Co-creation and Convergence - The Methodology for Designing the Migrant Integration Platform MICADO

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ABSTRACT

The article reports about the development of the platform MICADO, a Horizon2020 innovation action, that merged approaches in business intelligence, data analytics and visualisation in support of migrant integration management in European cities. The resulting application addresses public authorities, civil society organisations, and migrants alike, providing multilateral information access, data exchange, and navigation for all involved stakeholders and institutions. Resting on the hypothesis that co-creation among user groups plus data integration across departmental silos enables high-quality service provision for migrant education, housing, labour, and health, a novel project methodology was created that focussed on custom-tailored co-design and convergence activities. These formats substantially helped to collect, analyse, and streamline the requirements raised by the variety of local stakeholders and use cases. The new methodology ensured the co-creation of a location-agnostic universal solution, its diversification into locally specific solutions, and its parallel pilot application in four cities. The MICADO approach may thus present a promising blueprint for agile and responsive IT development in the sphere of publication services.

Keywords: ICT Solution, Public Services, Migration, Co-Creation, Convergence

Abbreviations

CSO   Civil and Society Organisations

EUPL   European Public License

H2020   Horizon 2020 Funding Program of the EU

ICT   Information and Communication Technologies

LESC   Local Expert and Stakeholder Committee

MICADO   Migrant Integration Cockpits and Dashboards

MVP   Minimal Viable Product

PA   Public Authorities

TRL   Technology Readiness Level

1   Project Background

Outlining the experiences and insights gained from the Horizon2020 Innovation Action MICADO, this text describes the novel conceptual approach (the so-called Pagoda scheme) that was used to developed the solution, and which can serve as a blueprint for future challenges in ICT-development in the field of public services and administration.

MICADO is the abbreviation for "Migrant Integration Cockpits and Dashboards" – the name indicates the type of solution targeted: an application with visual appeal and low-threshold usability, that is accessible to a diversity of user groups and stakeholders. The project consortium was composed of partners from public authorities, universities and ICT companies in the cities of Antwerp, Bologna, Hamburg, and Madrid, who have joined forces to create new digital services in support of migrant integration. The Digital City Science at HafenCity University Hamburg acted as the lead partner and coordinator of the project, bringing advanced skills in software development in the context of urban development. The partnership was built in a way that an effective innovation process between authorities, research institutions, civil society and migrants in each of the partner cities would be possible. It consisted of fifteen partner institutions from five countries, conveying knowledge from public administration, migration research, software development and urban research.

The Horizon Innovation Action was carried out 2019 through 2022, within the specific call "Addressing the challenge of migrant integration through ICT-enabled solutions" (DT-MIGRATION-06-2018-2019). The project responded to the framework topics "Integrating digitisation in all industrial technologies and societal challenges" and "Societal Resilience", of the European Commission's Horizon2020 work programme. To fulfil the call´s requirements, the project targeted the exploitation of state-of-the-art ICT, data science and business intelligence in support of migrant integration, and to provide for effective analysis and management of migrant information by way of advanced visualisation tools, such as data cockpits and dashboards. As a project outcome, a new digital solution was presented that had been applied in the four aforementioned pilot cities – each one a hot spot of migrant integration in Europe. The actual software product simplifies the user-driven exchange between migrants, public authorities and civil society organisations, and fills existing gaps in terms of data availability, information access, and targeted servicing. Resolving the issue of inadequate information provision for, and data linkage about migrants, the MICADO solution taps various migrant-related data from a diversity of accessible sources in the cities, and cross-connects them through a platform serving the different stakeholder and user parties.

Departing from previous findings in the areas of service design and co-creation (Tuttle, 1997; West *et al.*, 2017), the consortium came up with a new methodological approach that aimed to integrate all relevant stakeholders within a goal-oriented design and development procedure. It was assumed that facilitated co-creation among all participants can enable a new level of service quality in the provision of migration management. To achieve this goal, MICADO linked the following three target groups which were conceptualised as digitally interconnected agents and actors:

- *Public Authorities (PA):* Local authorities in charge of the administrative and legal processes concerning migrant integration;
- *Civil Society Organisations (CSO):* Associations and citizens' initiatives actively engaged with migrants' integration;
- *Migrants:* Especially non-EU country nationals (including 1st generation non-EU migrants), and EU migrants who were not born in the country of residence.

In each of the different geographical and cultural contexts of the project, a certain set of fundamental challenges in migrant integration management was found that would form the basis of the intended service design: housing, health, education, and employment. In each city or regional administration, these issues are usually responded to by a specific authority. Thus, the implementation of effective services and cross-institutional data integration is usually obstructed by organisational and technical constraints. In addition, the usage of migrant data poses yet another challenge in terms of privacy, security, and safety. Detailed data provision by, for, and about migrants, however, appears often necessary in order to custom tailor integration services and offers.

Focusing on these demands and requirements, the special co-creation and convergence processes that eventually led to the MICADO solution are the central focus of this paper. The article discusses and reflects the unique creative path that was to include and integrate multiple contributions from a various target groups and application areas, as posed by the involved EU cities and their cultural and socio-political diversity.

With the general aim of achieving migrants' social integration, MICADO hypothesized that digital servicing not only means the creation of improved migration infrastructures, but also catalysing the agency of migrants. To respond to such demands, the consortium acknowledged the need for a highly transdisciplinary and integrative perspective. It was assumed that ICT and data science open the ground for new conceptual approaches, theoretical investigations as well as practical implementation that can comprehend the richness of situated specificities as well as general trends in migration research and practice. Thus, MICADO binds together complex migrant-related data and a diversity of digital functionalities to raise migrants' social capital and enable their inclusion into legal systems and labour markets.

The comprehension of these challenges motivated the MICADO consortium to run a design and development process which prominently placed co-creation at its centre. The process itself (explained in the following sections) aimed to secure a new level of technical and methodological integration on the one hand, and ensure user orientation and applicability on the other. This process enabled MICADO to put forward a product on Technology Readiness Level (TRL) 7 – that is: a field-tested and ready-to-use ICT prototype comprising three separate service applications (one per target group) which are interconnect via the system backend (Figure 1). The platform thus consists of (a) the *PA application*, through which administration operators are able to monitor migration events at the local level and process individual migrants' cases; (b) the *CSO application* for third sector entities that allows for the dissemination of information on services targeting migrants; and (c) the *Migrants application* with multi-lingual virtual assistance through which individuals are able to receive guidance on integration processes, access relevant information, and store their documents, among other features.
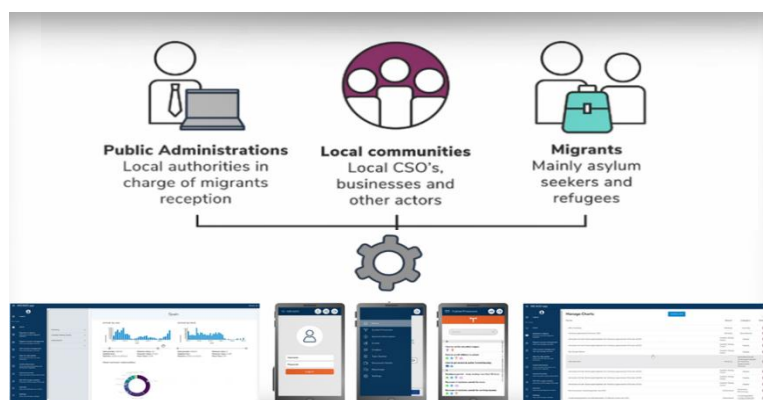

Figure 1: *Distinct yet connected applications for three target groups (Source: MICADO)*

Specific functionalities and features which can be used on these three different application include an Info Portal for the provision and exchange of valuable information for migrants, diverse Step-by-step Guides for leading through complex processes towards migrant integration, or a Courses & Events Monitor that publishes relevant activities for migrant integration. In addition, analytical features were implemented, such as visual displays of local migration statistics, or an analytic tracking of the platform´s activities and performance. The components described above form what the consortium had labelled the "universal MICADO" – a generic solution that was prepared for and provided to all partner cities engaged within the

project. It remained a main objective, however, to further develop more specific local solutions ("MICADAs") whose functional profiles would more closely respond to the individual conditions of each city.

The software features of MICADO can be investigated in depth on the website www.micadoproject.eu, while the software codes are published with the copy-left open source public licence scheme of the EU (EUPL European Commission's European Union Public Licence) on the repository Github (https://github.com/micado-eu/).

2   Conceptual Components for Co-creation, Convergence and Adaptation

In order to create an ICT solution with high responsiveness to the diversity of application contexts in the EU, the interdisciplinary and international consortium needed find effective forms of cooperation, and conceive a project design that could ensure the conceptual and technical coordination across MICADO´s development process. This overarching methodology needed to ensure that requirements from a multiplicity of partners and target groups would be collectively explored, processed and brought into workable unity (Sanders and Stappers, 2008). The invention of new measures to facilitate the key qualities of co-creation, concept convergence, and adaptation thus emerged as a priority task early in the project. While co-creation activities would be necessary to secure the user-orientation and novelty of the system, convergence activities would provide for its practical applicability and feasibility. Adaptation measures, in turn, would ensure the flexibility required for both grasping the complexities of the different local ecosystems, as well as reacting to sensitive issues such as the PA-side handling of personal information (which in cases may include representatives of vulnerable social groups) (Waltner-Toews and Kay, 2005). Consequently, the MICADO project was designed around extensive activities for multilateral user interaction and demand analysis. As prerequisites for the analysis and synthesis of collected requirements, as well as for a targeted design and development process, MICADO adopted a set of co-creative methods established in fields like design science or software development, and appropriated them for its specific purpose. Specifically, the co-creative approach differentiated into activities of "co-analysis" and "co-design". For the first, extensive workshops were run with all relevant target groups (PA, CSO, migrants) early on, as literature reports that their input is decisive especially in the first conceptual project stages (Stembert, 2017). Here, participants identified needs and requirements, and reviewed the service and data availability related to the four target domains of housing, health care, education and employment. In turn, the co-design activities engaged stakeholders and target groups via formats of collective design and ideation. Here, the so-called Double Diamond scheme was adopted as a key reference from the field of Design Thinking (Figure 2). The name refers to the graphical representation of successive phases of explorative and divergent activities that feed into analytical and convergent phases (Jilka, 2019, Kim, 2020, Plattner *et al.*, 2012, 2021). While divergence phases aim at generating a high number of potential solutions, convergence phases scope and narrow down the options into one feasible solution. Widely established the in fields of industrial design or software development, the method maintains the creativity of solutions and simultaneously their user-orientation and marketability (Nessler, 2018; Design Council, 2019; Heijne and van der Meer, 2019).
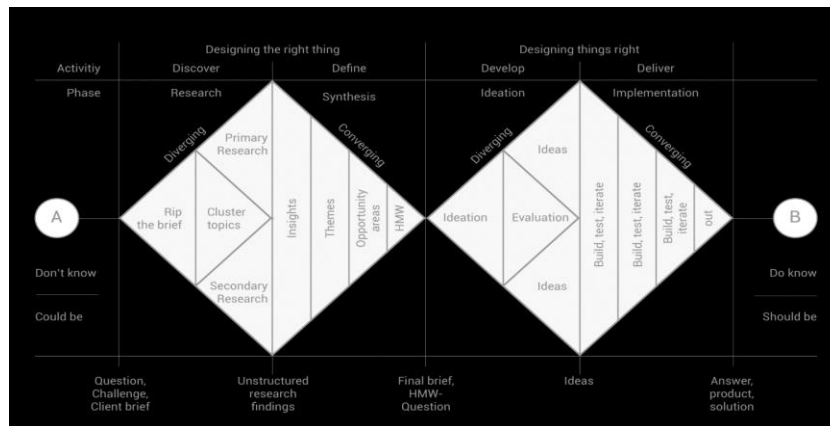
Figure 2: *Double Diamond scheme diagrammed (Source: Nessler, 2016)*

To implant the requisite flexibility both in the overall project process and in the technical solution, the MICADO team embraced an "agile approach". An established practice in the field of software development, Agility constituted the second conceptual key element of the MICADO process. In contrast to sequential work plans ("waterfall") featuring successive steps cascading from requirement definition over conceptual design, technical development and testing to final implementation, agile approaches propagate multiple iterative loops of these steps (Figure 3), in order to quickly deploy first prototype solutions that can be tested with users as soon as possible (Andrei *et al.*, 2019). The rationality is that repeated user testing generates insights which can neither be gained nor anticipated by pre-defined sequential work plans, but effectively drive the further development towards a feasible and applicable solution.

Figure 3: *Agile Approach (Source: Okeke, 2021)*

Agile software development projects regularly run through incremental phases of requirement and use case definition as key enablers for a successful design and development process. Demand definition commonly happens in co-creative workshops where user requirements and potential application scenarios are explored in a structured way. Subsequently, so-called Epics are created as overarching narratives binding together users in their situational context, the tasks they need to carry out, and the specific value that shall be created by the new product. Once promising use cases are defined, detail and precision are added by drafting User Stories. that break down the general aims and requirements into specific descriptions of the technical functions and features a user expects. Stated in a pattern-like format ("As a [user], I want to have [feature, functionality] in order to [purpose]") and collected in collaborative task management tools, these user stories provide a sufficient basis for the technical implementation of the software code.

Specially designed activities for use case and requirement definition, as described above, usually generate large "wishlists" of user stories for functionalities which cannot be implemented in their entirety, or at once, due to resource constraints. Hence, with strict assessment and prioritisation the features that are most relevant for the product success and performance need to be selected. The shortlisted functionalities define the so-called Minimal Viable Product (MVP), the core line-up of the technical solution to be implemented (Figure 4). The concept of the MVP is closely associated with the Lean Start-up methodology (Levinthal and Contigiani, 2018), as it emphasises "the importance of getting customer feedback from the earliest stage of the development process" to reduce the development costs and ensure the uptake of the product or service, by tailoring them towards their intended audience (Spencer, 2021). From testing a MVP – which is at the same time a development technique and a highly reduced version of a product that is ready-to-market – a development team can harvest the maximum knowledge about customers while investing least efforts (Ries, 2011). MVPs suggest enough value that early adopters are willing to use them; they demonstrate sufficient future benefit to retain the early adopters; and they provide feedback that can guide the future product development.
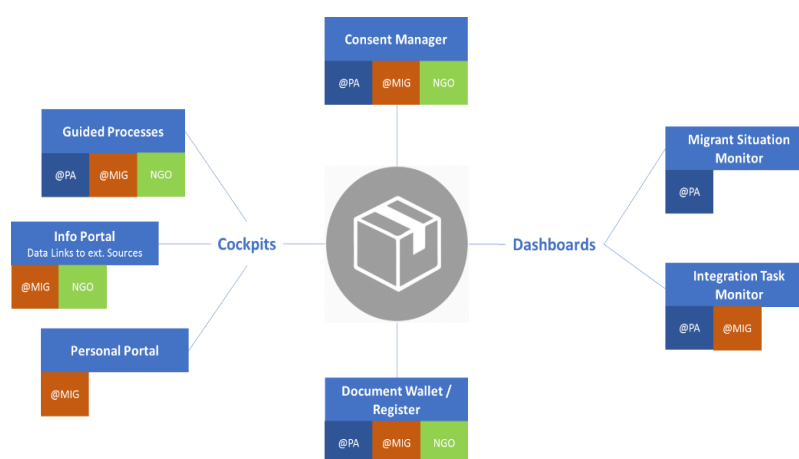

Figure 4: *Minimal Viable Product of the universal MICADO solution, showing key functionalities and features (Source: MICADO)*

The quick prototyping of the MVP aims for a "as-quick-as-possible" testing with end users. Their early involvement is a fundamental step in the agile and co-creative process (Hippel, 2005). While major portions of the technical development work are practically invisible to the end user (system architectures, data infrastructure engineering, scripting of code), the success of the product largely depends on the "look and feel" of the solution. Hence a clear anticipation of the user experience (UX) as well as user-oriented design of the graphical and navigational interfaces are a crucial task already early-on in the process, as they are the decisive contact points for the human-machine interaction, as well as for data collection and exchange. The testing with the end-users thus formed the last methodological component of the underpinning agile design and development process envisioned for MICADO.

MVP-oriented, user-driven, and co-creative – the components described above appeared very applicable to the challenges the MICADO consortium was to face. The co-development with the three user groups would ensure the overall relevance of the solution. The early feedback gathered with user tests would guarantee tailoring of MICADO to the needs of its target audiences and avoid the creation of unnecessary features. Finally, exposing the future users to the solution early on, and involving them in the development process, would strengthen their familiarity with the end product and create a sense of ownership. An

integration of these conceptual measures promised to ensure the usability of the MICADO solution as well its sustainability beyond the project's lifetime.

3   A Novel Project Design: The Pagoda Scheme

While the previous chapter outlined selected approaches as conceptual cornerstones for the MICADO project design, this chapter explains how they were shaped into a comprehensive project design. The implementation of this overarching methodology may serve as a potential blueprint for endeavours similar to MICADO, namely cross-national consortia venturing in the development of ICT solutions for the public sector.

Commonly, migrant integration needs to address a range of demand scenarios and application contexts. PAs in different European regions and cities utilise different systems and data, and provide distinct services according to the needs of their specific migrant populations. CSOs run a variety of activities and offer highly diverse support in respect to their regions and locations. Depending on background and nationality, migrants face specific administrative and legal constraints as a consequence of treaties between their countries of origin and their countries of residence. The specific demands also depend on the level of language skills and education, as well as on age and gender. Acknowledging such complexities, MICADO not only integrated into its partnership PA, CSO and migrant stakeholders from the four partner cities, but also conducted systematic research on their needs in each place. To address such local concerns but also create an EU-wide applicable solution, a novel project design for the MICADO partnership was sought and found.

The agile and co-creative design of the project – and specifically the collection, analysis, and streamlining of stakeholders' requirements – oriented itself at the Double Diamond scheme introduced in chapter 3. Transformations of this scheme, however, became necessary. MICADO had to maintain that all co-creation activities would lead to a solution that on the one hand would be universally applicable, but on the other hand would meet the specific demands of (at least) the four pilot cities. To this end, a co-creative methodology was established which earned the name of "Pagoda" due to its resemblance with a Double Diamond scheme put upright and branching into a number of pillars at its base (Figure 5). These multiple pillars at the output end of the sequence represent the novelty of the project design. MICADO converges the multiplicity of collected demands and requirements not into only one feasible product at the end of the first diamond sequence, but leads to the development of a family of contextualised derivations at the end of the second sequence. Being the project´s key conceptual innovation, this new procedural scheme provided for the systematic co-creation of user requirements and their condensation into a MVP, for the parallel testing of the product across the distributed partnership, as well as for the final uptake of the customised products by the local stakeholders and end-users.
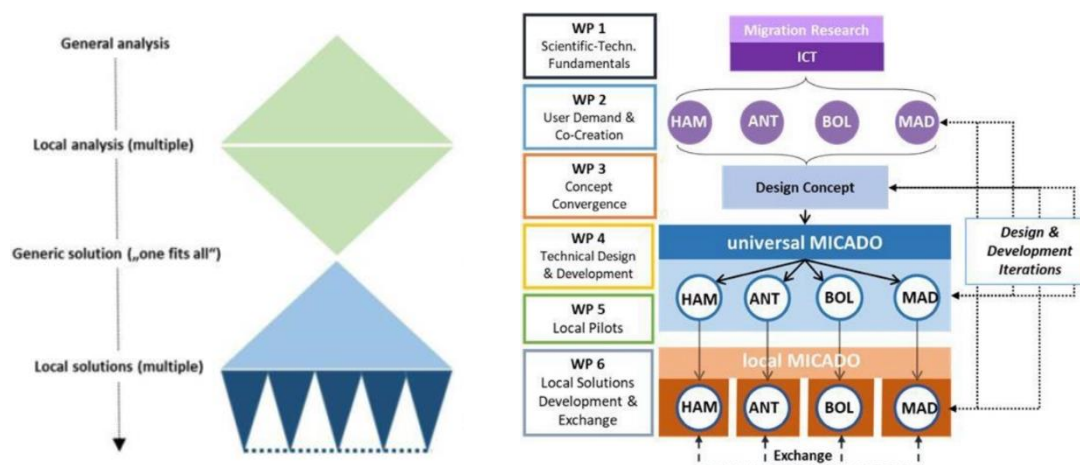
Figure 5: *Double Diamond Transformation: the "Pagoda" as a procedural scheme for MICADO (Source: MICADO)*

The first section of the Pagoda starts off – similarly to the regular Double Diamond – with a two-step co-creative sequence of divergence and convergence activities. During this phase, the consortium collected requirements from the entire partnership, assessed them and narrowed them down into the one generic solution, represented by the MVP (described at the end of chapter 2). The second co-creative sequence in the Pagoda entails the technical implementation, user testing and local pilot application, which produced the contextualised solutions of the so-called MICADAs.

The fact that the second convergence phase does not narrow down to a single solution represents a strong deviation from the Double Diamond scheme. Rather than leading to one final product – as is the common objective of design thinking methodologies, it conveys the insights collected during the pilot testing into a parallel development towards multiple location-tailored applications, one per pilot city.

Figure 6: *Co-creative definition of use cases and user stories (Source: authors' archive)*

To practically implement the Pagoda concept, the MICADO partnership developed a number of new tools, methods and structures. On organisational level, Local Expert and Stakeholder Committees (LESCs) were established that functioned as central contact for co-creation activities in each city. They had a lead role in the end-user workshops that addressed PA officials, CSO activists, and migrants especially during the first project year of MICADO, in order to define needs and demands of the target groups and identify relevant use cases. In co-creative sessions (Figure 6), a large number of promising user stories were drafted, which subsequently were critically assessed and prioritised for the further technical development.

The actual co-creation focussed on the clarification and specification of the often vaguely stated requirements. Complying with the agile approach, tasks were rephrased into user stories which would allow the software development team to implement quick prototypes. Example: "As a Migrant, I want to have a checklist for the tasks done, so that I can see how far I have progressed in the overall integration process." In order to concretise the user stories as much as possible, "personas" were generated – fictitious individuals equipped with the personal needs, goals and barriers that a migrant faces when trying to arrange with a new environment. Their features were informed by the target groups directly, as well as by the empirical studies and requirements analysis carried out by MICADO researchers. The aggregation of these inputs pre-formulated the services and functionalities that MICADO would have to provide to its end users.

The point of methodological re-direction from co-creative divergence to concept convergence is a critical stage in any innovation process. To facilitate this moment of "revergence" (Heijne and van der Meer, 2019), the MICADO researchers devised a set of instruments to effectively carry out the classification and prioritisation of the requirements. All user stories were meticulously documented and assessed in conformity with their relevance and technical feasibility. To direct the limited resources to the most required features, the process elicited three strong indicators for prioritisation and synthesis: 1) number of cities where an issue was shared, 2) availability of data in each city, needed to meet the demand, and 3) criticality and urgency expressed by the stakeholders about the issue. The latter, for instance, was assessed in accordance to the number of stakeholders sharing the need, and combined with an estimate of its impact (Figure 7).

Figure 7: *Matrix for ranking demands and requirements to be fulfilled by the MICADO solution (left); Workshop handbook with structured descriptions of user stories (right) (Source: Zagórski et al., 2021)*

Over 300 use cases and user stories were co-created and streamlined into a concise product description by way of dedicated convergence workshops. The workshop handbook facilitated this process by visualising and pre-structuring the identified needs (Zagórski *et al.*, 2021). Synoptically reviewing all information gathered from the empirical research and analysis, the consortium shortlisted the most significant requirements, common demands and topics. User stories that ranked top after this assessment eventually defined the MVP, while lower ranked ones were kept for potential later development. The resulting MVP eventually anticipated – and pre-defined – the key functionalities of the future universal MICADO solution in a nutshell (illustrated already in Figure 4). Some of the envisioned features evolved at later development stages. The feature "Document Wallet", for example, became integrated into the functionality "Migrant Account Management". Still, all key elements were eventually implemented in the universal MICADO solution.

To conclude and safe-keep the results of the convergence workshops, to facilitate the exchange of information within the consortium and beyond, and to make them accessible for the subsequent technical design and development phase, all findings were compiled into a comprehensive "Logbook for Development" (Zagórski *et al.*, 2021). Together with the workshop handbook, the logbook formed the so-called "Convergence Kit", which represents a central milestone for MICADO as it triggered the further conceptual and technical development progress.

Aligning with the agile paradigm, the MICADO software development quickly deployed first components after the co-creation and convergence activities had commenced. After 2/3 of the project runtime, in early 2021, the software developers rolled out a comprehensive prototype ready for pilot testing in the four partner cities. Here, as the requirements analysis had revealed, easy-to-understand information delivery and good user experience (UX) became central. All information gathered in these tests was fed back into the ongoing development process thanks to another organisational innovation – an ad hoc work group established within the consortium intertwining the technical development team directly with the coordinators of the local pilot testing.

The interaction of the software development team – which worked across four European countries – rested on face-to-face workshops as much as on advanced tools for digital collaboration and distributed work (Figure 8). These instruments enabled the software developers to manage and monitor not only task priorities and implementation efforts, but also a development process that remained responsive to requirements emerging from the end-user tests. The effective combination of face-to-face interaction with digital collaboration tools contributed substantially to rendering the Pagoda a successful model for co-creation and convergence.
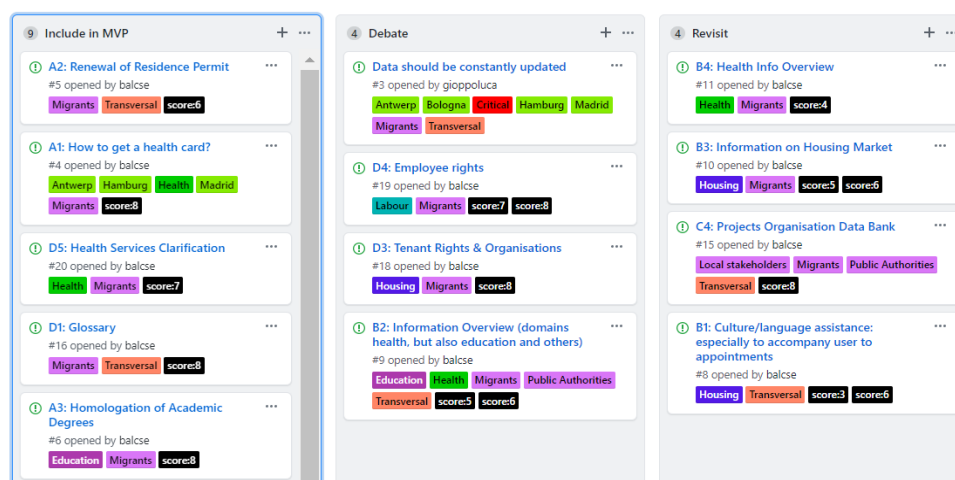
Figure 8: *Agile task management in software development – MICADO backlog in Trello (Source: MICADO)*

The universal MVP (Ries, 2011) as described above was purposefully designed to be a modifiable structure allowing for adaptation to different local conditions. The MVP represents key requirements and features shared by all four pilot cities, however, specific demands would still vary in each individual city eventually. Acknowledging highly specific requirements by way of drafting local MVPs lead to a second phase of co-creative convergence within the overall Pagoda process, which would not target a "one for all" solution but a family of derivative solutions. For achieving this, the universal modular MVP provided a set of key functionalities that could be enabled or disabled by the individualized MICADAs in respect to local requirements. As agents for the local design and development, local expert and stakeholder committees (LESCs) brought in the capacity to operate, further develop, and utilise the solutions on site. In the second-stage process of adaptation, they played a central role in short-circuiting migrants, PA officials and CSO

representatives in each city, and integrating their respective needs and demands. Together with their LESCs, the MICADO team in each city genereated context-specific use cases and personas (Figure 9) that indicated the MVP features to be provided by the customised versions, and be tested with the local end-users.

Figure 9: *Specifying local user groups with "Personas" (Bologna) (Source: Zagórski et al., 2021, p.139)*

Beyond the different sets of features for each city, the local MICADA solutions demanded different information content for each domain too. In the end, a range of factors decided the angle as well as the selection of content for the local applications – such as the desiderata identified at the initial project phase, the user stories drawn up in the subsequent co-creation phases, as well as the availability of data or local technical support. The synchronous and skilful integration of these factors eventually decided about the success of the pilot applications carried out in the four cities in the second half of the project runtime.

4   Pilot Applications and End-User Feedback

Upon definition of the local-specific MICADAs, their test implementation in the four pilot cities followed – the main instance of the second co-creation and convergence phase, according to the Pagoda scheme. Applying the scheme in practice implied that for the parallel local testing in Antwerp, Bologna, Hamburg, and Madrid an orchestrated plan was drawn, which served as blueprint for the derivation of individual local testing plans. The technical enabler for the replication of the universal solution and its adaptation into multiple local products was the open source publication of the MICADO source code under the European Union Public Licence (EUPL), thus enabling the deployment of local instances of the software in each city. The pilot testing of the customised solution aimed to collect first-hand feedback from the end-users to inform the final phase of the software development - especially concerning the system's operation, usability, and relevance for target groups. In each pilot city, the local MICADA was probed with two formats: usability tests and online surveys.

The usability tests commenced in summer 2021 with the first prototype version of the universal MICADO solution. Carried out under controlled conditions with a selected number of representatives for each user group, such usability tests commonly become a rich source of knowledge for the evaluation and the further

development of the product (Hertzum, 2016). The testing of MICADO specifically targeted design inconsistencies and deficits in user interfaces and content areas. Usability problems and operational shortcomings were monitored and propagated back to the software team, in order to be taken up in the final iteration of the development work. The testing data thereupon allowed an assessment of the level of accomplishment of the main usability goals, such as effectiveness, efficiency, and attractivity of the graphical user interfaces.

To achieve statistical significance, approx. 10 participants per subgroup, persona type, and application context had to be invited, complying with common standards in usability research (Hinderer *et al.*, 2003). According to testing guidelines established by the MICADO consortium, each city thus recruited the required number of participants for the testing sessions (Figure 10). The participants had to run through a set of tasks and work scenarios, defined by the pilot cities and contingent on the functionalities activated for the specific local application. After their trials, the participants reported their opinions and experiences in questionnaires and debriefing sessions. As a limitation to the tests, all pilot cities acknowledged facing a range of difficulties in approaching lower-skilled migrant users, as meeting places popular or familiar among participants were shut down due to the Covid-19 pandemic.

Target group	Subgroup/personas	
Migrants*	Refugees and asylum seekers	3
	Female migrants	3
	Migrants living for longer than 10 years in the immigrant country	3
	EU migrants & other categories of migrants	3
	Total	**12**
Public Authorities	Directors and middle management (coordinators, team leaders, etc.)	4
	1st line social workers/advisors	4
	Total	**8**
NGOs / Local communities**	NGOs and any other organisation working for and with migrants	4
	Civil society organisations / Volunteers	4
	Total	**8**
	Overall total	**28**

Figure 10: *Composition of the test group - Case: Bologna (Source: MICADO)*

The pandemic also impacted the testing methodology: usability tests needed to be conducted partly online, although personal presence especially in the case of migrants testing the mobile phone app would have given valuable inputs. Nonetheless, the usability tests reaped substantial insights about user navigation, information architecture, communication lexicon, visual layout and design of the web interfaces. The overall result from the tests was that especially CSOs and migrant groups reported considering the MICADO app useful for their daily work and life.

The second testing phase consisting of online surveys (dissemination started in mid-November 2021) targeted a much wider reference audience. The surveys addressed issues like how local stakeholders can use MICADO in the future, and whether the new solution will integrate with existing technologies, or replace them. Additionally, this testing phase aimed to verify that previously collected feedback got incorporated in the MICADO solution. Hence, between 20 and 30 participants per target group per city were given the chance to freely navigate through the apps and subsequently answer an online questionnaire about the app's appearance and usability. This broad public pilot application also reaped user statistics that serve as a basis for in-depth analysis of user preferences and behaviours.

In scientific terms, the online surveys presented a convergence challenge on yet another level. As the design of a questionnaire needed to appear meaningful to different cultures and languages, adequate culturally

sensitive translation as well as the subsequent consolidation of the multilingual results was a task that required multidimensional sensitivity.

The surveys in the four cities brought interesting conclusions. Aligned with the assumptions of agile and responsive IT development (Agile Alliance, 2001), the test cycles delivered first-hand knowledge that substantially impacted the technical improvement of the platform. While the heterogeneity of outcomes – resulting from the diversity of testing locations – imposed limits to the general convergence of results, valuable insights were drawn for the local adaptation of the solution. Hence, the second convergence phase conveyed the collected feedback primarily towards the city-specific MICADAs, and to respective local uptake and development teams.

The tests also indicated potential long-term effects that the solution may bring. An implication for PAs is the requirement to design integration measures on the basis of detailed data monitoring and analysis. For CSOs, the new application creates opportunities to better tailor offers and services based on migrants's requirements and behaviours. For the migrants themselves, the app enhances transparency and a comprehensive understanding of arrival and integration processes. The tests, however, also unearthed the difficulties that result from embedding a new IT solution within established institutional routines and environments. The sharing and integration of data across institutional departments as well as across national borders (which in the case of migration integration is a natural condition) remains a major challenge. In this respect, innovative organisational structures such as MICADO´s local groups and stakeholder networks can contribute to securing uptake and long term sustainability. To support a future continuation of both the universal and local solutions, uptake formats need to achieve an adaptation of the MICADO system to local end-users (this being particularly relevant in PA contexts) and a promotion of it to the open source software development community.

5   Outlook: A New Blueprint?

The MICADO consortium has endeavoured in combining two vastly different areas of research and practice: ICT development and social sciences. The scientific and methodological returns from this ambitious undertaking have been positive. But how far can MICADO serve as a methodological blueprint for similar project challenges in the context of European research and innovation? In order to reflect the overall approach from this angle, the following section situates the MICADO platform and its co-creative process in the context of ICT for public and urban management, and summarises the lessons learnt from the new methodology that eventually led to the existing solution.

There certainly is a large potential of digital technologies for dissolving boundaries between disciplinary fields and professional domains (Venturini *et al.*, 2017). The capacity to effectively bridge between qualitative and quantitative approaches, and to connect different levels of observation provides a suitable lever for managing the complexities and challenges of urban life. Hence, public authorities and decision makers eagerly adopted digital tools for socio-spatial development and urban management (Townsend, 2013). Despite bringing strong innovation potential, the application of digital tools may also lead to overly simplified views on their subject matters, and reduce the focus of description to few selected indicators (Kitchin, 2021). Especially when urban services are understood as platforms, often naïve and deterministic applications risk imposing positivist, reductionist, and overly abstract perceptions of cities (Barns, 2020, p.167; Kitchin, 2016, p.4). Projects targeting cities' digital public services – like MICADO – should acknowledge these pitfalls and start from concrete and well-defined challenges, rather than utilising existing digital solutions only because they are available.

To achieve a solution that is useful in practice and feasible in technical terms, MICADO has unfolded around a comprehensive process for co-creative demand definition and convergence. Almost one third of

the 3,5 year long project was invested in the analysis of user requirements and the screening of potential solutions. This paved the way for a smooth transition to the phase of technical implementation. However, also the activities of software coding and IT engineering needed to be accompanied by further co-creation and convergence activities. It was a major lesson learnt that these activities should not be time-boxed as a conventional "work package" within overall project schedule. As long as technical work progresses, co-creation and convergence are requisite "umbrella tasks". The continuous exploration of user demands as well as of technical possibilities was conditional for finding appropriate responses to identified challenges, especially on local level. This is exemplified by the fact that – despite a strong initial focus on cockpits and dashboards applications (as ingrained in the project name) – the technical scope had broadened to other service formats when ways were discovered that allowed the processing of qualitative information in a well-structured and understandable manner.

The joint definition of the MVP proved to be the decisive step for the project's progression. It effectively aligned the user requirements on the one hand, and the consortium's technical capabilities and resources on the other. Being subject to partially conflicting requests from the different stakeholder groups, however, the definition of the MVP effectively catalysed the overall synchronisation across the MICADO partnership. The consolidation of an agreed-upon MVP is remarkable also on the background that co-creation research has hinted at the difficulties that commonly emerge in the shift from divergence-oriented, co-creative activities to concept convergence and alignment, the latter naturally implying strong prioritisation, selection, and even exclusion of previously co-created content (Gräning *et al.*, 2013, Gurtner *et al.*, 2013; West, 2017). Although a required activity in any product or service innovation, convergence is a highly critical step in the context of multi-stakeholder settings and sensitive societal issues (Tuttle, 1997). In the case of MICADO, however, the challenging "revergence" point as the moment of shifting from creative divergence to result-oriented convergence (Heijne and van der Meer, 2019) was mitigated by well-choreographed group workshops and comprehensive collections of all requisite information (Apers *et al.*, 2021).

The effective streamlining of the requested functionalities of the MICADO product becomes apparent when reviewing the list of user requirements. The initially broad and abstract collection of demands necessitated strong condensation and concretisation - which was eventually achieved through iterative convergence activities. Although the derived MVP comprised all required core functionalities of the envisioned product, the pilot tests have shown that not all of them were needed to similar extent in the four partner cities. Local adaptation thus not only implies technical customisation of the universal MICADO solution, but also potential further omission of features and reduction of functionalities.

Apart from the definition of the digital product, the combined co-creation and convergence activities also became an effective social catalyst for the multi-partner consortium. Interactive stakeholder workshops and co-design games conditioned a productive dialogue between all involved parties. The exchanges between project teams, end-users, and external stakeholders have built and secured a high level of trust and engagement throughout the project runtime. Also, efficient moderation, communication and expectation management secured the coherence in the product and convergence in the partnership. Predictably, a multitude of divergent opinions emerged between the different work groups and local teams, as a side-effect of the different disciplinary approaches and local cultures. Co-creative interaction on individual and group level, however, became instrumental for establishing an atmosphere of mutual understanding and appreciation that enabled social scientists, ICT engineers, social activists as well as municipal administrators to co-operate on eye-level. The project design of MICADO not only depended on, but also facilitated inter- and transdisciplinary collaboration. The project was fuelled by the willingness of partners to communicate and operate beyond the boundaries of their domains, and to seek constructive compromise for the sake of

the project's progress. Experts from highly diverse fields of research and practice were exposed to tools, methods and terminologies uncommon to their original domains, thus triggering a high level of experimentation and cross-pollination across the consortium. For example, social scientists and public administrators had turned into users of collaborative software development tools (Github). Vice versa, software developers learned about the complexities of social research when translating the qualitative measures of migration research into the logics of program code.

These experiences make MICADO´s project design a promising conceptual pattern for challenges of a similar kind in the future. Research and innovation endeavours targeting ICT systems in the public realm, the Pagoda scheme provides a validated framework with generic applicability to a variety of contexts. It is suitable especially for multi-national and transdisciplinary partnerships which must recognise, process, and transform complex socio-technical requirements into feasible technical solutions. The individual procedures, such as local co-creation workshops and convergence choreographies, can be generalised to a large degree. Three factors thus remain crucial for the transferability of the MICADO approach. Firstly resource availability, as for instance local stakeholder networking is time-intensive and demands substantial organisation efforts. Secondly, communication and interaction technology remain fundamental elements for conducting parallel work about geographically distributed concepts where development teams depend on advanced methods for long-distance collaboration. Finally, previous experience of the project partners plays a role for the success of international cooperation projects, which indeed was a decisive factor for the success of MICADO too.

6 Data availability statement

The data that support the findings of this study are openly available on the website of the MICADO project (www.micadoproject.eu) in the subsection "Project/Project Reports" https://www.micadoproject.eu/project-reports/. The source code of the MICADO platform is published under EU Public License (EUPL) on the open source repository github: https://github.com/micado-eu/

7 Declarations

7.1 Funding statement

7.2 Publisher's Note

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