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Orchestrating the spatial planning process: from Business Process Management to 2nd generation Planning Support Systems

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Abstract

Metaplanning can be considered as a necessary step for improving collaboration, transparency and accountability in sustainable and democratic spatial decision-making process. This paper reports current findings on the operational implementation of the metaplanning concept developed by the authors relying on Business Process Management methods and techniques. Two solutions are presented which implement spatial planning process workflows thanks to the development of original spatial data and processing services connectors to a Business Process Management suite. These results can be considered as a first step towards the development of 2^{nd} generation Planning Support Systems.

Keywords: Spatial Planning, Metaplanning, Geodesign, Business Process Management BPM, Spatial Web Service, Planning Support Systems

1 Spatial planning, geodesign, and metaplanning

Metaplanning can be defined as the design of the planning process. In real-world spatial planning practices (i.e. Regional Planning or Local Land Use Planning) often metaplanning, as something which is usually not explicitly required by law, is neglected. In such cases taming complex multi-actor planning processes and procedures may result confusing. While on the one hand lack of common understanding among the actors may easily arise, implying difficulties in collaboration, on the other hand understanding how, why, when, by whom planning decisions are made may results blurred both to internal and external stake-holders and observers. The latter should be not considered a minor pitfall as both propositions from advances in planning theory (i.e. Innes' communicative planning, in Khakee, 1998, p. 370) as well as binding regulations on Strategic Environmental Assessment (SEA, Directive 2001/42/EC) –the environmental impact assessment of plans and programmes– require in plan-making not only the evaluation, explanation and documentation of the product (i.e. the final plan) but also of the process. However, what SEA regulations and good practice guidelines usually suggest is the *ex-post* evaluation of some specific part of the SEA-planning process (i.e. degree of public participation in consultation or reliability of data sources), and an *ex-ante* metaplanning approach is most of the time disregarded.

An emerging trans-disciplinary debate among spatial planning and Geographic Information Science scholars concerns the definition and the implementation of the concept of Geodesign [7]. Geodesign can be defined as an integrated process informed by environmental sustainability appraisal which includes project conceptualization, analysis, projection and forecasting, diagnosis, alternative design, impact simulation and assessment, and which involves a number of technical, political and social actors in collaborative decision-making. The innovation in Geodesign, compared to older approaches in environmental planning and landscape architecture, is rather on the extensive use of digital spatial data, processing, and communication resources.

As a matter of facts nowadays, the Information Society reached a mature age, and we face unprecedented wealth in terms of digital (spatial) data sources. The concept of Digital Earth [3] is slowly shaping into reality, and both authoritative and volunteered geographic information resources are available to support analysis and decision-making. Nevertheless in spatial planning, professionals and decision-makers still lag-behind in the digital uptake in the practice, and in properly taking advantage of developing Spatial Data Infrastructures. Hence, making the Geodesign concept operational may be still considered a challenging task.

A small but active research community worldwide, as extensively reported in [6], tried to address these difficulties proposing advanced Planning Support Systems (PSS). By their early proposition [8] PSS were defined as "architecture(s) coupling a range of computer-based methods and models into an integrated system for supporting the planning functions" or more operationally user-friendly microcomputer-based planning system(s), which integrates GIS, sketch tools and spatial models". Indeed, since their early definition PSS were thought as architectures featuring several of the components a Geodesign support system would have. More recent propositions define PSS "a combination of planning-related theory, data, information, knowledge, methods and instruments that take the form of an integrated framework with a shared graphical user interface" [6]. However, it has been noted that the evident obstacles to PPS adoption may be inherent in the concept that comprise first generation PSS [11]. As a matter of facts, most recent perspectives addressing the gap between PSS and real-world urban and regional planning practices concern transparency, flexibility and simplicity [14].

The relevance of the concept of metaplanning, as the activity of specifying actors, activities, methods, tools, inputs and outputs, workflows or in other words the *ex-ante/in-itinere* adaptive design of planning process is also central to the Steinitz's Geodesign framework [13], where the planner (i.e. the coordinator of the Geodesign team) chooses and clearly defines the methods for the study according to a decision-driven approach (i.e. the second iteration), before the resulting workflow is actually implemented (i.e. the third iteration).

According to these considerations, the operational implementation of the concept of metaplanning can be achieved through the description of the planning process. Several attempts have been proposed by scholars to formalise the description of the planning process for diverse purposes, however these results appears to have affected neither the planning practice nor Planning Support System design [7, 1, 6]. As a matter of facts, limitations in Planning Support Systems diffusion may be addressed to lack of flexibility, thus of adaptability to contextual planning process settings.

To address these issues a possible approach is to rely on recent advances in Business Process Management (BPM) [15]. Process-orientation has gained big momentum in the last decade, and BPM techniques and tools have been developed aiming at two main objective: improving process management and easing information system development. BPM found extensive application in industry where goods and services production processes are constantly running and under improvement. Introducing BPM in the production life-cycle requires effort, but it is usually acknowledged that the costs then pay off in the long run as the number of process instances grows.

The authors argue in this paper that PSS design should also be process-driven, rather than technology-driven, and since metaplanning concerns the design and formalisation of the actual planning process, metaplanning should also inform the design of the information systems for planning support. To address this challenge, Business Process Management methods and tools have been applied by the authors to implement the metaplanning concept in the urban and regional planning and Strategic Environmental Assessment domain, claiming that metaplanning may both improve the process and ease customised PSS development accordingly: together the latter results entail the concept of 2nd generation PSS. In this paper the authors report the ongoing results of their research and present original software developed as proof-of-concept of 2nd generation PSS.

2 Implementing metaplanning with Business Process management

The evolution of contemporary spatial governance makes urban and regional planning complex processes -involving actors, activities, resources, objectives, and outputs- which are often difficult to manage in a logical, transparent and accountable manner. As a matter of facts a new figure of planner is emerging as a 'process manager' [16] whose role is the coordination of interacting actors in complex workflows of activities.

Moreover, communication among stake-holders and the broader public is a major issue in SEA, and it can be only correctly realised if proper (i.e. understandable by all) information is given to all the participants [12]: this need also includes information about the process which should explain clearly how, why, and by whom decisions are made. To address these issues a metaplanning approach is proposed by the authors.

Metaplanning can be defined as the explicit design of a (urban and regional) planning process. According to Emshoff [5] poor results of planning are often actually due to poor metaplanning. Since the '70, the concept of metaplanning has been dealt with by several disciplines including artificial intelligence and management science, but it has barely attracted the attention of the planning scholars. As a noteworthy exception de Bettencourt et Al [4] argued metaplanning should be a well-defined step in the plan-making process in order to enhance understanding and coordination among the actors and to achieve expected outcomes. To these Campagna [2] added the enhancement of responsibility, transparency and accountability in the planning process, as well as the definition of the requirements for and the ease of the implementation of process-oriented Planning Support Systems. In order to achieve the latter objectives, Business Process Management (BPM) is proposed in this paper as methodological and technical approach for metaplanning operational implementation.

BPM includes concepts, methods and techniques to support the design and analysis as well as the administration, the configuration, the enactment of business processes [15]. Hence, two are the main objectives of BPM: on the one hand BPM should support the improvement of a process (i.e. business perspective: design and analysis), while on the other hand it should ease the implementation of the supporting information system (i.e. IT perspective: configuration and enactment).

The last decade faced the diffusion of a growing number of software system - Business Process Management Systems (BPMS) - which enact a business process on the base of an explicit process model representation. A Business Process Model (BPm) is a set of activities models and execution constraints among them. From this perspective, urban and regional planning processes can be considered as business processes and Planning Process Models (PPM) can be drawn for descriptive (i.e. as-is) or prescriptive (i.e. to-be) purposes. In planning theory and practice several languages have been used to describe planning processes ranging from natural language descriptions, such as articles in planning regulations, to graphical notations, such as workflow diagrams in planning handbooks. However, most of the latter lack the semantic richness necessary to define planning process models to be used to administrate and enact process instances.

In the last decade, Business Process Model and Notation (BPMN) has been developed and maintained by the Object Management Group as a standard graphical notation for representing business processes in form of diagrams. The rich semantic of this language allows representing actors (i.e. pool and lanes) and activities (i.e. tasks or sub-process) and a variety of executions constraints. Tasks can be manual, automatic or mixed, representing possible diverse situations found in real-world processes: automatic and mixed tasks are those which are supported by the execution of distributed data or processing services. BPMN diagrams are easy to understand from both humans and machines, becoming the core of business process life-cycle. In facts, many off-the-shelf BPMS feature a BPMN diagram editor for design and analysis, a repository where models are collected, and a process engine which orchestrates the integrated execution of services supporting tasks.

In the reminder of this paper, two examples are presented as proof-of-concepts, aiming at demonstrating the core of this approach on the base of which 2nd generation Planning Support Systems can be implemented.

3 From business process management to Geodesign

The concepts and assumptions presented in the earlier sections have been implemented by the authors in a research project aiming at finding operational way to support both metaplanning and the PSS development from the early stages of the planning process according to a Geodesign approach.

Central to this proof-of-concept is the idea to model the planning process using a BPMN editor in a BPMS and to use the model to orchestrate the technology integration for planning support.

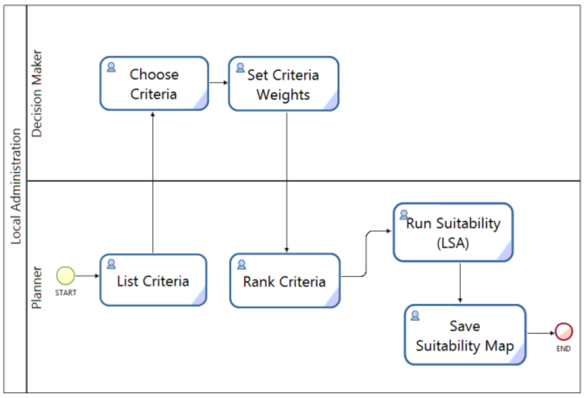
In this project Bonita BPM v6.2.2. suite (referred also to as ‘the BPMS’ in the reminder) was chosen for it is an open source platform and includes a wide array of BPM functions accessible through a user friendly interface. This BPMS enables the configuration phase of BPM through connectors, which supply functionality (i.e. IT services) to the activities (i.e. the model tasks) by integrating applications, data and services. In the current version connectors to the most used productivity applications and services including email systems, database management systems, information systems (e.g. CRM, ERP, or CMS), web services (using SOAP protocol) are available. For example, business process tasks can send a pre-defined customized email to the customer using an email connector. Unfortunately, no connector is given for accessing spatial data (e.g. WMS, WFS or WCS) and processing services (i.e. WPS). Hence, the first challenge to be addressed in order to implement a test-bed for the implementation of BPM-based metaplanning and for a 2nd generation PSS platform implementation was to create spatial data and processing services connectors for the BPMS.

Two different approaches have been tested so far in the project, including both complex (i.e. online or desktop applications) and atomic components (i.e. spatial data and processing web services). In the next sections two examples are presented, each of which implementing one of the two solutions respectively. The examples are based on a single case study simulating a land suitability analysis (LSA) [9], which can be thought of as a sub-process of a more complex PPM. The LSA sub-process proposed here should be considered as a dummy for the demonstration of capabilities offered by BPM-based approach to planning process design and enactment. This sub-process aims at finding suitable areas for a given land-use according to several criteria. The sub-process entails a number of tasks that should be performed in coordination by different actors in the organizational environment (i.e. the planner and the decision-maker in this example).

The execution ordering of activities and the sequence flow among actors, representing the handover of tasks, can be finely modeled through BPMN in Business Process Diagrams (BPDs). The BPD of the LSA case study is shown in Figure 1.

As shown in Figure 1, in this scenario the planner (P) who is in charge of starting this technical activity (i.e. the LSA sub-process) sets a list of criteria, which is sent to the decision-maker (DM).

Figure 1: Suitability analysis BPD. Model in BPMN.



The DM chooses relevant criteria and then sets weight expressing their relevant importance, and send back the results to P. P ranks criteria values along a suitability scale through a utility function and the runs the analysis calculations. The results of the calculations are then saved.

In the following paragraph this scenario is implemented in two alternative ways.

3.1 Integrating BPMS and GIS

The first solution, provided to orchestrate the technology integration, concerns the call of pre-configured desktop GIS projects from the BPMS during the workflow execution.

For this purpose a custom connector has been developed by the authors taking advantage of the features offered by Bonita BPM. The suite offers several opportunities for the integration of external programs and technologies directly in the workflow through ad-hoc connectors. Connectors can be added to tasks (activities) for accessing external information systems, taking input from the end-user or directly from the process. Bonita BPM offers ready-to-use predefined connectors for several systems and applications and also allows the creation of new connectors from scratch. The connector to call desktop GIS projects during the workflow run has been developed as a system script that allows executing desktop GIS applications in the end-user platform relying on the Windows command shell engine. This capability offered by connectors allows the coordination of work among people and the assignment of specified activities according to individual roles. In the case study example the connector is used to automatically call a pre-configured GIS project in the planner platform to execute the LSA.

Similar GIS workflow management solutions are already available in the market, however in our case unlike in others to our knowledge the control of the workflow execution is performed thanks to the BPD represented in standard BPMN.

In this case, the LSA BPD in Figure 1 is adapted to the technical solution chosen for implementation. In Figure 2a the LSA BPD is shown grouping the activities that are performed by the GIS desktop application by the dashed line, while in Figure 2b the adapted LSA BPD is shown, where grouped tasks are executed within the GIS thus hidden in the diagram.

Figure 2a: Original LSA BPD grouping the activities performed by the GIS desktop application.

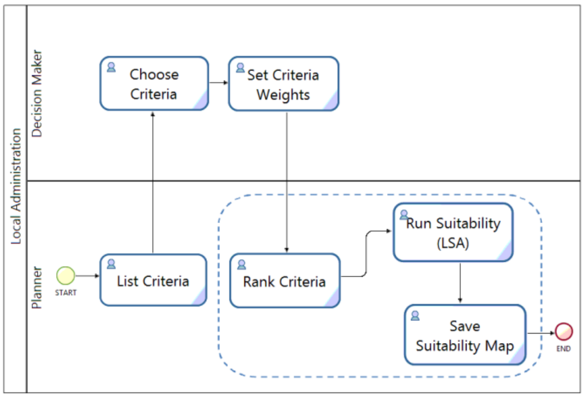
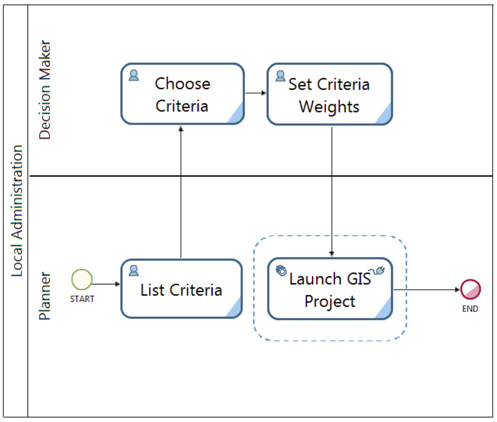


Figure 2b: Adapted LSA BPD in solution 1 (relying on the GIS desktop application connector).



The adapted LSA sub-process is started by P who lists a set of criteria and passes them to DM via a web form. The second activity is performed by DM that accesses the form and chooses criteria. The form template can be designed and implemented directly in the BPMS, offering an input user-friendly interface. After the selection of criteria, when the third activity is activated the platform provides another form, where weights are assigned to criteria according to their relative importance to the DM. The last activity performs the collection of input data, and thanks to the connector the automatic execution of a predefined GIS project in P's workstation. The last part of the process involves the run of the land suitability analysis by P according to DM's input.

The use of a predefined desktop GIS project allows P to perform analysis by means of advanced features offered by GIS applications. In other words, the LSA requires the integration of spatial analytical tools that are supplied in this use case by desktop GIS application. We tested this use-case with both commercial and open source desktop GIS applications. This may be of advantage in urban and regional planning settings for custom GIS project can be prepared by specialists for other professionals.

This first example aims at demonstrating how the integration of BPMS and desktop GIS application offers a technical environment able to coordinate collaborative activities among the actors of a planning process, supplying GIS (and not-GIS) functionalities to the BPMS run-time during the workflow execution. This first solution can be considered viable for planning support in those cases where the task requires relevant flexible human intervention. However, in a number of tasks which may be instantiated in an urban and regional planning process, more advanced automation may improve efficiency. In the next paragraph, a second demonstrator is presented aiming at showing advanced spatial data and services BPMS orchestration possibility.

3.2 Orchestrating WPS by BPMS

The second solution concerns the atomic orchestration of standard spatial data and web services directly within the BPMS. To this end, a custom connector invoking spatial web services (i.e. WFS, WPS) has been developed in Java using Bonita BPM Engine APIs, in order to enable the spatial data and services chaining by the BPMS.

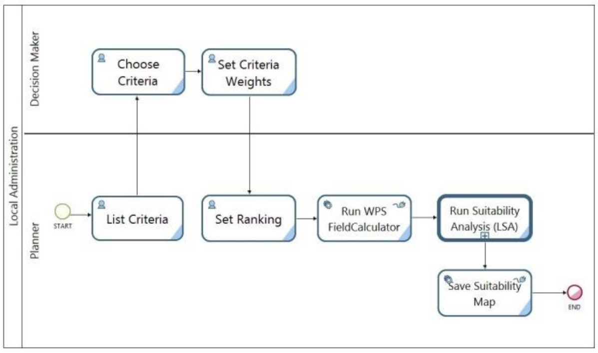
The development of the connector included two steps:

- the connector definition: it controls the external interfaces of the connector (the inputs and outputs), both visible to the users and to the BPMS;
- the connector implementation: where configuration and execution of the connector are defined by implementing default Java class for connectors.

The developed connector requires the user to specify the following parameters: i) a URL of WPS and operation to be executed, ii) input data (e.g. link to WFS and selected features, or input parameters), and iii) the output format (e.g. GML, KML, or shape-file). During the business process execution the connector retrieves and validates input parameters; then it generates xml-encoded request to WPS, containing input parameters (e.g. WFS link and features, processing operation). This request is then submitted to the URL of the WPS. The WPS performs the request querying data from WFS and processing input data (including input parameters), and returns xml-encoded response to the connector. The connector receives this response and saves the results into the global variable of the business process.

Figure 3 shows the adaption of the base LSA BPD to the spatial web services orchestration solution. The first three activities (list criteria, choose criteria and set criteria weights) are performed by humans, hence they are the same as in the previous solution. The fourth activity is performed by a planner who sets ranks manually in this example. The next activity reads stored ranking data, acquires input layers as WFS features and parameters for WPS execution, then requests the WPS to run the thematic attribute 'field calculator' process. In this experiment we used the 52°North WPS with 220+ SEXTANTE Processes extension on Apache Tomcat 7.0. The result of the execution is then transmitted to the sub-process which invokes a WPS operation for the criterion map 'Union' and eventually the WPS executes the field calculation which performs the weighted sum. The last activity takes the result of the LSA and saves the output suitability map in the location specified by the user thanks to another simple connector developed by the authors. The saved suitability map can be opened in a desktop GIS application or published as WMS or WFS. The later step is currently under development, thus it is not included in the model in figure 3.

Figure 3: Suitability analysis BPD with the introduction of the connector for spatial web services.



The purpose of this second case study is to demonstrate the orchestration of spatial web services via BPMS. Unlike the previous example, in this case a greater programming effort was required. However, this second solution may open further alleys for 2nd generation PSS development for it enables a higher level of computer support to humans thanks to the orchestration.

4 Conclusions

Recent advances in urban and regional planning, enhanced complexity in spatial governance, and Strategic Environmental Assessment call planners to novel approaches to planning process management and assessment. The authors propose the concept of metaplanning as viable solution for planning process improvement in term of actor collaboration, and process transparency and accountability. Accordingly a novel BPM approach to metaplanning is proposed.

The authors claim that a BPM approach to metaplanning may also ease the agile development of process-oriented 2nd generation Planning Support Systems. To proof this concept alternative technology solutions are proposed which demonstrate with reference to a simple process metaplanning in action.

The early results of this research project can be considered as a first contribution towards the creation of an architectural framework for 2nd generation Planning Support System design and implementation.

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