Digital Innovation in Cities

Lessons for replicating open source software solutions

Case Study: Dordrecht, the Netherlands

Authors:
Dana van der Zee, Gerard Don,
Sebastiaan van Herk

Contributors:
Caitlin Ball, Camilla Sandberg,
Berry Gersonius, Ellen Kelder,
Annemarie Lammers,
Özlem Safranti-Bozkurt

Interreg
North Sea Region
SCORE
European Regional Development Fund

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Introduction

Cities across Europe share many challenges. Typically they tackle these challenges in isolation. With the help of open data and digitalisation, cities can more easily tackle challenges together and collaboratively **improve** their **public service delivery i**n important domains such as mobility, energy and water.

Improving public services together through digitalisation requires a partnership that is inherently transparent and collaborative, with open collaboration as a key principle. Open collaboration enables natural connections to form between challenge owners in different cities and allows anyone to reuse, change and distribute what has been made by partners.

Open source and **open data** are two core principles underlying the vision of open collaboration. The open source principle emphasises the importance of making software accessible and open for everyone to use, change, improve, and share. The open data principle encourages making data accessible to all if possible under a licence that allows for re-use of the data by anyone.

The Smart Cities and Open data RE-use (SCORE) project brought together 8 cities and 2 universities collaborating on open-source software solutions and open data.

The project aimed to increase efficiency and quality of public services in cities through smart and open data-driven solutions.

Three main indicators were designed to assess its success.

Improvement in **quality** of service

Reduction in solution development **time**

Reduction in public services **costs** using open-source software solutions

The SCORE partners co-developed and replicated several solutions, continuously learning how to best design and reuse open-source solutions.

This case study report will analyse the process of replicating an open-source solution within the SCORE project, capturing the lessons learned on replication and sharing best practices. The Replication Guidelines produced as part of the SCORE project will be used to assess the replication of a SCORE solution in the city of Dordrecht, a mid-sized city located in the Netherlands with limited IT capacity and resources. By applying the framework on a real-life case, it will also be easier to understand the nuances of the framework in practice.

Theoretical Framework for Replication

The Replication Guidelines were developed to support cities in replicating each other's solutions. The guidelines consist of a 5-step iterative process:

In the figure above, the 5 steps in the replication process are presented in a linear way. However, this is a very non-linear process in practice. Some activities may happen in parallel or be repeated later in the process, and several iterations may be necessary to come to the final solution. Additionally, steps might differ in terms of time and effort. These 5 steps are used to structure the case study.

Case study on Replicating the QR code toolkit solution

The City of Dordrecht wants to measure the experience and usage of the city´s healthy living environment to improve the quality of urban green spaces such as city parks. Within the SCORE project, the City of Dordrecht replicated a dynamic QR code toolkit solution developed by the IT partner of the City of Ghent. The dynamic QR code toolkit allows a broader range of civil servants to generate and use QR codes as a generic, expandable, and reusable starting point for a variety of city services and citizen workflows. Instead of QR codes being a static hyperlink, the toolkit develops dynamic QR codes that can serve as a contextual access point to which different actions can be attributed in different service delivery contexts (to citizens, to employees, or to a combination of both).

In practice this means that the same QR code can be used for different purposes, for example managing assets and devices.

Before Dordrecht started the replication process of the QR code toolkit, the solution had already been replicated amongst different departments within the city of Ghent and by the city of Aarhus.

In this publication, the replication case study in Dordrecht is presented along the 5 steps process of the theoretical framework. The lessons learned from the different steps are schowcased, making the framework come to life. Results achieved thanks to the replicated solution and replication process are presented. Conclusions and recommendations about replication of open source software solution are discussed.

Replication case study: QR codes to evaluate the use of the park

Replication is often understood as copying the results from one case to another. In the context of transferring open source software solutions between cities, a broader definition of replication is used. As such, replication can be understood as the process of replicating the entire solution (Full Replication Scenario) or reusing parts of a solution by taking generic components directly or by adapting them to allow for functioning in a different context.

This section examines the different steps taken and experiences gathered during the replication process of the QR code toolkit. The learnings of this process are showcased structured along the steps of the Replication Guide to understand practical nuances of this framework.

1 Identify Need(s)

What is this step about?

Identify challenges and/or opportunities for cities regarding public service delivery, and how they are being experienced by the city and citizens. You can **identify a need** to be met **directly** (providing citizens with a service) or **indirectly** (providing the government with a service that helps them to serve the citizens better).

How did this go in Dordrecht?

The starting point for the Green-Blue City Team of Dordrecht was their involvement in the SCORE project, in which they defined general city challenges to be solved (2018). One of these challenges was defined as follows:

How can we optimise the design and maintenance of our blue green infrastructure to provide more ecosystem services?

Two workshops were organised between Fall 2021 and Spring 2022 to specify this need and to find practical use cases, already with a solution in mind. A clear indirect need for improving public service delivery was identified: *Monitoring the use of parks to be able to improve their functions and/or benefits for citizens and nature.*

Addressing this need fits well within the strategic objectives of the city of Dordrecht, specifically of the Green-Blue City Team. Out of the team´s three main objectives, one is a healthy living environment which contributes to citizens' health by providing green space to exercise and be outdoors. The city wants to understand better how it can measure 'experience and usage of the healthy living environment'.

Lessons for Dordrecht and other cities

The identified need (and thus its potential solution) fits very well in the strategic vision and goals of Dordrecht. The Green-Blue City ambition is of high political priority leading to multiple investments in green infrastructure, citizen engagement efforts and high involvement in collaborative projects. This is a key enabling factor for replicating an existing open-source solution - the solution is then seen as helping/accelerating the achievement of strategic goals. This also means that the required resources (time/money) and support will be available for sustaining and/or follow up on the solution.

- **As a municipality, you should always align identified needs with strategic goals. By linking these initiatives to running processes and projects, the necessary resources are freed up.**

In practice you often already have a selection of solutions in mind that you try to match to certain needs. Steps 1 and 2 happen in parallel, or you might even start from the perspective of Step 2.

- **If that is the case, make sure you still take time to define a clear need or challenge to be solved, to avoid a technology-push and make sure the solution contributes to what you want to achieve as a city.**

Keep in mind that the needs of a city could be both challenges, as well as opportunities that help contribute to a certain ambition or goal.

2 Define Solution

What is this step about?

City challenges and opportunities are often shared with other cities, so the chance is high that another city has already been working on a solution that you can reuse.

When you find such a solution, you must check its replicability - how and to what extent you will be able to take this solution forward. Is the solution open-source, well-documented, and to what extent will you have to adapt the solution to your context?

How did this go in Dordrecht?

For Dordrecht this step was closely linked with step 1 of the process. Within the SCORE project, Dordrecht looked around for replicable, open-source solutions and then tied these to the identified needs.

The solution for improving Dordrecht's public service delivery in its parks made use of a solution from the City of Ghent: A dynamic QR code toolkit, developed open source with replicability in mind. Moreover, the solution could be replicated fully (Full Replication Scenario). This made the replication process a lot easier.

This dynamic QR toolkit is a **meta solution** in the sense that its applicability is very broad. When dealing with a meta solution, it is logical that you don't always start with identifying the need. Rather, keeping this solution with its widely applicable use cases in mind, you think about what different needs it can fulfil. To start, use cases were identified to test the solution, one of them being Sterrenburg Park.

Lessons for Dordrecht and other cities

For mid-sized cities that often lack in-house development capacity, it is strongly advised to be part of leading networks around your city's priority themes. This ensures you know of and have access to relevant solutions. Because of Dordrecht's collaboration within the SCORE project, the city was able to identify the solution and have close contact with the original developers to ensure smooth replication.

- **Small and mid-sized municipalities should ensure to be part of regional (e.g. Smart City field labs Zuid-Holland), national (e.g. Smart City Agenda NL) and/or international (e.g. Interreg SCORE project) networks around open data, open source and smart cities. Being connected through these networks allows small and mid-sized cities to get the most out of digital innovation without having to initiate a lot themselves.**

3 Set the context

What is this step about?

The four Main Components to set the context are:

- **Stakeholders.** Relevant city departments, national/local agencies, relevant private actors, end users

- **Security, privacy & legislation**. Important to understand, legislation can be a limited adoption factor
- **Digital Compatibility.** Make sure you have access to the necessary data in a compatible format, and that the infrastructure can be put into place
- **Business case.** Show expected (economic, social, and environmental) return on investment to policy makers. Open-source solutions have to potential to be cheaper, faster, and better than regular solutions

How did this go in Dordrecht?

After defining the Sterrenburg use case based on the identified need, several important local **stakeholders** were **involved** and **engaged** that are key to a successful implementation. The most important of these is Mr. Hoffmann, the manager of a local community centre (including a library) at the entrance of the Sterrenburg Park. In addition, neighbourhood partners and municipal colleagues in the liveability forum have been engaged to help incentivize QR-code use.

Legislation and privacy were not much of an issue with this solution since it involves an active choice of the end user to share or not share data. Moreover, the QR code toolkit does not store any data, only the websites to which it links refer to. Thus, this aspect becomes relevant again in Step 5.

It was difficult to ensure the digital compatibility context for this solution. The requirements (e.g. a hosting server) were checked with the solution developer Ghent, and the city of Aarhus who replicated the solution before. However, it was difficult to find a solution owner who was willing to become responsible for this in Dordrecht (and ensure budget for this). To get to a minimum viable solution, the cloud was chosen as an alternative to Dordrecht's internal server.

A clear business case for this solution, or for open-source solutions in general, has not been made in Dordrecht. Work needs to be done to educate and convince policy makers and to embed this way of working as part of standard organisational practices across the organisation (or at least within the Green-Blue City team). In this specific case, Dordrecht´s interest in this solution mainly comes from two sources:

- Success stories from other cities
- Dedicated time and resources available to test and explore the solution (thanks to SCORE)

Lessons for Dordrecht and other cities

Privacy and legislation are usually a time consuming and difficult barrier, so non-sensitive solutions are considerably easier to implement.

- **Privacy non-sensitive solutions are easier to reuse. If there is sensitivity, testing and experimenting with a solution in a Living Lab is advised.**

Digital compatibility: For mid-sized cities with limited resources, it can be challenging to integrate a solution within the city and its current IT infrastructure. By taking the time to map out the options and find the right people within the organisation, alternatives can be explored to overcome this hurdle. For example in the case of Dordrecht, the solution in the cloud meant avoiding adaptations in the local IT environment, creation of additional space on the local server and/or any changes to the server hosting processes.

- **It is valuable for cities such as Dordrecht to invest time and resources in obtaining a clear overview of the city´s digital landscape, accessibility and understanding throughout the organisation.**

Success stories and EU resources (time and money) were necessary enabling factors for solution implementation as a clear business case was still lacking.

- **Cities like Dordrecht should keep in close contact with other cities, to be aware of opportunities and stimulate replication processes.**

4 Make Adaptations

What is this step about?

Both **technical adaptations** as well as **contextual** and **operational** adaptations will have to be made. It is important to evaluate: 1) to which extent use cases are similar or different from the original solution, 2) how much technical customization will have to be done, and 3) to what extent it is possible / beneficial to adapt city operations to fit the solution context.

How did this go in Dordrecht?

The actual replication process in Dordrecht went smoothly. At the time Dordrecht did not have internal software development capacity to replicate the solution. Through Bax & Company, the facilitator of the replication process, the city hired a freelance external developer. **In less than a day**, the developer was able to adapt the technical aspects of the solution to the Dordrecht context and a **minimum viable product** was **ready** for testing.

The solution developer, District09 Ghent, was key to making the replication a success. The solution was made **replicable-by-design**, and the solution was documented in detail on GitHub. During the process the solution developers assisted the replication by providing information to the freelance developer and making small adaptations needed to host the solution in an online cloud rather than on a local server.

The replication and testing of the solution also led to improving the functionality. During the testing, some bugs were discovered and could easily be solved and improved through technical adaptations. This is one of the benefits of open collaboration. With multiple people testing and using the same solutions, bugs and problems are identified and can be resolved quicker – **improving** the **functionality for all** users.

Hosting the solution in the cloud meant avoiding making contextual adaptations, such as making space available on the local server and/or adapting the server hosting processes to allow solutions such as this one to be incorporated.

Lessons for Dordrecht and other cities

The actual technical replication of the solution is very simple and straightforward, as long as the original solution is open-source and well-documented (replication-by-design).

- **When looking for additional open source solutions, cities should identify solutions that have been made replication-by-design**.

Contextual and operational adaptations are not always easy to make. Sometimes there are work-arounds to at least get started with implementing the solution (e.g. hosting in the cloud), but it is important to realise that in order for such solutions to be implemented at scale, you will have to address these contextual and operational factors. At the moment of the QR-code solution implementation, it is not always clear yet in Dordrecht where certain data / digital responsibilities / ownership lie.

- **It is key to tackle contextual and operational factors in the near future in order to ensure effective uptake of this solution and others, and in general to improve the cities' ability to work with and use data.**

Dordrecht should make serious work of creating conditions for digital (open source) solutions and open data, to keep improving the digital literacy of employees.

5 Test and Prepare to implement

What is this step about?

First test the solution in an urban 'living lab'. This should take around 6 months (in parallel with step 4) and will help gather and evaluate valuable technical and contextual data to improve and adapt the solution for larger scale implementation.

How did this go in Dordrecht?

The QR toolkit was made available to the Green-Blue City team of Dordrecht in spring 2022. The local team in Dordrecht together with Onderzoekscentrum Drechtsteden and advice from the Bax & Company team delivered the design of the 'healthy living' survey, the type of questions to ask and the protocols for managing and analysing the information collected, while protecting data privacy and generating the insights that the city is looking for.

In summer 2022, three billboards with QR codes were placed in the park and with this, the city has a new tool available to deploy whenever needed. Before the toolkit implementation, the survey had also been promoted through more traditional channels such as flyering in the neighbourhood. Initial results showed that the QR code toolkit is significantly increasing the number of respondents (60 reponses in 2 weeks versus 60 responses in 2 months).

Through word-of-mouth and enthusiasm of those involved, the solution spreads outside of the scope of the initial need and use case identified. An example of another use case in Dordrecht (implemented in SCORE) is a QR code guided pod walk and puzzle walk. The QR code toolkit solution can potentially help address many other needs in the city.

Lessons for Dordrecht and other cities

Trying out use cases in different organisational departments stimulates adoption / uptake of the solution.

- **For people to take and feel ownership, you need success stories. To ensure the solution will be used to its full potential, it is important that Dordrecht exploits the existing use cases and narratives.**

Results & Impacts

The three indicators (time, costs, and quality) are assessed to see to what extend the replication process was successful. Other impacts created beyond these indicators are highlighted. The replication process took place in the context of a mid-sized city with limited IT capacity and resources, but the results and impacts created can also be relevant beyond this context.

Assessing the indicators

-94% Reduction in solution development **time**

The time needed to replicate the solution is compared to the time it would take to develop the solution from scratch.

Basic replication of the QR code toolkit took place in half a day, instead of the estimated 45 days that Ghent´s IT partner District09 used to develop the toolkit. After half a day, the City of Dordrecht had a working solution functioning on the Heroku cloud app. Although this process created a working solution, a roughly 2-day upgrade of the instalment of the solution took place to improve the interoperability of the solution, ensuring the toolkit had increased functionalities to operate with and between systems of the municipality. In the case of the QR code toolkit, replication in Dordrecht turned out to be a time efficient process due to a number of reasons.

Firstly, the solution was developed in an agile way. The process of creating 'replicable-by-design' solutions ensures different components are produced that can easily be used independently of each other. Secondly, both the code and instructions for replication are documented in a detailed and generic way, which makes it easy to understand and use for developers not involved in the initial creation of the solution. Thirdly, the solution had previously gone through a few replication cycles within the city of Ghent by different departments, and by the city of Aarhus. This improved the replicability of the solution and allowed for sharing best practices, accelerating the replication of the QR code toolkit in Dordrecht.

- €

Reduction in public services **costs** using open-source software solutions

The cost savings attached to the most basic replication of the QR code toolkit using a cloud-based server can come from different directions, such as making public services more efficient by enabling civil servants to perform their tasks faster, or eliminating costly steps in the process of delivering a public service.

In the city of Dordrecht, the QR code toolkit is used as a tool to engage citizens in evaluating the use of the park. In this case, the cost reduction is expected to take place through offering a digital and **more efficient way** of **collecting** the **opinion** of people, instead of using groups going around the park to hand out paper versions of the survey and digitising them. In the long term, further cost reduction is expected by allowing better informed decision making for policy measures with help of the QR code toolkit. Additionally, because of the dynamic feature of the QR code toolkit, the QR codes can be reused for other purposes, thereby saving production costs.

In addition to direct cost savings as discussed above, this solution has a lot of potential indirect cost savings. Being a meta solution, applicable to an infinite variety of use cases, this solution has great potential for replication throughout the city allowing for further cost reduction. For example, in the city of Dordrecht, the dynamic toolkit is expected to support a QR code guided pod walk in the city passing by historical buildings, landmarks, and artwork, which also offers the option of an escape room puzzle for city discovery. Once incorporated into the organisation, the toolkit should be an alternative solution in many use cases.

x4

Improvement in **quality** of service

Digital technologies and software solutions are considered to have high potential to increase the quality of public services and benefit the end-users. End-users of the solutions can be (groups) of citizens directly using the public services, but also city workers and civil servants providing the service in their daily tasks.

In Dordrecht, the direct end-users of the QR code toolkit are the visitors of the park, which are mainly citizens from in and around the neighbourhood. Compared to the conventional way of requesting input from citizens and evaluation policy measures with citizens, the QR toolkit could contribute to this service. Initial results show a significant increase in the number of respondents to the survey, from 60 in 2 months to 60 in 2 weeks.

However, the exact impact created in terms of helping the city to deliver healthier green spaces is still unknown.

Besides the visitors of the park, the landscape architects and park managers also benefit from the solution, as it enables them to make better informed decisions to improve the (re)design and maintenance of the city parks.

Other Impacts

Improving the quality of the solution

Replicating the QR code toolkit in a different context and by a developer that did not design and create the solution in the first place has brought significant improvements to the quality of the solution itself. The iterative process that is inherently connected to the agile process of replication continuously improves the solution step-by-step. In the case of Dordrecht, **replication upgraded** the **documentation** and **manuals** of the QR code toolkit on GitHub and improved the integration of the solution and the online server the solution is running on. This is an important benefit of the process of replication, that contributes to high quality and generic solutions in the long-term that can be easily replicated.

Digital transformation within the city

Consciously going through the process of replicating open source solutions whilst participating in a open source / open data project provided the city of Dordrecht a **new angle** towards digital transformation and innovation in their public services. As a mid-sized city, the city of Dordrecht maintains a challenge driven approach towards policy making and public service delivery. Based on the challenge, objectives are formulated that result in specific policy measures. In practice, this means the municipality has a department working on increasing the Green-Blue areas within the city through policy measures such as creating green areas (e.g. parks) in every neighbourhood. Dordrecht used participation in the SCORE project to further exploit this by using open source software solutions and open data to monitor the effects of the policy measures. Although this approach does not directly target an objective of digitally transforming a city, it does **contribute** to **digital innovation** of a public service **within** a specific **department**. At the same, it allows department staff to **build digital capacity** and understanding and provides **new opportunities** to work with open data.

Conclusion

Based on the case study of Dordrecht replicating a QR-code toolkit solution from Ghent - can we recommend other cities to replicate open source software solutions?

We can conclude that **working with open source software** does have the potential to be **faster** than alternatives. There are a variety of **cost reductions foreseen** that we were not able to quantify yet. The **quality of service delivered** in terms of citizens engaged improved with **a factor 4**. Quality improvement in terms of helping the city to deliver healthier green spaces is still unknown.

-94% Reduction in solution development **time**

- € Reduction in public services **costs** using open-source software solutions

x4 Improvement in **quality** of service

We **recommend** every mid-sized city to at least consider **including open source replication into their digital innovation strategy**.

Every city is unique in terms of its organisational structure, culture and (technical & digital) capabilities. There are many other ways a city can obtain a digital solution to improve their public service delivery (such as developing it yourself, or buying a solution from a private party).

For each given situation, a challenge owner needs to ask themselves whether replicating an existing solution will be the best option or not. The answer to this question might change over time and is therefore useful to repeat every once in a while.

Below, we have outlined what we believe are some of the **key considerations** for **replicating** an **open source software solution successfully**.

Resources available (time, budget, people)

Replicating open source software solutions **can be** a **time-intensive** process, especially at the start. Replication requires time, budget and people from both the replicating party as the party whose solution is replicated. In the case of Dordrecht, we have seen that sufficient support from Ghent´s side made the replicating substantially easier. A professional facilitator who brings together the right people and stimulates effective collaboration accelerates this process.

Although considered cheaper than making a software solution in-house, replication still requires a significant amount of budget that needs to be made available in advance. In terms of people, keep in mind that development capacity could be made available both in-house and outsourced, e.g. a freelance developer.

Degree of replicability of the solution

Replication works best with solutions that are open source, modular, and interoperable. Working with solutions that are designed with replication in mind from the start makes successful replication more likely. A detailed documentation of a generic code makes it easy for developers who have not been involved in the initial creation of the solution to replicate. The more replication cycles a solution experiences, the easier future replications become.

Determine indicators from the start

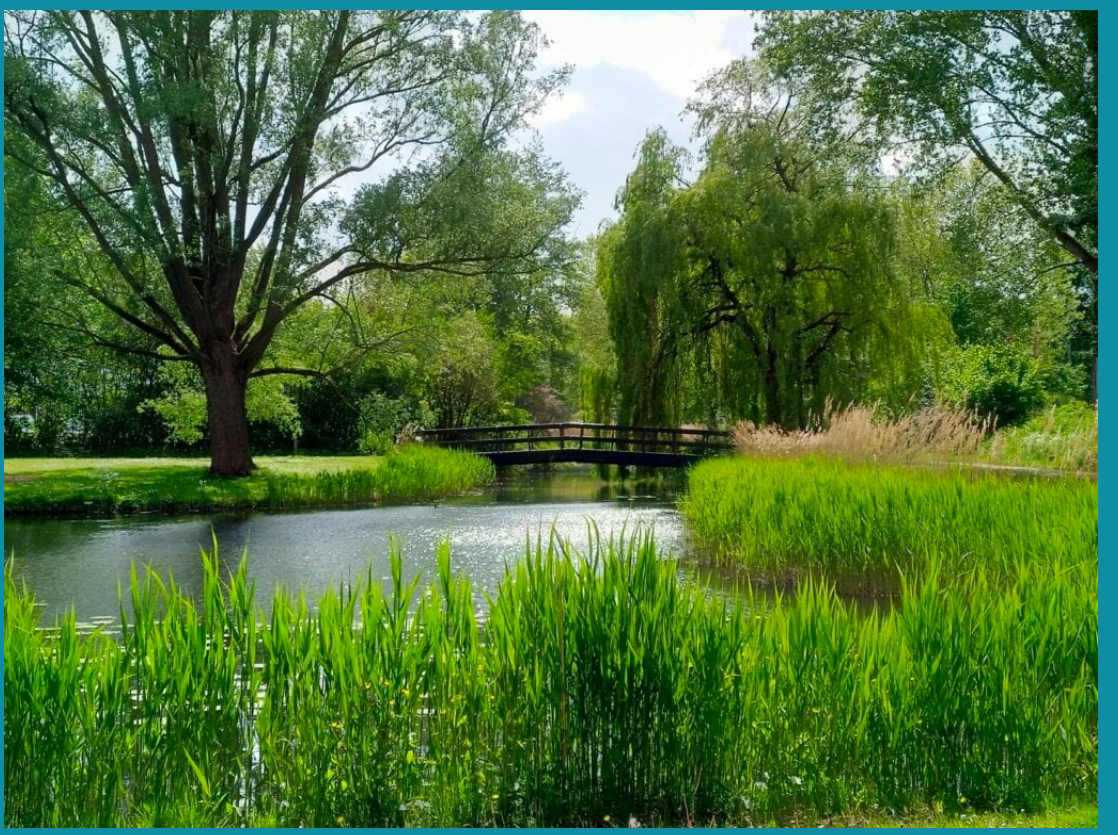
Think about how you will evaluate the successfulness of replicating an open source software solution from the start. The indicators designed in SCORE are a good starting point here: will the solution improve quality and reduce costs and time spent compared to the alternatives?

Deciding upon indicators is crucial for creating the business case for replicating open source software solutions, and for future decision making on whether to replicate, buy or produce software solutions.

Focus on the needs, but be realistic

When starting a replication process, it is important to take time to identify the needs of the party replicating (e.g. a city or a regional authority). This could be a specific challenge the party is dealing with or an ambition that could be fulfilled with help of the software solution. Once identified, it is advised to keep the needs in mind at all times during the execution of the replication process. Replication is inherently context specific.

The probability of finding a replicable solution that is solving your needs 100% and that can be applied to an identical use case to yours is low, so it is important to be realistic while replicating. Do not strive for a 100% replication of the solution, but focus on fulfilling the required functionalities and key objectives of your defined needs.



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