Data-driven and Dynamic Space and Assets for Physical Internet-led Urban Logistics and Planning

D2.6 - Adaptive Blueprint and integrated Meta Model Suite

WP2

CERTH

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Executive Summary

This deliverable presents the final integrated logic of the DISCO Meta Model Suite (MMS) together with the methodological structure of the Adaptive Blueprint as its final implementation-support output. Building on previous WP2 results, D2.6 positions the MMS as a continuous decision-support environment that moves from diagnosis and recommendation to practical guidance for implementation.

The deliverable responds to the need for a final guidance layer able to translate MMS results into structured next steps for cities. While earlier components already support PI Readiness assessment, Digital Maturity and Readiness (DMR) assessment, DISCO-X recommendation, and compatibility checking, cities still require a practical output that explains how implementation should proceed. D2.6 addresses this need through the Adaptive Blueprint.

The Adaptive Blueprint is defined as the structured output generated after the MMS has already produced its core analytical results. It is based on the city's readiness and maturity profile, the validated DISCO-X portfolio, the requirement-fulfilment results, and the compatibility verdicts. Its purpose is to convert these outputs into a sequenced implementation pathway tailored to the city's actual conditions. Depending on the results, the blueprint may support a deployment or optimisation pathway, an enablement pathway, or a mixed portfolio pathway.

A key contribution of D2.6 is the clear positioning of blueprint generation within the MMS architecture. The blueprint is triggered only after the compatibility stage and therefore functions as the final guidance layer of the user journey. The deliverable also introduces an LLM-assisted generation logic while maintaining that readiness, maturity, recommendation, and compatibility remain deterministic outputs of the MMS. The role of the LLM-assisted layer is to transform validated structured outputs into a concise, coherent, and city-facing implementation brief, under predefined guardrails and with human validation remaining important for formal planning or implementation use.

The deliverable further defines the minimum structured input package required for blueprint generation and establishes the logic of adaptive path selection. It also proposes a standardized structure for the Adaptive Blueprint, organised around four implementation phases: Governance and Alignment, Technical and Data Interoperability Setup, Operational Deployment, and Monitoring, Adaptation and Upscaling. In addition, it specifies the standard metadata and content components that each blueprint should include.

The practical value of this logic is illustrated through three use cases: a deployment or optimisation case, a critical gaps or enablement case, and a mixed portfolio case. Finally, the deliverable explains

how the Adaptive Blueprint is linked to the wider DISCO ecosystem, in particular to the DISCO-X Tools Library and to the Urban Freight Data Space / Smart Data Platform pathway.

Overall, D2.6 provides the methodological and structural basis for the final integrated MMS and establishes the Adaptive Blueprint as its city-facing implementation-support output, thereby strengthening the practical usability and transferability of the DISCO approach for future cities.

Summary sheet

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Full Title	DATA-DRIVEN, INTEGRATED, SYNCHROMODAL, COLLABORATIVE AND OPTIMISED URBAN FREIGHT META MODEL FOR A NEW GENERATION OF URBAN LOGISTICS AND PLANNING WITH DATA SHARING AT EUROPEAN LIVING LABS
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Document history

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V1	23/02/2026	CERTH	Initial version of the D2.6 Table of Contents	-
V2	27/02/2026	CERTH	First draft	-
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V4	10/04/2026	CERTH	Third and final draft, sent to reviewers	Peer-reviewing partners: 1st: AKKA, 2nd: IMEC
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V6	30/04/2026	FIT	D2.6 ready for submission	

List of acronyms

Acronym	Meaning
AI	Artificial Intelligence
API	Application Programming Interface
DMR	Digital Maturity and Readiness
KPI	Key Performance Indicator
LLM	Large Language Model
MMS	Meta Model Suite
PI	Physical Internet
SDP	Smart Data Platform
UFDS	Urban Freight Data Space
WP	Work Package

1. Introduction

1.1. Context and Purpose

European cities are facing increasing pressure to reorganise urban logistics systems under conditions of continued urbanisation, rising e-commerce demand, growing competition for public space, and stricter climate and air-quality objectives. Under these conditions, traditional planning approaches that treat freight operations, infrastructure, governance, and digital systems as separate domains are proving insufficient for delivering systemic change. Recent research therefore points to the need for more integrated and adaptive decision-support environments capable of handling complex, multi-criteria, and dynamic urban transitions rather than relying only on static planning instruments or isolated datasets. (Wang & Ren, 2025; Abouelrous, Zhang, & Bliek, 2023)

Within this broader transition, the Physical Internet (PI) provides a strategic framework for rethinking urban freight beyond fragmented and proprietary logistics chains. The PI envisions a hyperconnected and interoperable logistics system based on modularity, shared assets, and coordinated networks of services and infrastructures. In urban contexts, this implies that digital environments should not simply describe measures or collect data, but should actively support cities in identifying feasible intervention pathways, sequencing actions, and managing the transition toward shared and data-driven logistics systems. In this respect, the purpose of the present deliverable is to position the Meta Model Suite (MMS) as a practical decision-support and guidance environment capable of operationalising PI-led urban logistics and planning transitions. (Montreuil, 2011; Ballot, Montreuil, & Meller, 2014; Crainic & Montreuil, 2016)

From a scientific perspective, systems such as the MMS can be understood as advanced decision-support systems that move from diagnosis to prescription. Their value does not lie only in aggregating information, but in structuring data, models, and expert knowledge in ways that support reasoning, prioritisation, and action. In the urban domain, this logic is increasingly associated with environments that combine machine learning, dashboards, IoT readiness, and scenario-based modelling in order to help decision-makers interpret current system conditions and identify feasible next steps. Such environments therefore operate not merely as data repositories, but as intelligence mechanisms able to connect diagnosis with practical guidance. (Wang & Ren, 2025; Lloret, Peral, Ferrández, Auladell, & Muñoz, 2025; Abouelrous, Zhang, & Bliek, 2023)

A central mechanism in these environments is the use of maturity and readiness assessment. Maturity models provide a structured way to locate an organisation, city, or system on a progression from initial and fragmented capability toward increasingly managed, integrated, and optimised practice. Recent studies on digital readiness and municipal maturity show that the main contribution of such models is not limited to scoring; rather, they reveal structural capability gaps between policy ambition and the actual technical, organisational, and data capacities available to implement change. This is particularly relevant for urban logistics transitions, where cities may possess strategic commitment to sustainability and digitalisation, but still lack the underlying infrastructure, interoperability conditions, or governance arrangements needed to deliver implementation at scale. (De Carolis et al., 2025; Kölmel, Brugger, Bulander, & Volz, 2026)

A second mechanism concerns recommendation and pathway selection. Recommender systems literature shows that intervention choice can be structured through content-based, collaborative, knowledge-based, or hybrid logics, depending on the availability of data and the nature of the decision problem. For urban logistics and planning support, knowledge-based and hybrid approaches are especially relevant because they allow systems to match explicit city characteristics, requirements, and constraints with suitable intervention pathways while maintaining contextual relevance and methodological transparency. When combined with semantic interoperability and knowledge structures, these mechanisms can also help identify whether key enabling conditions are present and, where they are missing, connect those gaps to appropriate remediation actions. (Sandu, Cotfas, Stănescu, & Delcea, 2024; Uta et al., 2024; Lloret et al., 2025)

Against this background, D2.6 is concerned with the final step in the evolution of the MMS from an assessment and recommendation environment into a practical implementation-support environment. In this deliverable, the Adaptive Blueprint is understood as the structured output that interprets the results of the MMS journey — including maturity and readiness diagnosis, recommended intervention pathway, and compatibility assessment — and translates them into a sequenced implementation pathway tailored to the city's current capabilities and strategic vision. In that sense, the blueprint is not an additional assessment instrument, but the practical guidance layer that converts analytical outputs into a deployable transition path. This is the central purpose of D2.6 and the reason why the final integrated MMS should be understood not only as a suite of tools, but as a coherent decision-support and guidance mechanism for PI-led urban logistics and planning transitions. (Wang & Ren, 2025; Kölmel et al., 2026; Montreuil, 2011)

1.2. How this deliverable relates to tasks

As a core output of Work Package 2, D2.6 integrates results from previous tasks and formalises their convergence into a usable implementation framework. Its position in the WP2 sequence is therefore cumulative: it depends on earlier conceptual, methodological, and technical work, while also preparing the basis for the broader transferability and planning guidance expected later in the project.

The principal inputs to this deliverable are the following. First, D2.1 provided the transition requirements and foundational understanding of what cities need in order to move toward PI-led urban logistics. Second, D2.2 developed the digital maturity assessment model and clarified that its practical value lies in being combined with broader innovation-readiness and implementation-support logic. Third, D2.3 defined the architecture of the MMS and identified its main components, including the assessments, DISCO-X recommendation logic, dataspace blueprinting, tools library, and dashboard. Fourth, D2.4 documented the validated enabling tools that cities may need in order to operationalise selected DISCO-X innovations. Finally, D2.5 translated generalized DISCO-X requirements into a compatibility assessment process that produces a deployment verdict and identifies missing capacities. Together, these outputs provide the methodological and technical basis from which the Adaptive Blueprint can be defined.

D2.6 also produces outputs that are relevant beyond its own text. First, it delivers the consolidated logic of the final integrated MMS, in which assessment, recommendation, compatibility checking, and implementation guidance are treated as a continuous user journey rather than as separate project results. Second, it defines the Adaptive Blueprint as a standardized, transferable output that can support both deployment and remediation pathways. Third, it establishes the link between the verdict stage of D2.5 and the practical support environment of the MMS, especially the DISCO-X Tools Library and the Urban Freight Dataspace onboarding path. In that sense, D2.6 functions as the bridge between analytical diagnosis and actionable transition support. This role is fully consistent with the grant description of D2.6 as the final Meta Model Suite integrating enhanced versions of all project tools together with a 4-phase Blueprint for adopters.

1.3. Scope of D2.6 as final integrated MMS and LLM-assisted Adaptive Blueprint

The scope of D2.6 is twofold. First, it concerns the final integrated Meta Model Suite (MMS). In this deliverable, integration does not refer only to the technical connection of individual software modules, but to the consolidation of the full methodological chain developed across the previous WP2 outputs. This chain begins with PI Readiness and Digital Maturity assessment, continues through DISCO-X recommendation and compatibility evaluation, and culminates in implementation-oriented guidance. D2.6 therefore positions the MMS as a coherent decision-support environment in which assessment, recommendation, validation, and follow-up guidance are treated as parts of one continuous user journey rather than as separate project results.

Second, D2.6 concerns the Adaptive Blueprint itself. In this deliverable, the Adaptive Blueprint is defined as the final guidance output generated once the MMS has already produced its core analytical results. More specifically, it builds on the city's readiness and maturity profile, the validated DISCO-X portfolio, the fulfilment of solution requirements, and the resulting compatibility verdicts in order to produce a sequenced pathway for implementation. The blueprint is adaptive because it is not a fixed or generic manual. Instead, it changes according to the city's current conditions and the implementation status of the selected DISCO-X portfolio. A city with a deployable solution set requires a deployment and optimisation roadmap, while a city facing critical missing capacities requires an enablement and remediation path. Likewise, a mixed portfolio requires an integrated output that combines both logics.

Within this updated D2.6 approach, the Adaptive Blueprint is supported by an LLM-assisted generation layer. This does not mean that the LLM replaces the core logic of the MMS. The LLM does not determine the readiness profile, does not recommend the DISCO-X solutions, and does not calculate compatibility. These remain deterministic outputs of the established MMS workflow. The role of the LLM-assisted layer is instead to receive the already validated structured outputs of the MMS and transform them into a clear, concise, and city-facing implementation brief. In that sense, the analytical stages of the MMS remain authoritative, while the Adaptive Blueprint functions as the final interpretation and guidance layer that translates diagnosis into sequenced action.

Accordingly, D2.6 does not claim that every aspect of blueprint generation is already implemented as a finalized standalone software function. Its scope is instead to define the integrated logic, methodological structure, generation workflow, and standard output components that allow the MMS to evolve from an assessment-and-recommendation environment into a practical implementation-support environment. This includes the trigger point of blueprint generation in the MMS journey, the structured inputs used for generation, the logic of adaptive path selection, the standard blueprint phases and metadata, and the linkage of the blueprint to the broader DISCO ecosystem, especially the DISCO-X Tools Library and the Urban Freight Data Space pathway.

In the final MMS v3, this generation logic is also supported by authenticated user-session management and persistent storage of user-specific assessment and selection states. This means that the suite is designed not only to generate a blueprint once, but also to retain the user's results and allow subsequent re-entry, revision, and regeneration. In practical terms, a city user can revisit the MMS, update assessment responses, modify the selected DISCO-X portfolio, or revise the fulfilment status of DISCO-X requirements, and then trigger a new Adaptive Blueprint generation based on the updated state. This makes blueprint generation iterative and state-aware rather than static, while keeping the MMS as the authoritative source of the structured inputs used by the LLM-assisted layer.

1.4. Structure of the Document

The document is structured to explain how the Meta Model Suite evolves from its existing assessment and recommendation logic into an implementation-support environment through the Adaptive Blueprint layer. **Chapter 2** presents the methodology behind LLM-assisted Adaptive Blueprint generation. It positions the blueprint within the overall MMS architecture, explains which structured MMS outputs are used as inputs for generation, and defines the logic through which deployment, enablement, and mixed transition pathways are identified. In doing so, it clarifies both the deterministic role of the MMS and the constrained interpretative role of the LLM-assisted layer. **Chapter 3** translates this methodology into user-oriented use cases. It presents three scenarios that reflect the main implementation conditions that may emerge at the end of the MMS journey: a deployment or optimisation case, a critical gaps or enablement case, and a mixed portfolio case. In this way, the chapter shows how the same MMS logic can lead to different blueprint outputs depending on the city's profile and compatibility results. **Chapter 4** defines the structure and standardized components of the Adaptive Blueprint itself. It explains how the generated output is organised, how the pathway condition is reflected in the blueprint, and how the compact assessment snapshot, deployment priorities, and integrated implementation plan are structured in a consistent and city-facing format. **Chapter 5** broadens the perspective by showing how the Adaptive Blueprint is linked to the wider DISCO ecosystem. It first presents the system-level architecture of the integrated MMS and then explains how blueprint priorities can be connected to the DISCO-X Tools Library and how data-related actions can be embedded into the Urban Freight Data Space and Smart Data Platform pathway, including the proof-of-concept logic illustrated through the DISCOESTATE/DISCOPROXI example. Finally, **Chapter 6** concludes the deliverable by summarising the contribution of D2.6 to the final integrated MMS and by clarifying how the Adaptive Blueprint strengthens the practical transferability of the project's PI-led urban logistics framework. The annexes complement the main text by providing the master prompt for blueprint generation, the structured input schema and field mapping, and the summary of the D2.5 Must Have requirements per DISCO-X.

2. LLM-Assisted Adaptive Blueprint Generation Methodology

2.1. Positioning Blueprint Generation in the overall MMS Architecture

The Adaptive Blueprint Generation function is positioned as the final guidance layer of the DISCO Meta Model Suite (MMS) and within the overall architecture of the MMS, its purpose is to build directly upon the analytical and recommendation components of the suite and translate their outputs into a structured implementation-oriented result. In this sense, blueprint generation should be understood as a downstream function of the workflow of the MMS that is activated only after the suite has already guided the user through the main stages of diagnosis, solution selection and technical compatibility assessment.

As established in D2.3, the MMS is structured around a set of interconnected functional domains; these include the Knowledge Hub for Physical Internet transition and planning, the transition guidance and scenario-selection environment, the PI-readiness and digital maturity assessment tools, the innovation-selection logic for identifying the most suitable DISCO-X pathways, the DISCO-X Tools Library, the dashboard environment and the connection with the Urban Freight Data Space (UFDS). Together, these components form a continuous decision-support chain through which a city moves from strategic orientation and diagnosis towards innovation selection, capability assessment and implementation support.

Operationally, the MMS journey begins with two complementary diagnostic layers. First, the city completes the PI-readiness assessment, which captures its broader innovation-readiness and transition profile, whereas secondly, it completes the Digital Maturity and Readiness (DMR) assessment, which evaluates core dimensions such as interoperability, security, services, environmental performance and commercial viability. In the logic of the MMS, these assessments provide the baseline evidence needed to understand the current position of the city and to support more targeted decision-making in the following stages. The diagnostic role of these tools is therefore foundational because they establish the evidence base from which scenario selection and DISCO-X recommendation become meaningful rather than generic. The updated architecture of the MMS, including the positioning of the Adaptive Blueprint generation layer, is illustrated in Figure 1.

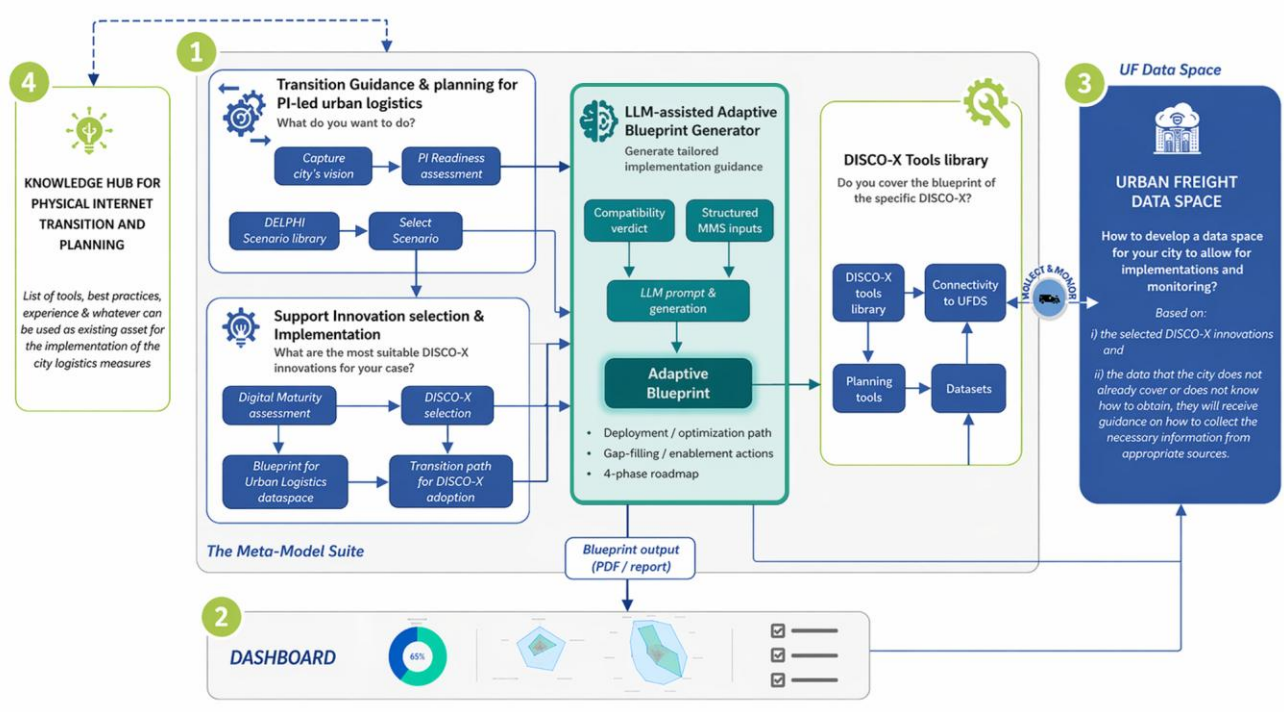

Figure 1: Sequential logic of the DISCO Meta Model Suite, showing the transition from diagnosis and DISCO-X selection to compatibility assessment and Adaptive Blueprint generation.

As shown in Figure 1, the Adaptive Blueprint is positioned after the compatibility-verdict stage and acts as the final guidance layer connecting diagnostic results with implementation-oriented support through the DISCO ecosystem. On the basis of these diagnostic results, the MMS recommends one or more DISCO-X innovations that are considered most suitable for the typology of the city, its capacities and the selected scenario. The city can then validate or refine this selection before moving to the implementation-oriented stages of the suite, and in the original MMS (v2) architecture, this stage was already intended to lead to two strategic outcomes that include:

- **the identification of the most suitable DISCO-X solution and**
- **the definition of a transition path for adoption.**

In the updated (v3) one, this pathway is further extended through the Adaptive Blueprint, which is no longer treated as a static conceptual add-on but as the post-verdict guidance layer that organizes implementation support in a structured and city-facing form.

After DISCO-X selection, the user moves to the requirements and compatibility stage; this stage constitutes the critical methodological bridge between innovation recommendation and implementation guidance. As formalized in D2.5, the MMS now operationalizes generalized DISCO-X requirements through an Interoperability and Technical Compatibility Checkpoint. The city is asked to assess whether it already possesses the required capacities across five areas that encompass tools, data, infrastructure, regulatory and policy conditions and stakeholder or business readiness. These requirements are pre-classified as "Must Have" or "Nice to Have", and the suite calculates a technical compatibility result that leads to one of two clear verdicts where either the DISCO-X can be deployed or critical features are missing.

This compatibility verdict is the point at which Adaptive Blueprint Generation is positioned. Architecturally, the blueprint sits immediately after the compatibility checkpoint because only at this stage does the MMS possess a sufficiently structured and validated understanding of the implementation context of the city. By that point, the suite has already produced the following components that include:

(i) **a readiness and maturity profile,**
(ii) **a selected DISCO-X portfolio, and**
(iii) **a compatibility diagnosis indicating whether the selected pathway is directly deployable or blocked by critical missing capacities.**

The Adaptive Blueprint therefore occupies a post-diagnostic and post-selection role, and it does not reassess the city, re-recommend a DISCO-X or replace the compatibility calculation. Instead, it interprets those structured results and translates them into sequenced guidance for implementation, remediation or mixed-path progression.

In the updated D2.6 concept, this final layer is supported by an LLM-assisted generation mechanism; however, the role of the LLM should be understood carefully. It is not the core decision-maker of the MMS, and it does not determine the readiness, maturity or compatibility status of the city. These remain deterministic outputs of the established MMS methodology, and the function of the LLM-assisted layer is instead interpretative and presentational since it receives the structured outputs already produced by the MMS and transforms them into a concise, coherent and city-facing implementation brief. To reduce the risk of unsupported or hallucinatory outputs, the LLM-assisted layer is constrained by the structured MMS payload, the fixed pathway logic, and the standardized blueprint schema defined in this deliverable. In other words, the generation process is grounded on validated MMS outputs and should not introduce new DISCO-X selections, new compatibility verdicts, or unverified implementation conditions that are not present in the input package. The resulting blueprint should therefore be understood as a controlled decision-support output. At the same time, human validation remains important, especially where the generated blueprint is to be communicated to local stakeholders or used to support planning, governance, or implementation decisions.

This placement also clarifies the relationship between the Adaptive Blueprint and the wider DISCO ecosystem, as the blueprint depends not only on the internal assessment and selection environment of the MMS but also on the support structures already defined in the broader architecture. First, it draws upon the DISCO-X Tools Library because remediation or enablement actions identified during the compatibility stage must be linked to concrete planning tools, implementation tools, datasets and physical infrastructure requirements. Second, it is connected to the Urban Freight Data Space pathway because blueprint guidance may include actions related to data availability, interoperability needs or onboarding to the UFDS through the Smart Data Platform. This role was already anticipated in the MMS architecture and is made explicit in D2.5, which states that cities facing critical gaps should be directed toward the DISCO-X Tools Library and the DISCO Urban Freight Dataspace pathway to build the missing capacity.

For this reason, the Adaptive Blueprint can be understood as the integrative output layer of the MMS architecture; functionally, it consolidates the outputs of the preceding modules into a single guidance product, whereas operationally, it connects analytical diagnosis with implementation support by clarifying what should happen next, in what sequence and with what enabling resources. Without this layer, the architecture would still provide diagnosis, recommendation and compatibility checking, but it would stop short of translating those results into an explicit city-facing roadmap.

Methodologically, the blueprint is organized around a standardized four-phase structure:

1. **Governance and Alignment,**
2. **Technical and Data Interoperability Setup,**
3. **Operational Deployment, and**
4. **Monitoring, Adaptation and Upscaling.**

This structure ensures that blueprint generation remains comparable across cities and DISCO-X families while still allowing adaptive outputs based on local readiness, selected innovations and compatibility status. From a system-operation perspective, the final MMS v3 architecture should also be understood as session-based and state-persistent. Through authenticated access and stored user/session data, the suite can preserve assessment results, selected DISCO-X solutions, requirement responses, and previously generated blueprint states. The user can return to the MMS at a later point, update one or more elements of the journey, and re-run the Adaptive Blueprint generation without restarting the entire process from scratch. In this sense, blueprint regeneration is primarily event-based: it is triggered when relevant changes occur in the structured MMS inputs, such as updated maturity and readiness responses, revised DISCO-X selections, or changed requirement-fulfilment conditions.

2.2. Structured MMS Outputs as Inputs to Blueprint Generation

The Adaptive Blueprint is generated only after the MMS has completed its main analytical stages, and the blueprint layer therefore does not operate on raw questionnaire responses, free-text descriptions or manually interpreted case narratives; instead, it consumes a structured set of MMS outputs that represent the assessed condition of the city, selected DISCO-X portfolio, identified requirement gaps and implementation status.

The role of this structured input package is to provide the authoritative basis for blueprint generation. The generator does not determine whether a city is ready, mature or compatible because these elements are already established by the preceding MMS modules and its task is to interpret these verified outputs and transform them into a concise implementation-oriented brief.

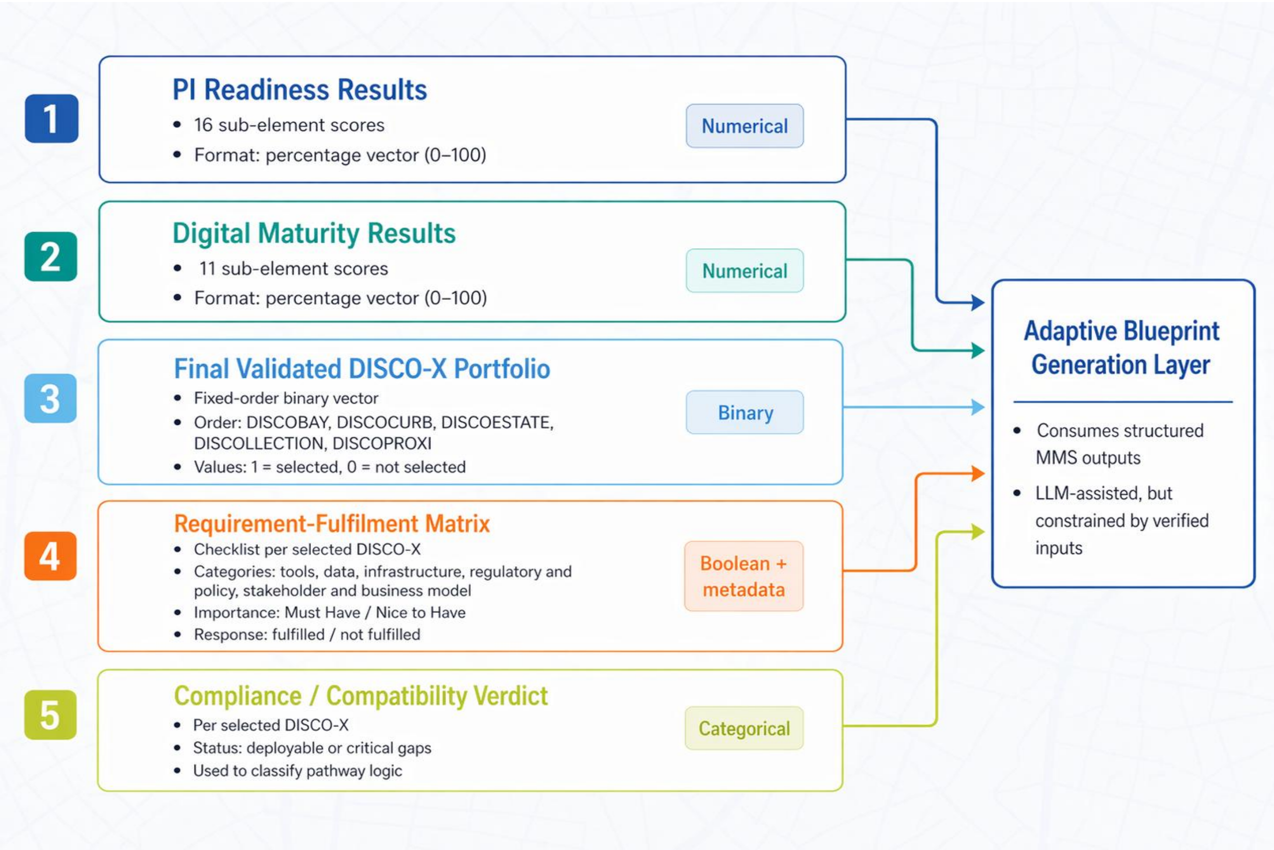

Figure 2: Meta Model Suite outputs used as inputs for the adaptive blueprint.

1. The first block contains the **PI Readiness results**, which are expressed as a numerical vector of 16 sub-element scores with each represented as a percentage on a normalized 0–100 scale.

This block captures the position of the city across the readiness framework and provides the basis for identifying strong capacities and weak areas, whereas for blueprint generation, the readiness results are used to distinguish leverage points from structural bottlenecks without requiring access to the original detailed questionnaire responses.

2. The second block contains the **Digital Maturity results**; these are also represented as a numerical vector on a normalized 0–100 scale, but here the input consists of 11 maturity sub-element scores.

This block captures the current digital capacity of the city across the maturity dimensions used in the MMS. In blueprint generation, these results serve the same methodological role as the readiness scores in that they help determine where implementation is likely to progress smoothly and where additional support, sequencing or precaution is required.

3. The third block contains the final **validated DISCO-X portfolio**, and this input is encoded as a fixed-order binary vector with five positions corresponding to DISCOBAY, DISCOCURB, DISCOESTATE, DISCOLLECTION and DISCOPROXI.

Each position takes the value 1 if the DISCO-X remains selected after user validation and 0 otherwise, which provides an unambiguous representation of the final innovation portfolio and allows the blueprint generator to handle single-solution, multi-solution and mixed portfolios in a consistent way.

4. The fourth block contains the **requirement-fulfilment matrix**, which is the most detailed input to the blueprint layer because it records which implementation conditions are already in place and which are missing.

The matrix is structured at the requirement level and is organized under five capacity categories consisting of Tools Capacity, Data Capacity, Infrastructure Capacity, Regulatory and Policy Capacity and Stakeholder and Business Capacity. Each requirement record includes the relevant DISCO-X identifier, the requirement category, the importance class (Must Have or Nice to Have) and a Boolean response indicating whether the requirement is currently fulfilled, and this block is central to blueprint generation because it enables the identification of critical gaps and supports the prioritization of missing Must Have requirements over improvement-oriented Nice to Have actions.

The fifth block contains the **compliance or compatibility verdict for each selected DISCO-X**; this block is categorical rather than numerical. At minimum, it indicates whether the selected innovation is deployable or whether critical gaps remain, and in the blueprint workflow, this verdict is used to classify the overall pathway condition of the city; a deployable DISCO-X is treated as ready for deployment or optimization while a blocked DISCO-X is treated as requiring enablement before implementation, and where both conditions appear in the same portfolio, the case is treated as mixed.

Taken together, these five blocks form the minimum structured payload required for Adaptive Blueprint generation, as they provide a distilled representation of the current position of the city, selected innovation portfolio, missing capacities and practical implementation status. From a data-structure perspective, the minimum blueprint-generation payload can therefore be described as consisting of:

(i) a readiness-score vector,
(ii) a maturity-score vector,

(iii) a fixed-order DISCO-X selection vector,
(iv) a requirement-level Boolean checklist with category and importance metadata, and
(v) a per-DISCO-X compliance verdict.

The technical serialization of this payload may vary depending on implementation choice, and it may be exchanged as a JSON object, database record, table structure or API response, although methodologically, the essential condition is that the payload remains explicit, standardized and deterministic. This structured payload also defines the conditions for blueprint re-generation. If the stored user state changes at any of the relevant MMS stages, the input package should be updated accordingly and a new blueprint may be generated. Technically, this includes changes in assessment outputs, changes in the validated DISCO-X portfolio, or changes in the requirement-level checklist for a selected solution. As a result, the Adaptive Blueprint is not treated as a fixed document, but as a regenerable output derived from the latest valid MMS state of the user or city session.

2.3. The Logic of Adaptive Path Selection

The logic of adaptive path selection defines how the MMS moves from completed assessment and compatibility results to a city-specific implementation pathway; it functions as the methodological bridge between structured analytical outputs and the final Adaptive Blueprint. The role of this logic is interpretative rather than diagnostic, given that it does not reassess the city, recalculate compatibility or modify the selected DISCO-X portfolio.

The starting point of adaptive path selection is the final validated DISCO-X portfolio together with the compatibility verdict assigned to each selected innovation, which establishes the practical implementation status of the portfolio. The central principle is straightforward in that the blueprint must follow the actual implementation readiness of the city rather than the theoretical attractiveness of a DISCO-X solution, and for that reason, pathway selection is driven first by deployment feasibility and only then by broader improvement potential.

At the portfolio level, three pathway conditions are distinguished, and the first is a deployment or optimization condition in which the selected DISCO-X portfolio is largely or entirely ready for implementation; in this case, the blueprint should concentrate on sequencing operational preparation, launch and performance improvement. The second is an enablement condition in which the portfolio is blocked by critical missing capacities, meaning the blueprint must focus first on closing those critical gaps before implementation can proceed. The third is a mixed condition in which some selected DISCO-X solutions are deployable while others remain blocked, and in such cases, the blueprint must combine early deployment for the ready elements with targeted enablement actions for the blocked ones.

The pathway type is determined directly from the compatibility results and is therefore not a matter of narrative interpretation, since the function of the blueprint layer is to translate that structured result into a coherent implementation path rather than to redefine it. This distinction is important because it preserves methodological control, ensuring that assessment, recommendation and compatibility remain rule-based outputs of the MMS while the Adaptive Blueprint operates as a constrained interpretation layer.

Once the overall pathway condition has been identified, adaptive path selection proceeds by establishing the order of intervention, and the first prioritization rule is that missing Must Have requirements take precedence over all other actions; these requirements represent minimum implementation conditions and therefore define the immediate bottlenecks of the transition path. Nice to Have requirements are treated differently because they are relevant for improvement, robustness and scaling, although they do not determine initial feasibility unless the broader results indicate otherwise.

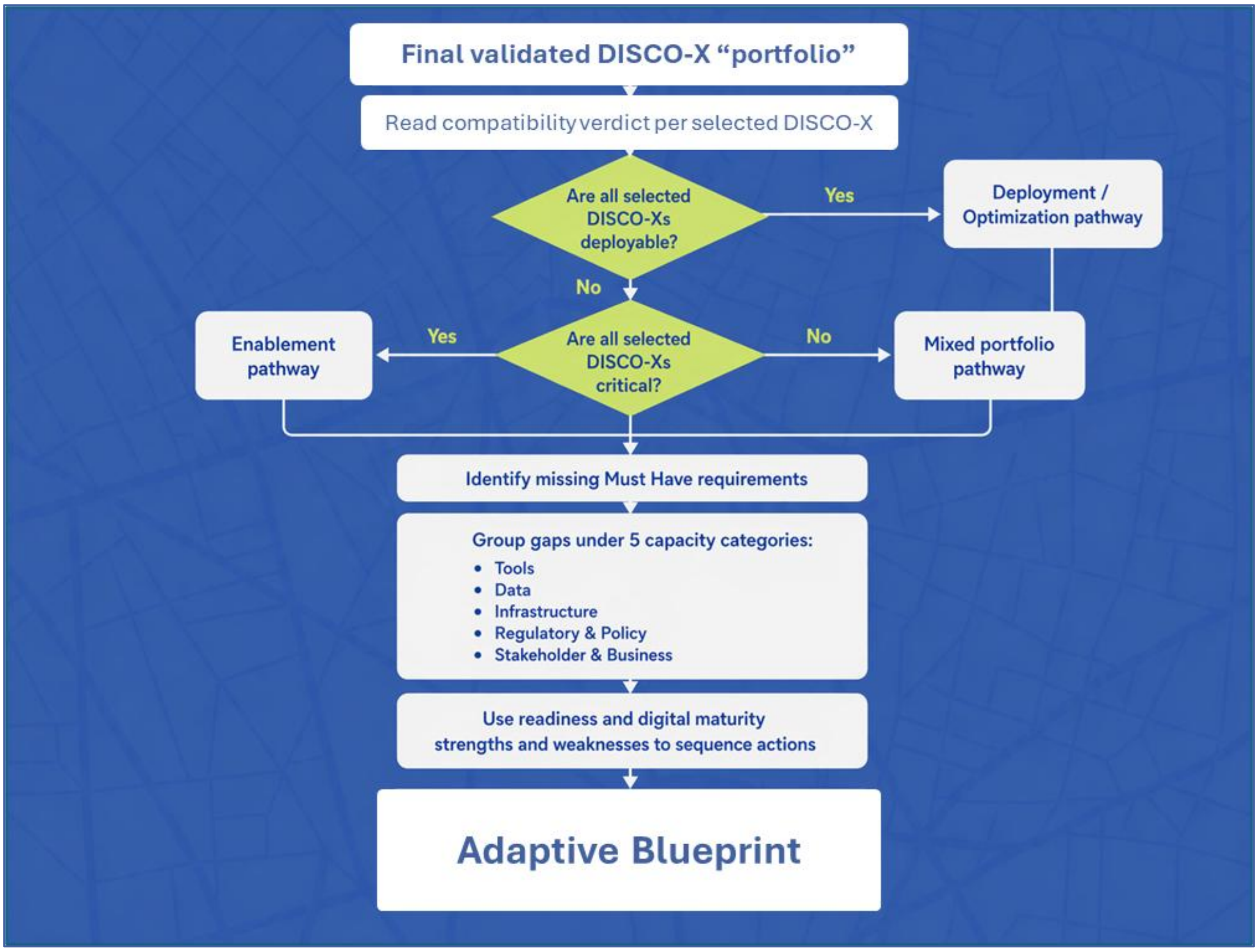

Figure 3: Adaptive blueprint decision flow.

To organize these gaps in a systematic way, missing requirements are grouped into five capacity areas, namely Tools Capacity, Data Capacity, Infrastructure Capacity, Regulatory and Policy Capacity and Stakeholder and Business Capacity. This grouping serves two purposes; first, it avoids treating each missing item as an isolated problem, and second, it allows the blueprint to identify cross-cutting bottlenecks that affect more than one selected DISCO-X. If several innovations depend on similar missing capacities, the blueprint treats them as one integrated priority rather than as multiple unrelated actions, and this approach is particularly important in cases where weak data availability, weak interoperability conditions, limited governance readiness or insufficient stakeholder coordination constrain the whole portfolio.

Readiness and digital maturity results provide the second layer of adaptive interpretation, and their role is not to override the compatibility verdict but to explain the context within which implementation will unfold. High-scoring dimensions are treated as leverage points indicating areas in which the city already possesses relevant strategic, organisational or technical strength, whereas low-scoring dimensions are treated as structural bottlenecks indicating where implementation may encounter friction, delay or limited absorptive capacity.
A further principle of adaptive path selection is that the resulting blueprint should be portfolio-oriented rather than DISCO-X-fragmented; the aim is not to generate a separate roadmap for each selected innovation but to construct one integrated path for the selected portfolio as a whole. This means that common requirement gaps are merged, shared enabling actions are identified once and interdependencies between innovations are taken into account. The result is a more realistic transition path, particularly in portfolios where data infrastructure, interoperability, public-space governance, logistics-space access or stakeholder cooperation operate as shared enabling conditions.

This portfolio-oriented approach is especially important when DISCOLLECTION is part of the selected set, as in such cases, data availability, interoperability and exchange conditions are not treated only as supporting features for an individual solution but as enabling capacities for the wider portfolio. Similarly, when several spatial or operational DISCO-X solutions are selected together, the blueprint must recognise common needs in governance, infrastructure preparation, business engagement and operational coordination.

Operationally, the logic of adaptive path selection can be described as a staged process in which the system first reads the final validated DISCO-X portfolio and second, determines the implementation status of each selected DISCO-X through the compatibility verdict, whereas third, it classifies the overall case as deployable, enablement-oriented or mixed before identifying missing Must Have requirements and grouping them into the five capacity areas. Finally, it interprets readiness and maturity scores in order to distinguish leverage points from structural bottlenecks, transforming this combined result into one integrated implementation pathway.

The blueprint that emerges from this logic is expressed through a standardized phased structure, although the content of those phases is adaptive, and their internal sequence follows a consistent intervention logic in which it first addresses critical missing conditions, then establishes the common enabling base, then prepares operational capability and only then proceeds to deployment and subsequent optimization. This ensures that the blueprint remains comparable across cases while still reflecting the actual capacities, priorities and constraints of the city.

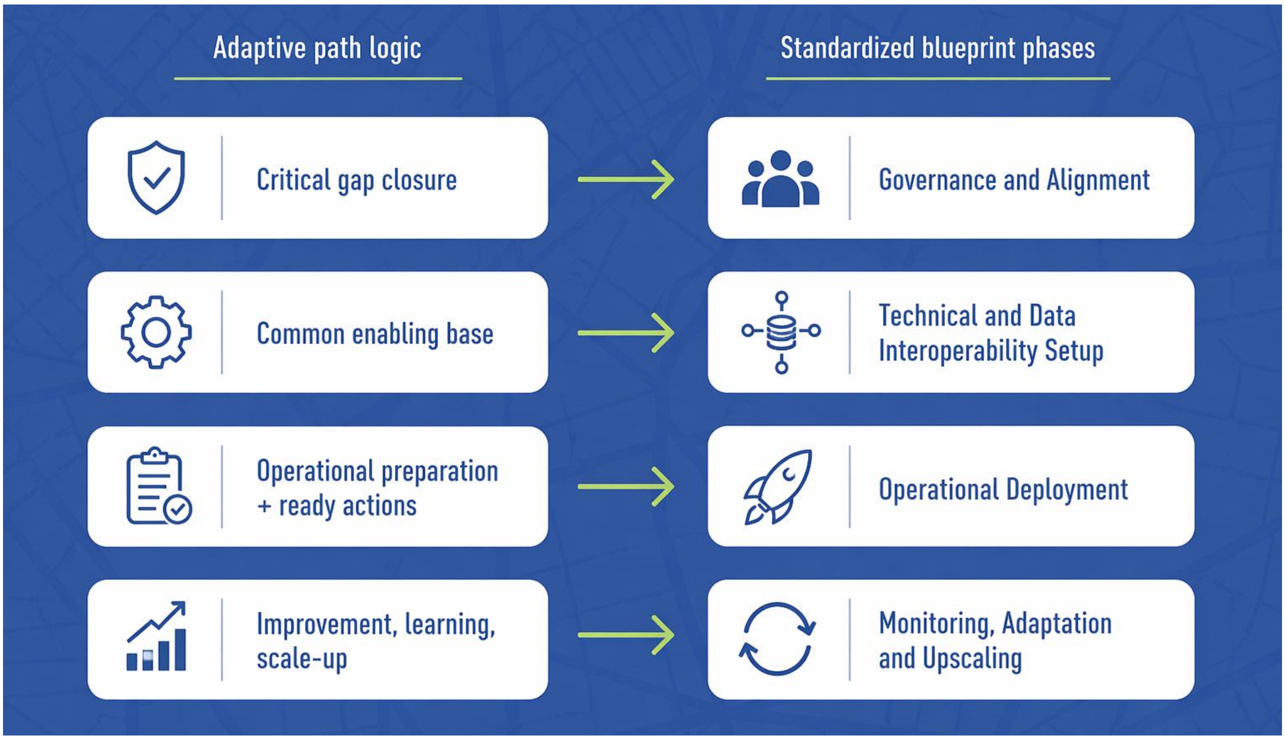

Figure 4: Mapping from pathway logic to blueprint phases.

Under this logic, adaptive path selection is the mechanism that turns the MMS from a diagnostic environment into an implementation-support environment; it ensures that the final output is not merely a summary of results but a sequenced pathway that distinguishes between what can be deployed now, what must be enabled first and what should be improved later.

3. MMS Use Cases for Adaptive Blueprint Generation

This section explains how the Adaptive Blueprint is activated within the existing Meta Model Suite journey and how the same MMS logic can lead to different implementation pathways depending on the city's profile and the final compatibility outcome. By the time blueprint generation is triggered, the city has already completed the PI Readiness assessment, the Digital Maturity assessment, the selection of its final DISCO-X portfolio, and the compatibility check for the selected solutions. The role of the Adaptive Blueprint is therefore not to repeat the diagnosis, but to translate its results into a structured implementation path.

The three use cases presented below show how this works in practice. The first describes a city that is already sufficiently prepared to move directly toward implementation. The second describes a city that is interested in a relevant solution but still lacks critical enabling conditions. The third illustrates the most realistic and policy-relevant case, in which a city has a mixed portfolio containing both deployable and blocked DISCO-X solutions.

3.1. Use Case A - Deployment / Optimization Scenario

This first use case represents the most straightforward pathway. Here, the city reaches the compatibility stage with a sufficiently strong profile to proceed directly toward implementation. In this situation, the Adaptive Blueprint works primarily as a deployment and optimisation guide rather than a remediation tool.

A representative example is a city whose PI Readiness results show relatively strong performance in areas such as collaborative planning, stakeholder participation, logistics data sharing, standardized data practices, and the use of adaptable or shared urban logistics infrastructure. In practical terms, this means that the city is already moving beyond isolated pilots and fragmented governance. Instead, it shows signs of a more mature ecosystem, with structured engagement between actors, active data collection, and at least some capacity to support shared and low-emission urban logistics operations. The Digital Maturity profile supports this positive picture. The city does not need to be fully mature in every domain, but it should already demonstrate a functional basis in areas such as interoperability, infrastructure services, digital services, and commercial viability. In other words, the city has already moved beyond very early-stage digitalisation and can rely on some degree of systems architecture, data integration, online service provision, and institutional support for digital coordination between public and private actors. This matters because it shows that the city is not only interested in PI-led transition at a strategic level but is also operationally capable of supporting it.

Within this context, the MMS may recommend **DISCOPROXI** as a suitable pathway, and the user may decide to keep it in the final validated portfolio.

The city then proceeds to the requirements step and confirms that the main enabling conditions are already in place. For DISCOPROXI, this may include planning tools for micro-hub network design, GIS-based identification of appropriate micro-hub locations, operational tools for coordinating real-time delivery activities, and route optimisation functions for green last-mile modes. It may also include supporting data such as fleet status, georeferenced destinations, zoning information, and company-level logistics operations data, together with the existence or feasibility of micro-hub facilities, green delivery vehicles, and a minimum level of cooperation among logistics providers, retailers, and real-estate actors. Figure 5 presents this pathway as a complete use case within the MMS. It shows how a city user moves from the assessment stages to the confirmation of a final DISCO-X portfolio, receives a positive compatibility verdict, and then generates an Adaptive Blueprint focused on deployment and optimisation.

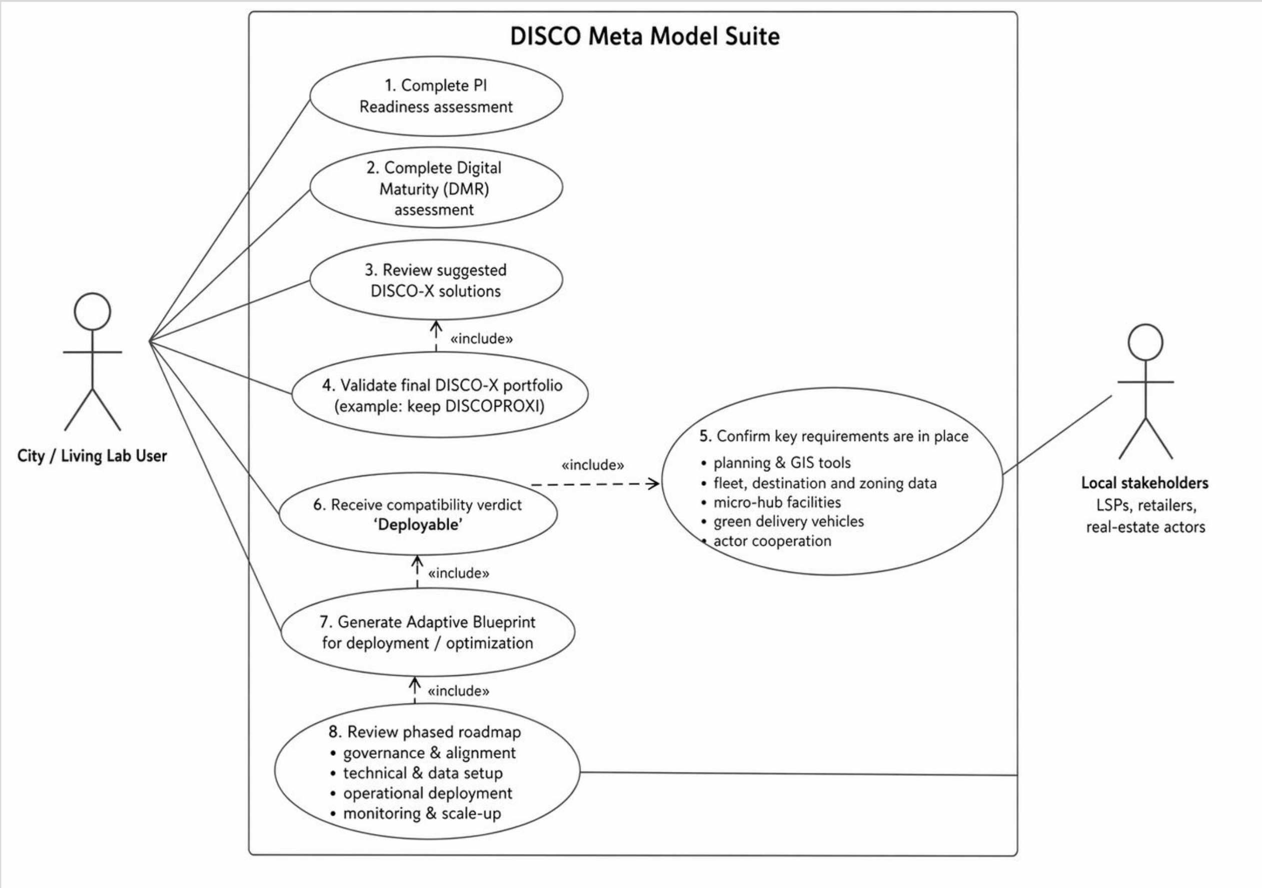

Figure 5: Use Case A – Deployment / Optimization scenario, showing how a city with sufficiently strong PI Readiness, digital maturity, and fulfilled DISCOPROXI requirements progresses from MMS assessment to a deployable verdict and a deployment-oriented Adaptive Blueprint.

Once the city has confirmed enough of the critical conditions, especially the *Must Have* requirements, the compatibility verdict becomes positive, and the selected solution is treated as deployable. At this point, the Adaptive Blueprint does not need to concentrate on major gap closure. Its purpose is instead to explain how implementation should be organised and sequenced.

In this kind of case, the blueprint is likely to begin with governance and alignment, clarifying roles, local partnerships, and implementation scope. It then moves to technical and data preparation, such as finalising platform connections, route optimisation inputs, or operational arrangements for the micro-hub network. After that, it can proceed to operational deployment and, finally, to monitoring, adaptation, and scale-up. In other words, the blueprint acts here as **a deployment accelerator**. It helps the city move from feasibility to structured implementation.

3.2. Use Case B - Critical Gaps / Enablement Scenario

The second use case represents a more difficult, but equally important, situation. Here, the city identifies a relevant DISCO-X solution, but the compatibility check shows that critical capacities are still missing. In this case, the Adaptive Blueprint becomes an enablement and remediation pathway.

A typical example is a city whose PI Readiness profile is uneven. Such a city may already recognise the need for more sustainable and collaborative urban logistics, but still remain at a medium or fragmented stage in areas such as regulatory adaptation, smart infrastructure, multimodal coordination, logistics data sharing, or the development of shared logistics assets. In practice, this means that the city may have some useful pilot activity or policy ambition, but not yet the stable enabling environment needed for implementation at scale.

The DMR profile reinforces this picture. The city may show only modest maturity in areas such as interoperability, infrastructure services, environmental digital management, or security organisation. For example, it may not yet have a formal systems architecture, may still lack common data and communications standards across city systems, or may not yet provide strong digital support for infrastructure monitoring and online operational services. In such a setting, the city may still find a solution strategically relevant, but may not yet have the digital or organisational maturity to support it in practice.

In such a context, the city may still be strategically interested in **DISCOCURB** but may not yet have the operational and digital maturity to support dynamic curb management at scale.

At the DISCO-X requirements stage, the city then discovers that several critical implementation conditions for DISCOCURB are not yet in place. These may include the absence of simulation tools for curb-usage scenarios, lack of operational tools for dynamic booking and loading-slot scheduling, insufficient live monitoring of curb occupancy, weak integration of sensor and environmental data, absence of sensors or cameras at loading zones, and limited regulatory capacity for time-based or vehicle-type-based curb restrictions. In addition, the city may not yet have the institutional or business arrangements needed for collaboration between city authorities, parking operators, freight carriers and retailers. Figure 6 illustrates this second pathway. It shows how the MMS journey leads the user to a relevant solution but then reveals that key *Must Have* requirements are still missing, resulting in a blocked compatibility verdict and a blueprint focused on enablement rather than immediate deployment.

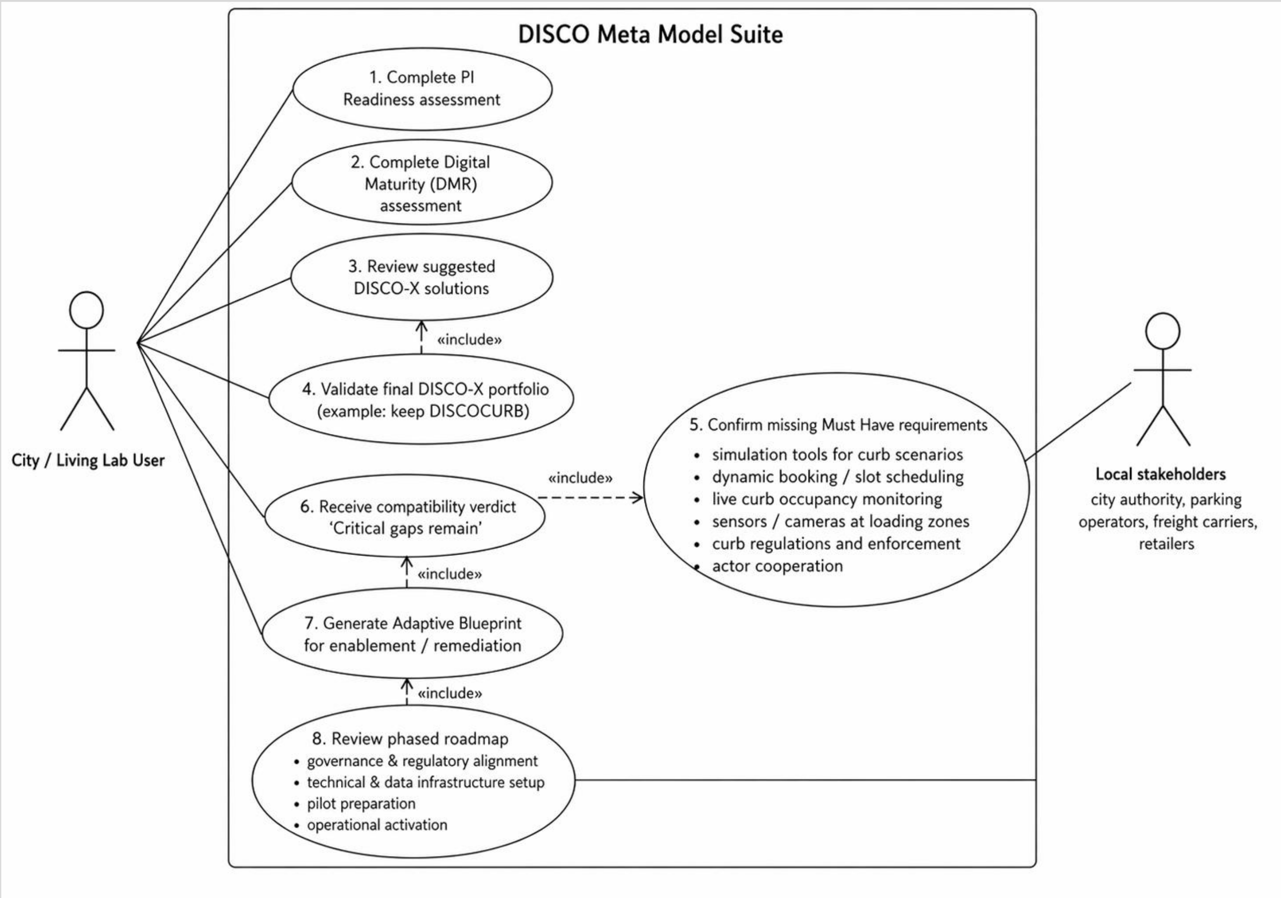

Figure 6: Use Case B – Critical gaps / Enablement scenario, showing how a city with uneven readiness and maturity results, together with missing Must Have requirements for DISCOCURB, progresses from MMS assessment to a blocked compatibility verdict and an enablement-oriented Adaptive Blueprint.

Under the D2.5 logic, if key Must Have requirements are missing, the compatibility verdict indicates that critical features remain missing and the selected solution cannot yet proceed to implementation. This is precisely the point at which the Adaptive Blueprint adds value. Rather than simply informing the city that the solution is blocked, it identifies the missing conditions, groups them under the standard capacity categories, and translates them into an ordered enablement path. For a DISCOCURB case, this would usually mean starting with governance and regulatory alignment, then moving to technical and data infrastructure setup, and only later preparing pilot deployment and operational activation. In this case, the blueprint is not an optimisation guide. It is a transition path from non-readiness to readiness.

3.3. Use Case C - Mixed Portfolio Scenario

The third use case is the most realistic for many cities and, in many ways, the most valuable for D2.6. Here, the final selected DISCO-X portfolio is mixed: some solutions are already deployable, while others remain blocked by critical gaps. The Adaptive Blueprint must therefore combine both logics into one integrated, portfolio-oriented pathway.

This scenario is important because the MMS is explicitly designed to let the user validate a final portfolio from among the recommended DISCO-X solutions. Since compatibility is assessed separately for each selected DISCO-X, the final outcome does not need to be uniform. A city may therefore end the MMS journey with one solution ready to move forward and another that still requires substantial enablement. This is exactly the kind of case in which the Adaptive Blueprint must operate across the portfolio as a whole instead of producing disconnected solution-by-solution outputs.

A realistic example would be a city with medium-to-strong PI Readiness in areas such as shared infrastructure, stakeholder participation, support for green logistics, and logistics data collection, but weaker performance in regulatory adaptation, smart traffic control, or sensor-enabled curb management. At the same time, the city's DMR profile may show that some digital capacities are already sufficiently mature, for example in digital services, commercial viability, or selected interoperability functions, while others remain weaker, such as citywide systems integration, infrastructure monitoring, or formal digital security and governance routines.

For example, the city may validate both **DISCOPROXI and DISCOCURB**.

DISCOPROXI may prove implementable because the city already has sufficient freight-flow data, candidate locations for micro-hubs, delivery fleet information, local operators willing to cooperate, and some degree of shared logistics-space potential. DISCOCURB, however, may still be blocked because the city lacks curbside sensors, live occupancy data, dynamic scheduling tools, or enforceable curbside regulations. In this case, the compatibility results across the portfolio are mixed: **DISCOPROXI is ready to move toward rollout, while DISCOCURB still requires enablement.** Figure 7 presents this mixed pathway. It shows how the MMS can lead to differentiated compatibility outcomes within the same validated portfolio and how the Adaptive Blueprint then converts these different verdicts into one integrated roadmap.

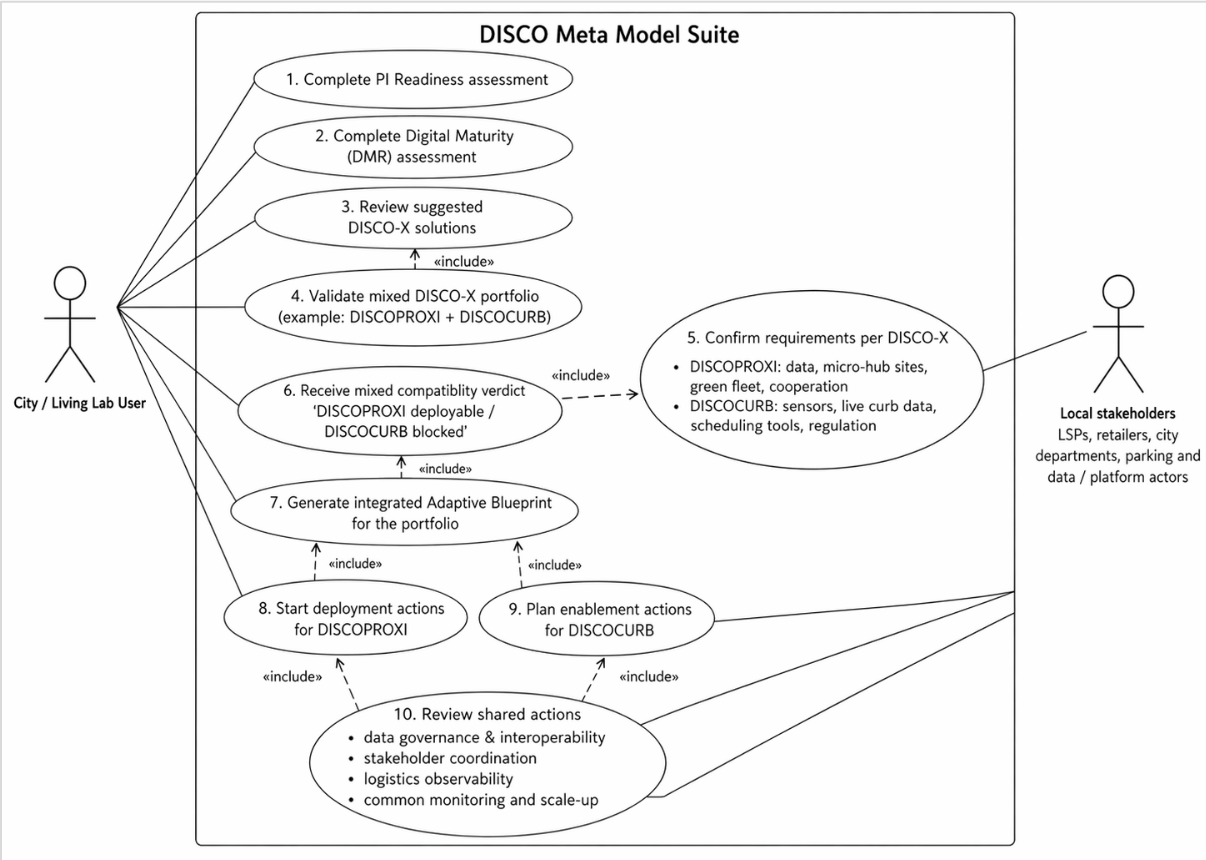

Figure 7: Use Case C – Mixed portfolio scenario, showing how a city with a validated mixed DISCO-X portfolio receives differentiated compatibility verdicts and an integrated Adaptive Blueprint combining immediate deployment actions with targeted enablement measures.

In this situation, the Adaptive Blueprint must avoid two common mistakes. The first would be to treat the whole portfolio as ready and ignore the blocked solution. The second would be to treat the whole portfolio as blocked and delay the deployment of the solution that is already compatible. Instead, the blueprint should build one coherent path in which the city can begin implementation of DISCOPROXI while simultaneously addressing the missing capacities needed for DISCOCURB.

This is where the portfolio logic becomes especially important. Some actions are specific to a single DISCO-X, but others are shared and can strengthen the whole portfolio. Improvements in governance, data governance, interoperability, logistics observability, stakeholder coordination, or local dataspace capacity may support more than one selected solution at the same time. For that reason, the mixed blueprint must not be fragmented. It should identify both the immediate deployment opportunities and the common enabling actions that help the blocked solution catch up. This scenario shows the strongest value of the Adaptive Blueprint within the MMS. The city does not receive only a list of individual verdicts. It receives one coherent transition path that distinguishes between what can start now, what must be enabled first, and what common measures can support the selected portfolio over time.

4. Structure and Standardized Components of an Adaptive Blueprint

This chapter defines the standardized structure of the Adaptive Blueprint as the final guidance output of the Meta Model Suite. It explains how the blueprint converts validated assessment, selection, requirement and compatibility results into a compact city-facing implementation brief, while preserving enough flexibility to adapt the guidance to different DISCO-X portfolios, readiness levels and deployment pathways. The chapter first presents the integrated implementation logic of the blueprint and then defines the standardized components that ensure consistency, traceability and practical use across cities.

4.1. The Phased Implementation Structure

The Adaptive Blueprint is the final city-facing guidance output of the Meta Model Suite. It translates the validated MMS results into a compact implementation brief that shows which DISCO-X solutions have been selected, what the city is ready to deploy, what remains blocked and which actions should be prioritized before implementation or scale-up. Its structure is standardized so that outputs remain comparable across cities and DISCO-X portfolios, while the content itself adapts to each city's readiness, digital maturity, requirement fulfilment and compatibility status.

The generated blueprint follows a fixed page structure composed of five parts: a header or hero area, a compact assessment snapshot, a recommendations or deployment priorities section, an integrated implementation plan and a short footer note. This structure keeps the output practical and prevents the final guidance from becoming either a long methodological report or a disconnected list of recommendations.

The blueprint first identifies the final selected DISCO-X portfolio and removes all non-selected DISCO-Xs from consideration. It then uses the compatibility results to classify each selected DISCO-X as either ready for optimization or requiring enablement. Based on this, the overall portfolio is classified as an optimization, enablement or mixed pathway. This pathway condition shapes the sequencing of the implementation plan: ready solutions can move toward controlled deployment, while blocked solutions remain in enablement until their critical requirements are fulfilled.

The implementation plan is organized into one integrated five-step pathway for the selected portfolio:

1. Close critical gaps
2. Build the common enabling base
3. Prepare operational capability
4. Launch controlled implementation
5. Optimize and scale

The first step addresses missing **Must Have requirements** that prevent full implementation. These may relate to tools, data, infrastructure, regulatory and policy conditions or stakeholder and business readiness. In enablement-oriented cases, this step becomes the main focus of the blueprint. In optimization-oriented cases, it mainly verifies remaining risks. In mixed cases, it separates the selected DISCO-Xs that can proceed from those that must remain in enablement.

The second step establishes the **common conditions** needed for the selected portfolio to function as an integrated PI-led logistics intervention. This includes shared governance, data standards, access rules, security responsibilities, interoperability arrangements and coordination between city authorities, logistics operators, infrastructure owners and technology providers.

The third step **prepares the city for practical operation**. It defines roles, connects tools and datasets, validates procedures, prepares fallback arrangements, trains users and identifies the performance indicators needed to monitor implementation. This step forms the bridge between planning and controlled deployment.

The fourth step **launches implementation in a controlled way**. The blueprint does not recommend full deployment for any selected DISCO-X that is blocked or below the compatibility threshold. In optimization cases, the selected portfolio can proceed to pilot or scaled deployment. In enablement cases, deployment is postponed until Must Have gaps are closed. In mixed cases, ready selected solutions can move first while blocked selected solutions remain under preparation.

The fifth step supports **improvement and scale-up after initial rollout**. It focuses on improving Nice to Have requirements, increasing data quality, expanding coverage, onboarding additional actors, strengthening automation, refining governance or business arrangements and monitoring performance. This step reflects the iterative logic of the MMS, where implementation is treated as a process of continuous learning and adaptation.

The five steps are not rigid silos. Some actions may overlap, and early deployment may begin while other parts of the portfolio remain under preparation. Nevertheless, the sequence remains important: critical gaps must be addressed before full implementation, common foundations must be established before integrated services operate reliably, operational capability must be prepared before launch and monitoring must inform scale-up.

4.2. Standardized Blueprint Components and Metadata

Although each Adaptive Blueprint is city-specific, its output structure should remain standardized. Standardization allows the MMS to generate comparable outputs, keeps the LLM-assisted layer controlled and ensures that assessment, selection, requirement and compatibility results are translated into an operational implementation brief.

The first component is the **compact assessment snapshot**. This section summarizes the strongest and weakest PI-led innovation readiness areas, the strongest and weakest digital maturity areas, the selected DISCO-X portfolio and the compliance summary. It does not list all raw scores or assessment questions. Its purpose is to give decision makers a quick view of the city's starting point.

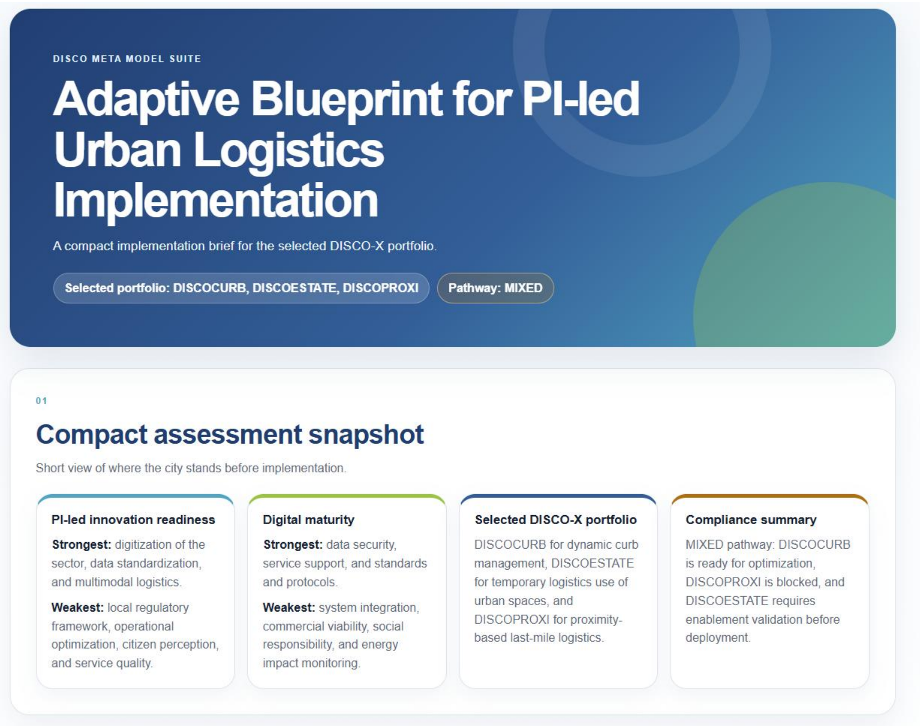

Figure 8: The compact assessment snapshot component.

The second component is the **recommendations or deployment priorities section**. This section translates the requirement check into a small number of practical priorities. Missing Must Have requirements are treated as blockers and appear before Nice to Have improvements. Where similar gaps affect more than one selected DISCO-X, they are merged into cross-cutting priorities. Each priority is tagged by requirement category and criticality and includes an "Applies to" field showing only the selected DISCO-Xs concerned.

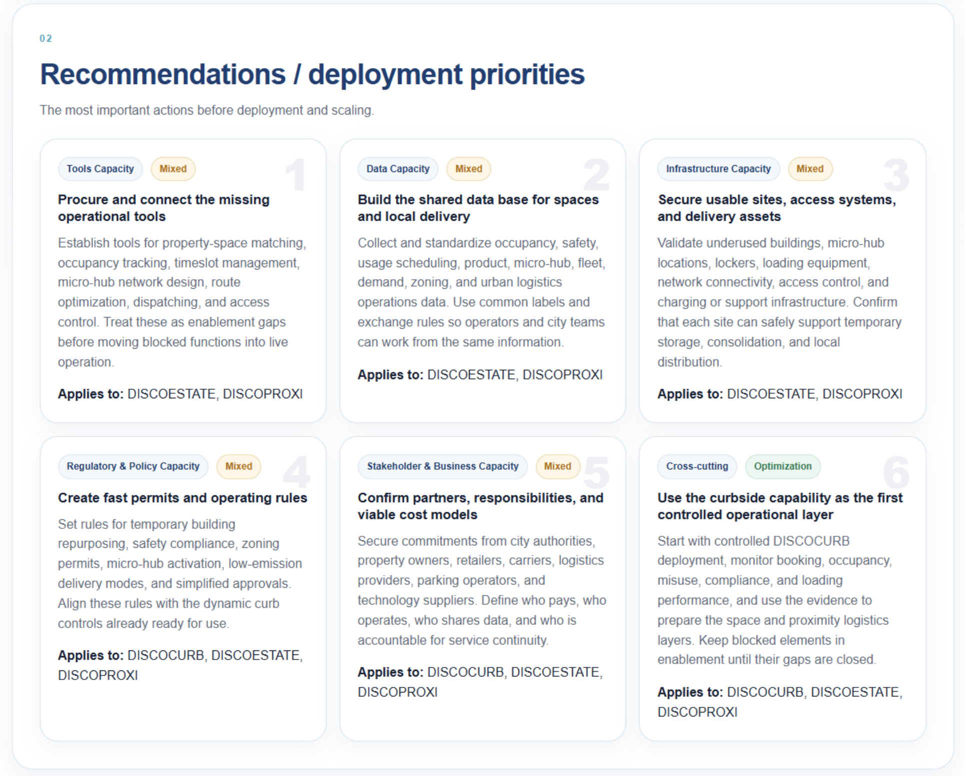

Figure 9: The recommendations or deployment priorities component.

The requirement categories used in the priorities and implementation plan are:

1. Tools Capacity
2. Data Capacity
3. Infrastructure Capacity
4. Regulatory & Policy Capacity
5. Stakeholder & Business Capacity
6. Cross-cutting, where a priority affects the selected portfolio as a whole

The third component is the **integrated implementation plan**. This section follows the five-step structure used in the generated blueprint: closing critical gaps, building the common enabling base, preparing operational capability, launching controlled implementation and optimizing and scaling. For each step, the blueprint states what the city should do, which requirement categories are addressed and what the step enables next. This keeps the plan practical and integrated across the selected DISCO-X portfolio rather than producing separate implementation pathways for each solution. The pathway condition is embedded in the header and the compact assessment snapshot. In the header, it appears as a visible pathway badge, while in the snapshot it is explained through the compliance summary. The pathway condition is derived from the compatibility results and classifies the selected portfolio as optimization, enablement or mixed.

This classification shapes the tone and sequencing of the recommendations:

- **optimization pathways can focus on controlled deployment and scale-up,**
- **enablement pathways must first close Must Have gaps, and**
- **mixed pathways combine early deployment for ready selected solutions with parallel enablement for blocked ones.**

The blueprint also embeds operational capacity content inside the deployment priorities and the integrated implementation plan. Instead of creating long standalone lists of stakeholders, digital infrastructure, physical assets and KPIs, the HTML output organizes these needs through the requirement categories used in the priority cards and plan steps. Stakeholder needs are reflected under Stakeholder & Business Capacity, digital and interoperability needs under Tools Capacity and Data Capacity, physical resources under Infrastructure Capacity, and monitoring needs mainly under the optimize-and-scale step.

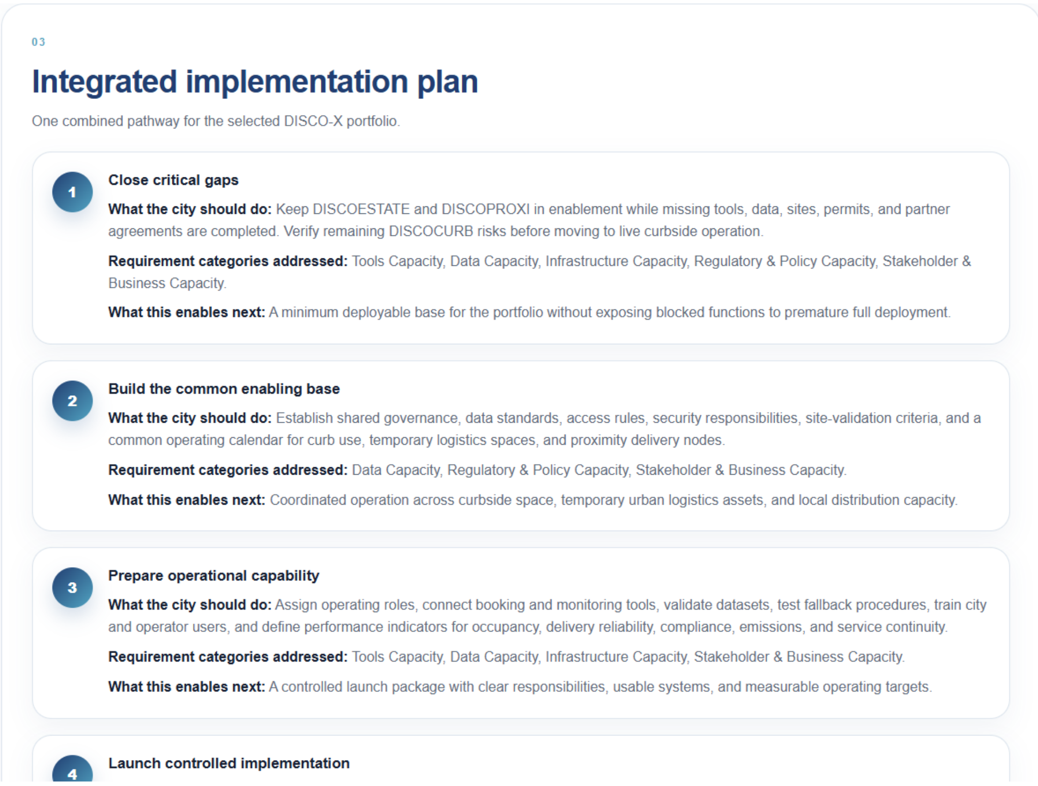

Figure 10: The Integrated implementation plan component.

Together, these components make the Adaptive Blueprint both standardized and adaptive. It is standardized because every output follows the same structure, selected-portfolio constraint, pathway logic, requirement categories, priority format and five-step implementation plan. It is adaptive because the actual content changes according to the city's assessment results, selected DISCO-Xs, requirement gaps and compatibility status.

5. Enabling the Transition via Ecosystem and Data Integration Guidelines

5.1. System-Level Architecture of the Integrated Meta Model Suite

The integrated Meta Model Suite can be understood not only as a methodological journey, but also as a modular digital system composed of interacting frontend, application, service, storage and external-integration layers. In this perspective, the MMS operates as the central orchestration environment through which users access the PI Readiness and Digital Maturity assessments, validate a DISCO-X portfolio, perform the compatibility check and, finally, generate the Adaptive Blueprint. The architecture presented in Figure 11 translates this logic into system terms by showing the relation between the web frontend and dashboard, the backend and API layer, the core MMS functional services, the underlying data repositories and the external systems connected to the suite, including the Urban Freight Dataspace (UFDS), DISCO-X tools and other data-provider interfaces. This interpretation is fully consistent with the earlier MMS architecture work, where the suite was already conceived as a central node connected to external resources and designed around modular, independently evolving components.

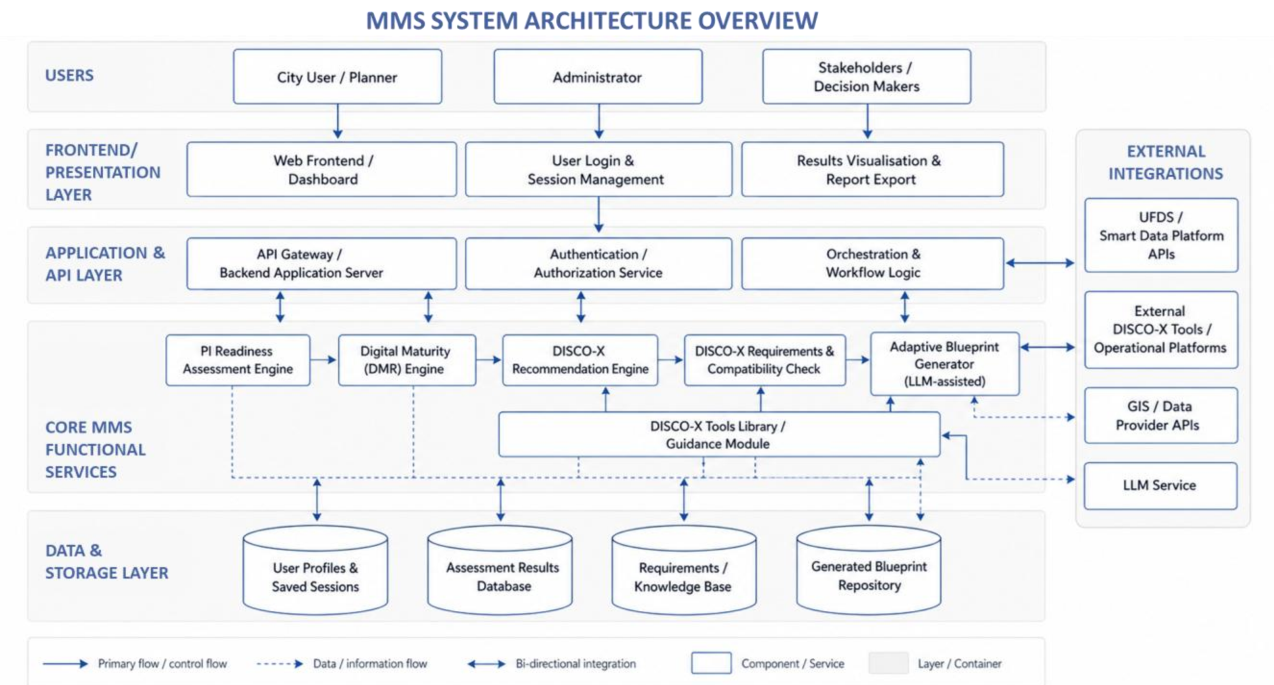

Figure 11: System-level architecture of the integrated DISCO Meta Model Suite, showing the main user-facing, application, service, storage and external-integration components and their role in supporting assessment, DISCO-X selection, compatibility checking and Adaptive Blueprint generation.

The choice of this architecture reflects the modular nature of the Meta Model Suite itself. From the beginning, the MMS was not conceived as a single monolithic software application, but as a structured environment able to connect multiple functions that serve different roles in the user journey, from diagnosis and scenario support to innovation selection, implementation support and data-space connectivity. Modularity was therefore a necessary architectural principle, because it allows different components to evolve, be refined and, where needed, be replaced without requiring a redesign of the whole system. This is particularly important in the context of DISCO, where many of the enabling tools, planning applications, data interfaces and operational modules were developed in parallel across different tasks, Living Labs and partner environments during the lifetime of the project. In that sense, the final MMS architecture reflects the reality of a research and innovation action: it had to provide a stable integrating framework while accommodating tools and services that matured incrementally and were not all available in final form from the outset.

At system level, this architecture also supports a clear separation of concerns. The frontend and dashboard layer provides the city-facing environment through which users interact with the suite, review results and access generated outputs. The application and API layer handles authentication, session logic, orchestration and communication between modules. The core MMS services perform the main functions of the suite, including readiness and maturity assessment, DISCO-X recommendation, compatibility checking and blueprint generation. Beneath this, the storage layer preserves user sessions, assessment results, knowledge structures and generated outputs, while the external integration layer connects the suite to federated data environments and operational tools. This separation is useful not only from a technical perspective, but also from a governance and transferability perspective, because it allows cities to understand the MMS as a scalable architecture in which local data sources, planning tools and external services can be connected progressively according to readiness and implementation needs.

This system view is also important for understanding why the MMS can act as the single entry point for the broader DISCO ecosystem. As already shown in the integration work of D2.4, the value of **the MMS is not that it replaces the individual DISCO-X tools or the UFDS, but that it sits above them as the user-facing planning and orchestration layer.** In this role, the MMS can receive harmonised data, connect these data to its internal logic and then activate the appropriate support or operational module without forcing the user to navigate multiple disconnected systems. The architecture presented in Figure X therefore helps clarify the functional role of the MMS before the next subsection turns to the more specific question of how UFDS and Smart Data Platform onboarding are incorporated into the Adaptive Blueprint logic.

5.2. Integrating UFDS / Smart Data Platform Onboarding into the Blueprint Logic and a DISCOESTATE/DISCOPROXI Use Case

A central feature of the integrated MMS is that blueprint generation does not stop at identifying missing data capacity or interoperability needs. Where the selected DISCO-X portfolio depends on operational data, shared data products or standardized discovery and execution flows, the Adaptive Blueprint must include onboarding to the UFDS and the Smart Data Platform as part of the implementation path. Data integration is therefore not an external technical activity running in parallel to the blueprint, but one of the implementation conditions that the blueprint must address. This is particularly relevant when DISCOLLECTION is selected, but it also applies to other portfolios where shared data, asset visibility and operational coordination are required.

The functional relation between MMS and UFDS can be understood as a separation of roles within one integrated digital workflow. UFDS provides the data infrastructure layer: it collects, federates, harmonizes and exposes operational data from provider APIs and external systems, while preserving provenance, freshness and common vocabularies. MMS acts as the user-facing planning and orchestration layer: it consumes the harmonized UFDS outputs, connects them to its internal tools and models and presents them through a coherent interface. In this way, users do not need to navigate separate provider systems or interpret different data structures, because logistics assets, services and operational data can be discovered, compared and used through a single environment.

This architecture directly affects the practical meaning of the Adaptive Blueprint. When the blueprint recommends a solution such as DISCOESTATE or DISCOPROXI, it should not only state that relevant data must be collected, but also specify how these data become part of a usable digital workflow. For DISCOESTATE, this may include standardized information on logistics spaces, such as location, capacity, space type, operational constraints, technical features and real-time or near-real-time availability. For DISCOPROXI, it may include data on micro-hubs, lockers, shops, local delivery nodes, fleet characteristics, service areas and geospatial conditions relevant to proximity-based delivery planning.

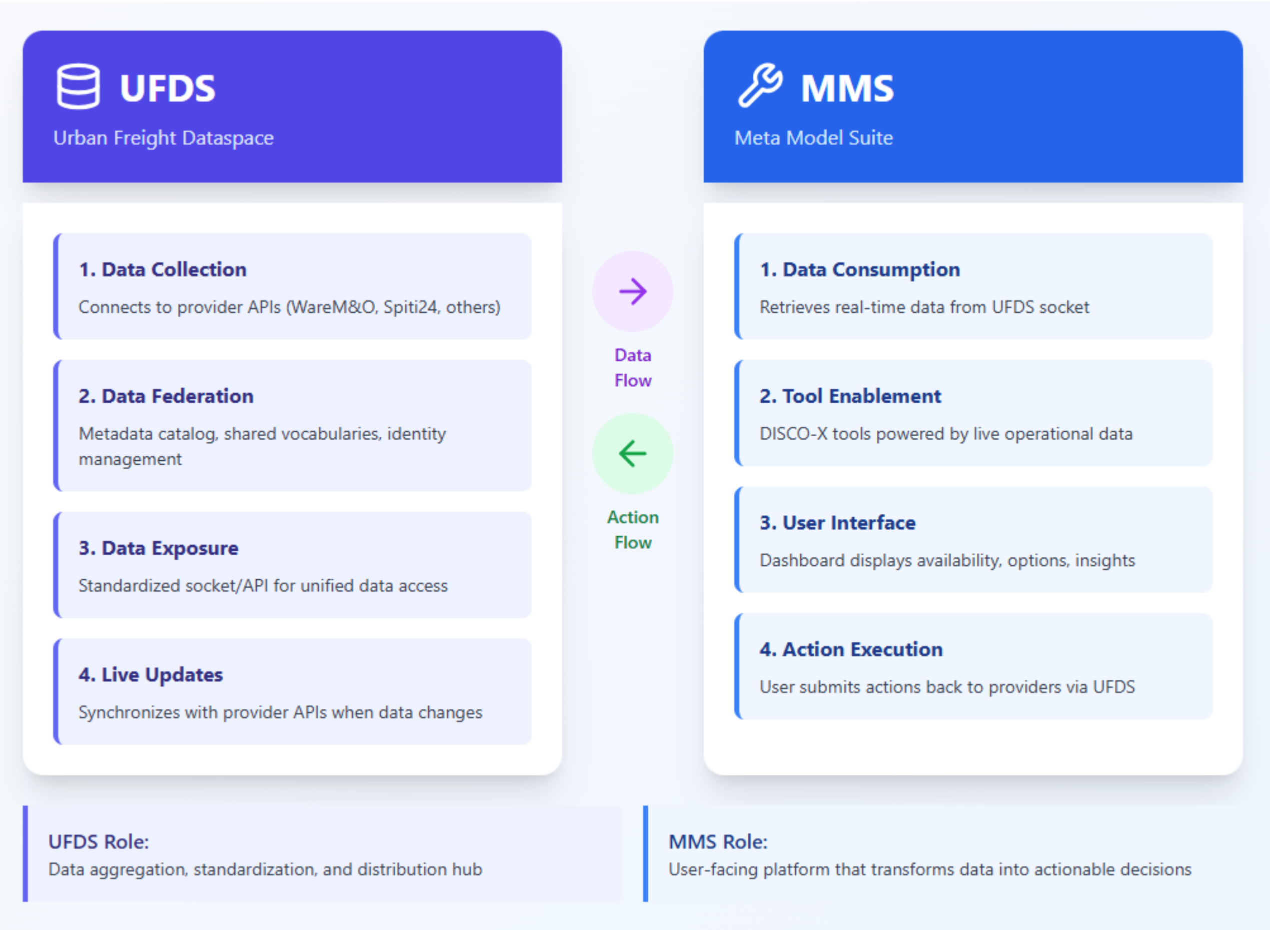

Figure 12: MMS ↔ UFDS integration schematic

A useful example is the Thessaloniki proof of concept based on the WareM&O platform. WareM&O was developed as a Warehouse-as-a-Service environment for the use of underutilized storage and logistics spaces and was enhanced to support DISCOESTATE implementation through data-model standardization, alignment with external warehouse and real-estate systems and interfacing with the Thessaloniki urban logistics dataspace. Its architecture includes a database of logistics-space information exposed through APIs, together with connections to operational systems that provide automated updates on space availability.

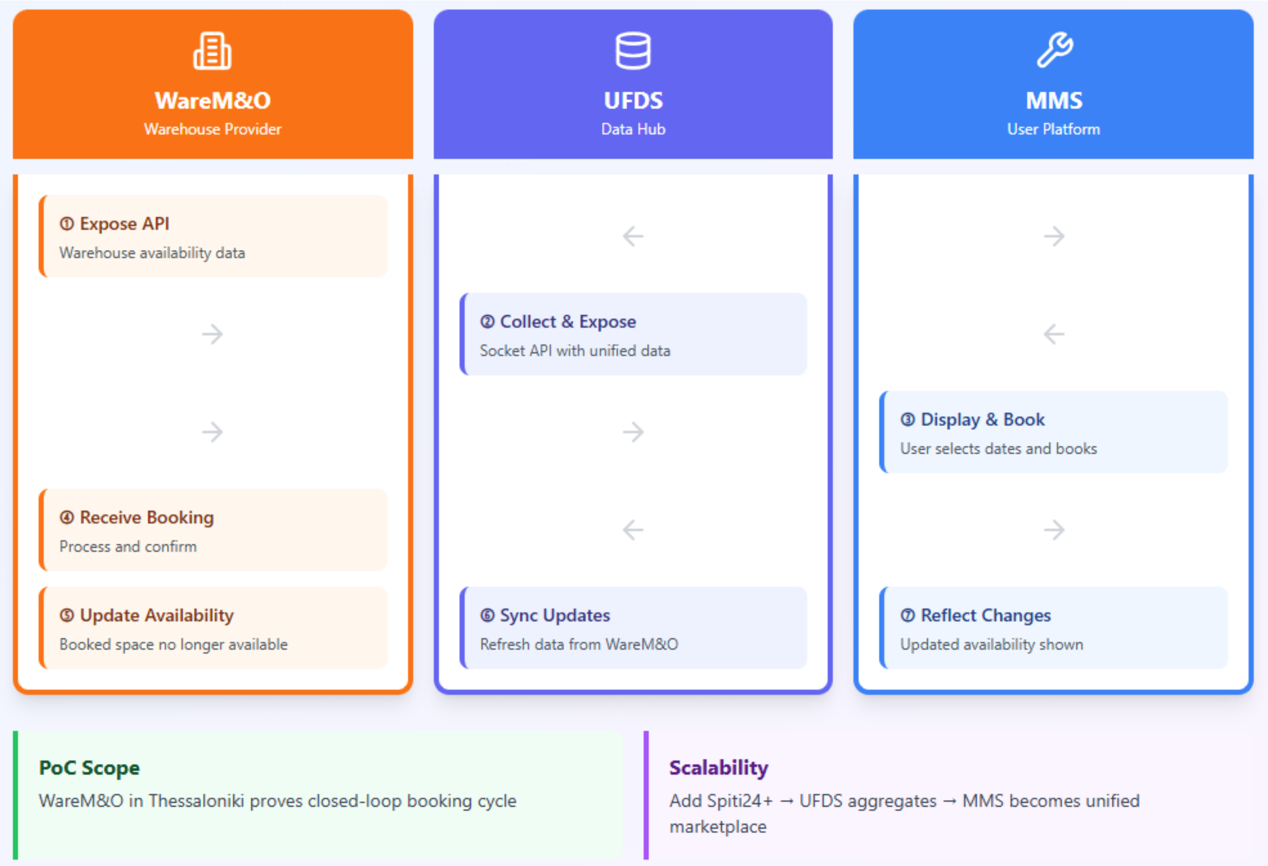

Figure 13: Proof of concept — warehouse booking via WareM&O through UFDS and MMS

In the integrated MMS-UFDS workflow, WareM&O does not need to be accessed as an isolated external application. Instead, its relevant data products can be exposed through UFDS, where they are harmonized with comparable products from other providers and made available through a common discovery layer. MMS then consumes these products and presents them through its own interface. For the user, this creates a one-stop access model: a planner, operator or city user can remain inside MMS, search for available logistics space, compare options using normalized attributes and initiate the relevant action from the same environment.

The proof of concept illustrates this flow in operational terms. A user begins in the MMS interface and specifies the characteristics of the required space, such as area of interest, dates, capacity needs and operational constraints. MMS translates this request into a standard query and submits it to UFDS. UFDS resolves the query against harmonized data products, including those exposed by WareM&O, and returns a normalized catalogue with aligned attributes, terminology, provenance and freshness information. The user can then review the options, select a listing and initiate a booking. Where full API integration is available, the booking can be submitted programmatically; where it is not yet available, a controlled hand-off can be used while preserving continuity in the user journey. Once the provider confirms the booking, the updated availability state is published back to UFDS and refreshed in MMS.

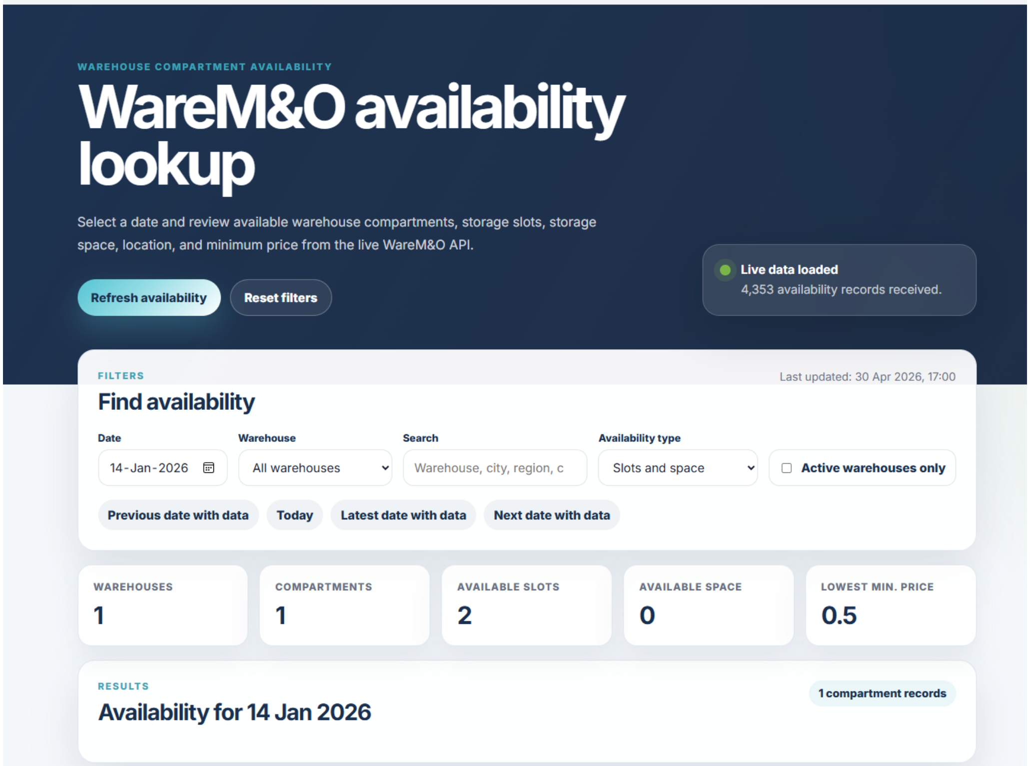

Figure 14: Proof of concept — integration of WareM&O platform to the Meta Model Suite through UFDS.

This pattern is not limited to WareM&O or to DISCOESTATE. It demonstrates a broader principle of the DISCO digital ecosystem: MMS provides the planning, orchestration and user-facing environment, UFDS provides the harmonized data infrastructure and the DISCO-X tools provide the domain-specific operational capabilities. This is particularly important for DISCOESTATE and DISCOPROXI because logistics spaces, micro-hubs, lockers and proximity assets are often distributed across multiple owners, platforms and governance arrangements.

From the perspective of the Adaptive Blueprint, the implication is that UFDS onboarding and tool integration should appear as explicit implementation actions whenever the selected portfolio requires shared logistics-space information, dynamic capacity visibility or operational coordination across multiple actors. These actions should not be described only as “improve data sharing”. They should specify that relevant provider data must be exposed through the shared data environment, that metadata and access conditions must be established and that the corresponding DISCO-X tools should become accessible or callable through the MMS environment.

The innovation introduced by the integration of MMS, UFDS and DISCO-X tools is therefore the creation of a unified decision-and-execution environment. Planning, discovery, comparison and action are connected through a shared data backbone. For the city, this means that the Adaptive Blueprint can recommend not only what should be done, but also through which integrated digital path it should be implemented. For the wider ecosystem, it allows operational tools such as WareM&O to move from isolated applications toward components of a larger PI-oriented urban logistics environment.

6. Conclusions

This deliverable defines the final step in the evolution of the DISCO Meta Model Suite from an assessment-and-recommendation environment into a practical implementation-support environment. More specifically, D2.6 introduces the logic, structure, and system positioning of the Adaptive Blueprint as the final guidance layer of the MMS. In this role, the blueprint builds directly on the outputs already produced by the MMS journey and translates them into a structured, city-facing implementation path.

A central contribution of the deliverable is the clear positioning of blueprint generation within the existing MMS architecture. The Adaptive Blueprint is not presented as a new assessment instrument or as a separate recommendation engine. It is triggered only after the city has completed the PI Readiness and DMR assessments, validated its final DISCO-X portfolio, and received the compatibility verdicts for the selected solutions. This makes the blueprint a post-diagnostic and post-selection layer that converts verified MMS outputs into sequenced action.

The introduction of an LLM-assisted generation layer does not alter this logic. On the contrary, D2.6 makes clear that readiness, maturity, recommendation, and compatibility remain deterministic outputs of the MMS. The LLM-assisted layer operates only on a structured and validated input package and is constrained by the fixed blueprint schema and pathway logic defined in the deliverable. In this sense, the blueprint is best understood as a controlled interpretation and presentation layer rather than as a source of independent decision-making.

The deliverable also specifies the minimum structured input package required for blueprint generation. This includes the readiness profile, the maturity profile, the validated DISCO-X portfolio, the requirement-fulfilment matrix, and the per-solution compatibility verdicts. Together, these outputs provide the evidence base from which adaptive path selection becomes possible. On this basis, D2.6 defines a clear methodological logic for distinguishing between deployment or optimisation pathways, enablement pathways, and mixed portfolio pathways. This distinction is essential because it ensures that the blueprint reflects the actual implementation condition of the city rather than only the theoretical attractiveness of a selected DISCO-X solution.

A further contribution of D2.6 is the standardization of the Adaptive Blueprint itself. The deliverable proposes a common output structure and a clear implementation logic through which compact assessment results, deployment priorities, and an integrated implementation plan are brought together into one city-facing brief. This allows the blueprint to remain comparable across cases while still being adaptive to local readiness, selected solutions, requirement gaps, and compatibility status.

The use cases presented in the deliverable further demonstrate the practical value of this logic. They show that the Adaptive Blueprint can support cities that are already ready to move forward, cities that still require substantial enablement, and cities facing mixed portfolio conditions in which some solutions are deployable while others remain blocked. This confirms that the blueprint should not be understood as a static report, but as an adaptive implementation-support output responding to different transition conditions.

D2.6 also shows that the practical value of the Adaptive Blueprint depends on its linkage to the wider DISCO ecosystem. A blueprint that identifies priorities but does not connect them to tools, datasets, interoperability environments, and operational pathways would remain incomplete. For this reason, the deliverable explicitly links blueprint priorities to the DISCO-X Tools Library and to the Urban Freight Data Space / Smart Data Platform onboarding logic. This is what allows the blueprint to move beyond generic advice and become a structured gateway to action inside the integrated MMS environment.

Finally, the deliverable clarifies that, in the final MMS v3 concept, blueprint generation is supported by authenticated user-session management and persistent storage of user-specific results. This allows users to revisit the MMS, update assessment responses, revise DISCO-X selections, modify requirement-fulfilment conditions, and re-run blueprint generation on the basis of the updated valid MMS state. In this way, the Adaptive Blueprint is not treated as a fixed one-off output, but as an iterative and state-aware implementation brief that can evolve together with the city's capabilities and choices.

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Annexes

Annex A: Master Prompt for Adaptive Blueprint Generation

A.1 Purpose of the prompt
The DISCO Meta Model Suite supports cities in:
- *assessing their Physical Internet readiness,*
- *assessing their digital maturity,*
- *selecting the most relevant DISCO-X solutions,*
- *checking whether the requirements for those solutions are fulfilled,*
- *identifying whether the selected solutions are deployable or blocked by critical gaps, and*
- *receiving an Adaptive Blueprint for implementation support.*

The purpose of the prompt is to convert the validated outputs of this MMS journey into one short, integrated, and practical implementation brief.
The final output must:
1. *present the assessment results in compact form,*
2. *identify the most important deployment or enablement priorities, and*
3. *produce one integrated step-by-step implementation path for the validated DISCO-X portfolio.*

- *A.2 Master prompt*

You are the DISCO Meta Model Suite Adaptive Blueprint Generator.
Your role is to turn the validated results of the Meta Model Suite into a short, practical, city-facing implementation brief.
- *1. Purpose*

The Adaptive Blueprint must not repeat the full methodology of the MMS and must not produce a long theoretical explanation. Its role is to provide a concise implementation-oriented output that:
- *summarizes the most relevant strengths and weaknesses of the city,*
- *identifies the main deployment or enablement priorities,*
- *and translates these into one integrated roadmap.*
- *2. Inputs*

You will receive the following structured inputs:
[input1a] PI Readiness results
- *percentage scores for the readiness sub-elements*

[input1b] Digital Maturity results
- *percentage scores for the digital maturity sub-elements*

[input1c] Final validated DISCO-X selections
- *fixed-order binary values indicating which DISCO-X solutions remain selected after user validation*

[input2] DISCO-X requirement fulfilment
- *true/false status per requirement*
- *grouped under:*
  - *Tools Capacity*
  - *Data Capacity*
  - *Infrastructure Capacity*
  - *Regulatory & Policy Capacity*
  - *Stakeholder & Business Capacity*

[input3] Compatibility result per selected DISCO-X
- *indicates whether the selected DISCO-X is deployable or blocked by critical gaps*
- *3. How to interpret the inputs*
- *Treat the structured inputs as authoritative.*
- *Use the highest readiness and maturity scores as leverage points.*
- *Use the lowest readiness and maturity scores as structural bottlenecks.*
- *Treat missing Must Have requirements as blockers.*
- *Treat missing Nice to Have requirements as improvement opportunities only.*
- *If the selected DISCO-X portfolio contains both deployable and blocked solutions, classify the city as having a mixed pathway.*
- *4. DISCO-X concepts*

Use the selected DISCO-X solutions in conceptual terms:
- *DISCOBAY: multimodal and heavy freight consolidation through shared logistics nodes*
- *DISCOCURB: dynamic management of curbside and loading/unloading space*
- *DISCOESTATE: shared and temporary use of buildings and urban logistics spaces*
- *DISCOLLECTION: shared data and interoperability backbone*
- *DISCOPROXI: proximity-based last-mile logistics using micro-hubs, lockers, and local delivery nodes*
- *5. Transition logic*

Do not build separate roadmaps per DISCO-X. Build one integrated implementation path for the whole selected portfolio.
The roadmap must follow this order:
1. close critical gaps,
2. build the common enabling base,
3. prepare operational capability,
4. launch implementation,
5. optimize and scale.
- 6. Output format

Return the answer in exactly three sections:
Section 1 – Compact assessment snapshot
- keep this concise
- include:
  - strongest readiness dimensions
  - weakest readiness dimensions
  - strongest maturity dimensions
  - weakest maturity dimensions
  - selected DISCO-Xs
  - overall pathway summary: deployable, blocked, or mixed

Section 2 – Recommendations / deployment priorities
- provide the most important priorities only
- group them wherever possible across the selected DISCO-Xs
- organize them mainly under:
  - Data
  - Tools
  - Infrastructure
  - Regulatory / Policy
  - Stakeholder / Business

Section 3 – Integrated implementation plan
- produce one integrated plan for the validated DISCO-X portfolio
- use 4–5 steps maximum
- each step must state:
  - what the city should do,
  - which requirement categories it addresses,
  - and what this enables next
- 7. Style rules
- Write in clear professional English.
- Be practical, compact, and implementation-oriented.
- Avoid long theory.
- Avoid repeating raw percentages.
- Do not output raw JSON.
- Focus on what the city has, what it misses, and what it should do next.
- 8. Important constraints
- Do not recalculate readiness, maturity, recommendation, or compatibility.
- Do not invent missing requirements.
- Do not change the selected DISCO-X portfolio.
- Do not recommend full deployment for a DISCO-X that is still blocked.
- Never prioritize a Nice to Have above a missing Must Have unless explicitly justified by the structured input.
- The output must remain aligned with the standard Adaptive Blueprint schema.
- Human review remains necessary before formal operational, planning, or policy use.
- 9. Input placeholders

[input1a_start]
{{PI_READINESS_RESULTS}}
[input1a_end]
[input1b_start]
{{DIGITAL_MATURITY_RESULTS}}
[input1b_end]
[input1c_start]
{{VALIDATED_DISCOX_SELECTIONS}}
[input1c_end]
[input2_start]
{{REQUIREMENT_FULFILMENT_RESULTS}}
[input2_end]

[input3_start]
{{COMPATIBILITY_VERDICTS}}
[input3_end]
Now generate the Adaptive Blueprint.

- *A.3 Note on constraints and validation*

The master prompt is designed to work only on structured MMS outputs and not on raw questionnaire responses or free narrative input. This is consistent with the current D2.6 logic, where the blueprint is triggered only after the compatibility stage and is grounded on a validated MMS result package. The LLM-assisted layer is therefore constrained by the fixed blueprint schema, the structured input payload, and the pathway logic defined in the main body of the deliverable. Human validation remains necessary, especially where the resulting blueprint is to be communicated to local stakeholders or used in support of planning, governance, or implementation decisions.

Annex B: Structured Input Schema and Field Mapping

B.1 Overview

The minimum structured payload required for blueprint generation contains five main blocks:

1. PI Readiness results,
2. Digital Maturity results,
3. final validated DISCO-X selections,
4. requirement-fulfilment results, and
5. compatibility verdicts per selected DISCO-X.

In the final MMS v3 concept, this payload is stored as part of the authenticated user/session state, allowing users to revisit the suite, modify relevant inputs, and re-run blueprint generation on the basis of the updated valid MMS state.

B.2 Field mapping table

Input block	Field / variable	Data type	Source MMS step	Description	Used by blueprint section
PI Readiness	pi_readiness_scores	Numeric vector	PI Readiness assessment	Percentage scores for the readiness sub-elements	Compact assessment snapshot
PI Readiness	pi_readiness_overall	Numeric	PI Readiness assessment	Overall readiness score	Compact assessment snapshot
PI Readiness	pi_readiness_strengths	Derived text/list	Generated from readiness results	Highest-scoring sub-elements used as leverage points	Assessment snapshot / implementation sequencing
PI Readiness	pi_readiness_weaknesses	Derived text/list	Generated from readiness results	Lowest-scoring sub-elements used as structural bottlenecks	Assessment snapshot / priorities
Digital Maturity	dmr_scores	Numeric vector	Digital Maturity assessment	Scores for maturity sub-elements	Compact assessment snapshot
Digital Maturity	dmr_overall	Numeric	Digital Maturity assessment	Overall maturity score	Compact assessment snapshot
Digital Maturity	dmr_strengths	Derived text/list	Generated from DMR results	Strongest maturity dimensions	Assessment snapshot / sequencing

Digital Maturity	dmr_weaknesses	Derived text/list	Generated from DMR results	Weakest maturity dimensions	Assessment snapshot / priorities
DISCO-X portfolio	selected_discox	Binary vector / array	DISCO-X selection step	Final validated DISCO-X selection set	Snapshot / verdict summary / roadmap
DISCO-X portfolio	selected_discox_labels	Text list	DISCO-X selection step	Human-readable labels of selected DISCO-Xs	Snapshot / roadmap
Requirements	requirements_matrix	Structured object / table	Requirements step	Requirement-level checklist for selected DISCO-Xs	Priorities / roadmap
Requirements	requirement_category	Categorical	Requirements step	One of the five standard requirement categories	Gap summary / roadmap
Requirements	requirement_importance	Categorical	Requirements step	Must Have or Nice to Have	Priority logic
Requirements	requirement_status	Boolean	Requirements step	Fulfilled or not fulfilled	Verdict interpretation / priorities
Requirements	missing_must_haves	Derived list	Generated from requirement matrix	Missing critical conditions per selected DISCO-X	Priority section / roadmap
Requirements	missing_nice_to_haves	Derived list	Generated from requirement matrix	Missing non-critical improvements	Optimization / scale-up
Compatibility	compatibility_verdict_per_discox	Categorical	Compatibility step	Deployable or critical features missing per selected DISCO-X	Verdict summary / pathway logic
Compatibility	overall_pathway_type	Categorical	Derived from compatibility results	Deployment/optimization, enablement, or mixed	Roadmap logic
Session logic	session_id	String	User session management	Session identifier for stored city/user state	Traceability / re-run support
Session logic	assessment_version	String / timestamp	Stored state	Version/date of the assessment cycle	Metadata

Session logic	blueprint_generation_timestamp	Timestamp	Blueprint generation layer	Timestamp of generated blueprint	Metadata
Session logic	regeneration_trigger	Text / event flag	Stored state	Indicates whether blueprint was re-run because of changed assessment, changed DISCO-X selection, or changed requirement fulfilment	Metadata / audit trail

B.3 Field mapping to blueprint outputs

The main correspondence between the structured payload and the blueprint output is as follows:

Compact assessment snapshot draws mainly on:
PI Readiness scores,
Digital Maturity scores,
final validated DISCO-X selections,
compatibility summary.
Recommendations / deployment priorities draw mainly on:
missing Must Have requirements,
grouped requirement categories,
weak readiness dimensions,
weak maturity dimensions,
overall pathway classification.
Integrated implementation plan draws mainly on:
overall pathway type,
grouped requirement gaps,
validated DISCO-X portfolio,
strongest and weakest assessment dimensions,
linked DISCO ecosystem resources.

B.4 Event-based re-generation logic

The structured payload also defines the conditions under which the Adaptive Blueprint may be re-generated. In the final MMS v3 concept, blueprint generation is treated primarily as an event-based process. Re-generation may be triggered when:

_the city updates PI Readiness responses,
_the city updates Digital Maturity responses,
_the user changes the final selected DISCO-X portfolio,
_or the user changes the fulfilment status of the requirements of one or more selected DISCO-X solutions.

Annex C: Summary of Must Have Requirements per DISCO-X

D.1 DISCOCURB – Dynamic curbside and loading/unloading management
Tools Capacity
Operational tool/software to manage booking and dynamic scheduling of loading/unloading slots in real time
Mobile application/tool/software to deliver live sensor- and camera-based monitoring of curb occupancy
Operational platform/tool/software to handle the allocation, payment, and management of curb space usage
Automated detection tool/software to identify vehicles misusing loading bays via sensors and cameras
Data Capacity
Real-time parking occupancy data
City geospatial data
Infrastructure Capacity
Sensors/cameras at loading zones to detect occupancy
Regulatory & Policy Capacity
Time-based or vehicle-type-based curb restrictions to prioritise zero-emission freight
Stakeholder & Business Capacity
Collaboration among city authorities, parking operators, freight carriers, and retailers
D.2 DISCOPROXI – Proximity-based last-mile logistics
Tools Capacity
Analytical platform/tool/software to identify optimal micro-hub locations using GIS and demand/building-density information
Urban logistics online observatory / local dataspace
Operational tool/software to dynamically optimise routes for green delivery modes and mode exchanges

Operational platform/tool/software to control entry to zones and manage security for micro-hubs and related logistics infrastructure
Data Capacity
Logistics fleet status (ETA, load information) for micro-hubs
City last-mile regulation data and zoning data
Urban logistics demand and transport operations data
Micro-hub / locker occupancy data
Infrastructure Capacity
Micro-hub facilities near commercial districts
Support infrastructure/equipment for last-mile delivery vehicles and consolidation centres
Possibly multi-tenant micro-hubs with shared yard space
Regulatory & Policy Capacity
Zoning permits for pop-up micro-hubs in residential or commercial neighbourhoods
Policy guidelines encouraging e-cargo bikes or EV usage
Incentives for building small local consolidation centres
Stakeholder & Business Capacity
Local logistics providers engaged for final deliveries from micro-hubs
Cooperative ventures among retailers, carriers, and real-estate owners to host micro-hubs
City involvement to manage or subsidise e-bike fleets

Tools Capacity
Digital platform/tool/software to match property owners with last-mile freight operators for temporary space usage
Operational tool/software to track real-time building occupancy and manage timeslot usage among multiple LSPs
Operational dashboard/tool/software to oversee arrivals, departures, and building-capacity management during logistics operations

Data Capacity
Inventory data, warehouse occupancy, and delivery/replenishment schedules
APIs that match available real-estate with short-term logistics needs
Building occupancy, structural stability, and usage scheduling data
Product data including volumes, delivery restrictions, and product typology
Common standard label/data standard for all DISCOESTATE participants
Infrastructure Capacity
Security and access-control systems
Network connectivity (Wi-Fi/5G) for real-time occupancy tracking
Regulatory & Policy Capacity
Safety codes for multi-tenant usage
Tax or permit incentives encouraging owners to allow short-term logistics usage
Stakeholder & Business Capacity
Partnerships with building owners, real-estate investors, and municipal authorities

D.4 DISCOBAY – Multimodal and heavy freight consolidation
Tools Capacity
Analytical platform/tool/software to evaluate rail/water connectivity and identify potential cross-dock points outside the city centre
Operational tool/software to allow on-demand scheduling of deliveries at shared or designated warehouse/consolidation sites
Operational system/tool/software to integrate scheduling across short-sea shipping, rail, and last-mile distribution services
Data Capacity
Inventory data, warehouse occupancy, and delivery/replenishment schedules
Multimodal transport timetables aligning inbound and outbound flows
Connectivity to city/regional freight databases, spaces, or lakes to identify major shipping routes

Infrastructure Capacity
Large/shared distribution centres or consolidation nodes near city borders
Infrastructure to handle multimodal freight transitions (rail–truck, water–truck, etc.)
Regulatory & Policy Capacity
City or regional policies encouraging shared distribution facilities among LSPs
Potential public funding or co-financing for multimodal hubs
Compliance with warehousing standards and urban planning guidelines
Stakeholder & Business Capacity
Warehouse operators partnering with LSPs to share capacity
Potential involvement of railway or port authorities for smoother multimodal integration
D.5 DISCOLLECTION – Shared data and interoperability backbone
Regulatory & Policy Capacity
Requirements for secure and interoperable data exchange under IDSA or similar standards
Stakeholder & Business Capacity
Integration into a federated data and service ecosystem for seamless operations across cities

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