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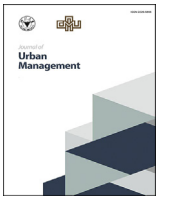

Research Article

Digitalizing planning culture: A change towards information model-based planning in Finland

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ABSTRACT

While digitalization is expected to bring benefits in the area of land use planning, it is also redefining planning practices and entire planning cultures. Limited research exists on this digital transformation, and this article aims to narrow this gap through an empirical case study. In Finland, there is an ongoing transition towards information model (IM)-based planning, driven by public government development programs. Its principal focus is to achieve national-level interoperability of plan data. A harmonized IM for local master and detailed plans has recently been developed for use in municipal urban planning in the future. In addition, a national information system (IS) for built environment data is currently being developed. In this article, the perspectives of Finnish urban planners towards the national IM and IM-based planning were examined through a questionnaire. The results indicate that IM-based planning has a strong impact not only on planning outcomes (i.e., land use plans) but also on the planning context (e.g., planning practices and the planners themselves, software and information systems (ISs), and planning law). We argue that the high expectations set for IM-based planning will not be met without paying attention to the viewpoints of planners, planning practices, and the changes to planning culture in a wider sense. In addition to the technological aspects, the focus should also be on the social and contextual elements of planning.

1. Introduction

Digitalization is expected to offer benefits in terms of land use planning and to contribute to sustainability by enabling more comprehensive and accurate impact assessments of plans. In Finland, the migration to information model (IM)-based planning is being driven at the national level through development programs and legislation. In 2020, an interoperable (i.e., based on shared, machine-readable structure, syntax, and semantics) national-level IM for local master and detailed plans (i.e., municipal-level land use plans) was developed. Various stakeholders were engaged in the development process, and feedback was gathered via a public web questionnaire. In this article, planners' perspectives towards the national plan IM and IM-based planning are examined through this questionnaire.

The digitalization of urban planning has been ongoing for decades. The first wave began in the 1990s with the spread of CAD and GIS systems and the digitization of planning data (Batty, 2021; Hersperger et al., 2021). In the recent developments in Finland, the aim has not been solely to define a machine-readable specification for plans, but to ensure that it is interoperable and structurally harmonized at

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a national level. Technical interoperability of spatial data, including plans, is specified in the INSPIRE directive (INSPIRE, 2007), while a more holistic view of interoperability (including semantics) is specified within the European Interoperability Framework (EIF) (European Commission, 2017). In general, the current situation is that harmonization of plan data is needed at both national and international levels (Fertner et al., 2019). Harmonization always requires a well-defined vocabulary (ontology) to allow shared semantic agreement to be achieved and maintained on the information being exchanged between information systems (ISs), individuals, and organizations.

Traditionally, plans have been produced with a visual representation of the map in mind and regulations in the form of descriptive texts and numerical values. The plan provisions may be long verbal descriptions that are open to interpretation. The need to produce plans in accordance with the new national IM not only requires the implementation of new capabilities into existing software or entirely new software (ESPON DIGIPLAN, 2021b) but also applies adaptation pressure on planning practices and plan-making (Hersperger et al., 2021).

It can be argued that this digital transformation is so significant that it is necessary to describe it as a comprehensive cultural change in urban planning organizations (Anttiroiko, 2012; Potts, 2020; Silva, 2010) and planning support systems (Geertman & Stillwell, 2020). Factors associated with the prevailing planning cultures have been considered to slow down or hinder the introduction of new technological innovations such as digital participation tools (Brown, 2015; Kahila-Tani, 2015; Nummi, 2020), and planners may have skeptical attitudes toward novel digital tools (Geertman & Stillwell, 2020). Contextual factors such as the dominant planning style, policy models, the characteristics of planning processes, and the political context have also been identified as dimensions affecting the development of planning support systems (PSSs) (Geertman & Stillwell, 2020). From the point of view of practice, this can be seen as a need to redefine planning and review planning practices in order to take full advantage of the digital transformation (Hersperger & Fertner, 2021).

Recent research on IM-based planning has focused on digital plan data, the distribution of these data (Fertner et al., 2019) and the impacts of digitizing plan data on planning practice (Hersperger et al., 2021). One topical academic discussion focuses on the relationship between digital communicative approaches to planning and statutory planning (zoning) (Geertman & Stillwell, 2020; Hersperger & Fertner, 2021). Furthermore, Pelzer et al. (2015) point out that the communicative and participatory nature of planning should be emphasized when developing new digital tools to support planning. Thus, attention needs to be paid not only to technical solutions but also to the interactions between the actors, the characteristics of knowledge in this area, and their role in planning.

In the area of digitalization of planning, there is a clear gap between practice and research. It has also been argued that the role of information and communication technology (ICT) has been ignored in theoretical studies in the field of planning (Potts, 2020). Hersperger et al. (2021) argue that reflective research is needed to analyze the impact of IM-based planning and to avoid the technocratic development of land use planning. Furthermore, Hersperger and Fertner (2021) argue that we should not overlook the formal planning process and regulative activities in this digital transformation.

A strong argument in favor of performing localized studies of digital planning is that the IMs utilized in digital planning are tailor-made for a specific context in terms of legal frameworks, culture, planning processes, and local planning conditions. It has been argued that the added value of digitalization in urban management is context-specific, meaning that attention should be paid to the characteristics of the users and the issues and questions at hand (Jiang et al., 2021). One particular limitation of the most recent research is that it has not explored planners' experiences of the transition to IM-based planning.

This article aims to fill this research gap in two ways: firstly by exploring the experiences of planners in regard to IM-based planning, and secondly by analyzing the results in relation to the different aspects of planning culture and suggesting how the concept of planning culture should be interpreted in order to support a holistic assessment of the digital transformation. In this article, we apply the concept of planning culture (Othengrafen, 2010, 2012, 2014) as a framework to analyze the impact of IM-based planning from a user-centered perspective.

1.1. Drivers of the digitalization of urban planning

The efficiency and transparency of planning and the drive for innovation are the primary objectives in the digitalization of spatial planning (Hersperger et al., 2021). Efficiency is particularly enhanced by easy access to and smooth transfer of plan data between systems. Transparency is a key factor in building trust, and is associated with open government, better access to information, and better opportunities for public participation (ESPON DIGIPLAN, 2021b; Hersperger et al., 2021). The distribution of digital plan data has been promoted to ensure transparency and usefulness to public and private actors (Fertner et al., 2019).

Hersperger et al. (2021) argue that while digitizing plan data has been proven to enhance the efficiency and transparency of planning, its full benefits are expected to be realized only in the future. Opportunities for innovative solutions have been identified, especially in communicative planning (Hersperger et al., 2021), and in the area of planning support science (PSS), the added value is seen to come from digital PSS tools that support collaboration and can help achieve a more sustainable future (Geertman & Stillwell, 2020). Furthermore, the added value of digitalization depends on how well the functionalities of the tools can help to solve cities' planning problems (Jiang et al., 2021).

Innovation refers not only to novel digital methods and tools for urban planning and design (Boland et al., 2022), but also to the creation of new services for citizens, such as digital participation tools (Hersperger et al., 2021). Furthermore, digitalization promotes the development and automation of smart cities (ESPON DIGIPLAN, 2021b); for example, machine-aided processing of building permits (ESPON DIGIPLAN, 2021a) can strengthen knowledge-informed planning and decision-making by enabling data analytics and traceable decisions (Hersperger et al., 2021). Functionalities that can support analysis, modeling, and visualization in interactive planning processes have been reported to add value, particularly in regard to mobility problems (Jiang et al., 2021).

In Finland, the value of interoperable plan data for creating a health-promoting, well-functioning, and energy-efficient living environment is highlighted in the information distributed by the Ministry of the Environment (2022d). Similarly to the wider European context (ESPON DIGIPLAN, 2021b), easy access to data and its impact on efficiency is emphasized. It is argued that these data will support decision-making and the development of better public services, and will promote business activities (Ministry of the Environment, 2020). It is noteworthy that the roles of citizens, openness, and democracy are not emphasized very strongly as objectives for this transformation. Citizen actors are referred to mainly as data users in the role of inhabitants, and data producers as owners and users of buildings (Ministry of the Environment, 2022e). This reflects an administration-centered approach with a focus on efficient administration and public services. The limited emphasis on the need for improved transparency may reflect the citizens' trust in the authorities in Finland, which is among the highest in the world (OECD, 2021).

1.2. Digital plan data and information model-based planning

In general, plan data includes regulations for land use, and is produced by spatial planning authorities (Hersperger et al., 2021). The concept of digital plan data is not precisely defined, and almost any collection of data with any level of structuring in any format qualifies as 'digital plan data'. When defined more strictly, digital plan data consist only of geodata in geographic information systems (such as georeferenced raster or vector data, or machine-readable IM-based plan data) (ESPON DIGIPLAN, 2021b).

Depending on its structure, a plan IM specifies a more or less strict vocabulary that defines the expressivity (specificity and limits) of a plan. The Finnish plan IM defines the terms and definitions of the elements of the plan, the relations between these elements, and all the attributes associated with the elements. It also includes a set of code lists that must be used in IM-based plans. These include, for example, code lists for the various types of plan (i.e., different types of local master and detailed plans) and types of plan regulation (e.g., functional use of the area, placement of buildings, the maximum permitted gross floor area) (Ministry of the Environment, 2021). All the definitions (i.e., of the plan IM, code lists, and vocabularies) are published and maintained via the Finnish Interoperability Platform by the government authorities (Digital and Population Data Services Agency, 2022a).

In this article, digital plan data are considered narrowly as the implementation of the national plan IM (Ministry of the Environment, 2022c). The focus of this paper is on statutory planning and formal plan data in the area of Finnish municipal planning (i.e., local master and detailed plans).

1.3. Digitalizing the planning system in Finland

In many European countries, plan data are available in digital format and are nationally accessible, but are not necessarily in an interoperable IM format (ESPON DIGIPLAN, 2021b; Hersperger et al., 2021). Nordic countries are at the forefront of this development. For example, in Denmark, an open database of legal plans (plandata.dk) has been available since 2006, and in Norway, the sharing of digital plan data via the plan register has been mandatory since 2012. In both countries, the countrywide register includes standardized plan data in the form of geodata, including spatial outlines of the plans that are linked to legally binding plan documents. The Danish database also includes detailed zoning data for municipal plans (e.g., block areas with building regulations and intended usage) (Fertner et al., 2019). In Finland, a national information service containing all of the Finnish municipal plans is not yet available, and many municipalities instead publish plan data on their own internet map services. Although there is a system for the open publication of geodata (Paikkatietoikkuna, https://kartta.paikkatietoikkuna.fi/), the use of this system has not been mandatory, and only some of the municipalities currently publish their plan data there.

Finnish municipalities have autonomy and a planning monopoly, which has also resulted in individual solutions to the digitization of plan data. Thus, the availability of the plan data varies, and the structure of the information is not uniform. Finland is now taking the 'digital leap' and is solving these challenges by moving to nationally standardized (interoperable and IM-based) plan data and data distribution. A centralized national IS for built environment data (called RYTJ) is being developed and built (Finnish Environment, 2022) to enable the management and distribution of digital plan and building data. In the European context, no other examples of national ISs with machine-readable plan data existed in 2021 (ESPON DIGIPLAN, 2021b).

In Finland, the transformation towards IM-based planning has been boosted by national development projects, legislation, and funding (Ministry of the Environment, 2020). In the area of legislative reform, IM-based planning has been referred to as a new tool for planners (Ministry of the Environment, 2022a), while the social and cultural implications of this reform for planning practices have not been addressed. Instead, the justification for the law emphasizes the economic value and improvements in the efficiency of planning (Ministry of the Environment, 2022b).

Strong emphasis has been placed on the semantic interoperability of plan contents. During 2020, a nationally interoperable (i.e., based on shared, machine-readable semantics) IM for master and detailed plans was developed in Finland. This IM consists of a conceptual data model, harmonized code lists (e.g., zoning regulations), and a formal information exchange model, all of which are based on the concepts and their relations specified in the conceptual data model (Ministry of the Environment, 2022c).

The objectives for developing the plan IM were to prepare common national definitions for the central concepts of the planning process and planning information, and to create physical data models to ensure technical interoperability between systems. When designing the IM, no stand was taken on the presentation of the information, and a conscious effort was made to abandon the idea that there is one correct way of presenting plan data. Instead, the focus was on expressing the substance of the plan, based on the idea that the content of the plan consists of structured information, following the logical IM (Ministry of the Environment, 2022c).

In practice, applying the plan IM means a change towards IM-based planning in which the structure of the plan data is predefined and the contents of plans (plan objects and regulations) are primarily expressed by means of harmonized and uniform codes

(Fig. 1). This is different from current practices, in which urban plans are developed as visual maps rather than as structured and machine-readable data.

1.4. Cooperation on semantic interoperability in Finland

Collaboration on semantic interoperability is a vehicle for this transformation in Finland. The Ministry of the Environment has set up a cooperation committee for the interoperability of information on the built environment (Ministry of the Environment, 2019), with actors who are professionals in the field of the built environment, and who are predominantly from local and state administrations. The concept of cooperation builds on the European interoperability framework (EIF) (European Commission, 2017), and applies its methodology. A dedicated information system for interoperable data specification (Interoperability Platform, yhteentoimiva. suomi.fi) is openly available for all actors, and the aim is to introduce it for use in all sectors in Finland (Digital and Population Data Services Agency, 2022b). The definitions used in the plan IM are also published on the interoperability platform. In addition, there is a website (tietomallit.ymparisto.fi) where IMs of the built environment are described and which also contains more detailed material related to the IMs, such as physical data models and documentation.

2. Research questions, methods, and data

The aim of this study is to shed light on the digital transformation of Finnish planning culture by analyzing the opinions of municipal planners on the shift towards the national IM and IM-based planning in general. We attempt to find the perspectives (concerns and expectations) of Finnish municipal planners (i.e., local detailed and master planners) on the shift to IM-based planning, and to explore how these perspectives reflect on the concept of planning culture.

The research data were gathered as part of a project led by the Ministry of the Environment in Finland, where the national IM for local master and detailed plans was developed in cooperation with planners and other stakeholders (e.g., experts in land survey, plot division, GIS, and building control). Two feedback questionnaires were applied during the project. The first collected feedback on the draft conceptual model of the plan, i.e., the key concepts of the plan, their definitions, and the relationships between the concepts. In this paper, we use the data from the second questionnaire, which was applied two months later (Oct. 23rd to Nov. 6, 2020) when the IM had been developed further. The first author of this paper was responsible for stakeholder interaction in the project, and designed, implemented, and analyzed both of the questionnaires.

The aim of the second questionnaire was to gather feedback about the developed conceptual model, the logical IM, and the code lists for local master and detailed plans. In addition to direct detailed feedback on the IM, respondents' opinions on IM-based planning were collected through open-ended questions. In this paper, the detailed feedback on the IM is not utilized, and instead the focus is on an analysis of the responses to the open-ended questions, which were as follows:

- "What advantages do you see in applying the IM to land use planning?" and "What challenges do you see in applying the IM to land use planning?"
- "Are all planning solutions (necessary steering effects) expressible by the IM and codes?"
- "What are the implications for the management and migration of IM-based plan data in municipalities' own information systems?"

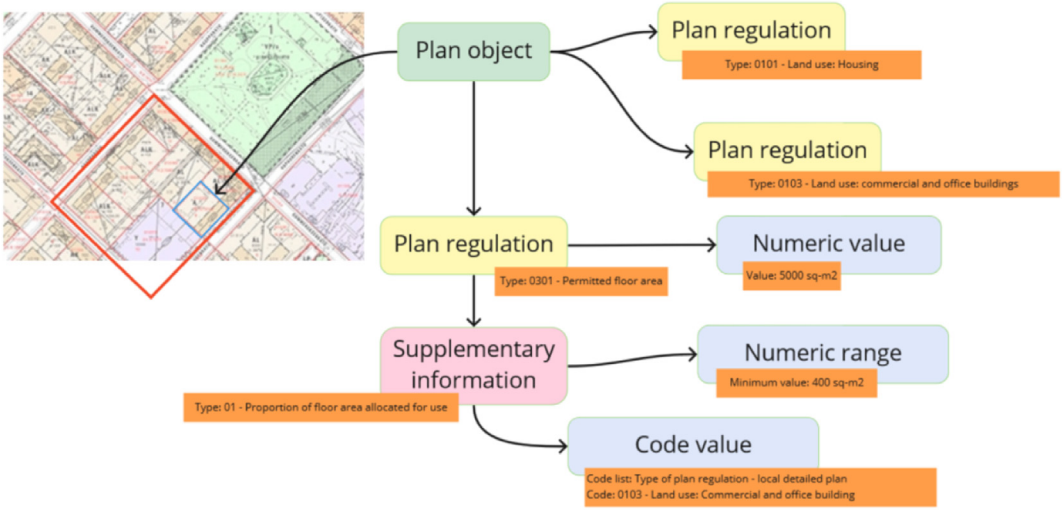

Fig. 1. A simple example of regulations for one zoning area in the form of IM-based plan data. This example illustrates one imaginary block area (i.e., a zone in a local detailed plan) with housing as the primary purpose of use (permitted floor area 5000 m^2). However, commercial or office space also needs to be included in the area (minimum 400 m^2) (figure created by Spatineo Oy (CC by 4.0), authors' translation).

- "What will you use the plan data for, and what information do you need?" and "Is the information you need available through the plan IM and code lists?"
- "What has been solved well in the IM?" and "What are the weaknesses of the IM?"
- "What are the impacts of the IM on the management of data in land use planning in general and/or in municipalities' own information systems?"
- "In addition to the formal planning data, the IM can be extended for the use of more informal data (e.g., initial perceptions or information provided by citizens). How useful do you believe these extension possibilities will be?"
- "Does the plan IM enable the needs of future IM-based planning?"

In total, 78 representatives of stakeholder groups responded to the questionnaire. Large cities (with populations of more than 100,000) were predominant among the respondents, and the majority of all respondents were from the public sector (74%, n = 78) (Table 1). The majority of respondents with land use expertise were from municipalities (65%, n = 78).

In this paper, we focus on the responses of municipal planners, i.e., those respondents who selected as their expertise local detailed or master planning and whose organization was a city or a municipality. The respondents who selected "other land use planning" as their area of expertise were excluded from this analysis, as almost all of them represented regional councils (i.e., regional planning).

In total, half of the questionnaire respondents were municipal planners (50%, n = 78); 35 of them gave answers to the open-ended questions, and thus were included in this analysis. More than half of these respondents were from large cities (51%, n = 35), more than one third were from medium-sized municipalities (40%, n = 35), and a minority (5%, n = 35) were from small municipalities (Table 1). Local master planning expertise was slightly more prevalent (64%, n = 35) than local detailed planning (59%, n = 35) (Table 2). One third (33%, n = 39) of the respondents indicated that they had expertise in both.

The majority (77%, n = 35) of the respondents with the role of municipal planner were familiar with the concept of IM-based planning. One of them was an IM expert, and a third (33%) indicated that they were able to apply IM in land use planning. A minority (13%) of respondents were new to the plan IM. A number of respondents indicated in their verbal responses that they had been involved in the development project of the national plan IM, suggesting that these respondents may have been more likely than usual to be planners who were familiar with the IM.

As explained above, the research data consisted of open-ended responses to the questionnaire. The quantitative results from the respondents were analyzed using Excel, and the qualitative data with Atlas. ti. The process started with a data-driven content analysis to identify each planner's experience. After this, the findings were linked with the analytical framework, i.e., the elements of planning culture. Respondents' perceived challenges and expectations were classified data-driven into three categories: preconditions for the reform, perceived benefits and challenges. The classification shown in Table 3 is drawn up based on how respondents have expressed the issue. For example, "Learning new skills and knowledge" and "Developing municipal information systems" have been brought up as a precondition for the success of the reform.

3. Planning culture as an analytical framework

There are several different ways to conceptualize planning and its elements. For example, Witte and Hartmann (2022) constructed a three-part (planning triangle) framework that distinguishes between the object (land use), process (policies and governance) and context of planning (administrative and institutional context). Frank Othengrafen's (2012, 2014) concept of planning culture differs from this, as it focuses on the actors and the interactions between them, which, together with the planning system and the attitudes and norms of the actors, form the planning context. Compared to the institutionally focused frame of Witte and Hartman (ibid.), Othengrafen's (ibid.) concept is more suitable for our practice- and user-oriented analysis, as it recognizes a planner as a central actor in constituting the planning culture and also takes into account the planners' mental worlds.

Othengrafen (2012, 2014) describes planning culture as 'the cultural DNA of planners and planning institutions'; this is not immutable, but forms an open and dynamic system in which actors and institutions interact to form a unique, context-specific, and constantly changing culture. According to this author, planning culture is influenced by legislation, administrative practices, economic

Table 1
Respondent's organization (all respondents, n = 78, and municipal planners included in this analysis, n = 35).

Organization	% of respondents (n = 78)	% of municipal planner respondents (n = 35)
Large city (population over 100,000)	35%	51%
City/municipality (population 50,001–100,000)	2%	3%
City/municipality (population 10,001–50,000)	22%	40%
Small municipality (population less than 10,000)	4%	6%
Regional council	5%	
State authority	5%	
Private sector/IT	2%	
Private sector/urban planning	9%	
Private sector, other	5%	
Research and education	1%	
Third sector (NGO)	8%	
Private citizen	1%	
Other	1%	

Table 2
Expertise of the respondents (n = 77) and expertise of municipal planners (n = 35) (in this study, we focused on respondents who were municipal planners with expertise in local detailed and master planning).

Expertise of the respondent	% of respondents (n = 77)	% of municipal planners (n = 35)
Local detailed planning	51%	59%
Local master planning	48%	64%
Other land use planning	31%	
Real estate and land survey	22%	
Public participation	27%	
GIS	47%	
Building control	4%	
Civil engineering	1%	
Traffic planning	4%	
IT and software design	14%	
Other	6%	

Table 3
Results and frequencies for classified findings (frequency indicates the number of respondents who mentioned the issue) (n = 35).

Classified findings	f	%
Planning artifacts		
Challenge: Plan-making will become more complicated	2	6%
Challenge: Converting old plans requires massive effort	10	29%
Challenge: Visualization of the plan will be more difficult	4	11%
Challenge: Specific characteristics of master plans	4	11%
Challenge: The quality of the environment is neglected	1	3%
Benefit: Improved quality of plan data	4	11%
Benefit: Interoperability of plan data	13	37%
Benefit: Smarter analytics and automated statistics	12	34%
Actors and their interactions	f	%
Precondition: Collaborative development of the information model	4	11%
Benefit: Improved citizen participation and access to information	5	14%
Benefit: Enhanced cooperation in planning	3	9%
Cognitive frames and norms	f	%
Precondition: Learning new skills and knowledge	12	34%
Planning system	f	%
Precondition: Addressing the specificities of municipalities	12	34%
Precondition: Developing municipal information systems	18	51%
Precondition: Developing the information model	7	20%
Precondition: Comprehensibility of the information model	9	26%
Precondition: Usability of planning tools	7	20%
Precondition: Renewal of planning practices	2	6%
Challenge: Legislative requirements for municipalities	3	9%
Challenge: Level of demand for reform	2	6%
Challenge: Inflexibility of the information model	16	46%
Challenge: Comprehensiveness and level of detail of the data model	6	17%
Benefit: No benefits for planning	1	3%
Benefit: Streamlined plan amendments	2	6%
Benefit: Data management	10	29%
Benefit: Efficiency gains	3	9%
Benefit: Need for reform	3	9%
Benefit: Harmonizing practices	5	14%
Societal context	f	%
Precondition: Adequate resources and support for municipalities	10	29%
Challenge: High costs of the reform	5	14%

and technological developments, traditions, values, beliefs and attitudes, and many unconscious factors and patterns of thinking. Each planning culture has a different understanding of planning objectives and concepts, such as sustainable development and good living conditions. Othengrafen (ibid.) therefore considers an understanding of the planning culture to be important for both researchers and practitioners.

Othengrafen's (2012, 2014) concept of planning culture is composed of three entities:

1. Planning artifacts: The end results and outputs of planning are the concrete artifacts produced by the planning process, such as plans or designs, visualizations illustrating them, and reports and explanatory texts for the plans. The physical urban and spatial fabric is also an outcome of the planning process.
2. Planning context: At the heart of the planning context are the actors and the informal and formal interactions between them. These relate to the individual cognitive interpretative frameworks and prevailing norms of the actors on the one hand, and to the legal planning system and other institutional settings on the other.
3. Social context: The social context refers to the unconscious underlying beliefs, perceptions, and values that influence planning and the judgments made by the planner. These include, for example, societal perceptions of time (e.g., future- or history-oriented) and perceptions of uncertainty. The social context is also related, for example, to the general characteristics of society, such as individual rights, the value of private property, and the degree and importance of community.

In Othengrafen's (2014) concept, the role and impact of information technology are not explicitly discussed. However, elements of technology can be found in the outcomes (plans) and in the planning system (processes and tools). Thus, software and computational analysis methods, for example, form part of the planning context, and it is clear that digital plan data should be considered as planning artifacts. In this article, we discuss plan IM as a formal definition for digital plan data and IM-based planning as a technological concept, which both belong to the planning context in this framework.

In the following chapter, the results of our analysis are presented following the analytical framework. In the subsequent chapter, we discuss the impact of the transition to IM-based planning on the prevailing planning cultures.

4. Results

In the following sections, we present the perspectives of Finnish municipal planners (i.e., respondents from municipalities with expertise in local master or detailed planning) on the shift towards the national plan IM and IM-based planning. These findings are classified based on the components of Othengrafen's (2014) concept of planning culture (i.e., planning artifacts, planning context, and social context). The three elements of planning context (actors and their interactions, cognitive frames and norms, and planning system) are described separately. The frequencies of the findings are presented in Table 3. The results consist of the perceived challenges, benefits and preconditions for the reform that were identified by the respondents. One condition for the reform that was frequently mentioned by the respondents was the need to take into account the specific requirements of municipalities. The particularities of the municipalities are related to their distinctive practices, customized software solutions, and the diversity of plan data in terms of format and plan regulations. These stem from the cultural aspects of Finnish municipal planning, or in other words the autonomy of municipalities and decentralized decision-making, which in local plans is delegated to the municipalities. This finding further justifies the use of planning culture as an analytical framework in this article.

4.1. Planning artifacts

Many respondents mentioned machine readability as a benefit of IM-based planning. In the context of this questionnaire, machine readability can be understood as a dimension of IM-based plan data, as the respondents were giving their opinions on the national plan IM. On the other hand, some respondents expressed critical views on whether true machine readability could be achieved. One was concerned that the IM would not be applied correctly, while another believed that even IM-based plan data would not be machine-readable if parts of the regulations (e.g., additional building rights, supplementary regulations to the number of stories) of the plan were in verbal form.

The respondents also expressed aspirations for smarter analytics, suggesting that the added value would emerge through the new tools enabled by the IM-based plan data. Easier production and reporting of plan statistics for different authorities (e.g., property taxation) and for municipal monitoring land use planning (e.g., unbuilt planned gross floor area) and impact analyses that could be utilized before and during planning were seen as enhancing the efficiency and quality of planning practices. One respondent described the use of plan data as follows:

> *"[I use plan data for …] Planning forecasting and monitoring data (incl. basic plan data, permitted floor area and usage, plan phases with timetables and processing, all in GIS), various extractions from the plan data such as conservation, carbon neutrality provisions, etc." (local detailed planner, large city, author's translation).*

The expectations were also that the IM would contribute to the consistency and comparability of plans from different municipalities. This would especially improve the quality of regional planning and supra-municipal impact analyses.

Some respondents saw IM-based plan data in particular as providing a better understanding of plans for citizens. On the other hand, there were also doubts as to whether this would improve the comprehensibility of planning information for citizens if the plan data were not available in the form of a traditional map visualization. A particular challenge related to visualization is an understanding of the scale and accuracy of the plans. This was considered particularly relevant for master plans, where the scale of planning is larger, and the locations and dimensions of elements, for example, should not be interpreted as being precisely defined:

> *"The general nature of the master plan and the variety of ways in which it is presented bring their own challenges. How do we prevent material from being read in too much detail, even if it is accurate? Is it sufficient to have a code indicating that the location is indicative? This leaves a lot to interpretation. It may also be more challenging to communicate to the public if the data model-based approach makes the traditional map-like formula less important as a way of visualization" (local master planner, medium-sized city, author's translation).*

A few respondents pointed out that producing IM-based plan data was perceived as more demanding in terms of accuracy, particularly in regard to detailed planning. There was an expectation that no interpretation of the plan data would be needed for plot division and in cadastral systems if plans are drawn up directly in GIS format.

In addition to the plan data, planners emphasized the importance of digitizing background information for planning (planning data), such as previous plans and strategies and information about the built, natural, and social environments. The planning data are important, as they motivate planning solutions. Since there is a huge variety of planning data, it was understood that it would not be feasible to maintain all plan-related information in an interoperable IM-based format. Instead, these data were expected to be available in GIS format and to be linked to the plan data without the need to add PDF files as attachments. There were also expectations for the structuring of all formal plan documents (the plan report and the plan for participation and assessment), which form part of the actual plan information.

> *"As long as the data are attached to the data model as 'dumb' PDF files, the information they contain cannot be used to a greater extent in the search and analysis. If we think ambitiously, could there be a national information model for the Participation and Assessment Plan and the Plan Description at some point in the future, a template that would be filled with a certain kind of data? But this is a distant future option" (local master planner, large city, author's translation).*

Many respondents were concerned about the conversion of old, existing, legally binding plans into IM-based format. This was seen as an important prerequisite to obtain the benefits of the IM, but the workload and costs were estimated to be enormous:

> *"This information modeling work has mainly focused on the new plans and their conversion into a data model format, and making them available to all via the national database. However, it is up-to-date planning data that have the greatest value, and bringing them up to the same level forms the biggest challenge. Only then it will be possible to rely on the national database and to exploit/extend the data from it" (local detailed planner, large city, author's translation).*

4.2. Actors and their interactions

A few respondents discussed collaboration between stakeholders. They pointed out that defining common concepts could contribute to better collaboration not only between planners and stakeholders, but also between planning organizations and at different levels of planning (i.e., municipal detailed and master plans). This could help to overcome the gap between master and detailed planning. One respondent pointed out that up-to-date, reliable, and accurate information benefits all the stakeholders of planning. Nationally interoperable IM and plan data were considered to support collaboration between municipalities, especially for urban-regional planning.

A need to increase the transparency of planning or the benefits for public participation purposes was not widely identified in this research. However, some respondents saw the value of digital plan data for citizens, and one emphasized the importance of increasing the quality of participation:

> "Participation has been an integral part of the planning process in the era of the Land Use and Building Act. Information models and data management systems can make it easier to exchange information between different stakeholder groups. The information model should serve specifically to improve participation" (local detailed and master planner, municipality with less than 50,000 inhabitants, author's translation).

4.3. Planning system

Finnish municipalities are in very different situations regarding the use of information systems for digital plan data. Many of the respondents raised concerns about the resources needed to develop municipal ISs, especially in the case where these systems are tailored to the municipality's own needs. Thus, implementing the plan IM would entail different levels of cost for municipalities.

Some respondents saw that the change would be easier for cities that already have a database and IM-based planning information system. Others emphasized that the digitalization of land use planning is already ongoing in municipalities. In particular, large cities have their own IM-based systems that may not be interoperable with the national plan IM:

> *"It should also be taken into account that different municipalities may already have advanced IM-based systems for the needs of land use planning. A national system should not hinder the development of these" (master planning expert, large city, author's translation).*

> *"In principle, we are already in a good situation, as the planning and real estate departments, building control, municipal engineering, etc. use the same map and register data. We have one main geographic information system, and the plan IM will not fundamentally change the way we work." (local detailed planner, large city, author's translation)*

The respondents demanded flexibility in the IM. Planners emphasized that the IM should not have too much impact on planning solutions, and should be flexible enough to support all of the different steering needs. One of the principal concerns among respondents was that the IM could not express all the different planning solutions related to local specificities. Under current legislation in Finland, municipalities are free to supplement the instructive list of regulations with their own. According to the respondents, flexibility is needed not only to meet the needs of existing municipal plans but particularly to meet future planning needs, which cannot yet even be predicted. These unexpected future needs were more often associated with local master planning than detailed planning. To respond to these changing future needs, open collaborative practices were expected from the development and maintenance of the national IMs.

The arguments for flexibility included the following:

"If the information model becomes too rigid and relies on existing zoning, it will not allow municipalities to plan in a proper way. The most important thing is to guide land use in a good and high-quality direction; the rigidity of the IM should not prevent this" (local master planner, large city, author's translation).

The future land use management needs that were identified were related, among other things, to the steering of a mixed urban structure:

"We need better tools to manage the mixed urban fabric. The old plan regulations cannot be applied any more. It is really difficult to answer this questionnaire when there is so much we could do differently. It would have been easier to comment on a new idea than on how to improve the old [plan regulation] categories. They must be developed in many different ways" (local master planner, large city, author's translation).

There were also concerns that the IM could limit creativity and the planner's freedom of expression, and could influence planning solutions. The main concern was that quantitative regulations (e.g., building rights) would be emphasized in plans at the expense of qualitative factors (e.g., architectural and landscape values).

"In IM-based planning, it is the information that is emphasized, but not necessarily the architecture and the values of the environment. How does IM-based planning combine the visions and plans of an architectural consultant or take care of the townscape? It's difficult if the IM-based software does not lend itself to this. It will be a pity if urban planning is reduced to measurable information only, making it more difficult to realize architectural and townscape values in planning" (local detailed and master planner, a municipality with 10,000 – 50,000 inhabitants, author's translation).

"Does IM thinking specifically challenge the creativity of vision and design?" (local master and detailed planner, a municipality with 10,000–50,000 inhabitants, author's translation).

The quality of the planning process was also expected to improve, as interoperable plan data add clarity and predictability to the process. Some respondents considered that the efficiency of work would increase through streamlining and harmonization of practices, and, for example, the automation of statistics (e.g., reporting plan information to other authorities). One respondent expressed a wish for a smoother process for small amendments (e.g., technical corrections) to plans. Improvements were also expected to come from data management and novel digital tools that will facilitate the sharing of digital plan data and the availability of information needed for planning processes (i.e., up-to-date digital plan data to be used in other planning processes).

Some respondents pointed out different aspects of the usability of IM-based planning software. One considered that it was important to integrate the validation of planning data into the tools, to allow the planner to directly assess whether the plan produced is consistent with the national plan IM. At the same time, from the planner's point of view, it would be important for the plan IM to support the heterogeneity and incompleteness of plans during their preparation. The content of a plan is developed throughout the process, and the regulations are usually modified during this process. In some responses, the usability was also understood to be linked to the IM itself.

"It is difficult to imagine (and therefore to answer the question about) how the model works in practice, as the example shown in the video was very simple. The main concern is that the metadata should follow the plan objects, so that they are updated in one place (the same place as the regulation); otherwise, it will be too much work to update it in many places. You need to be able to create plan objects without the regulation being ready yet (as it almost never is at the drawing stage), and then if the regulation is not automatically updated to the plan objects the fields will be empty. Drawing up the plan in this way will become much more complicated and therefore slower" (local detailed planner, large city, author's translation).

4.4. Cognitive frames and norms

In general, respondents' attitudes toward the change varied. Some saw reform as necessary and desirable, while others would prefer to keep the old system or at least to slow down the transformation. The need for new digital skills (especially GIS and database skills) was widely recognized and emphasized by the respondents. It was also recognized that IM-based planning changes the way planning is done. This change is not only technical: it also involves a new way of thinking:

"Work processes are changing, which means new training, guidance, advice, support for skills, and understanding. Resources and a positive forward-looking attitude, change management, and change agents are needed" (local detailed planner, large city, author's translation).

For some respondents, it was difficult to comprehend what it would mean in practice to apply the plan IM. For example, the way in which plan regulations would be formulated in the future was not sufficiently clear from the presentation material:

"I would have hoped for more explanation so that I would have been able to explain in my own municipality what it was all about. More examples are needed of how these things will show up in practice, for example when a plan regulation is made" (local master planner, large city, author's translation).

4.5. Social context

On a societal level, digitalization is widely accepted, and has been boosted by national policies (Finnish Government, 2019) and development projects (e.g., Project RYHTI (Ministry of the Environment, 2020)). The respondents did not question digitalization in general, although the plan IM was criticized in various ways.

The government has a key role in promoting and supporting these reforms. Many respondents emphasized that the implementation of the IM in municipal ISs should be financed with national funding. The unequal resources and capacities of

municipalities were seen as a problem, and the respondents pointed out that municipalities need financial resources, support, and guidance to make the transition.

5. Discussion

IM-based planning has a strong impact on planning outcomes (digital artifacts) and the planning system (e.g., planning law and ISs). Our results show that it also transforms or imposes adaptation pressure on other elements of the planning context, for example both on individuals (i.e., actors and their interactions, planners' cognitive frames and norms) and municipal organizations (i.e., planning practices and processes). At the societal level, our results show the differences between municipalities, their resources and capabilities.

We find Othengrafen's (2014) concept of planning culture to be a functional framework for analyzing the impacts on planning of an IM-based approach from the perspective of practice. Fig. 2, which shows the relationships between IM-based planning and the elements of planning culture, illustrates our interpretation of the digitalization of planning from the perspective of the ongoing reform.

The components impacted by IM-based planning in a digitalized planning culture are as follows:

(1) **Digital artifacts**: The output of IM-based planning consists of machine-readable and interoperable plan data. Our empirical results show that the weaknesses of document-based planning practices have been identified and the advantages of IM-based planning are expected to arise from smarter analytics, automated reporting, and better data management, which can ensure up-to-date and accurate plan data.

Digital plan data do not directly lead to interoperability and machine readability. The challenges of creating and maintaining good quality digital plan data have been identified in ESPON DIGIPLAN (2021b). The authors suggest a coordinated data review as a solution to ensure the quality of information. Our results indicate that planners prefer automatic validation functions that are integrated into planning tools.

It has been argued that an IM-based plan can make planning information available to a wider range of stakeholders and in a more comprehensive way than in the past (Hersperger et al., 2021). Our results show that planners have some skepticism about how informative an IM-based plan would be, and there are concerns that it could lead to overly detailed interpretations, particularly at the local master planning level.

In the latest proposal for a new digital planning law in Finland (Ministry of the Environment, 2022a), however, it seems that the map is still considered a primary type of representation of planning data, and thus PDF documents will still have a role in planning in a similar way to other countries (e.g., Denmark (Fertner et al., 2019), and Austria (Hersperger et al., 2021)). Our results show that for some planners, sticking with PDF documents as legally binding plans would be a relief, while others, already oriented towards IM-based planning, may be frustrated by the slow pace of change.

(2) **An IM-oriented mindset** means a cognitive frame with the ability to produce and use structured plan data. Our results show that the IM can be perceived as constraining and as limiting a planner's freedom of expression when defining regulations. In practice, IM-based planning requires a comprehensive change in plan-making. The question not only concerns technical skills but also a new way of thinking and designing plans.

We expect that the most significant changes in the planner's work will involve decomposing the regulations into a structured form

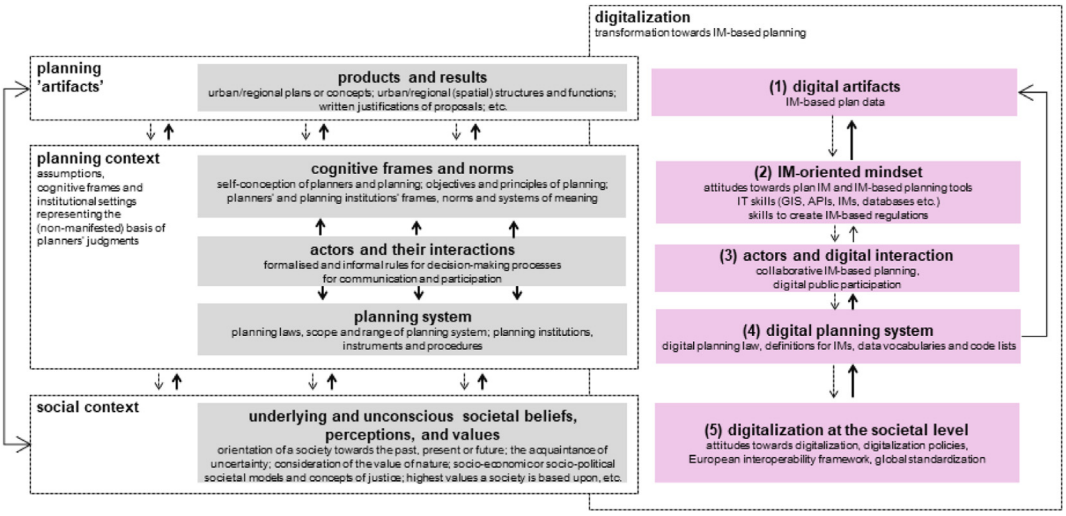

Fig. 2. Interpretation of the digitalization of planning culture based on Othengrafen's (2014) concept of planning culture (author's illustration).

and using predefined codes to define the logic of the regulations. The demand for better examples of the application of the plan IM for different plan solutions and the difficulty of understanding the plan IM reveal this implicitly from the results.

It is noteworthy that other recent studies related to digital plan data (Fertner et al., 2019; Hersperger et al., 2021) do not discuss the issue of structuring the regulations. Our findings indicate that the focus should be on the questions of how standardization of planning regulations and very detailed structuring of the regulations may impact the quality of plans, the scope of planning, and planning practices. In the end, the issue is the extent of the added value of very detailed and comprehensive IM-based plan data.

For a planner, an IM-oriented mindset includes a positive attitude towards digitalization and using new IM-based tools, the new skills needed to adopt these new digital technologies and tools (e.g., GIS, APIs, IMs, 3D, databases, etc.), and a certain kind of "data-driven thinking", which is needed to be able to formulate structured plan regulations.

(3) **Actors and digital interaction:** IM-based planning requires closer cooperation between local detail planning, plot division planning, building control, and property formation, as there will be less scope for interpretation of the plan after its adoption. Attention should be paid to the development of cooperation and the elimination of administrative barriers. A plan IM can help in this regard by establishing a common language for municipal planning.

Our results show that there are some expectations of an increase in the quality of public participation, especially through web-based information sharing and map-based feedback systems. However, in national developments led by the Ministry, citizens are seen as receivers of information or providers of feedback, which aligns with the idea of traditional, administration-led public participation. This indicates that the academic discussion of an active role for citizens in the development of living environments (e.g., Staffans & Horelli, 2014; Wallin, 2019) is not currently reflected in the digital transformation of planning. It will be important to widen the discussion by raising the question of how the role of citizens could expand towards becoming co-creators of the built environment, and how this would impact on the choices that are made in the plan IM.

(4) **The digital planning system** includes new legislation regulating the plan IM, modified or new IM-based planning software and planning support systems, and the plan IM, including vocabularies and code lists for plans.

The national IM and the associated legislation will force municipalities to follow the formal IM definition precisely. The implementation of the IM will be achieved by developing planning software, meaning that much will be expected in terms of software usability. The planning tools should support planners in drafting plans, completing the regulations step by step during the process, and validating plan data against the IM. These tools should be not only intuitive, but also efficient. Management of the structured plan regulations will play a key role. While the planning software will mainly be developed by software companies, engaging planners in the development of these tools will be critical.

In this research, many respondents reported difficulties in understanding the IM and how plan data will be produced according to this model. As pointed out by Hersperger and colleagues (Hersperger et al., 2021), the ability of planners to produce digital plan data themselves has made the process more efficient. The danger is that these reforms will require a level of knowledge and skills that not all planners can reach, which in turn could lead to slower and less efficient processes. Therefor, the usability of planning software will play an important role in the efficiency of IM-based planning.

Although few respondents to this questionnaire explicitly mentioned improvements in the efficiency of planning as a benefit, they expressed other aspects that related to more efficient practices. These included easier access to and automated distribution of information through interfaces. A precondition for achieving these expectations is the machine readability and interoperability of plan data. However, as Jiang et al. (2021) have noted, the actual added value will only be realized through the functionalities of future digital tools.

The concern that the IM will constrain planning has been expressed in previous studies (see Hersperger et al., 2021). Our results show that the limitations of the IM are seen to be related to the expression of qualitative requirements, future planning needs and the recognition of local specificities. Moreover, these results show that planners want to be involved in the development of the IM. The Cooperation Committee for Built Environment Data, which was set up by the Ministry of the Environment, is therefore very important, but it must also ensure that the views of a wide range of planners are heard and that the various needs for reform are considered in the development of the IM.

(5) **Societal digitalization phenomena** are associated with broader political and public opinions on digitalization, policies, directives, and frameworks (e.g., the European Interoperability Framework, INSPIRE), global standardization, and digital innovations developed outside the planning context which have an impact on national legislation and funding for the implementation of the national plan IM.

At the societal level, Finland's future-oriented attitude (Othengrafen, 2012) is an asset in terms of digitalization. The development of digital plan data and the IS for built environment data has strong political support, and hence also funding at the national level. However, resources are also needed at the municipal level to be able to meet the new requirements. This forward-looking orientation is not evident in the planning sector, as our results show a contradiction in terms of whether the IM should be developed for current needs or for future planning.

There seems to be both scope and a need to highlight the potential of digital plan data to enhance transparency, as this issue was not directly addressed in the responses to the survey. Although Finland has a high level of trust in public authorities, there is room for improvement. It is important to remember that digitalization can make it more difficult for certain stakeholders to access information

and participate (OECD, 2021). For this reason, improving transparency must continue to be borne in mind throughout the digitalization of land use planning.

6. Conclusions

In this study, we have explored Finnish municipal planners' perspectives on IM-based planning in regard to the development of the national plan IM. Our results indicate that the high expectations for IM-based planning will not be met without paying attention to the experiences of municipal planners, planning practices, and the changes in the planning culture in a wider sense. In addition to the technological aspects, the focus should also be on the social and contextual elements of planning (e.g., local planning practices, reflection of the specific characteristics of the local environment in planning, planners' individual cognitive frames and mindsets, and actors and planning collaboration). The transition towards IM-based planning requires changes in planning traditions inherited from the era of paper-based planning (e.g., document-based practices, visual maps as planning outcomes, and verbal regulations that are open to interpretation).

The concept of planning culture can help in an analysis of the systemic changes brought by IM-based planning. In this case, our analysis of the planning culture revealed the following aspects that should be given more focus in the future, both in research and in the development of IM-based planning.

Firstly, a change towards an IM-oriented mindset is needed from planners. It is evident that IM-based planning requires new skills; however, we argue that in parallel with the discussion of skills, it should be recognized that understanding the plan IM is very difficult. Our results indicate that many of the planners who were participating in the development of the national IM could not understand how to develop a plan according to this model. The major change for planners is the need to start developing structured plan regulations, which are required to achieve the expected level of interoperability. New planning software can help with this, but an understanding is still required of the principles of using the elements of the plan IM. Thus, there is a need for both illustrative material on various IM-based plan solutions and for IM education for students and practicing planners.

Secondly, we request an open and honest debate on the implications of the plan IM. It should be acknowledged that the plan IM can have both positive and negative impacts on the quality of planning and the final result, i.e., the living environment. These requests to improve the IM for future planning needs must be taken seriously, and further development of the model in collaboration with planners will be necessary. Nor should we close our eyes to the fact that the terminology and concepts selected for the IM will guide and limit the way we talk about planning, and which aspects of plans will be measured and emphasized. For this reason, attention must be paid to the terms, definitions, and content of code lists for the IM that is eventually decided upon.

The aim of this article is not only to fill the gap in academic research but also to contribute to the professional discussion by providing empirical results that can be used for research and development, both in Finland and in other countries. We would therefore like to highlight that the rhetoric used by government authorities in legislative renewals and national development projects can have an impact on the success of the renewal. Based on our research, we suggest that rather than trivializing the impact of the reforms on the everyday work of planners, the challenges should be acknowledged. The plan IM is not only a new tool for planners, but also represents a strong intervention in the prevailing planning culture, and its implications should be carefully analyzed. A constructive debate on this topic, which would shed light on the issue from many angles, is needed. Planners should have a safe space to express their views on these reforms, as they will be the ones implementing the IM in their work. We are in the middle of a transformation, and the right direction should be discovered together.

Declaration of competing interest

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