



Article

Conceptual and Operational Integration of Governance, Financing, and Business Models for Urban Nature-Based Solutions

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Abstract: Governance, financing, and business models are deeply interlinked and relevant for the successful implementation of urban nature-based solutions (NBS). However, during the definition of urban NBS projects the importance and interrelation of these models are usually neglected. To overcome this limitation, this paper presents an overarching framework (conceptual and operational) and a derived preselection web tool which interrelate governance, financing, and business models for NBS projects. First, based on recent literature, governance, financing, and business models that could be applied to NBS were mapped, and their integration proposed. Later, key contextual factors influencing NBS implementation were identified. They form the basis of a WHAT-WHO-HOW framework that structures the links between specific NBS projects, their implementation context, and the most suitable models. From that framework, and an analysis of 50 successful NBS case studies, a suitability matrix was developed with known models. The matrix allows pairing types of NBS and their initiating actors with suitable financing and governance models. Lastly, a tailored NBS business model canvas was designed to evaluate the business model components. From the overarching framework, the preselection web tool was created to guide decision-making on suitable governance, finance, and business models in the early phases of NBS projects.

Keywords: nature-based solutions; implementation models; governance; financing; business models; urban areas



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1. Introduction

Nature-based solutions (NBS) are gaining traction as a novel umbrella concept that represents solutions inspired by and composed of nature, offering an alternative to traditional grey solutions. NBS are considered multifunctional and cost-effective solutions that are capable of addressing societal challenges [1–3], for example in providing strategies for the mitigation of natural hazards [4–6]. However, compared to traditional grey solutions, conceptual uncertainties (e.g., return of investment) still arise around NBS projects, hampering their acceptance among decision-makers and private stakeholders [7]. Besides conceptual uncertainty, the reluctance of the general to accept NBS initiatives also stems from a lack of legitimate participation processes during their planning and design [8,9]. Moreover, a disconnection between short-lived political cycles and long-term urban challenges blurs responsibilities and poses challenges (e.g., financial) to the establishment of continuous maintenance programs for urban NBS [10]. NBS implementation may also be hampered by governance issues such as the rigidity of municipal structures and their legal frameworks [11], as well as a lack of coordination between departments [12–14]. Consequently, during the definition of urban planning actions at the local level (as well as specific urban

interventions), conceptual uncertainties, in addition to the rigidity coming from local governments, generate implementation barriers that could impede the consideration of NBS as suitable solutions or reduce their success.

Urban planning actions such as urban greening strategies usually involve five phases, i.e., preparatory/exploratory, feasibility/conceptual, formal planning, design/implementation, and operational or post-implementation. Similarly, urban interventions or projects, e.g., the regeneration of a public square, tend to be structured in seven phases, i.e., strategic definition, preparatory briefing, conceptual design, spatial coordination, technical design, construction, and operational (see RIBA Plan of Work [15] for further details). In both cases, it is during the first three phases when conceptual uncertainties around urban NBS need to be resolved and suitable governance, financing, and business models for them need to start being defined to overcome or minimize implementation barriers.

In part, the conceptual uncertainties of NBS are associated with their innovative nature and novel governance and business models [16] which do not always match those of grey solutions. For the definition of strategic or specific urban NBS projects, especially during the preparatory and conceptual phases, several authors state the need to analyse key stakeholders (social actors), the suitability of governance arrangements, and funding and business models [17,18]. Qiao et al. also emphasize that an informed implementation of urban NBS requires an analysis of the rules that govern the interactions among social actors and available resources [19]. This analysis should occur in early planning phases. Furthermore, to increase the acceptance and success of NBS projects in the post-implementation phases, it is crucial to adapt them to the local socio-ecological context where they will be implemented [16,20,21]. For this adaptation, it is necessary to consider key contextual factors in the preparatory and conceptual phases of urban NBS projects or action plans including them. Despite the importance of the above aspects to overcome NBS implementation barriers, institutions supporting urban NBS mainstreaming, e.g., the European Commission [22] via initiatives such as H2020 projects, still tend to disregard them in the definition of frameworks and decision support tools for NBS.

Despite the above limitations, decision-makers and initiating actors of NBS projects are starting to demand user-friendly tools that offer guidance at least for the selection of suitable business models for NBS. The definition of business models is usually considered the first step for developing a strong business case [23]. However, the societal benefits stemming from NBS implementation (e.g., enhanced urban cooling) are not always easy to capture or link to a return on investments [16,24]. The monetary value of NBS and their business potential are highly dependent on their social value, the preferences of the different stakeholders, and the specific socio-political context where they are implemented [16,25]. The cost-effectiveness and feasibility of NBS projects are also determined by their long-term management (occurring in the post-implementation phase), which is linked to governance models decided in the pre-implementation phases. Consequently, the specific combination of governance, business, and financing models used to plan, develop, and manage a particular NBS directly influences its performance [26]. Therefore, a more effective NBS implementation process would benefit from an integrated consideration of collective action arrangements between stakeholders (governance model) and the associated financing and business models, including market-shaping strategies (MSSs), which are opportune for lessening the uncertainties associated with new markets [27].

The aim of this paper is twofold: (i) to present the development of an overarching NBS implementation framework that considers governance, financing, and business models in an integrated way; (ii) to present a preselection web tool of NBS implementation models developed based on the previous overarching framework. The overarching framework was developed at a conceptual level and an operational level. For the conceptual level, key literature on governance, financing, and business models was reviewed. The operational level was supported by the empirical assessment of cases studies of successful urban NBS projects that had already been implemented, which acted as “real-life” grounding examples guiding the suitable combination of models. As a practical value for decision-makers, the

preselection tool could help to mitigate the abovementioned implementation barriers and overcome the limitations of current decision support tools for urban NBS.

Regarding the socio-economic and geographic scope, this research is focused on European urban contexts, and therefore the framework and preselection tool were developed to be suitable in those contexts. In this sense, it is important to clarify that this paper understands “urban contexts” as any type of city, town, peri-urban or suburban area, or small thinly-population settlement, as has recently been recommended by the United Nations [28]. Consequently, urban NBS projects might involve interventions that span along a municipality or cross several, or which are limited to an urban block or groups of them, and might co-involve local to regional governance levels. It is also relevant to clarify that the development of a global framework and decision support suitable for any context is beyond the scope of this research, may not have been feasible (e.g., due to core planning system differences), and would have required an in-depth understanding of many other planning and governance systems. Additionally, as emphasized in the previous paragraphs, the early phases of urban planning actions and specific urban projects are the critical phases when governance, financing, and business models should be defined. Hence, the framework and online preselection tool presented here were developed to be useful at those stages when information is not complete, mainly qualitative and tools should be simple enough to be integrated in current workflows.

The following section describes the seven methodological steps carried out for the integration of governance, financing, and business models at the conceptual and operational levels, including the development of the online implementation model preselection tool. From the next section, the term “implementation model” (IM) is used only when referring to the integration of governance, financing, and business models. The term “governance” refers to collective action arrangements designed in order to implement NBS projects, while the term “government” refers to the formal organisations of the “public sector” [29]. Section 3 presents key results regarding (i) the map of governance, finance, and business models as well as their integration; (ii) the advantages and limitations of different integrations of implementation models; and (iii) the canvas defined for the implementation model preselection tool. In the last section, the advantages and disadvantages of the current work are summarised and future outlooks are briefly outlined. Section 4 is devoted to discussion and main conclusions are featured.

2. Methodology

The methodological approach utilised to undertake the integration of governance, financing, and business models for NBS projects covers 7 steps, as shown in Figure 1. The 7 steps aim to develop the abovementioned overarching NBS implementation framework covering the conceptual level (through key literature) and the operational level (through the empirical assessment of cases studies) in the 3 dimensions (governance, financing, and business models):

1. Mapping and clustering of governance, financing, and business models from key literature.
2. Definition of an integrated model (IM) typology that clusters governance, finance, and business models based on the degree of involvement of different types of social actors.
3. Identification of implementation factors linked to a particular socio-ecological system.
4. Definition of the WHAT–WHO–HOW framework (WHAT: NBS project, WHO: initiating actors, HOW: the implementation model) that interrelate the key contextual factors.
5. Development of the suitability matrix that builds on the previous steps and an analysis of 50 real NBS case studies (see Table A1 in Appendix A or the database in [30]). It matches NBS projects with suitable IMs, considering the initiating actor of the project and contextual factors (e.g., ownership, scale) using the WHAT–WHO–HOW framework.
6. Building of the NBS business case by assessing how suitable the sustainable business model (SBM) classified by Lüdeke-Freund et al. [31] is for NBS projects. The NBS-oriented business model canvas (BSM) of [32] was selected as a suitable tool to integrate and visualise the results.

7. Creation of the IM preselection tool.

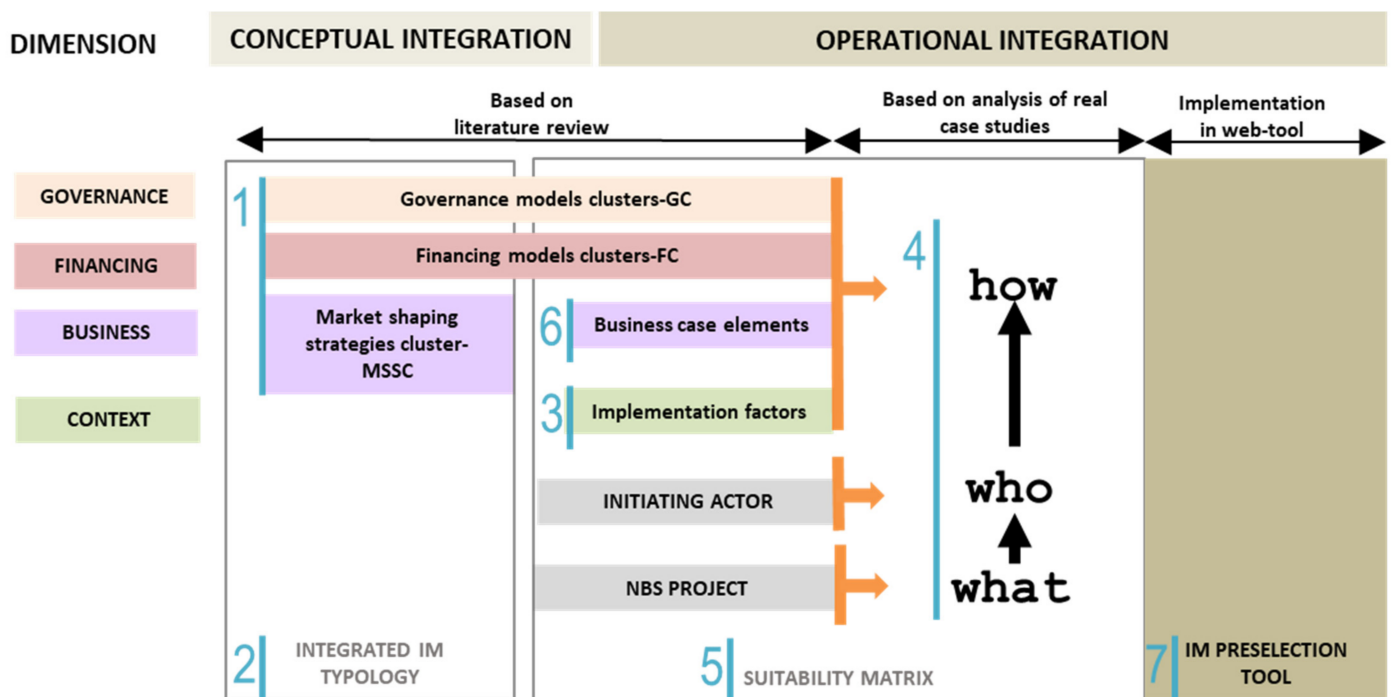


Figure 1. The 7 methodological steps for the conceptual and operational integration.

Steps 1 and 2 correspond to the conceptual side; meanwhile, Steps 3 to 6 represent its operationalisation (practical character) to support the implementation of real NBS projects. The following subsections describe in detail each of the steps.

2.1. Conceptual Integration

Conceptual integration is explored to endow operational integration with a robust framework based on current theoretical perspectives in the field. It also provides a reflection on integrated strategies of governance, financing, and business models and their implication in terms of NBS project implementation.

2.1.1. Step 1: Mapping and Clustering of Governance Models, Financing Schemes, and Business Models

Urban and environmental governance arrangements were analysed to identify and map them. Both are relevant since urban NBS projects or action plans integrating them require models that are at the intersection of urban and environmental governance.

For mapping purposes, urban governance is understood with its double meaning, described by Moretto as [33]: (i) “the formal, institutional theoretical and normative side” and (ii) the side that is “informal, local, community-based beyond policies and strategies”. Similarly, for mapping, environmental governance is considered as presented by Chaffin et al. [34] as a system composed of public institutions and private organizations that define a set of legal and social norms and regulations to govern environmental resource use and protection. To better understand current environmental governance models, the literature review conducted by Lemos and Agrawal was used as a basis [35].

In terms of financing models, depending on the governance model, urban NBS type (e.g., urban forest, green roofs), size, and scope, the NBS project can be funded through diverse financing models. The options can range from informal, grassroots, citizen-led fundraising to structured multi-national cooperation plans managed by development financing institutions. Both conventional and non-conventional funding methods to pay

for NBS implementation were mapped using as a basis the funding methods reviewed in the N4C project [36].

The urban and environmental financing and governance models found in literature could not be structured in clearly delimited boxes since conceptually models overlap regarding some characteristics. The triangle formed by state/government, market, and community (governance and financing triangle) can be used as the framework to schematically structure and classify strategies for environmental governance and financing strategies [35]. This triangle is formed by 3 axes (i.e., government-community, government-market, and community-market) that connect the above 3 attributes (Figure 2).

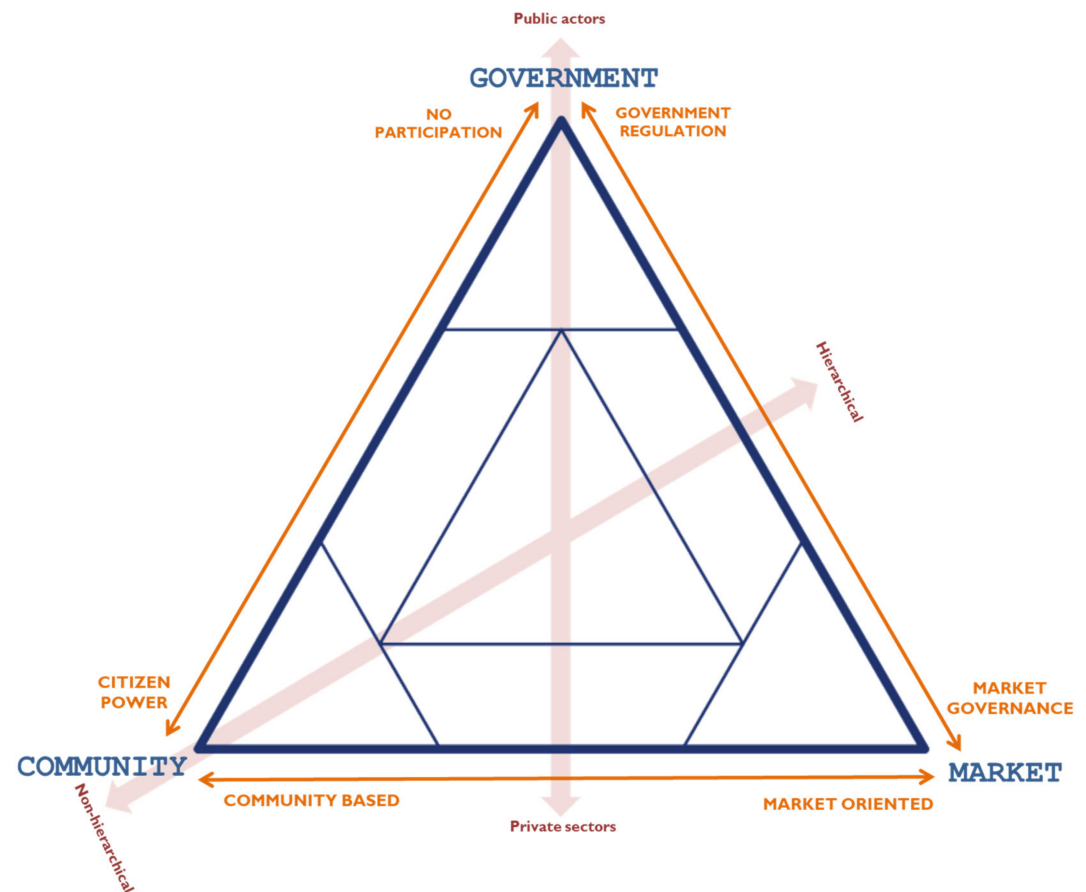


Figure 2. Mapping governance, business, and financing models in a 3-axis scheme to facilitate its posterior integration.

Based on the work of Abbot and Snidal, the “governance and financing triangle” is divided into 7 different zones which were used to map different types of governance and financing arrangements [37]. During the operational integration, the triangle also facilitates the identification of suitable implementation models according to the initiating actor (WHO).

The gradients in urban governance are well represented as the Government–Community axis. In 1969, Arnstein proposed that the degree of involvement of the citizen in planning processes could be placed at different degrees ranging from no participation to citizen control [38]. Governance decisions could range from an approach where the government aims to achieve public support for already-made decisions to a situation where the public has the power to assure accountability or even to plan and manage without intermediaries. To better understand at which point on this axis a model is placed, the intensity of participation can be classified according to the range of parties included in the decision-making

process, the intensity and direction of information flow, and the level of influence in the decisions to be made [39].

The environmental governance side can be represented as the Government–Market axis. Here, the involvement of market actors in environmental collaboration helps to overcome the inefficiencies of government action by injecting competitive pressures through market actors capable of achieving bigger profitability in the utilization of environmental resources [35]. In a competitive context, self-interested individuals express their desires as consumers in a specific market. The different models for this kind of arrangement could be placed on a spectrum that ranges from almost fully public-sector governance (government regulation) to almost fully private-sector governance (market governance) through a mixed model with different degrees of private involvement: solely agreeing on the framework of the project, creating joint ventures with equal participation of private and government, or taking authority over what to do and how to do it, making efforts to include the broader community.

The Community–Market axis represents the cases in which the governance and financing arrangements occur between private actors in a non-hierarchical mode. In other words, this axis becomes more relevant for decisions led by citizens, with minimum intervention of public government or by private organizations that act as market actors or balance between both.

Concerning business models, conceptual mapping focuses specifically on sustainable business models (SBMs) as considered by Geissdoerfer [40]. This means that models either incorporate concepts, principles, or goals that aim at sustainability or integrate sustainability into their value proposition, value creation and delivery activities, and/or value capture mechanisms. In the specific case of NBS, which need to fulfil the provision of social, economic, and environmental benefits cost-effectively [22], it was considered necessary to narrow down conceptual business models to those that consider sustainability criteria. As part of the review of business models, a study mapping SBMs by proposing archetypes was considered as a potential reference [41]. However, in that study SBM archetypes were not defined with enough detail to be mapped, and a posteriori, it could not have been used to build conceptual integrated implementation models. As an alternative, literature on market-shaping strategies [27,42] was found to be more adequate for the initial mapping of SBMs and their posterior integration as part of implementation models.

The identification of potential business models for novel solutions such as NBS projects which differ from governance and financing models requires a case-by-case approach. However, due to the uncertainties associated with NBS (as anticipated in Section 1), there is still a commercial reluctance from the business side. In fact, private sector participation in NBS projects is still incipient [30]. Market-shaping strategies (MSSs) have already been identified as appropriate to mitigate uncertainties associated with new markets [27], justifying their use. Specifically, Knight et al. identified collaborative relationships, long-term contracts, and the use of intermediaries as market-taking strategies to mitigate supply uncertainty in new markets, and considered possible implications for market evolution and dynamics [27]. Pro-active shaping strategies are also useful where the institutional framework is insufficiently supportive and the regulatory framework and cultural-cognitive aspects are highly rigid [42], which is the case of NBS projects, as already reported in Section 1. Therefore, the use of market-shaping strategies could serve as a tool for use in combination with the triangle formed by the 3 types of initiating actors (i.e., public institutions, private businesses, citizen community). Mapping of MSS could be also overlapped on the triangle, and it would facilitate the inclusion of the private sector in the implementation of NBS through the shaping of the emergent market. Two main literature sources were used to identify the MSS, and their application to NBS projects was assessed as can be seen in Table 1.

Table 1. Market shaping strategies (MSSs) and their application to NBS projects (P = primary source; S = secondary source).

TARGET	MSS	SOURCE		NBS APPLICATION
		P	S	
CLUSTER 1: PRIVATE MSS Initiating actor: MARKET *				
Community	Obtaining knowledge about user behaviour	[43]	[44]	Using the obtained knowledge for NBS-oriented product development
	Shaping the preferences of the end-users	[43]	[27,44,45]	Promoting NBS through collaborative marketing and direct relationships with citizens
	Reframing the discourse	[43]	[46]	Building a new discourse around social and ecological values of NBS instead of monetary ones
	Building demand for sustainable innovation	[43]	[47–49]	Integrating the principles of open innovation co-creation along the value chain for NBS projects
Market	Boundary spanning within and beyond the firm	[43]	[50]	Strategic partnerships among private actors can develop in business ecosystems, improving the suitability for NBS projects
	Buyer–buyer cooperation	[43]	[27]	
Government	Influencing the regulatory institutions	[43]	[45,51]	Exemplary NBS projects could help to gain visibility and increase the awareness and legitimisation of citizens and public bodies
CLUSTER 2: PUBLIC MSS Initiating actor: GOVERNMENT *				
Market	Public procurement	[27]	[52,53]	As a strategic tool to influence markets, promoting fair competition among suppliers of NBS and incentivising innovation and investment
	Encouraging new suppliers	[27]	[54,55]	The government can incentivise new suppliers to enter the NBS market
	Innovation by agency	[27]	[56]	A third party, such as a national buying agency, can promote NBS innovation
CLUSTER 3: COMMUNITY MSS Initiating actor: COMMUNITY *				
Market	IT applications	[27]	[57]	The NGO can use IT-based applications to reduce the costs and risks of trying new suppliers and products
	Vendor cooperatives	[27]	[58]	Act as an independent intermediary between the buyer and the supplier in NBS implementation
	Industry standardisation	[27]	[52]	Participation in industry standardisation processes can influence the industry supply to promote NBS
	Identification of one's own needs	[27]	[52]	The identification of one's own requirements regarding NBS and communication to potential suppliers can influence the market
	Joint understanding	[27]	[52]	A joint understanding between the end-user and the sellers can promote NBS products and projects

* For each of the clusters (in bold) the initiating actor correspond to one of the vertices of the 3-axis scheme.

2.1.2. Step 2: Typology of Integrated Implementation Models

The governance, financing, and business models were conceptually integrated into different types of implementation models (IM). This integration builds on the work of Lupova-Henry and Dotty on the governance of sustainable innovation [43]. Lupova-Henry and Dotty define approaches based on the role of initiating actors, similarly to the

definition in Section 2.1.1. Each IM was characterised, describing its 3 types of models, their advantages and disadvantages, and recommendations for their implementation.

2.2. Operational Integration of Implementation Models

2.2.1. Step 3: Consideration of Implementation Factors

The first step to make the conceptual integration operational to support the implementation of NBS urban projects is to introduce the context into the decision-making process. This is necessary because urban NBS projects are highly context-specific, being closely linked to a particular socio-ecological system [59]. As part of this study, 2 types of implementation factors were differentiated (for detailed information, see Table A2 in Appendix A)

- (i) Context conditions, i.e., regulatory socio-cultural and economic context factors, which the project developer cannot influence as they are imposed by the specific situation of the city;
- (ii) Project developer requirements, i.e., factors dependent on the end-user, such as budget or the desired participation level or scale.

An identification was made of those factors which influence the selection of governance models (GMs), financing models (FM), or business models (BM), as well as the implementation factors which are structurally related to the NBS project.

2.2.2. Step 4: WHAT–WHO–HOW Implementation Scheme

To structure the links between specific NBS projects, their implementation context, and the most suitable IM, the WHAT–WHO–HOW scheme was selected for its simplicity and operativity (Figure 3). It has previously been used to analyse governance strategies in the field of sustainable innovation [43]. This framework makes it possible to link 3 key dimensions in the implementation of NBS projects:

- (i) The specific NBS project (WHAT), which is the combination of the NBS types defined and the implementation factors that are structurally related to the NBS (ownership and scale);
- (ii) The initiating actors (WHO) that form the basis of the “financing and governance triangle” and will determine the nature and rules of the IM;
- (iii) The implementation model (HOW) defined by the contextual factors and user requirements that also influence the governance, financing, and business models.

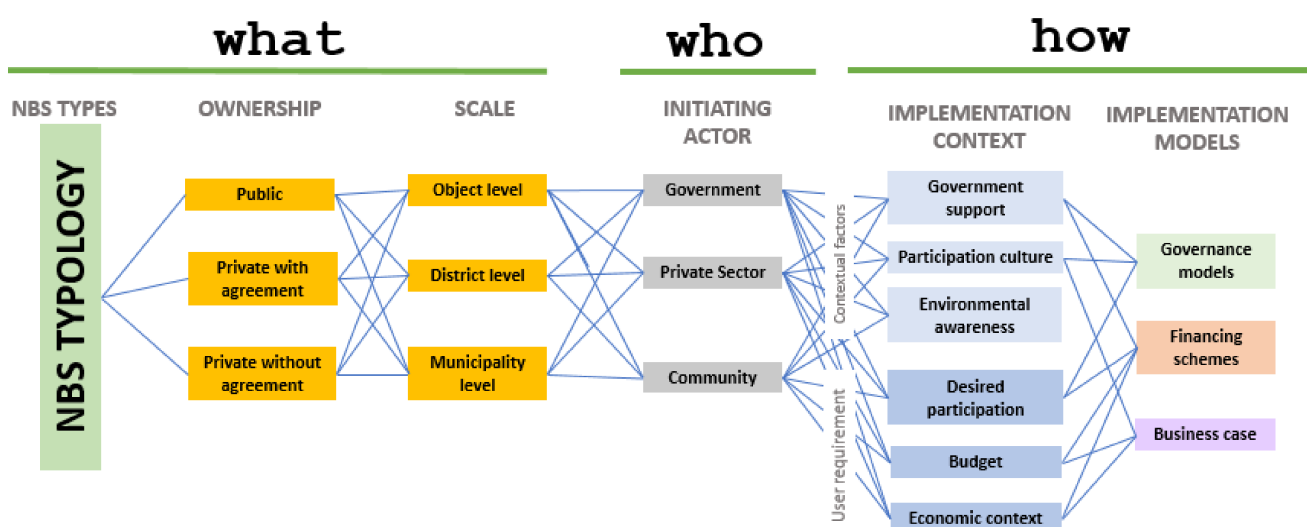


Figure 3. WHAT–WHO–HOW scheme for operative integration of IM.

To fully characterize WHAT, the list of possible NBS types was defined using the NBS typology developed in the N4C project [60]. To be able to define WHO in detail, sub-groups

inside the 3 types of initiating actors were identified (for detailed information see Table A3 in Appendix A). The list includes object and city-scale actors, which are typically identified in the literature as the key actors in NBS implementation [7].

2.2.3. Step 5: Suitability Matrix

The suitability matrix includes all the possible combinations of factors for every governance and financing model. First, a prototype of the suitability matrix was built using the information collected in the previous steps. The suitability of the different models was defined based on the experience of real NBS projects, for which implementation models were analysed in the N4C project (62 projects from Europe, 4 from America, and 1 from Asia) [30].

The N4C project provides an IM database of 56 of these projects and 11 projects from 4 case study cities: Milan (IT), Alcalá de Henares (SP), Szeged (HU), and Çancaya (TUR). Having discarded projects that had insufficient information on the factors that defined the governance and financing models (NBS typology, scale, ownership, initiating actor, desired participation, government support for governance, and budget for financing) or which were not real NBS implementation projects, 50 projects were then selected to link the governance models and 34 to build links regarding financing models (see Table A1 in Appendix A).

To test and adapt the first prototype, all the factors (WHAT–WHO–HOW) identified in the literature review for each governance and financing model were compared against the reviewed NBS projects. In the event of non-coincidence (see Tables A3 and A5 in Appendix A), the projects were re-evaluated to analyse the reasons and then adapt the suitability matrix to include the valid non-considered combinations.

This case study analysis showcased that most projects are multi-NBS projects (i.e., that include more than one NBS type) and only 3 projects involved single NBS typologies. Therefore, multi-NBS projects were incorporated in the matrix and an analysis of the factors that differentiate single-NBS projects from multi-NBS projects was conducted. The incorporation of multi-NBS projects was carried out using the same process: defining the WHAT–WHO–HOW factors for the projects and linking them to the IM.

2.2.4. Step 6: Building the Business Case

As mentioned in Section 2.1.1, the creation of a business model requires a case-by-case approach. However, the initiating actor can be supported with a narrow list of suitable and compatible options for the different elements of the business model to facilitate the creation of a specific one for their NBS project.

The SBM patterns classified by Lüdeke-Freund et al. [31] were used to facilitate the definition of business models adequate for NBS. Concurrently, the model developed by Osterwalder and Pigneur [61] was used as a basis for the definition of the business model canvas (BMC). Some of the 9 initial elements of their BSM were adjusted to tailor them more closely to the characteristics of NBS projects. This adjustment was made using as a supporting reference the work of the H2020 project Connecting Nature [32]. The 9 elements of the BMC make it possible to break down the implementation proposal into different governance, financing, and business case elements and link them to SBM patterns.

Selected governance and financing models provide a direct answer to some of the elements (key partners and key resources/investors) of the BMC, but the rest had to be defined on a case-by-case basis. To support this definition, the potential applications of SBM patterns to NBS were assessed according to 4 criteria:

- (i) Scale: the SBM is applicable at the building, district, or municipal scale;
- (ii) Domain: the SBM may be applicable in building environments or urban strategies;
- (iii) Geographical framework: the SBM may be applicable in Europe;
- (iv) Value chain: the SBM may be applicable in the business sector related to NBS.

Each pattern was assessed according to these criteria using 3 levels (high, medium, and low) and their suitability was evaluated according to a final score. For details regarding the intermediate results of this assessment, see Table A6 in Appendix A.

2.2.5. Step 7: IM Preselection Tool

The suitability matrix was implemented in a web-based tool (the IM preselection tool) that is offered in an automatized form-suitable IM for specific NBS projects and implementation conditions. To ensure that the tool was accessible and user-friendly, its usability was tested in a pilot version by members of the Nature4Cities consortium and sister H2020 projects consortium, and attendees participating in the N4C webinars. Their feedback was collected and used to define the current version of the IM preselection tool, which can be explored in [62].

3. Results

3.1. Mapping of Governance, Financing, and Business Models (Market-Shaping Strategies) and Their Conceptual Integration in Implementation Models

The mapping and cluster of the 13 governance and 18 financing models identified are presented through the “governance and financing triangle” in Figure 4. On top of them, 15 market-shaping strategies that would help to define the business models are presented in Figure 5. The overlapping of both types of results, supported by the work of Lupova-Henry and Dotty [43], facilitated the definition of 4 IM approaches: State-Centric, Corporate-Centric, Society-Focused, and Collaborative. They are mapped in Figure 6 and their governance, financing, and market-shaping defining characteristics are described in Table 2.

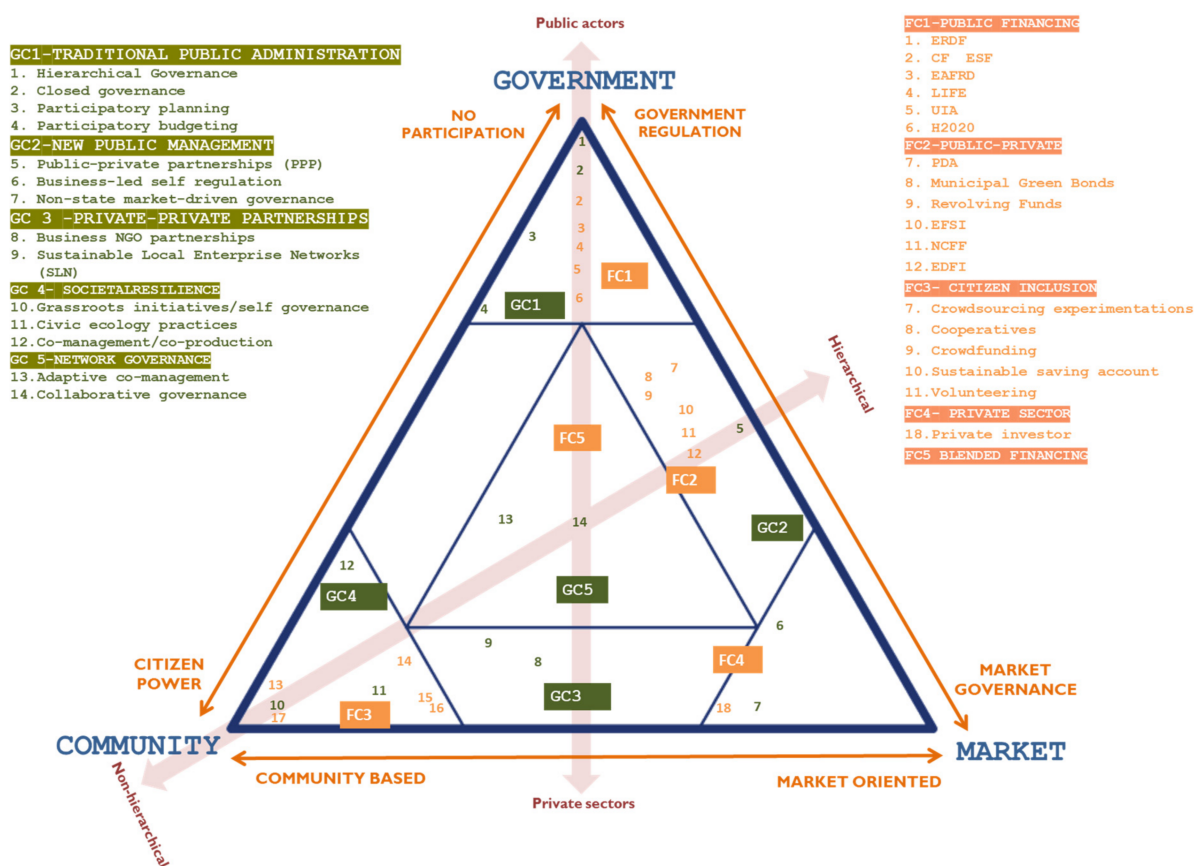


Figure 4. Map of governance and financing models.

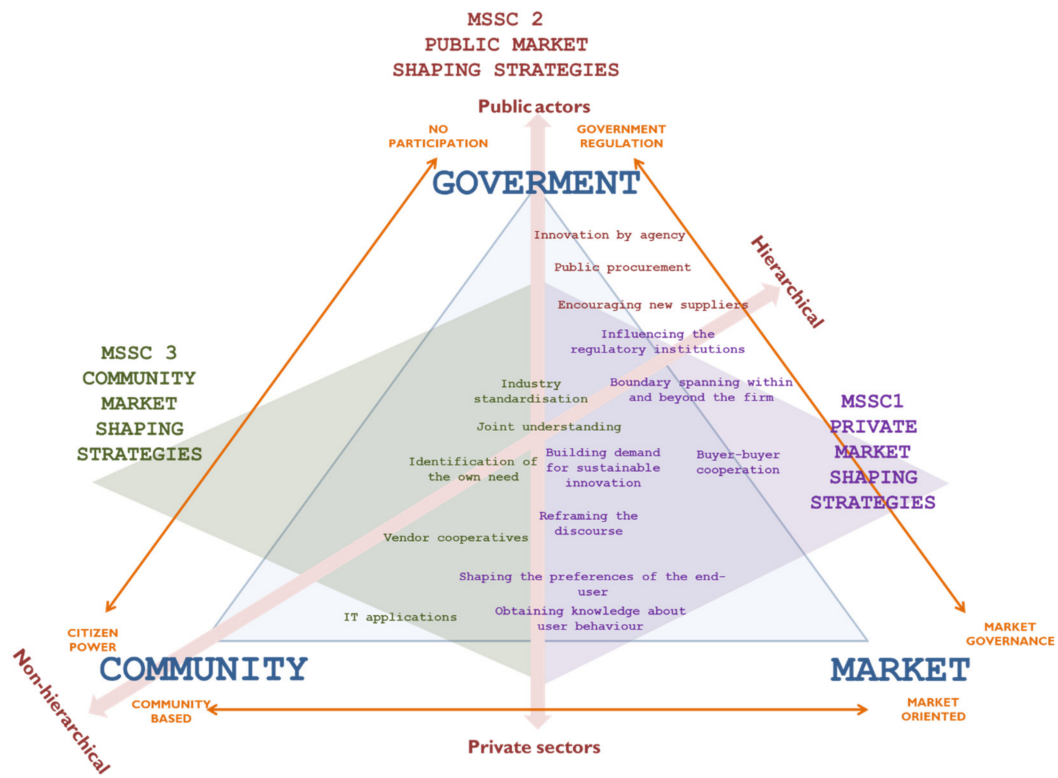


Figure 5. Map of market-shaping strategies clusters (MSSCs).

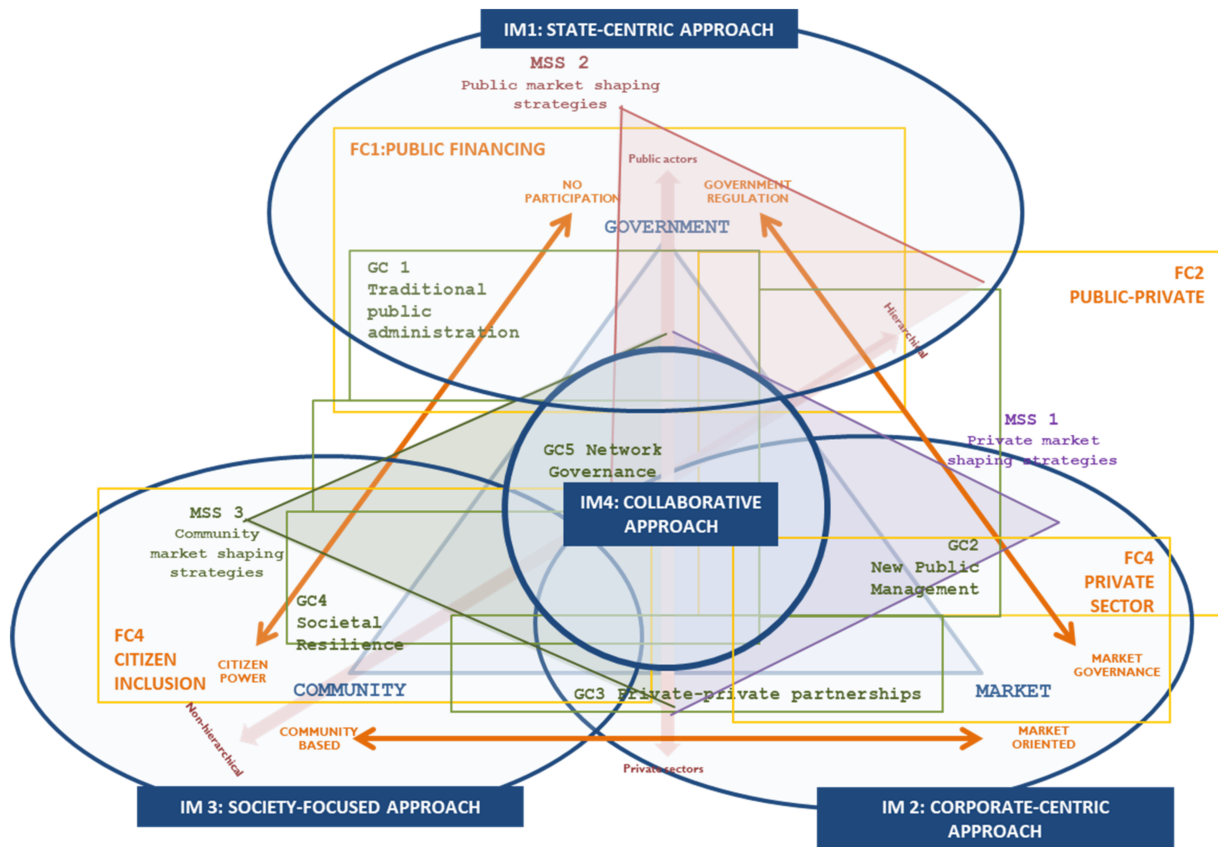


Figure 6. Map of integrated IM typology.

Table 2. Implementation models, their advantages, disadvantages, and recommendations.

IM	ADVANTAGES	DISADVANTAGES	RECOMMENDATIONS	SOURCES
IM1: STATE-CENTRIC APPROACH				
GM Traditional public administration	Could be highly operational for urgent problems and may initially provide large step-change improvements.	Less capacity for aspects required by NBS projects: local innovation, continuous improvement, and highly contextualised solutions. Services provided by a centralised entity could be more vulnerable to failure.	Facilitate collaborative arrangements without losing the government role: steering when partnerships exhibit the capacity for delivering and regulating when strategic planning is required.	[35,63–65]
FM Public financing	The allocation of a sufficient budget for implementing and maintaining NBS projects can endow sustainability during tight financing periods.	City budgets for green development and maintenance often face budget constraints. Financing mechanisms require co-financing.	Try the cooperation of multiple funding mechanisms, public-private partnerships, and blended finance.	[10,11,66,67]
MSS Public market-shaping strategy	Local governments can use incentives and the removal of administrative barriers to create partnerships with businesses where citizens can participate. Public procurement can modify markets to advance policy goals, promote competitive alternatives, and incentivise innovation.	Lack of incentives and motivation to attract private investment. In early-stage technologies, public market-creation mechanisms do not always lead to the development of sustainable innovation.	PPP can create new opportunities for efficient uptake of NBS through a common understanding of needs.	[27,42,43,68–70]
IM2: CORPORATE-CENTRIC APPROACH				
GM New public management	Fair competition in the private sector renders some processes more efficient and provides operational knowledge. Governments play important roles and they remain non-authoritative.	Could have low legitimacy and acceptance and display power asymmetry. Not always aligned with the community. More inclusive models might be suitable, but they require conditions that are rarely met.	Public responsibilities should not be eliminated. Government involvement in certain services ensures the efficiency of economic markets by reducing capital risks, increasing access to information, and reducing monopoly power.	[8,10]
FM Public–private	Inclusion of companies and the private sector in the implementation and management of NBS projects helps to overcome budget constraints and limitation of resources.	PPP are highly context-based. Strategic calculations could lead to the divergence of interests.	Efforts may be made to include the broader community, but authority over what to do and how to do it rests with the companies.	[70,71]

Table 2. Cont.

IM	ADVANTAGES	DISADVANTAGES	RECOMMENDATIONS	SOURCES
MSS Private market shaping strategy	Divesting from dominant solutions can leverage private funding, creating conditions for new BM. Researching the real needs of end-users engages the community and renders solutions more acceptable. Strategic partnerships with private actors can develop in business ecosystems suitable for NBS projects.	May neglect environmental and social values to maximise economic results. Utilitarian, short-term use triggers community rejection. Influence in the regulatory framework could be used to maximise economic results and avoid regulations.	Encourage methods to transfer the benefits of common goods provided by NBS to the initiators to stimulate private investment and render NBS more attractive. It is crucial to include social and environmental values along with monetary values to gain legitimacy.	[8,10]
IM3: COMMUNITY-FOCUSED APPROACH				
GM Societal resilience	High legitimacy and acceptance of the projects as they reflect local context. Can play a significant role in providing on-the-ground evidence of the multiple benefits of NBS. Management of natural resources is one field that is especially well suited for these types of governance.	Bottom-up initiatives often concern public green spaces, relying on public resources. There is a limit to the decentralisation of public goods and services. Grassroots movements are inherently unpredictable. Active society is required.	Try to include other stakeholders (especially local government). The involvement of scientists and NGOs helps to ensure larger impacts and longer-term sustainability but is not mandatory. There are sometimes adversarial relations with government and business.	[72,73]
FM Citizen-inclusive financing instruments	Flexibility and fewer requirements for financing. Self-financing and self-management projects can be sustainable and resilient as they are less dependent on changes.	Complexity of the civic market. Glamorous projects may be required. Benefits may not be in line with the time invested.	Try to ensure public funding to complete alternative financing systems.	[74,75]
MSS Community market-shaping strategy	A BM approach can facilitate the sustainability of grassroots projects. Tools such as IT-based ones and vendor cooperatives can define industry supply and monitor the market.	May require expertise that is not always available. Introduction of economic factors in voluntary-based approaches could create tensions.	Try to introduce private investment through a long-term partnership with socially conscious companies.	[27,52]

Table 2. Cont.

IM	ADVANTAGES	DISADVANTAGES	RECOMMENDATIONS	SOURCES
IM4: COLLABORATIVE ECOSYSTEM				
GM Network governance	Approach conceived for dealing with uncertainty and complexity. The “maturation period” of some NBS projects could provide an opportunity for long-term collaborative approaches.	Transaction costs are high and are usually only possible in democracies. Differences in organisational cultures between business and community.	Establish trust relationships to strengthen collaboration paths.	[34,76–79]
FM Multi-source	More mature international financing landscape. High suitability for large and complex projects. Sense of belonging renders it easier to mobilise efforts to obtain financing from different sources.	Difficulties in accessing private funding if agreement among stakeholders is weak.	Ensure blended financing mechanisms to achieve resilient, long-term economic sustainability.	[80]
MSS Multi-source	The business case approach is crucial to ensure the economic sustainability of collaborative projects. An integrated vision can also help to identify missing key partners and elements.	The limited inclusion of a business approach could generate tensions between different stakeholders.	Use the business model canvas as a tool to develop the business case and to identify missing key partners and elements.	[23]

3.2. IM Preselection Tool

The IM preselection tool presents the knowledge generated in the previous steps in a simple, easy-to-use, and automatized way. It integrates the three dimensions of the IM of NBS projects: governance, financing, and business. As illustrated in Figure 7, the tool is split into four steps to guide the users (decision-makers) on suitable IM for their NBS project. Besides those four steps, the tool also includes a Home page and a Conclusion page.

START THE PROCESS

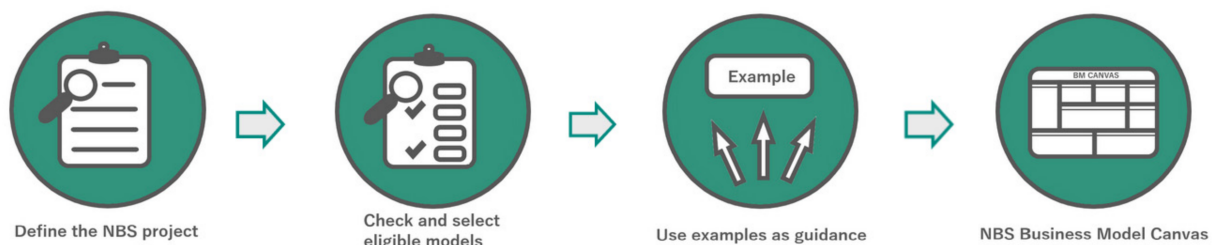


Figure 7. Process followed by the IM Preselection Tool to support the definition of IMs.

First, the users define the NBS project and implementation factors, which will restrict the number of adequate governance and financing models. Second, the users select the governance and financing models that they would like to explore. A new cluster was included in the tool to offer specific guidance regarding the financing methods related to

financial institutions. Third, the tool provides examples of NBS projects homologous to that of the user which have applied the selected models. This provides practical examples that could be further investigated by the user and used as a guiding reference in their NBS project. In the last step, as illustrated in Figure 8, the tool presents the users with the BMC (further details about the BMC can be found in Table A7 Appendix A), where they will find the following information:

- (i) The previously selected governance and financing models in the form of key partnerships and key resources/investors;
- (ii) Suitable SBM patterns related to the context in which the NBS project will be developed. Please check if it's supplementary materials that could help in the definition of the business case;
- (iii) Some questions that must be answered to complete the design of the business case appropriate to the NBS project.

NBS Business Model Canvas Template

Key Partnerships	Key Activities	Value Proposition	Other Stakeholders	Beneficiaries
GOVERNANCE MODELS	BUSINESS CASE	BUSINESS CASE	BUSINESS CASE	BUSINESS CASE
Adaptive co-management Governance model Government + Community + Priv... Key partners	Business pattern Examples Closing-the-Loop Patterns Business pattern Co-Product Generation or Industria... Examples	Business pattern Examples	Business pattern Examples	Business pattern Examples Government + Community + Private Key beneficiaries
To read the questions, please put the mouse on the info boxes	QUESTIONS TO BE ANSWERED	QUESTIONS TO BE ANSWERED	QUESTIONS TO BE ANSWERED	QUESTIONS TO BE ANSWERED
	Key Resources/Investors	Key Resources/Investors	Benefits Delivered	Benefits Delivered
	FINANCING MODELS	FINANCING MODELS	BUSINESS CASE	BUSINESS CASE
	Citizen inclusion Financing model High Budget 2,000,001 € and up Amount		Business pattern Examples	
	QUESTIONS TO BE ANSWERED	QUESTIONS TO BE ANSWERED	QUESTIONS TO BE ANSWERED	QUESTIONS TO BE ANSWERED
Cost Structure	Cost Structure	Potential Revenue Streams	Potential Revenue Streams	Potential Revenue Streams
BUSINESS CASE	BUSINESS CASE	BUSINESS CASE	BUSINESS CASE	BUSINESS CASE
		Business pattern Examples		
	QUESTIONS TO BE ANSWERED		QUESTIONS TO BE ANSWERED	QUESTIONS TO BE ANSWERED

Navigation buttons: GO BACK TO INPUTS, GO BACK TO ELIGIBLE MODELS, FINISH THE PROCESS

Logos: European Union, NBS BM CANVAS, NATURE 4 CITIES

Download button: DOWNLOAD THE NBS BM CANVAS

Figure 8. IM Preselection Tool BMC element visualisation.

The completed NBS BMC does not provide a one-size-fits-all solution. Instead, it provides users with information that would help define their specific IM (particularly regarding the business model) within a structure, narrowing down the potential options.

Once all steps are performed, on the Conclusion page the IM preselection tool provides a link to an NBS Implementation Handbook. Together with the results of the tool, it can be used to further guide the users (decision-makers) on the definition of the IM for their specific NBS project.

4. Discussion and Conclusions

This paper presents a two-fold approach (conceptual and operational) that analyses and compiles adaptable reference governance, financing, and market-shaping models to guide the development of implementation models (IMs) tailored to specific NBS projects and contextual conditions. The information gathered from the two-fold approach is embedded in a structured way into an IM preselection tool available to support decision making.

At a conceptual level and using the current literature, governance and financing models were compiled and structured based on the roles of initiating actors. Additionally, the theoretical framework for business models was defined based on a sustainable business model (SBM) approach and market-shaping strategies. The conceptualization provides a theoretical basis to help to build tailored IMs, including the creation of specific business models. However, the conceptual level alone presents limitations regarding their application to real NBS projects. For example, as already anticipated in previous sections, business model archetypes need to be very specific to the product or solution (NBS type) for which they are generated, and therefore need to be based on practical contextual and solution-specific data. In this sense, without the empirical data collected from real NBS projects at the operational level, the framework would have missed a good characterization of suitable business models archetypes. In more general terms this means that the abstraction process required for the conceptual level does not bridge the gap between theory and practice. Thus, the definition of implementation factors and building on real NBS case studies permitted overcoming this gap.

The operational integration of the governance, financing, and business models is based on a modular approach that helps to define smaller elements of the implementation model and uses the SBM “patterns” reported in the literature as a pragmatic way to present characteristics of models. As a result, this operational integration supports adaptation to specific contexts, which, as already mentioned, cannot be achieved by only using the conceptual side. It also permits the visualization of results using the NBS business model canvas (BMC).

During this research, members of NBS-related H2020 projects and attendees of public workshops validated the user-friendliness of the IM preselection tool through involvement in a testing process. This process permitted solving the deficiencies detected by the first users, such as lack of clarity in the description of some concepts (*“I think if you are not part of the project it’s difficult to understand the terms”, “Maybe more examples for communities description are needed”, “Some information about what ‘economic context is’ would be helpful” or “I am not familiar with some terms in the business canvas therefore, I had a bit difficulty interpreting the canvas”* are some of the comments that illustrate this limitation). They also highlighted the need to improve the visualisation of the BMC, suggesting making the canvas editable *“so that the user can configure the different sections”*. Moreover, they highlighted that some examples of an already-completed canvas might help understand what kind of information is needed in each case.

However, some aspects still need further development. For example, to cover the broad range of potential NBS projects, it is necessary to include new reference case studies. As another example, the approach is focused on the urban side, as already mentioned in the Introduction, and therefore it would not be adequate for rural NBS projects. As a user experience limitation, the current version of the tool still needs to become more interactive to improve its user-friendliness. Despite the limitations, the IM preselection tool was well received by experts and attendees as a tool supporting the definition of tailored IMs for specific NBS projects.

As an important characteristic, the IM preselection tool does not offer a simple one-size-fits-all output. This means that it does not offer a final IM ready to be used, which would lead to unsuccessful implementations due to the context-specificity of urban NBS projects. As a one-size-fits-all output, it would have been also inadequate for application in the early planning/project phases where information is partial and qualitative, being too rigid and therefore ineffective. Instead, the preselection tool provides users with information that would help them define their specific IM (especially the business model) inside a structure and narrows down the potential options. For example, it considers the conditions (e.g., spatial scale) that would constrain the definition of the business model and helps to reflect on specific SBM patterns that would influence it using guiding questions. In this sense, the IM preselection tool helps to overcome information overload, which is identified in the NBS literature as one of the barriers to accessing the knowledge generated [10]. Hence, the IM

preselection tool supports users, but is not intended to substitute their necessary reflection. As a practical use, the IM preselection tool, the IMs reported, and the NBS Implementation Handbook could easily be used in the early phases of urban NBS projects or action plans including them, e.g., the preparatory and conceptual phases, by decision-makers and/or professionals involved in NBS projects (such as urban planners or landscape architects). This method offers a set of effective and structured strategies that could be introduced in subsequent steps to the rest of the stakeholders involved, providing a starting point for an informed increasing definition of the IM that should continue during the rest of the phases of the NBS project. For example, based on contextual conditions the IM preselection tool helps to determine which different governance models are the most appropriate for different financing schemes. It also helps to define the appropriate elements in terms of business opportunities represented by the urban NBS project. Both aspects defined in a clear structured manner provide a starting point for the definition of the NBS IM that can also be further developed by users making use of the Implementation Handbook.

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Appendix A

Table A1. Selected projects used in the generation process of the characterization matrix (Source [30]).

PROJECT	NBS
Vrijburcht	Multi NBS: Private garden, Lawn, Green walls
UK National Forest	Multi NBS: Urban forest, Protection and conservation strategies
Park Lingezege	Multi NBS: Large urban public parks, Structures characterized by food and resource production, Urban green space management, Urban planning strategies
Hundertwasserhaus	Multi NBS: Choice of plants, Green roofs, Green walls and facades
Zorrotzaurre district	Multi NBS: Natural and semi-natural water bodies and hydrographic networks, Constructed wetland and built structures for water management, Urban green space management, Urban planning strategies
Swale_Floating Food Forest	Multi NBS: Structures characterized by food and resources production, Urban forests, Urban greens space management, Urban planning strategies
GAIA-Green Area Inner-city Agreement	Multi NBS: Large urban public parks, Single trees, Urban green space management, Urban planning strategies
Living Green City Graz	Multi NBS: Parks and gardens, Green roofs, Green walls and facades

Table A1. Cont.

PROJECT	NBS
A biotope-City and beyond-quartier for Vienna	Multi NBS: Green roofs, Green walls and facades, Urban green space management
VÄINAMERI Project	MULTI NBS: Ecological restoration, Urban green space management, Urban planning strategies
the DakAkker	MULTI NBS: Structures characterized by food and resources production, Green roofs, Urban green spaces management
Gomeznarro park	MULTI NBS: Systems for erosion control, Works on soil, Natural and seminatural water bodies and hydrographic networks, Constructed wetlands and built structures for water management
Green ventilation corridors in Stuttgart	MULTI NBS: Parks and gardens, Urban planning strategies
Green Roof Strategy in Hamburg	MULTI NBS: Green roof, Urban planning strategies
Bosco Verticale	MULTI NBS: Green roofs, Green walls and facades, Urban planning strategies
Drain Garden in Ober-Grafendorf	MULTI NBS: Constructed wetlands and built structures for water management, Urban planning strategies, Monitoring
Cloudburst Management Plan in Copenhagen	MULTI NBS: Constructed wetlands and built structures for water management
European Economic Area grants for implementing Climate Adaptation measures in Bratislava	MULTI NBS: Public urban green spaces, Lawns, Singles trees, Structures associated to urban networks, Green roofs, Urban planning strategies
Private and public funding to adapt Western Harbour in Malmö	MULTI NBS: Private gardens, Structures characterized by food and resource production, Choice of plants, Constructed wetlands and built structures for water management, Green roofs, Green walls and facades
European funds for flood protection measures in Smolyan	Natural and semi-natural water bodies and hydrographic networks
Conservation of Baltic raised bogs in Pomerania, Poland	MULTI NBS: Natural and semi-natural water bodies and hydrographic networks, Protection and conservation strategy
Multifunctional water management and green infrastructure development in an Eco district in Rouen	MULTI NBS: Parks and gardens, Structures associated to urban networks, Urban planning strategies
Barcelona trees tempering the Mediterranean City and beyond climate	MULTI NBS: Structures associated to urban networks, Urban planning strategy
Turbinenplatz	MULTI NBS: Public urban green spaces, Works on soil, Constructed wetlands and built structures for water management
Connswater Community Greenway	MULTI NBS: Large urban public parks, Structures associated to urban networks, Natural and seminatural water bodies and hydrographic networks, Urban planning strategies
Green strips Amsterdam	MULTI NBS: Structures associated with urban networks, Works on soil, Constructed wetlands and built structures for water management
Sportplaza Mercator Amsterdam	MULTI NBS: Choice of plants, Green roofs, Green walls and facades, Urban planning strategies
Citizen Initiative Greening Canals	Natural and seminatural water bodies and hydrographic networks
Smart City and beyond District Utrecht	MULTI NBS: Structures associated to urban networks, Constructed wetlands and built structures for water management, Green roofs, Urban planning strategies

Table A1. Cont.

PROJECT	NBS
Tide Park Rotterdam	MULTI NBS: Natural and seminatural waterbodies and hydrographic networks, Urban planning strategies
Photovoltaic Roof Garden	MULTI NBS: Green roofs, Urban green space management
The Avenue	MULTI NBS: Choice of plants, constructed wetlands and built structures for water management, Green roofs, Urban green space management
Hanging Gardens Oberlaa	MULTI NBS: Structures characterized by food and resource production, Green walls and facades
Kallang River-Bishan Park	MULTI NBS: Large urban public parks, Ecological restoration, Choice of plants, Natural and seminatural water bodies and hydrographic networks, Urban planning strategies, Monitoring
Thames Chase Plan	MULTI NBS: Large urban public parks, Ecological restoration, Protection and conservation strategies, Urban planning strategies
MA 48 Green Facade	MULTI NBS: Green walls and facades, Choice of plant, Monitoring
7 Seasons	MULTI NBS: Private gardens, Urban planning strategies
Urban Heat Islands Strategy Plan Vienna	MULTI NBS: Parks and gardens, Water, Urban green space management, Urban planning strategies
Green Connections project	Urban planning strategies
Plantation and management of an edible forest	MULTI NBS: Parks and gardens, Ecological restoration, Choice of plants, Systems for erosion control, Works on soil, Use of fauna, Protection and conservation strategies, Urban planning strategies
Restoration of the gallery forest on the right bank of the river Henares as it passes through the city	MULTI NBS: Ecological restoration, Choice of plants, Systems for erosion control, Works on soil, Use of fauna, Protection and conservation strategies, Urban planning strategies
İlhan Cavcav Park, Urban Green Space Management	MULTI NBS: Parks and gardens, ecological restoration, Choice of plants, System for erosion control, Works on soil, Natural and semi-natural water bodies and hydrographic network, Urban green space management, Waste management, Protection and conservation strategies, Urban planning strategies, Monitoring
İsmet İnönü Park, Water Management	MULTI NBS: Parks and gardens, Choice of plants, Natural and semi-natural water bodies and hydrographic network, Constructed wetlands and built structures for water management
Quarry Restoration: ATEg30–PERO	MULTI NBS: Parks and gardens, Structure for food and resource production, Ecological restoration, Choice of plants, Systems for erosion control, Works on soil, Natural and semi-natural water bodies and hydrographic networks
Quarry Restoration: ATEg32–GAGGIANO, TREZZANO SUL NAVIGLIO, ZIBIDO SAN GIACOMO	MULTI NBS: Parks and gardens, Structure for food and resource production, Ecological restoration, Choice of plants, System for erosion control, Works on soil, Natural and semi-natural water bodies and hydrographic networks, Urban green spaces management, Protection and conservation strategies
Quarry Restoration: ATEg15–PADERNO DUGAGNO	MULTI NBS: Parks and gardens, Structure for food and resource production, Ecological restoration, Choice of plants, System for erosion control, Works on soil, Natural and semi-natural water bodies and hydrographic networks, Urban green space management, Protection and conservation strategies
Quarry Restoration: ATEg20–POZZUOLO MARTESANA, TRUCCAZZANO	MULTI NBS: Parks and gardens, Structure for food and resource production, Ecological restoration, Choice of plants, System for erosion control, Works on soil, Natural and semi-natural water bodies and hydrographic networks, Urban green space management, Protection and conservation strategies

Table A1. Cont.

PROJECT	NBS
Reconstruction of Széchenyi square	MULTI NBS: Parks and gardens, Urban network structures, Ecological restoration, Choice of plants, Works on soil, Urban green spaces management, Waste management, Urban planning strategies
Plan for the rehabilitation of the waterfront of the Tisza River Part of Tisza Quay in Downtown	MULTI NBS: Parks and gardens, Urban network structures, Ecological restoration, Choice of plants, Urban green spaces management, Waste management, Protection and conservation strategies
Bird-friendly school gardens	MULTI NBS: Parks and gardens, Ecological restoration, Choice of plants, Works on soil, Urban green space management, Waste management, Protection and conservation strategies, Monitoring

Table A2. Implementation Factors (GM = governance model, FM = financing model, BM= business model).

IMPLEMENTATION FACTOR		GM	FM	BM	NBS
OWNERSHIP	Implementation conditions for developing and maintaining urban green infrastructure projects are very different depending on land ownership. NBS projects are frequently implemented on public land, but in a trend towards urban densification, it is also necessary to include private owners if a real impact is desired.	[76]			x
GOVERNMENT SUPPORT	The support of local government is decisive for implementing innovative solutions such as NBS, converting theories to action, facilitating collaborative arrangements, steering and orienting partnerships, attracting private investment through de-risking strategies and incentives, shaping early-stage markets through regulation, and providing public funding.	[66,69,81,82]	x	x	x
PARTICIPATION CULTURE	The success of NBS project implementation will depend on community acceptance, the involvement of all categories of stakeholders in the decision-making process, and the extent to which the community perceives the implementation process as having been transparent and inclusive.	[59,83]	x		x
ENVIRONMENTAL AWARENESS	An awareness of the importance of ecosystems and their services is required for the successful implementation of NBS projects through participatory approaches.	[59,83]			x
SCALE	The different types of NBS projects must be structured in their relevant scales, ranging from the building scale to the transboundary scale. Even when an NBS is implemented at micro scales, the wider context and consequences must be considered.	[59,76,84]			x
DESIRED PARTICIPATION	The initial planning of the desired involvement and detailed knowledge of communities targeted for implementation are very important for success.	[85]	x	x	
BUDGET	The range of available budget determines not only the type of NBS but also the complexity of the governance model and financing mechanism that can be used.	[7]	x	x	x
ECONOMIC CONTEXT	One of the most evident barriers to the implementation of any urban project is the lack of financing resources for all the relative costs of the project, including maintenance.	[7,18,85]			x

Table A3. Initiating actors and sub-groups of them from object to city-scale.

INITIATING ACTORS	SUB-GROUPS OF ACTORS	ROLE in NBS IMPLEMENTATION
GOVERNMENTS	Regional/national government	Large-scale NBS types such as parks, which have a high public interest factor, are often initiated by the government. Due to different regulations and laws, the implementation of NBS is influenced by the government at all levels, both positively and negatively.
	Local government/municipality	
COMMUNITY	Semi-government organisations/institutions	At the community level, the most important players are citizens and NGOs. Citizens: the initiation of an NBS by citizens often directly affects small NBS types such as neighbourhood gardens. Indirectly, however, citizens exert a strong influence on different NBS types of all sizes. This influence occurs via petitions and protests, but also through inquiries to municipalities and cities as well as through citizens' initiatives. NGOs: as consultants and lobbyists, NGOs often have a strong influence on initiating NBS. NGOs can evolve from citizens' initiatives. Large NGOs are often politically well-connected and can thus exert a strong influence on NBS via the government.
	NGOs/CSOs/interest groups	
	CBOs/neighbourhood communities	
	Citizens	
MARKET	Research institutions	The private sector and the market often initiate some NBS types that are at the object level. Influenced by government organisations, citizens, and/or NGOs, however, private and market actors can also initiate other NBS types, for example in the compensation for construction activities or for marketing purposes. Through lobbying, the private sector can influence the government, NGOs, and citizens.
	Private sector	
	Social enterprises/social entrepreneurs	

Table A4. Assessment of the suitability for NBS of the SBM patterns described and classified by [31].

Pattern Group (SBM Element)	Application Criteria					Suitability for NBS
	1	2	3	4	Total Score	
G1 Pricing and Revenue: Patterns that primarily address the revenue model of a business model, i.e., how offerings are priced, and revenues generated [31].						
"Differential pricing" [86]	3	1	3	0	7	MEDIUM
"Freemium"[86]	1	0	1	0	2	LOW
"Innovative product financing" [86]	1	1	3	1	6	MEDIUM
"Subscription model" [86]	1	1	3	1	6	MEDIUM
G2 Financing: Patterns that address the financing model within a business model, i.e., how equity, debt and operating capital are acquired [31].						

Table A4. Cont.

Pattern Group (SBM Element)	Application Criteria					Total Score	Suitability for NBS
	1	2	3	4			
"Crowdfunding" [86]	3	3	3	3	12	HIGH	
"Microfinance" [86]	3	3	3	3	12	HIGH	
"Social business model: No dividends" [87]	1	1	3	3	8	MEDIUM	
G3 Eco-design: Patterns that integrate ecological aspects into key activities and value propositions, i.e., how processes and offerings are designed to improve their ecological performance over their entire life cycle [31].							
"Hybrid model/Gap-exploiter model" [88]	0	0	3	0	3	LOW	
"Maximise material productivity and energy efficiency" [0]	3	3	3	1	10	HIGH	
"Product design" [89]	0	0	3	1	4	LOW	
"Substitute with renewables and natural processes" [40]	3	3	3	3	12	HIGH	
G4 Closing-the-Loop Patterns: Patterns that help integrate the idea of circular material and energy flows into partnerships, key activities, and customer channels, i.e., how materials and energy flow into, out of, and return to a company [31].							
"Co-product generation" [90]	1	3	3	3	10	HIGH	
"Industrial symbiosis" [91]	1	3	3	3	10	HIGH	
"Online waste exchange platform" [91]	0	0	3	1	4	LOW	
"Product recycling" [88]	1	0	3	1	5	LOW	
"Remanufacturing/Next life sales" [88]	0	0	3	1	4	LOW	
"Repair" [89]	0	0	3	0	3	LOW	
"Reuse" [89]	0	0	3	0	3	LOW	
"Take back management" [92]	0	0	3	0	3	LOW	
"Upgrading" [88]	0	0	3	0	3	LOW	
G5 Supply Chain: Patterns that modify the upstream (partners, resources, capabilities) and/or downstream (customers, relationships, channels) components of a business model, i.e., how inputs are sourced, and target groups are reached [31].							
"Green supply chain management" [92]	0	0	3	1	4	LOW	
"Inclusive sourcing" [86]	3	3	3	3	12	HIGH	
"Micro distribution and retail" [93]	1	1	3	1	6	MEDIUM	
"Physical to virtual" [86]	3	3	3	3	12	HIGH	
"Produce on demand" [86]	1	1	3	1	6	MEDIUM	
"Shorter supply chains" [94]	1	1	3	1	6	MEDIUM	
G6 Giving Patterns: Patterns that help donate products or services to target groups in need, i.e., how costs are covered, and social target groups are reached [31].							
"Buy one, give one" [86]	1	0	3	3	7	MEDIUM	
"Commercially utilized social mission" [95]	1	0	3	1	5	MEDIUM	
G7 Access Provision Patterns: Patterns that create markets for otherwise neglected target groups, involving modified value propositions, channels, revenue, pricing, and cost models, i.e., how value propositions are designed and delivered (and to whom) [31].							
"Building a marketplace" [86]	3	3	3	3	12	HIGH	
"e-Transaction platforms" [93]	0	0	0	0	0	LOW	
"Experience-based customer credit" [93]	1	3	3	3	10	HIGH	
"Last-mile grid utilities" [93]	3	3	3	1	10	HIGH	
"Value-for-money degrees" [93]	0	0	1	0	1	LOW	

Table A4. Cont.

Pattern Group (SBM Element)	Application Criteria					Total Score	Suitability for NBS
	1	2	3	4			
“Value-for-money housing” [93]	1	3	3	3	10	HIGH	
G8 Social Mission Patterns: Patterns that integrate social target groups in need, including otherwise neglected groups, either as customers or productive partners, i.e., how customers, partners, and employees are defined and integrated [31].							
“Expertise broker” [96]	3	3	3	3	12	HIGH	
“Market-oriented social mission” [95]	1	1	1	1	4	MEDIUM	
“One-sided social mission” [95]	1	3	3	3	10	HIGH	
“Social business model: empowerment” [87]	1	3	3	3	10	HIGH	
“Two-sided social mission” [95]	1	1	3	1	6	MEDIUM	
G9 Service and Performance Patterns: Patterns that emphasize the functional and service value of products and that offer performance management, i.e., how value propositions are defined and delivered [31].							
“Pay for success” [86]	3	1	3	3	10	HIGH	
“Product-oriented services” [88]	3	1	3	3	10	HIGH	
“Result-oriented services” [88]	1	3	3	3	10	HIGH	
“Use-oriented services” [97]	3	3	3	3	12	HIGH	
G10 Cooperative Patterns: Patterns that integrate a broad range of stakeholders as co-owners and co-managers, how partners are defined and how the organization is governed [31].							
“Cooperative ownership” [86]	3	3	3	1	10	HIGH	
G11 Community Platform: Patterns that substitute resource or product ownership with community-based access to resources and products, how value propositions are defined and delivered [31].							
“Sharing business” [98]	1	3	3	3	10	HIGH	

Table A5. Differences identified by governance model and project definition factors when comparing the combinations between the suitability matrix and the case studies.

Governance Models	N° of Projects that Introduce Changes in the Models	N° of Projects Influencing Each Factor				
		Initiating Actor	Scale	Ownership	Desired Participation	Government Support
Hierarchical	0	0	0	0	0	0
Closed governance	2	1	0	1	1	0
Participatory planning and budgeting	7	4	1	4	6	0
Public–private partnership	5	3	0	1	2	3
Business-led self-governance	0	0	0	0	0	0
Non-state market-driven governance (NSMD)	0	0	0	0	0	0
Business–NGO partnership	0	0	0	0	0	0
Sustainable local enterprise network (SLEN)	1	0	0	1	0	0

Table A5. Cont.

Governance Models	N° of Projects that Introduce Changes in the Models	N° of Projects Influencing Each Factor				
		Initiating Actor	Scale	Ownership	Desired Participation	Government Support
Co-management	2	2	0	0	0	0
Civic ecology practices	1	1	1	0	0	0
Self-governance/grassroots initiatives	2	1	0	0	0	1
Collaborative governance	11	4	2	1	8	8
Adaptive governance	4	4	0	0	3	4
Adaptive co-management	2	1	1	0	0	1
Total	37	21	5	8	20	17

Table A6. Differences identified by financing model and project definition factors when comparing the combinations between the suitability matrix and the case studies.

Financing Models	N° of Projects that Introduce Changes in the Models	N° of Projects Influencing Each Factor				
		Initiating Actor	Scale	Ownership	Desired Participation	Government Support
Public	2	0	0	2	0	0
Financing institutions	2	0	2	0	2	0
Public-private	9	0	1	3	8	9
Private	8	4	0	0	6	2
Citizen inclusion	1	1	0	0	0	0
Total	22	5	3	5	16	11

Table A7. Business case elements and NBS business model canvas.

NBS BUSINESS MODEL CANVAS TEMPLATE				
Key Partners	Key Activities	Value Proposition	Other Stakeholders	Beneficiaries
<i>Network of key partners that directly contribute to deliver the value proposition (strategic alliances, competitors, universities, etc.)</i>	<i>Most important actions a company must take to operate successfully</i>	<i>Product and services creating value for specific groups of beneficiaries</i>	<i>External stakeholders participating in the relationship between the NBS project and the groups of beneficiaries when the value proposition is delivered</i>	<i>Groups of people or organisations an enterprise aims to reach and serve</i>
GOVERNANCE MODELS	Eco-design patterns: Product design Substitute with renewables and natural processes Closing-the-loop patterns: Co-product generation Industrial symbiosis BUSINESS CASE	Service and performance patterns: Pay for success-based contracting Product-oriented services Result-oriented services Use-oriented services BUSINESS CASE	Community platform patterns: Sharing patterns Cooperative patterns: Cooperative ownership BUSINESS CASE	Social mission patterns: One-sided social mission Social business model Empowerment BUSINESS CASE

Table A7. Cont.

NBS BUSINESS MODEL CANVAS TEMPLATE				
Key Partners	Key Activities	Value Proposition	Other Stakeholders	Beneficiaries
	Key Resources/Investors <i>Resources to create and offer the value proposition, reach markets, maintain relationships, with beneficiaries, earn revenues (physical, financing, intellectual or human)</i>		Benefits Delivered <i>Those economic environmental and social benefits that the value proposition is providing to customer segments</i>	
	FINANCING MODELS		Access provision patterns Building a marketplace Last-mile grid utilities Value-for-money housing BUSINESS CASE	
	Cost Structure <i>Cost incurred to create and deliver value, to maintain beneficiaries, and generate new revenues</i>		Potential Revenue Streams <i>Cash a company generates from each group of beneficiaries</i> Pricing and revenue patterns Innovative product financing Subscription model BUSINESS CASE	
	BUSINESS CASE		BUSINESS CASE	

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