, actual use or embeddedness, the following research question was defined: 'How can drift influence PSS implementation and use?'

We employ a qualitative approach and draw on an ongoing PSS implementation in Rwanda of the Spatial Development Framework (SDF) methodology. Our study applies the concept of drift to

explain the effects of unplanned changes on PSS use and embeddedness as identified by the user. It builds on the PSS user approach study that adopts the technology acceptance model (TAM) to investigate the user understanding and perception that shape PSS acceptance (Vonk 2006). In contrast to existing applications of TAM to explain user acceptance in PSS research, this study implements TAM as an explanatory model for the user understanding and perception that initiates drift during PSS implementation. The findings advance knowledge of what shapes PSS implementation that can influence use and embeddedness and that neglecting the role of drift in PSS implementation contributes to the limited use and lack of embeddedness in the spatial planning practice.

The paper is structured as follows. The next sections highlight the role of drift in PSS technology and the case study. The research methodology discusses the basis for the adopted theoretical model (TAM and drift), data collection, processing, and analyses for the study. The results section describes how the user's understanding and perception of PSS usefulness and ease of use in the spatial planning process contribute to identifying drift. The paper concludes with research contributions, limitations, and implications of this research for further studies.

PSS technology and drift

Among the PSS research approaches, only the user approach can integrate components from the other approaches (instrument and transfer) to explain PSS use. User approach studies on PSS implementation and use have adopted the diffusion of innovation and technology acceptance model (TAM) (Vonk 2006; Vonk and Geertman 2008; Vonk, Geertman, and Schot 2005; Vonk, Geertman, and Schot 2007b). Diffusion of innovation explains at what rate, how, and why new ideas and technology are adopted (Rogers 1962); i.e. it explains the acceptance of new technology as a social activity; a compatibility among PSS technology, planning tasks, and users' knowledge.

TAM is a baseline model that utilizes 'external variables' to identify, understand, and predict individual user acceptance based on the attitude and intention to use as well as the actual use of the new technology (Davis 1989; Davis, Bagozzi, and Warshaw 1989); i.e. it explains acceptance at the individual user level, using perceptions of ease of use and usefulness. Perceived ease of use is the extent to which the user anticipates that adopting new technology will be effortless. Perceived usefulness is the extent to which the user believes that adopting the new technology enhances performance (Chen, Li, and Li 2011; Davis, Bagozzi, and Warshaw 1989; Davis and Venkatesh 2000). Davis, Bagozzi, and Warshaw (1989) highlighted how external variables help explain perceived ease of use and usefulness. These external variables include characteristics of technology (development or use), user, task or organizational structure. In PSS research implementing TAM, external variables are components of PSS technology, planning tasks, and users' knowledge. PSS research recognized the influence of users' behaviour on PSS use; however, the drift during PSS implementation that contribute to use, embeddedness or otherwise remain largely undocumented. As mentioned earlier, the concept of drift in ICT implementation explains how unplanned changes in technology, user behaviour and organizational procedures contribute to the outcomes (Ciborra 2002; Elbanna 2008; Holmström and Stalder 2001; Nandhakumar, Rossi, and Talvinen 2003).

Ciborra (2002) investigated how users' behaviour produced drift in ICT technology and organizational practice in seven cases. Drift was characterized by surprises, deviations, compromises and improvisations in technology use or organizational procedures, to enhance actual use and embeddedness. The drift outcomes varied, including the development of new standards for collaboration and coordination, changes in structure and routines, development of new system functions, ad-hoc adjustments to technology, and the emergence of new users within the existing structure. Drift that contributed to limited use was attributed to the lack of a new structure to enhance user collaboration, underutilization of the technology, and lack of knowledge-sharing among users. Ciborra's research confirmed that ignoring the drift that results from user acceptance and decisions hinders the

understanding of how embeddedness happens and can contribute to unexpected outcomes. Holmström and Stalder (2001) find it to be a prerequisite for implementing and embedding technology.

Other studies described drift as a consequence of changes in technology, user behaviour, or the existing installed base during implementation, to enhance actual use and embeddedness in organizational practice (Ciborra 2002; Elbanna 2008; Nandhakumar, Rossi, and Talvinen 2003). Rolland (2000) defined an installed base as established interconnected procedures, structures, processes, or technologies that become evident as a crucial part of implementing and embedding technology in organizational practice. This paper considers drift as a consequence of unplanned changes and a prerequisite to enhance the use and embeddedness of PSS in spatial planning practice.

TAM and drift provide complementary lenses through which we establish the need for research to document changes during PSS implementation and explain the influence on PSS outcomes in two ways. First, TAM utilizes external variables to explain users' perceptions (ease of use and usefulness) of PSS. It helps explain how such perceptions produce changes during PSS implementation. Next, the concept of drift helps recognize consequences of changes during PSS implementation that explain outcomes. Lastly, drift will be recognized as a prerequisite to PSS use and an explanation to outcomes. In this study, TAM explains how user understanding and perception shape intention to use, attitude towards use, and actual use of PSS. Second, it adopts drift to explain how user understanding and perception can initiate unplanned changes during implementation and use.

Research context and methods

Information systems and PSS studies adopted TAM to predict user acceptance (Davis 1989; Davis, Bagozzi, and Warshaw 1989) and to explain user acceptance of technology (Vonk 2006; Vonk and Geertman 2008), respectively. In this paper, TAM helps to highlight what initiates unplanned changes in PSS implementation, and drift explains how unplanned changes influence existing processes or structures required to achieve actual use and embeddedness in the spatial planning practice (Figure 1). This study focuses on the ongoing PSS application in Rwanda - Spatial Development Framework (SDF) methodology. It explores the following research question: 'How can drift influence PSS implementation and use?'

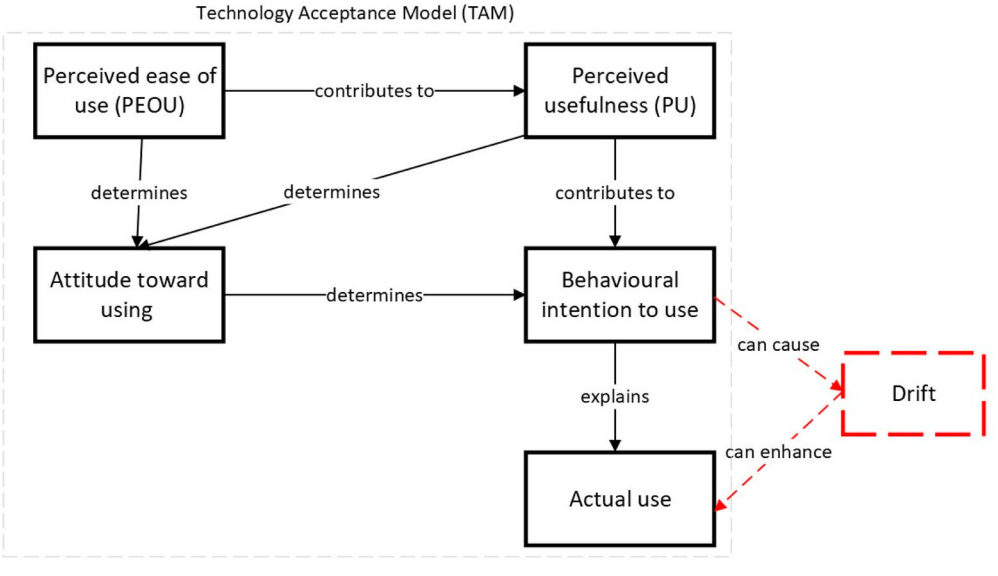

Figure 1. Theoretical research model.

Source: Adapted from Davis, Bagozzi, and Warshaw (1989, Figure 2) and Ciborra (2002, Figure 5.1).

The SDF methodology in Rwanda

The SDF methodology was developed by UN-Habitat and the faculty of Geo-information Science of the University of Twente and first applied in Darfur, Sudan (2011–2013) to identify spatial potentials and implement development policies for regional urban reconstruction. The SDF methodology has been implemented for various planning activities in developing countries (Boerboom et al. 2017; Spaliviero et al. 2019). Between 2015 and 2016, it was first implemented in Rwanda as a planning support system in the spatial translations of a Rwandan national urbanization policy that was not spatialized (Spaliviero et al. 2019). The implementation included training of sixty staff from the national and local levels of the planning process. A second phase took place between 2019 and 2020 to reevaluate the territorial structure three years after. This Rwandan instance of the methodology forms the case study for this paper.

Case study context

The Ministry of Infrastructure (MININFRA) implemented the SDF methodology to integrate spatial components during plan evaluation, execution, and monitoring across settlements and territories. However, the statutory agency in charge of planning governance, budgeting, evaluation, and funding executions for the entire country is the Ministry of Finance and Economic Planning (MINECOFIN). It coordinates this role through the annual Budget Call Circular sent to all ministries, departments and agencies at national and local levels (Republic of Rwanda 2018). In response to the circular, they prepare and submit annual performance contracts for review with new annual budget proposals for evaluation and funding. Therefore, there is a need to understand how the SDF methodology implementation by MININFRA impacts the planning process coordinated by MINECOFIN.

The adoption of the SDF methodology in Rwanda as a case study for this research builds on the identified gap from existing studies - the drift during PSS implementation that explain outcomes. Two studies explored the instrument and transfer approaches to understand PSS implementation and use in the planning process. The instrument approach identified the methodology's capabilities as a PSS for strategic spatial planning in Rwanda (Spaliviero et al. 2019). The transfer approach identified its implementation as a PSS for national policy transfer and translation at the regional and local levels (Mutuku, Boerboom, and Madureira 2019). None of these studies investigated how drift during the PSS implementation impact outcomes.

Since the start of implementation in 2015, the SDF methodology's embeddedness in the planning process has not been scientifically evaluated. Mutuku, Boerboom, and Madureira (2019) mentioned that embedding the methodology in Rwanda is achievable if implemented across all levels of the planning process. The authors conclude that individual perceptions of its usefulness could influence embeddedness (Mutuku, Boerboom, and Madureira 2019). Therefore, in this study, we examine the SDF methodology of Rwanda as a case study to investigate the PSS user approach and establish how it influences its implementation for use and embeddedness using the concept of drift. This case study helps find a) how user perceptions (ease of use and usefulness) affect individual attitudes or behaviours towards using PSS; and b) why the attitude or behaviour towards PSS use initiates drift in the implementation, institutional structures, and installed base (Figure 1). The findings from (a) and (b) help establish the contributions of drift to PSS implementation, use and embeddedness.

Data collection and selection of respondents

Our theoretical model identifies the drift in the SDF methodology's implementation that contributes to actual use and embeddedness. TAM utilizes external variables to explain users' perceptions (ease of use and usefulness) of PSS and how such perceptions produce drift during PSS implementation. Therefore, data collection focuses on identifying the role of users in the drift during the SDF

methodology's implementation that helps explain outcomes. We utilized the qualitative approaches for both primary and secondary data.

Primary data collection methods included a) semi-structured interviews with two groups of respondents, three early adopters (SDF users at the regional planning level) and one trained potential user from each of the five provinces (local planning process); b) field notes from participatory observation, carried out during a two-day training workshop for ten potential users, and c) non-participatory observation reports on the methodology's application in MININFRA, collected during ten weeks of fieldwork in 2020. The selection of the eight respondents considered an adequate spatial representation of trained users according to predefined criteria. At regional level, three respondents are early adopters involved in the SDF methodology's use in MININFRA. The selection of the five respondents from thirty trained potential users at the district levels followed a purposeful sampling method to select a small group that represents the thirty trained potential users from the district level planning process.

There are three criteria considered during the purposeful sampling of trained potential users. First, one respondent from each of the five provinces in Rwanda. Second, the selected respondent must be a GIS specialist or an urban planner. Lastly, the selected respondent must be working with the district planning process at a designated secondary city or an economic potential corridor. When a selected respondent from a province declined an interview, the snowballing method was adopted to accommodate referrals or contact another trained user within the same province using the predefined selection criteria. The interview process was reiterative over the ten-weeks fieldwork with an average number of contacts with each respondent were between four to seven times. The contacts vary among respondents depending on preferred location (office, hang-outs, email correspondences, and phone calls) and time (during working hours, lunch break, after working hours).

Secondary data collection included data from public websites, reports, documents, plans, and policies to review planning processes and the SDF outcomes in Rwanda (see Supplementary Material 1). Secondary data helped to configure the installed base for the Rwanda planning process and define the outcomes of initial SDF implementation. Also, it helped validate respondents' data on the drift required to enhance implementation and actual use in the spatial planning practice.

TAM was adopted to support the development of a) the interview guide for primary data collection and b) themes and codes for data processing and analyses. Drift guided the data analysis and interpretation. The semi-structured interviews allowed respondents to express themselves without bias, reflecting on open-ended questions. Both groups were interviewed using the same guide to ensure correlation, relatedness, and data triangulation during analysis. However, follow-up questions were independent of the interview guide. They varied across respondents, allowing them to elaborate on their individual ideas and perceptions. The signed informed consent forms highlighted respondents' preferences and availability for follow-up discussions. For a detailed overview of the primary data collection process (sources, purpose of data and results) see Supplementary Material 2.

Data processing and analysis

Primary data was analysed on how user understanding and perception of the ease of use and the usefulness of PSS in the planning process influence recommendations for drift in the SDF methodology's implementation. Primary data were transcribed using the Transcribe software, while data processing was completed with the help of computer-assisted qualitative data analysis software ATLAS.ti, based on developed themes and codes (see Supplementary Material 3). Themes for data analysis and interpretation were derived using deductive coding, which utilizes phrases from the theoretical research model, and codes were generated using the inductive coding method. This approach allowed finding the association between codes from different themes to establish relationships and create networks of codes for data interpretation.

Influence of drift on PSS implementation

This section reports on the findings regarding the research question ('How can drift influence PSS implementation and use in practice?') following the theoretical research model (Figure 1). Quotes from the interviews are presented as excerpts within paragraphs or tables to support the study's findings. User understanding was based on the acquired knowledge during training (five potential user respondents) or the use (three early adopter respondents) of the SDF methodology. External variables considered for respondents' perception of ease of use and usefulness of the SDF methodology are a) individual knowledge of geoinformation systems and tools, b) the availability of geoinformation systems and tools for use, and c) access to geoinformation systems and tools training. Hence, this is an expert-driven PSS rather than a PSS for non-technical experts.

Irrespective of the respondents' knowledge of geoinformation systems and tools, their understanding was shaped by received training on the SDF methodology's implementation framework and use for decision-making at the local and regional level planning process. Findings from the respondents' perceptions (ease of use and usefulness) influenced their attitude and behavioural intention to use the SDF methodology in the planning process. Follow-up discussions with individual respondents on the signs of embeddedness of the SDF methodology in the planning process at the regional and local levels resulted in two types of responses: first, challenges with the ongoing implementation framework for the SDF methodology, and second, suggestions about what should be done differently for the SDF methodology to become a part of the planning process. Then, the concept of drift helps identify changes that are consequences of the planning process or a prerequisite to embedding the SDF methodology in the country's planning process.

Variation in the perceived ease of use of SDF

The findings reveal variation in the respondents' perceived ease of use, dependent on the respondents' knowledge and capabilities to use geoinformation systems and tools. On the one hand, trained potential users with little or no knowledge of geoinformation systems and tools found the methodology challenging to learn and understand: 'The SDF is difficult to understand. Adoption for use might be a bit challenging (trained interviewee 4).' On the other hand, early adopters and trained potential users with adequate knowledge of geoinformation systems and tools perceived it as easy to learn and use: 'If staff are adequately trained, use of the SDF methods will be effortless (trained interviewee 3).' All respondents suggested that staff training in geoinformation systems and tools would improve job performance in the existing planning process and change the perceived ease of use.

User understanding and perceived usefulness of SDF

The respondents' overall understanding and perception acknowledged the methodology as an essential PSS for decision-making in the spatial planning process, which can embed spatial perspectives in non-spatial urbanization policy objectives for the country (Table 1). All respondents made references to the achievements of SDF implementation for the National Urbanization Policy

Table 1. Respondents' understanding and perception of the SDF methodology.

Respondent group	Understanding and perception
Early adopters	'SDF has introduced spatial components to land use planning and have identified the unbalanced distribution of Functions across districts (interviewee 6).'
Trained potential users	'SDF can integrate spatial components into policy implementation. Then it makes your work easier and faster (interviewee 1).'
	'SDF will help in the decision-making process for projects prioritisation during selection and implementation (interviewee 4).'
	'SDF makes decision-making for policy development and implementation easier (interviewee 3).'

(NUP): identifying planning gaps, enhancing collaboration in the planning process, providing spatial classifications of settlements into four hierarchies, producing spatial plans from non-spatial policies and developing strategic action plans.

Also, respondents recognized the benefits of the methodology for the planning process: improving job performance, enhancing collaboration and reducing duplication of infrastructure at the local level, achieving spatial implementation of non-spatial policies, enhancing plan evaluation for approval, implementation and monitoring.

Attitude and the behavioural intention to use SDF

Due to the SDF methodology's achievements, the early adopters have an optimistic attitude towards applying it to the planning process. Their favourable view matches the trained potential users' enthusiasm to use it in the planning process at the local level. All respondents agreed that the methodology would contribute to the spatial implementation and evaluation of non-spatial national policies at the local level and help achieve the Vision 2050 objectives for the country. The early adopters' attitude towards using the methodology determines the behavioural intention to use. The attitude and behavioural intention to use SDF according to the perceived ease of use or usefulness contributes to its actual use in the planning process. Even though, behavioural intentions among the trained potential users does not automatically ensure actual use, it still signals the potential of actual use in the planning process (Table 2).

Required drift in the implementation of SDF

Respondents' acknowledged the SDF methodology's usefulness as a PSS for improving the planning process. However, they highlighted that enhancing SDF implementation in the planning process and the local level might not be possible within the ongoing implementation coordinated by MININFRA (Table 3). The reason being that the planning process is a bottom-up approach in which local levels submit planning proposals to national level agencies for approval and funding. The SDF methodology's use is only done within MININFRA to provide recommendations to MINECOFIN on priority areas for physical and economic developments at the local levels. All respondents suggested that the actual use of SDF at national and local levels of the planning process must involve MINECOFIN, due to its role in funding, evaluating, and monitoring the planning process. MINECOFIN's adoption of the SDF methodology as part of the planning and budgeting process, is a required drift to embed the SDF methodology in the Rwandan planning process. The need to engage all ministries, departments, and agencies at the national level was also highlighted by respondents (Table 3). Without MINECOFIN adopting the SDF methodology as part of the planning and budgeting process, the SDF cannot be integrated into the planning process, especially at the local levels.

Trained potential users at the local level identified the Ministry of Local Governments (MINALOC) as another national agency that should implement the SDF methodology to ascertain actual

Table 2. Behavioural intention to use the SDF methodology by trained potential users.

Behavioural intention to use	Attitude
Highlight potentials of actual use	'Yeah, it is the best tool..implementation right now will be helpful to avoid the duplication of spatial functions across the region … if we can use it this year to start the planning for 2020–2021, it will be helpful (interviewee 1).'
	'If staff are adequately trained, use of SDF will be effortless (interviewee 3).'
	'SDF will contribute to the efficiency of my roles at the district if implemented (interviewee 3).'
	'SDF will make planning, monitoring and implementation easier. In terms of infrastructure development, it enhances identification, prioritisation and selection for implementation. Collaboration with regions for planning and implementation will be improved (interviewee 4).'
Cannot ascertain actual use	'SDF is difficult to understand, adoption for use might be a bit challenging (interviewee 4).'

Table 3. Drift in SDF implementation.

Respondent group	Highlighted drift in SDF implementation
Early adopters	'MININFRA has to work officially with the ministry in charge of finance and planning, MINECOFIN. Of course, I can plan good things, but when you have the money, you are the boss. How SDF can be embedded in the land use process at the national level starts from MINECOFIN. Then at the district, it goes through MINALOC (interviewee 6).'
	'There is a need to have SDF approved by the government so that institutions adopt it, and their results are integrated into the planning (interviewee 7).'
Trained potential users	'Adoption of the SDF has to start at the central levels, especially from ministries, departments and agencies in charge of district level coordination (e.g. MINALOC, MINECOFIN, LODA). … Although MININFRA is the facilitating agency for SDF adoption in land use planning, MINECOFIN should be the lead agency for adoption based on the performance contract evaluation, and approval for districts is their responsibility (interviewee 3).'
	'SDF development, adoption and implementation are dynamic and ongoing processes and need to involve all central agencies, which will encourage adoption at the district level. It is important based on the top-down nature of the land use process. Lack of implementation policy for SDF across the national and district levels is the major limitation to adoption (interviewee 5).'

use in the local planning process. MINALOC oversees coordination, monitoring, and evaluation of local level planning processes. It also supervises and allocates funds for local planning through the Local Administrative Entities Development Agency (LODA). However, neither MINALOC nor LODA can adopt the SDF methodology in their annual planning and budgeting process without a statutory directive from MINECOFIN via the 'Budget Call Circular'.

Discussion

The findings on the role of drift in implementing the SDF methodology corroborate the challenges resulting from the mismatch between PSS demand and supply (Vonk and Geertman 2008). In Rwanda, there was demand to develop SDF as a PSS for strategic spatial planning, with an allotted budget in the National Urbanization Policy document (Ministry of Infrastructure 2015). The demand resulted in its development and implementation for the spatial translation of non-spatial policies (Boerboom et al. 2017). Its continuous application by MININFRA since 2015 verifies its usefulness. As of early 2020, when the data were collected, SDF was still not embedded in the planning process at the national and local levels. If the continuous use of SDF since 2015 has not resulted in embedding it in the planning process, there is a need to investigate and provide knowledge on how to embed the methodology in the planning process.

In theory, the role of user understanding and perception (ease of use and usefulness) of PSS contributes to acceptance and actual use in spatial planning practice (Vonk and Geertman 2008). Still, findings reveal that integrating SDF in the planning process requires drift in the ongoing implementation. If this remains unresolved, it will result in two issues. First, its acceptance and actual use as a PSS in the planning process will be reduced. Second, the limited knowledge of the methodology's embeddedness in the planning process will persist.

This research identifies a gap in the three categories of approaches to studying what contributes to PSS use (Geertman and Stillwell 2009). In the Rwanda context, the methodology's capabilities and implementation as a PSS for planning processes are known (Spaliviero et al. 2019) (Mutuku, Boerboom, and Madureira 2019) (Oyeku, 2020). The authors conclude that embedding the methodology in the planning process is achievable. Findings from this research help explain how user understanding and perception of SDF influence use and embeddedness in the planning process (Table 3). It identifies a research gap – drift in PSS implementation that influences use and embeddedness.

Other findings validate earlier recommendations that documenting lessons learned from PSS implementation can contribute to achieving embeddedness (Vonk and Geertman 2008). The study revealed three important lessons. First, a high level of understanding of the methodology's capabilities and benefits in the planning process enhances user acceptance (Table 1). Second, the knowledge about achievements from prior SDF implementation in Rwanda helps respondents

identify the potential of its use and embeddedness in the planning process (Table 2). It explains the optimistic attitude and behavioural inclination towards use and contributes to the perceptions shaping the drift required to embed it in the planning process (Table 3). Third, user training and awareness raising will increase understanding and perception of the methodology's capabilities and benefits to the envisioned spatial planning process as well as enhance the potential of actual use or embeddedness (Table 2). The documented lessons will help users understand how to better embed SDF in the planning process at national and local levels.

This study cannot predict the application of the methodology at local level planning processes and related outcomes. Therefore, there is a need for further research on how the concept of drift contributes to PSS use and embeddedness from the instrument and transfer approaches. Moreover, drift is one of the many processes influencing the use and embeddedness of PSS in planning. There is a need for continuous research to ascertain whether the three categories of instrument, transfer and user approaches to studying PSS use and embeddedness are sufficient. Hence, further research should answer a vital question: Is there a need for a fourth category of institutional approach to studying PSS to better explain embeddedness and institutionalization?

Finally, this is a small scale and short study of 10 weeks, which was done at the end of a period of 5 years of implementation. It shows the principle of enriching TAM with drift. To draw full blown conclusions regarding how drift that took place and that is needed, one would need a more extensive interaction with a larger number of interviewees in different agencies. Processes of drift usually show after a long time and not take place over a short period of 10 weeks during which the study was done. Therefore, the documented drift in this article was a reconstruction of respondents' experience and documents reviews. Although local governments staff were trained as potential users of the SDF methodology, 5 years after, its use remained at the Ministry of Infrastructure at the national government level. Hence, the lens of drift offered very useful insights in understanding why the SDF methodology is yet to become part of the planning process at levels of government. To gain comprehensive insights on embedding and institutionalizing spatial methodologies and technologies such as the SDF methodology in the planning process, a longitudinal study is required to strategize around the phenomena of drift in the institutionalization of PSS.

Recommendations

Information systems studies on drift emphasize that individuals constitute the processes that create drift required to embed ICT implementation (Ciborra 2002; Elbanna 2008; Nandhakumar, Rossi, and Talvinen 2003). Our results show how individuals constitute the processes that create drift required to embed PSS in planning practice. Their knowledge of the planning process initiates drift – local levels coordination by MINECOFIN is done by MINALOC through LODA and SDF implementation is by MININFRA. Hence, to achieve continuous use and embed SDF in planning processes at all levels drift is required in the existing implementation structure. The respondents recommended the following actions:

1) **Implementation policy:** to enrol all ministries, departments, and agencies at the national level, there is a need for an implementation policy approved by the government. This drift is essential to embed SDF in the planning process because the institutional framework for land use planning approval, implementation, monitoring and evaluation in Rwanda is top-down (Ministry of Natural Resources 2017; Oyeku 2020). An official implementation policy at the national level will help integrate the methodology into the existing planning process at all levels of government. It will allow the national level to incorporate the spatial perspective in the non-spatial planning policies and processes for implementation, monitoring and evaluation. Also, it will enhance the continuous use and embeddedness in the planning process. Therefore, the implementation of the methodology at the local level must begin at MINECOFIN to achieve actual use and embeddedness.

2) **A statutory directive in the Budget Call Circular:** even though the planning process in Rwanda is top-down, decentralization policy makes it possible to develop annual plans at the local level (Commonwealth Local Government Forum 2018; Republic of Rwanda 2018). Therefore, the Budget Call Circular from MINECOFIN must include a statutory directive mandating local authorities to implement SDF for developing annual plans.

The recommendations of required drift corroborate earlier beliefs on factors that can influence the limited use of PSS in the planning practice (Geertman 2006). The three vital national agencies in charge of the local planning process (MINECOFIN, MINALOC, and LODA) need to incorporate the methodology in their procedures and practices to ensure its embeddedness in the planning process validates these factors (ibid.) (Figure 1). It is assumed that such drift will enhance the use of the SDF methodology to improve communication, collaboration, and stakeholder participation across all levels of government.

Figure 2 presents an overview of how the recommendations will enhance the use and embeddedness of SDF methodology in spatial planning practice across all government levels.

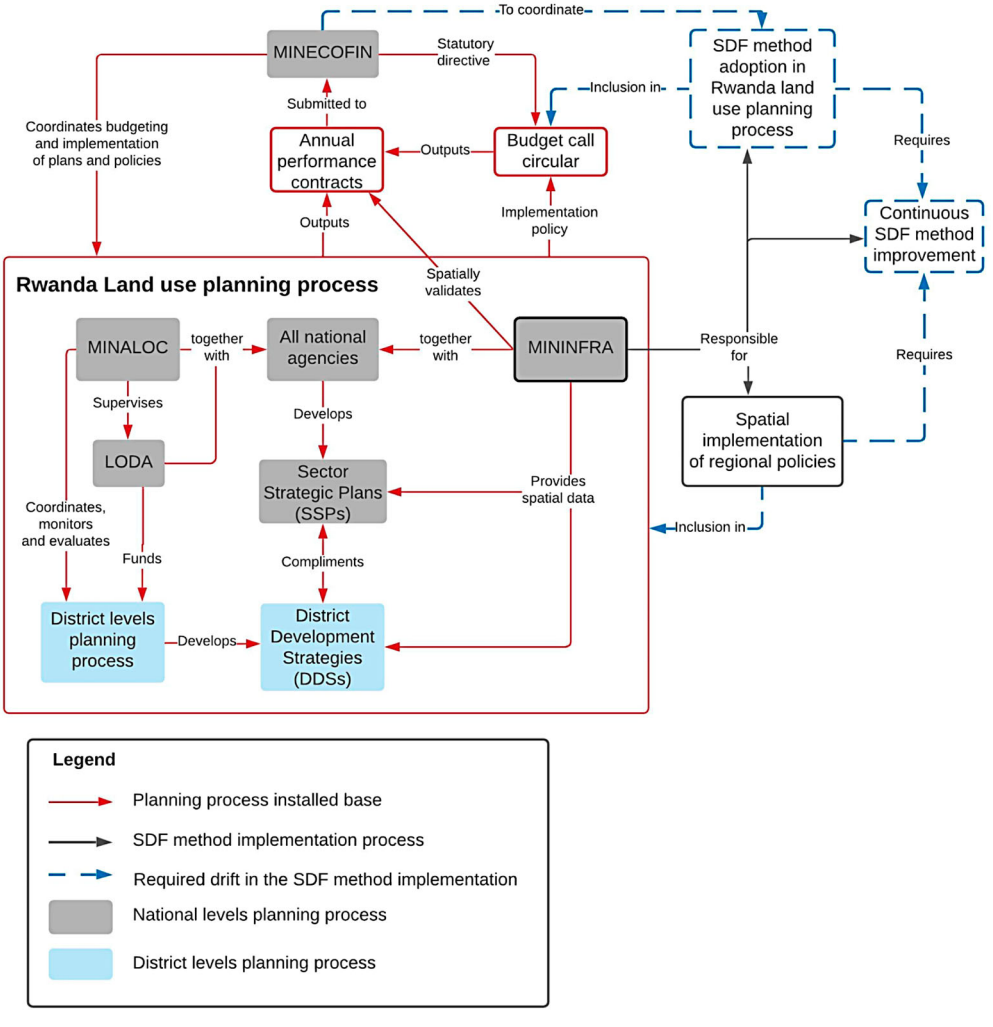

Figure 2. Required drift in the SDF methodology implementation.

Another recommendation by an early adopter is a continuous redevelopment of SDF to meet planning tasks, to ensure continuous use. The continuous redevelopment will contribute to adapting SDF for planning tasks, policy objectives and user characteristics in the planning process. Such redevelopments will require continuous capacity building for potential SDF developers and users at the levels of the planning process. It will, in turn, contribute to embedding the SDF methodology as a PSS in the spatial planning practice at all levels of government. Thus, drift pertains both to the institutions in which the PSS is to operate and to the PSS technology itself.

Conclusion

This paper addressed the following research question: 'How can drift influence PSS implementation and use?' This study provides insight into how drift during PSS implementation contribute to what happens. The findings show that depending on the user's understanding and perception, ascertaining the actual use and embeddedness of PSS could require drift in implementation and/or the institutional planning processes. Also, it complements information systems studies that described drift as a prerequisite to embed new technology or a consequence of changes during implementation, to enhance actual use and embeddedness in organizational practice. The results show that drift happens during PSS implementation. Therefore, investigating and documenting drift in PSS research would help enhance implementation, actual use and embeddedness in the spatial planning practice.

Findings from Rwanda's SDF methodology implementation illustrate how accomplishments in PSS use could contribute to ignoring the gap in research – drift during PSS implementation.

This study has raised awareness of a gap in PSS research. Rwanda's SDF methodology case study illustrates how accomplishments of PSS implementation could mask the gap in research – drift during implementation. In an inventory of recent research on PSS implementations and achievements (Geertman and Stillwell 2020a; Pelzer 2017; Pelzer, Geertman, and van der Heijden 2016; Pettit et al. 2018; Russo et al. 2018a; Russo et al. 2018b), none of the identified causes of limited use of PSS considered lack of drift during implementation as a possible cause of limited use. Therefore, this study reiterates that if drift during implementation remains omitted, its contributions will remain unknown and the limited use or lack of embeddedness of PSS will persist.

The contributions of this study stems from the adopted theoretical model. First, it illustrates how the consideration of external variables in TAM helps explain the user perceptions (ease of use and usefulness) of PSS and how such perceptions produce changes during PSS implementation. Second, it presents how the concept of drift, if considered in PSS research, helps gain better insights into how changes during PSS implementation explain outcomes. Therefore, we propose that a) identifying the drift in the PSS implementation is another perspective that will explain the causes of limited use, and b) implementing such drift will help enhance embedding PSS. Thus, the role of drift in PSS implementation and embeddedness in the spatial planning process cannot be overemphasized. Especially within the context of expanding the three categories of instrument, transfer and user approaches to studying PSS with a fourth one (institutional) to help achieve embeddedness and institutionalization.

We assume that exploring the theoretical model proposed here can contribute to a) identifying how to improve PSS implementation and enhance actual use in the planning process, and b) providing details on how to embed PSS as an institutionalized part of spatial planning practice across the globe.

The study has several limitations, grounded in the limited generalization of the findings. First, the research only considers the causes of drift by user acceptance of PSS, excluding the broader context of how interactions among users, PSS technology, and organizational complexities cause drift. Hence, it is vital to note that research must adopt a broader context to comprehensively understand the influence of drift on PSS implementation and embeddedness.

The second limitation concerns the constraints of the adopted theoretical lenses, TAM and the concept of drift. On the one hand, TAM can only explain user acceptance based on individual

understanding and perceptions; it cannot identify or evaluate reasons behind user acceptance or otherwise. This study's findings could neither predict the actual use nor the consequences of ignoring the recommended drift because of the lack of knowledge on why respondents accept the SDF methodology as a PSS. This was not done because TAM cannot explain reasons behind respondents' acceptance of the methodology.

On the other hand, drift considers more than individual user acceptance to explain reasons for institutional changes during ICT implementation that enhances actual use and embeddedness (Ciborra 2002; Ciborra et al. 2000; Elbanna 2008; Holmström and Stalder 2001), for example, to investigate actors' interactions and identify the underlying reasons for the outcomes (van Baalen and van Fenema 2005).

This paper only adopted drift to explain sources of unplanned changes in the implementation of SDF methodology in Rwanda. Therefore, we anticipate that the required drift in Rwanda's SDF methodology implementation is more than what was highlighted in Figure 2. Hence, we recommend further research to trace, identify, understand, and document details of actors, interactions and institutional change contributing to the implementation, actual use, embeddedness, and institutionalization. Such studies will provide additional insights to compare and analyse various case studies to establish 'how' embedding or institutionalizing PSS happens across different spatial planning systems and its contributions to PSS research.

It is essential to mention that this paper is not a comprehensive representation of various PSS uses or users. Therefore, our findings are strictly within the case study of SDF methodology as a PSS in the Rwandan planning process. However, since the case study illustrates a top-down implementation structure, we assume this research can be replicated to investigate PSS implementation in top-down planning processes common to developing African countries. We recommend that future studies replicate our theoretical model to help verify two research assumptions. First, investigating the role of drift in PSS implementation will help understand what contributes to PSS use or embeddedness. Second, exploring the adopted theoretical models contributes to a) identifying how to improve PSS implementation and enhance actual use in the planning process, and b) providing details on how to embed PSS as an institutionalized part of spatial planning practice across the globe. Such studies will help verify whether these findings also hold for other top-down planning processes or may expose additional limitations of the theoretical model.

Notes

All transcriptions were completed using the Transcribe (https://transcribe.wreally.com/) software, while ATLAS.ti (https://atlasti.com/) was used for data coding and analysis.

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Author contributions

This published manuscript was read and agreed to by all authors: Debbie Oyeku (D.O.), Luc Boerboom (L.B.), Ana Mafalda Madureira (M.M.), and Karin Pfeffer (K.P.). Their specific contributions are outlined as follows:

- Conceptualization: D.O., L.B., and M.M.
- Methodology: D.O.
- Data collection, processing, and analysis: D.O.

- Validation: D.O., L.B., and M.M.
- Writing (original draft): D.O.
- Writing (review and editing): D.O., L.B., M.M., and K.P.
- Supervision, L.B., M.M., and K.P.

Data access statement

Research data are not publicly available due to ethical restrictions and the privacy of research participants. However, data supporting the findings are available upon reasonable request from the corresponding author (D.O.).

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No potential conflict of interest was reported by the author(s).

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