Initiative for Climate Action Transparency – ICAT

Digitalization of

Transport Sector MRV System in Sri Lanka

Deliverable 2: Report on Software development and web interfaces

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ClimateSI, 2020

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Climate Smart Initiatives (Pvt) Ltd

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Climate Smart Initiatives (Pvt) Ltd.,

Sri Lanka.

List of Acronyms

API	Application Programming Interface
AWS	Amazon Web Server
CCS	Climate Change Secretariat
CPSTL	Ceylon Petroleum Storage Terminals Limited
DMT	Department of Motor Traffic
EF	Emission Factor
ESB	Enterprise Service Bus
GHG	Greenhouse Gas
IDE	Integrated Development Environment
LGC	Lanka Government Cloud
LGN	Lanka Government Network
LRT	Light Rail Terminals
MEWR	Ministry of Environment & Wildlife Resources
MRV	Monitoring, Reporting, and Verification
MTSM	Ministry of Transport Service Management
NPM	Node Package Manager
NTC	National Transport Commission
REST	Representational State Transfer
SDM	Software Development Methodology
SLC	Sri Lanka Customs
SLCERT	Sri Lanka Computer Emergency Readiness Team
SLR	Sri Lanka Railway
SLSEA	Sri Lanka Sustainable Energy Authority
SLT	Sri Lanka Telecom
SRS	System Requirement Specification
SW	Software
UNFCCC	United Nations Framework Convention on Climate Change
VET	Vehicle Emission Testing

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Executive Summary

Digitalization of transport MRV system enhances the transparency in assessing the GHG impacts of the transport sector NDCs while reducing the burden on the administration to track the progress of assessing NDCs.

However, converting manual MRV system in to a digitalized system is done through selecting the best software development methodology which can meet the requirements of the stakeholders. Agile model is selected as the software development methodology, since it allows continuous stakeholder involvement and ease of integrating a change.

In order to make the digitalized system more useful, possibilities of integrating the data bases of other institutions is also considered by keeping provision for REST-APIs.

Stakeholders are engaged or consulted whenever needed their feedback or inputs for the development of digitalized MRV system. Due to prevailing COVID 19 pandemics, consultations were limited to virtual meetings. However, validation and feedback sessions are conducted throughout the development of the software to identify and improve the areas which need the consultancy such as user interfaces, functionality of the interfaces, report templates, excel upload templates and mail templates etc. Then the system was upgraded by integrating possible changes suggested by the stakeholders.

1 Introduction

1.1 Background

Digitalized Transport MRV system will provide a single web-based online platform for the end users to fulfil their responsibilities more effectively and efficiently. Evolution from manual MRV system to a digitalized system will deliver vital benefits to its end-users.

- ✓ Reduce the administrative burden
- ✓ Increase transparency
- ✓ Reduce manual inputs, automate functions and give more time for the end users to spend on completing a meaningful work
- ✓ Facilitate real time decision making by allowing access for real-time information by reducing the response time of bringing a request through a chain of commands for days even in an emergency situation
- ✓ Ensuring foster collaboration across departments by enable teams to share necessary information in real time
- ✓ Increase accuracy across every input and output
- ✓ Maintain uniformity over the inputs and outputs
- ✓ Avoid human errors due to personnel or work-related pressure
- ✓ Enable end users to work remotely
- ✓ Increase efficiency

Conversion of a manual system to a digitalized system needs identifying of requirements from end-users. In the first deliverable of this project (*"Report on system and software design for MRV system"*), the functional and non-functional requirements of the digitalized MRV system were identified. Based on the identified requirements, the developers have to decide the suitable software development methodology to digitalize the transport MRV system. However, since the digitalization of MRV system has dynamic inputs, regular feedback or involvement of end-users is necessary to make sure whether the system achieve end-user requirements.

Whenever possible, integrating with the data bases of external institutions who manage MRV related data in their digitalized system is planned. This will allow them to automate the uploading of MRV data to the system.

1.2 Objective

Objective of the Initiative for Climate Action Transparency (ICAT)

Monitoring, Reporting and Verification to track the progress of NDC implementation is needed to meet the country's international reporting requirements, and "to build mutual trust and confidence and to promote effective implementation" of the Paris Agreement (Article 13.1 of the Paris agreement).

MRV of NDC progress is also important to meet domestic requirements. These could include reports: (a) to the parliament and the public in order to improve transparency; and (b) to policy-makers informing decisions on changes to the existing mitigation or adaptation actions.

ICAT project was founded to respond to these critical needs to support improved transparency and capacity building under the Paris Agreement. The primary objectives of ICAT are to:

- ✓ Strengthen institutional and human capacities in countries to develop and implement domestic system to MRV mitigation policies and actions (MPAs); and
- ✓ Develop tools and guidance that can be used for an effective system for MRV MPAs implementation.

Overall objectives of the assignment on digitalization of transport sector MRV

The main objective of this assignment is to evolve GHG MRV system for transport sector to a digitalized web-based system. This digitalized system will to measure, report and verify an emission reduction project under an NDC related to transport sector with more reliability, scalability, data integrity, adequate security and storage. As benefits, digitalization will enhance the efficiency, transparency and availability of the data for current and future use.

Objective of this deliverable

The main objective of this report is to explain the development process of the digitalized MRV system for transport sector and the stakeholder engagement during the development.

1.3 Scope

Report will provide a broader overview on the software development process, data base integration and the stakeholder engagement during the development of the digitalized MRV system for transport sector.

1.4 Methodology

As the second deliverable for the digitalization of transport sector MRV system, this report will describe: i) Development of digitalized MRV system; i) Database integration; and iii) Validation of the digitalized MRV system.

I. Development of digitalized MRV system

Converting the manual MRV system to a digitalized MRV system requires identifying of the suitable software development methodology as a priority. The identification of suitable software development methodology has been done based on the functional requirements identified during the deliverable 1 *"Report on system and software design for MRV system".*

The development of the digitalized MRV system is carried out using a standard SW development methodology, adhering to the best practices of software development and involving the stakeholders where the engagement is necessary for the feedback.

II. Database integration

Whenever possible, integrating with the databases which are already existing in external institutions with the digitalized MRV system are considered, to provide more automation for the data collection.

III. Validation of digitalized MRV system

In order to make sure the final outcome of the development is consistent with the end user requirements, feedback sessions, validation sessions and validation workshops for end users are carried out during the development process.

2 Development of digitalized MRV system for transport sector

2.1 Software development methodology

Software Development Methodology (SDM) is a framework used to structure, plan, and control the process of developing an information system. Waterfall model, iterative model, agile model are some examples for SDMs. Selecting the best SDM for the system or in other words, how well a system adhere to the SDM can effectively determine the success or failure of a project. Selection of the best SDM will depend on the requirements which were defined as functional and non-functional for the digitalized MRV system in deliverable one under this project.

Adhering to a properly-defined methodology enables a project to provide better estimates, deliver stable systems, keep the owner the Ministry of Transport Services Management (MTSM) of the digitalized system informed, create a clear understanding of the tasks ahead, and identify pitfalls earlier, allowing for ample time to make adjustments.

When SDM is not properly implemented, a variety of problems become more and more prevalent as development continues. For instance, a lack of proper communication between the customer and development teams often leads to systems that do not fulfil consumer desires.

2.1.1 Stakeholder engagement and requirements

Stakeholder engagement is vital in developing the digitalize MRV system for transport sector since the MRV system is dynamic. Stakeholders of the digitalized MRV system can be categorized as primary, secondary, tertiary and other.

Primary stakeholders	Secondary stakeholders	Tertiary stakeholders	Other stakeholders
• MRV system management isntitutions (MTSM, CCS) • UNEP DTU	• Activity data providers • Emission factor or default factor providers (Ex:CCS, O&M company, SLR, SLSEA, NTC ,DMT, SLC ,CPSTL ,VET)	• Project proponent	• Sri Lanka Computer Emergency Readiness Team (SLCERT) • Cloud services

Figure 2-1:Categorization of stakeholders of the digitalized MRV system for transport sector

Source: Own work

Primary stakeholders are involved in providing feedback regularly throughout the development process. Secondary stakeholders are reached when the developers need their feedback and clarifications on any change to the scope of the activity data and emission factors that they agreed in ICAT phase 1. Tertiary and other stakeholder are reached only if there is a requirement.

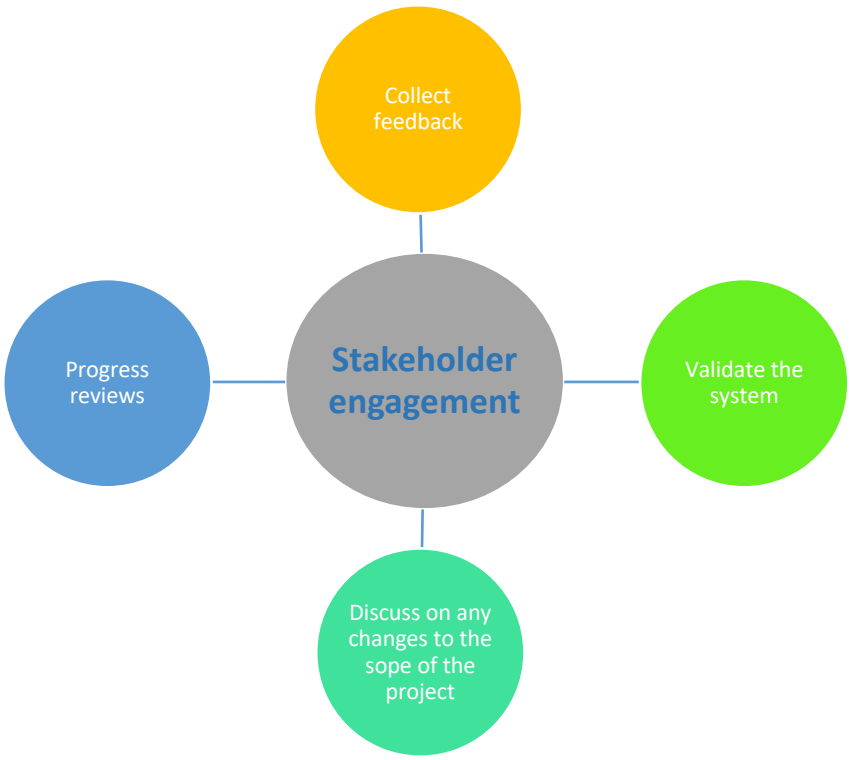

Figure 2-2: Areas which need stakeholder engagement

Source: Own work

Due to the prevailing COVID 19 pandemics faced by the world and also the country most of these stakeholder engagements are carried out through communication media such as phone calls, e-mails and other collaborative platforms like web conferencing, instant massaging etc. Workshops are planed where necessary. A detailed stakeholder engagement plan can be found from the annex 3.

2.1.2 Iterative development

The software development will be done through several iterative cycles in order to capture all stakeholders' ideas and feedback to the development. The initial design of the software was delivered in first report "*Deliverable 1_Report on system and software design for MRV system*" and the development is started accordingly. During the first phase, ClimateSI expects to develop and evaluate the user interfaces and capture stakeholder's feedback. Once the user interfaces are confirmed after few iterative cycles, the second phase (software development) will start by connecting digitalized MRV system with back end and developing the functionalities. In the second phase, Climate SI will run multiple cycles for different components of the digitalized MRV system and invite for different teams to capture the feedback. With the feedback and iterative improvements of those

cycles, the final planning, design and implementation will be carried out to make the final product.

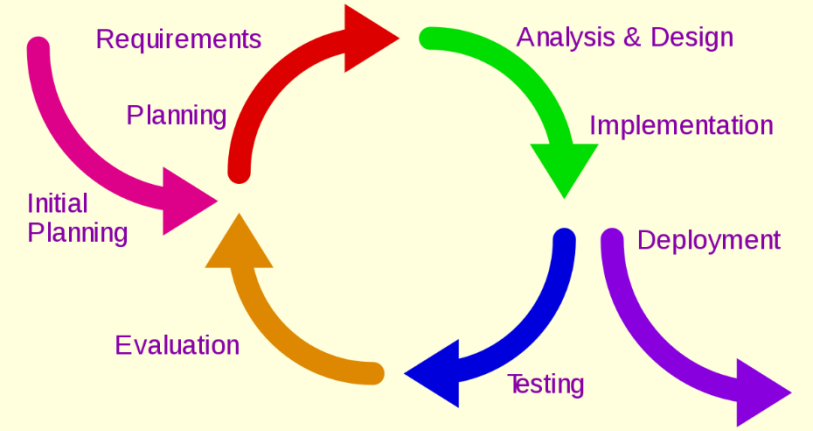

Figure 2-3:Iterative development

Source: Web [1]

2.1.3 Scope management and change management

Primary focus of this digitization project is to convert the existing manual MRV system to a more user friendly and convenient online system. Therefore, the initial scope of the digitization project is same as the manual MRV system. The scope was explained in detail in the first report "Report on system and software design for MRV system". Climate SI expects that within the iterative development cycles explained in section 2.1.2, all stakeholders will be able to understand the scope of the project and validate them for final deployment. However, ClimateSI understands that the MRV system will evolve in the future with more NDCs, projects etc coming in and ClimateSI is willing to support the owner of the MRV system [MTSM] by doing new additions or changes to the web-portal as listed below.

- Addition of other languages (Sinhalese and Tamil)
- Additions of new projects (number of projects per year)
- Additions of new NDCs (number of NDCs per year)
- Changes of methodologies (number per year)
- Addition of Sustainable Development (SD) impact on Transport sector

- Linking the digitalized MRV system for transport sector with the National Carbon Registry
- Addition of Non-NDC projects

Note: Support for these changes or new additions will be provided by ClimateSI only if there is a valid agreement for a post deployment warranty/support services available between the Climate SI and owner of the MRV system.

2.1.4 Methodology selection

The digitalization of transport MRV system is a very dynamic in its nature due to dynamicity of the data which used for calculations. For instance, activity data, emission factors and methodology changes from each mitigation action even under the same sub NDC and NDC. Therefore, the selected SDM should be able to fulfill the requirement of arranging the system within this dynamicity.

Agile model is selected as the best fit model considering the possibility of fulfilling many customized desires of the end-user by working closely with them for the development of the digitalized MRV system.

When using the agile model there is a high degree of collaboration between the clients and the SW development team by providing more opportunities for the SW development team to truly understand the client's vision. There will be frequent and early deliveries of working which increases stakeholders' trust in the SW development team's ability to deliver high-quality working software and encourages them to be more deeply engaged in the project. Also, by seen the working software frequently by the client, there is an added benefit of transparency.

Through a sprint back log and product backlog maintained during an agile model, new features can be developed quickly and frequently. In addition, since the sprints are fixed time boxes, the cost and the project plan can be seen early and decide which features need priority.

Having provisions to accept changes requested by the clients is another core benefit of agile model. In agile, there is an opportunity to constantly refine and reprioritize the overall product backlog. New or changed backlog items can be planned for the next iteration, providing the opportunity to introduce changes within a few weeks.

Agile model always focuses on the user desires. Therefore, agile commonly uses user stories with business-focused acceptance criteria to define product features. By focusing on features on the needs of real users, each feature incrementally delivers value, not just an IT component.

Further more agile improves the quality of each deliverable by breaking down the system in to manageable units which development team can focus on high quality development, testing and collaboration. Also, by producing frequent deliveries and conducting testing and reviews during each iteration, will help detecting mismatches of the expectations early and fixing the defects.

2.1.5 Prioritized feature development

Prioritizing features to be developed or the product backlog prioritization is an important practice in agile software development. The prioritization will help the sprint team to organize the product backlog for sequence development.

There are factors which affect the prioritization of product backlog items such as customer satisfaction, business value, complexity, risk and opportunity and cost. The priority will be assigned for the features which have highest added value to the system and features which are more important to fulfill the purpose of the project . Feature which are complex to develop with no much-added value to the purpose of the project will not be prioritized at the beginning.

However, the prioritization of features needs the involvement of scrum or sprint team with different roles. Figure 2-4 explain the role of each member of the scrum team in prioritizing the features.

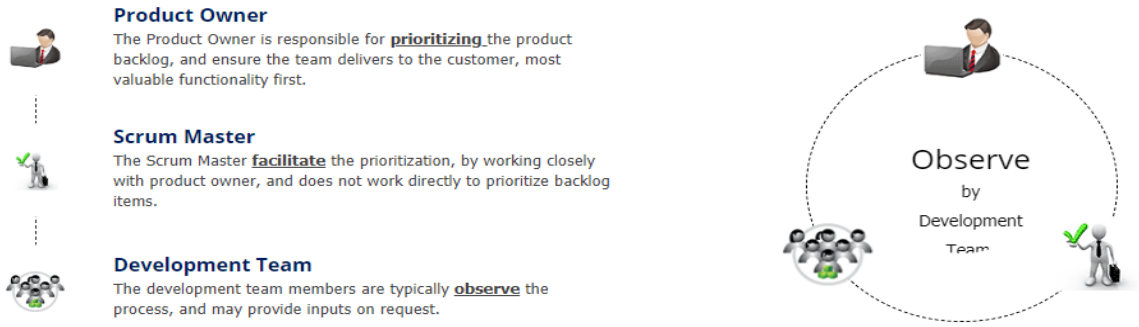

Figure 2-4:Scrum/ sprint team role in prioritization of features

Source: Web [1]

Sprint prioritization has also done for digitization of transport MRV using Jira software and a screen shot of the stories has attached below as figure 2-5.

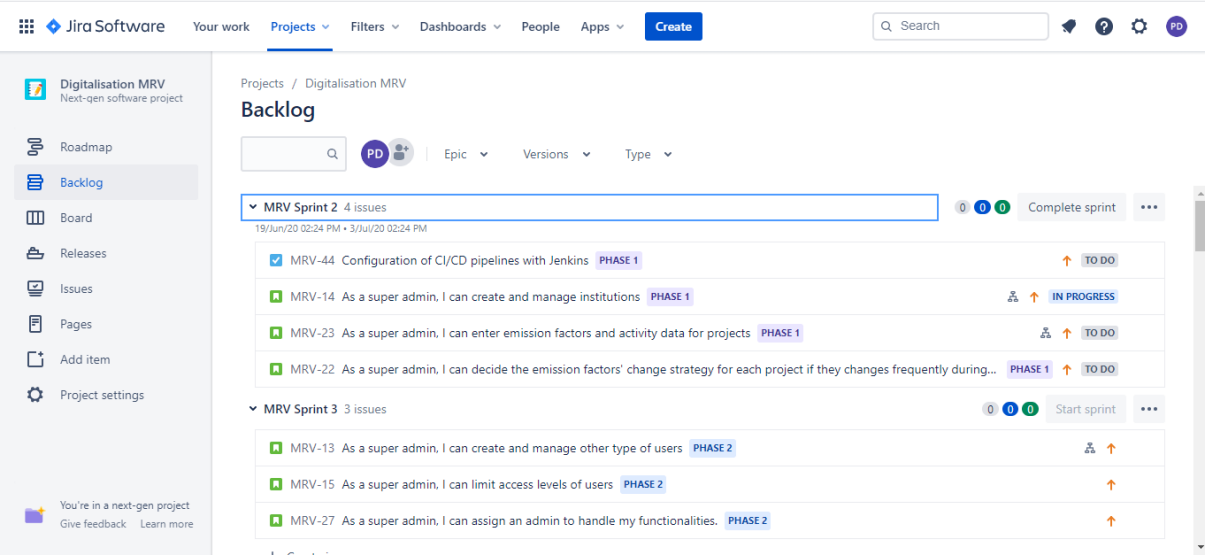

Figure 2-5:Prioritized product backlog for digitalization of transport MRV

Source: Own work

2.2 Development of the digitalized MRV system

The software development is a complex process and following the standard practices are essential to deliver a quality product. The following sections describe the way that addressed the digitalization of MRV system from the perspective of software development.

2.2.1 Components of MRV the System

The digitalized MRV system is built as web platform, so it falls under the category of web applications. The web application comprises of front-end application, back-end application, and database. These three can be seen as different components and they are developed/designed using different programming languages, frameworks, tools and best practices. The MRV back-end is developed using Spring (a popular Java framework for Java Enterprise applications) and the MySQL is used for database. The MRV front-end is crafted as single page application and it uses React Library (a popular front-end library - written by Facebook).

As the MRV application deals with three separable components, the connection / integration of those components is solely based on APIs. The front-end application sends

and receives data in JSON format and uses REST Methods. The back-end application provides infrastructure to handle request comes from front-end application and uses Spring-Data-Jpa (a library from Spring framework) to handle database connection pool.

2.2.2 Configuration Development Environment

2.2.2.1 *Front-end*

The VSCode is used for front-end development as a code editor. The VSCode is a widely used, open-source code editor by Microsoft. The VSCode requires to install some plugins to the React Application development. The linter, debugger, and build tools are required in addition to VSCode. The NPM (Node Package Manager) is used for dependency management. It simplifies the dependent management through a global repository.

2.2.2.2 *Back-end*

The IDEA Community Edition (by Jet Brains) is used for the back-end development as an IDE (Integrated Development Environment). The IDEA gives support for debugging, auto code completion, tools for version management, and source control and many handy tools. The Project Lombok plugin is installed for faster software development. The Maven is used to package the backend code.

2.2.2.3 *Source control and Version Management*

The source control and version management are very common in software development. Therefore, digitalized MRV system will maintain two repositories (front-end and back-end). For cloud replication, Bit bucket (by Atlassian) was used. A branching strategy is used to ensure agile development. In this strategy , initially the master branch is created and then the sprint branch will be created from the master branch. After each sprint (after code reviewed), the sprint branch will be merged into the master branch.

2.2.2.4 *Scrum Management*

Scrum management is managing the product and sprint backlogs. Scrum management for digitalization of transport MRV is done using the JIRA software. In scrum management there are several items such as product backlog, sprint planning, sprint backlog, developing sprints, deliver potential products, sprint reviews and retrospectives.

Clients will prioritize the features to be developed by entering user stories to the product backlog and then the sprints will be planned for the priority user stories and add them to

the sprint backlog. Then a sprint will be developed within a fixed time box for example 2-3 weeks. During this period there will be daily scrum meeting with the scrum master and weekly scrum meetings with the scrum team. After that the developed sprint or the potential product will be shown to the clients and collect feedback as a sprint review. In the sprint retrospective, the scrum team will discuss about the feedback and integrate possible changes to the next product development cycle. Figure 2- 6 to 2-9 illustrates the scrum management used for digitalized MRV system for transport sector.

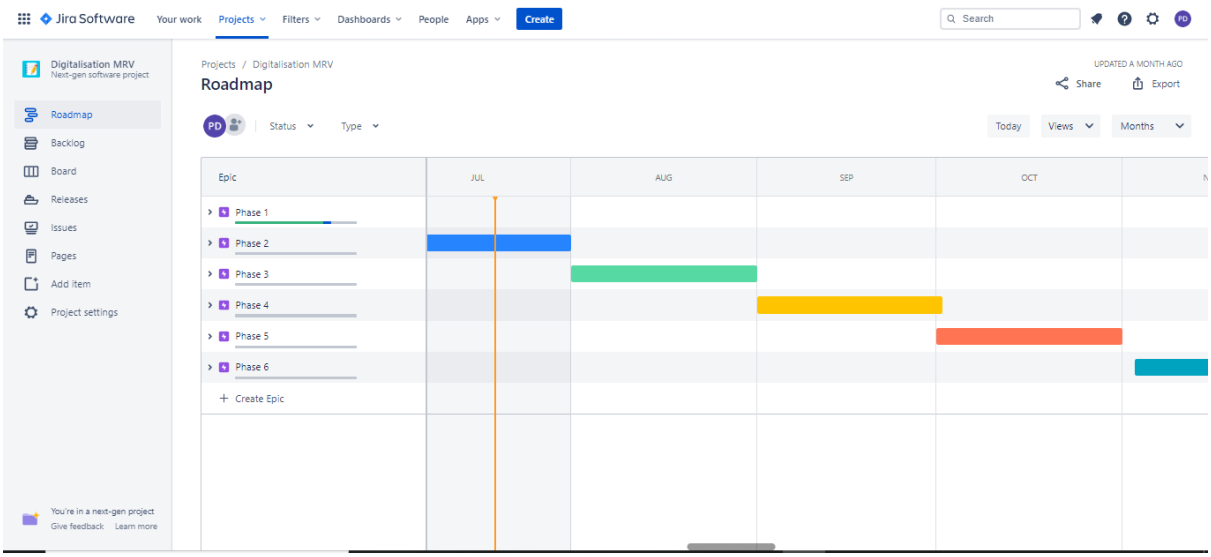

Figure 2-6:Project road map

Source: Own work

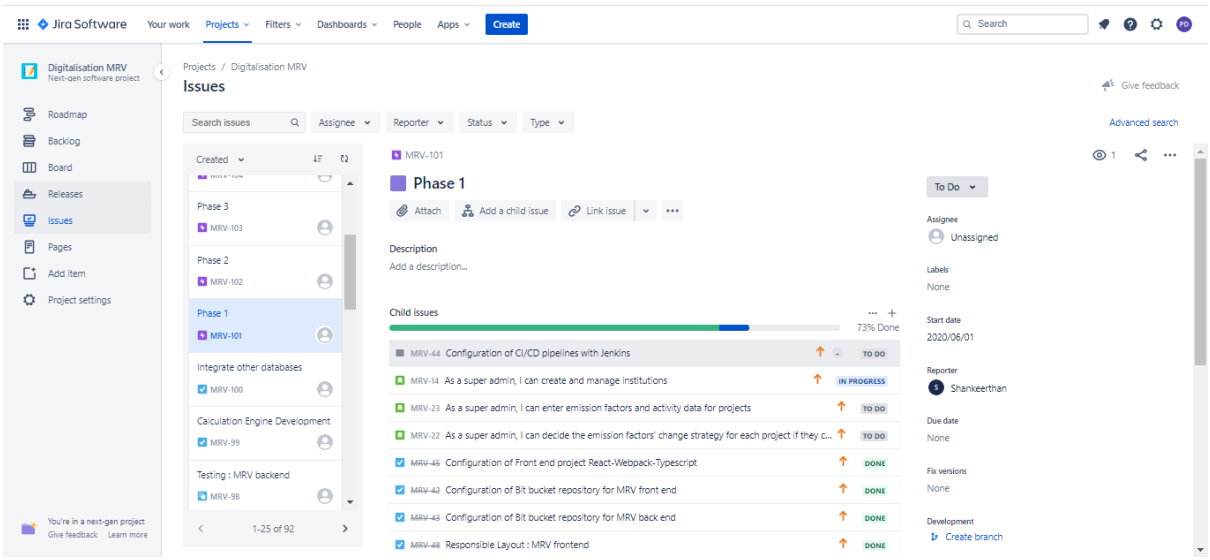

Figure 2-7:Creating an issue

Source: Own work

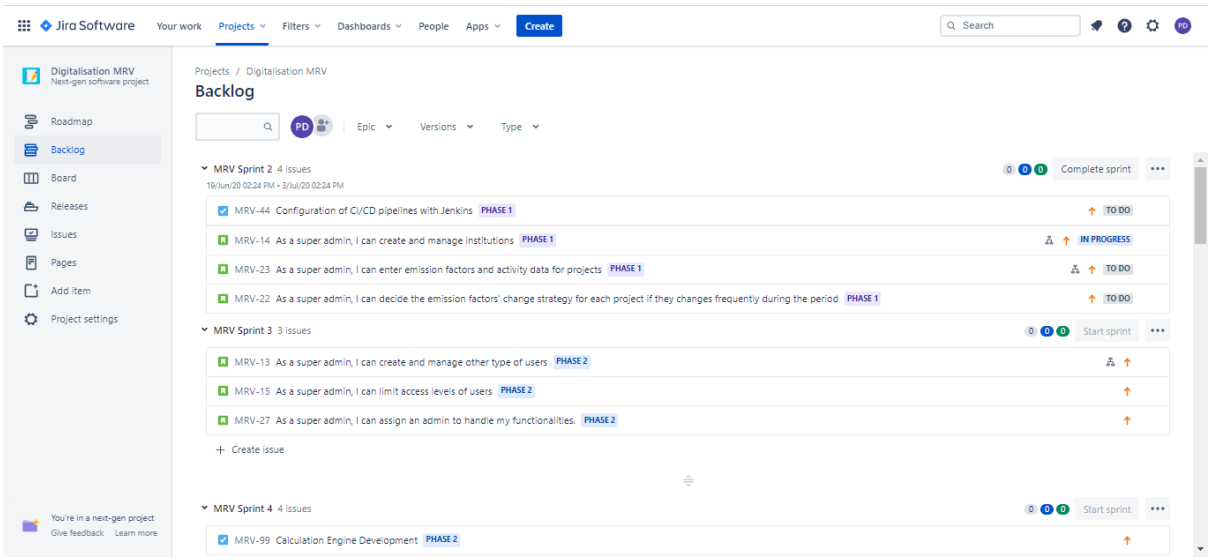

Figure 2-8: Sprint backlog

Source: Own work

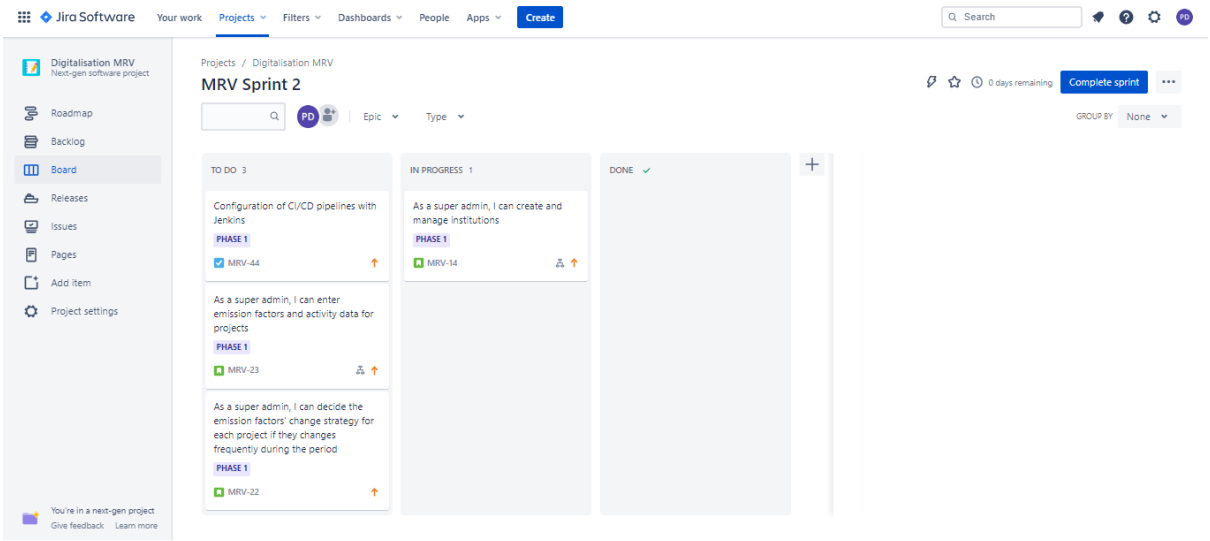

Figure 2-9:JIRA Dash board

Source: Own work

3 Database Integration

Assessing GHG impacts of the transport sector NDCs will require the data from multiple institutions. Some of these institutions such as Ceylon Petroleum Storage and Terminals Limited (CPSTL) already maintain digitalized data management systems. Integration of these data management systems with proposed digitalized MRV system will enhance the efficiency , accuracy and reduce the effort from those institutions.

3.1 Possibilities of Integration

Preferred way of integrating with other institutions' digital platforms is via open APIs due to security concerns. If an institution wishes to automate data reporting through their own software system, they can integrate to the REST-APIs of the MRV system.

Other than exposing the own APIs, MRV system is also able to integrate with consistent APIs exposed by the data reporting institutions.

3.2 Data exchange

The digitalized MRV system cannot run without the data from the institutions. It's common to connect existing services/applications via well-defined APIs. The connected systems provide benefits such as on-time data feeding, elimination of human checking on the data, and high accuracy of data. Database integration is considered when designing the system architecture of the digitalized MRV system. The term "Database Integration" may be misinterpreted as "connecting the physical databases directly". In software development, connecting multiple databases (belongs to different institutions) considered as a bad practice. Therefore, the digitalized MRV system uses the services built on the top of the databases to connect applications.

The main challenge to new applications that wants to integrate with existing applications/services is data exchange. The software systems usually build the data exchange as a different module. The key principle of software development is maintaining separation and modularity as much as possible.

The Enterprise applications use ESB (Enterprise Service Bus) to handle data exchanging parts with multiple services. In recent years with the emerge of microservices, the queues (Kafka, RabbitMQ) became popular in data exchanges.

The main responsibilities of data exchange are bridging the gaps between services, scheduling/ triggering API invocation, and filter only the relevant data (kind of conversion). The message format is an essential element to consider when designing a data exchange. The SOAP and REST mainly use JSON and XML. The core MRV back-end will support only JSON format and the data exchange will do the rest of conversion (to XML).

3.3 Assessing Security and Permissions

The data exchange is an occasion where the system exposes the APIs' details. Proper security management is necessary to protect data exchange from the security attacks. The security can be enforced at hierarchical levels such as, Data exchange level, Core Back-end level, database level etc.

The APIs will be exposed by the MRV system are planned to manage authorization and authentication of services (API consumers) using an API key methodology. DOS (Denial of Service) is one of the common and possible attacks and these attacks can be mitigated using a logbook. The logbook records the API invocation details and some restrictions can be placed (deny requests for a short period after the number of requests per second reached a certain threshold) by monitoring the frequency of API invocations from the intuitions or IP addresses.

The MRV system assumes that the API consumer always submit correct data when they send requests and managing their (Institutions' Information Systems) security is the responsibility of a particular institution.

4 End user validation of the digitalized MRV system

4.1 End users

End users are the personnel that a software program is designed for. The digitalized MRV system for the transport sector is designed for a wide range of end users who play different roles in handling emission reduction projects under each NDC for transport sector. However, MTSM as the owner of the digitalized MRV system has the right to manage all other end users of the system.

As detailed in section 2.1.2.4 of Deliverable 1, there are several categories of users such as,

- ✓ Administrators from MRV system management institutions and other institutions such as master admin (MA), backup master admin (BMA), admin and institutional admins (IAs).
- ✓ Data providers such as activity data providers and emission factor/default factor providers and project proponents
- ✓ Verifiers
- ✓ MRV system monitors who supervise assessing the GHG impact from the transport sector NDCs
- ✓ Other users such as general public (Note: There is no involvement of general public in validating the software system.)

These end users have different levels of access for the digitalized MRV system according to the function that they play in the MRV system. Therefore, the end users will receive the access for the interfaces of the digitalized MRV system according their role and the information that visible to them will be filtered according to their profiles/access rights.

4.2 Elements of the system to be validated

Validation of the digitalized MRV system will be carried out in several steps during the period of software development. Validation will cover several aspects of the digitalized MRV system which need to get feedback from the end-users during the software development listed below.

1. User interfaces
2. Functionality of the interfaces

3. Report template
4. Excel upload templates
5. Mail templates

4.2.1 Validation of user interfaces

Validation of user interfaces is an important step during the development of a software to make sure that the development meets the requirements of the end users. Therefore, digitalization of transport sector MRV system also includes user interface validation session with it's end users.

The objective of user interface validation is to collect feedback from the end users about the completeness of the interfaces. This includes collecting feedback on three areas namely;

- ✓ Format of the web interfaces: Ex: structure of the web interfaces
- ✓ General appearance of the web interfaces: Ex: titles used in the navigation/menu, heading for the main interface etc.
- ✓ Technical inputs: Ex; suitability of the technical words that presents on the user interfaces, suitability of the information shown related to MRV and whether the user can understand the data entry fields and the needed data for each field shown in the interfaces.

4.2.1.1 *Interfaces for end user validation*

Interfaces which were validated through validation sessions are attached in annex 1. A summary of the feedback received in each validation session for user interface validation will be discussed in the chapter 4.4 and more details of the validation sessions can be find in annex 2.

4.2.2 Validation of the functionality of the interfaces

Validation of the functionality of the interfaces will be carried out to validate whether the interfaces are functioning well with the inputs received from the end users and provide correct output. A functionality validation will includes checking the following functions;

- Whether the user can navigate freely among the different data entry fields (and tags // pages if any)
- Whether the system accepts all necessary data
- Whether the system shows the correct output for the correct inputs
- Whether the system shows error messages where necessary
- Possibilities of edit, delete and insert data
- Whether the users' entitlements and authority levels are functioning as expected

4.2.3 Validation of report templates

Digitalized MRV system for transport sector will help the users to generate reports through the system. For instance, it will generate a final NDC report for transport sector including all the NDCs which are in the scope of digitalization of transport MRV system. Other than that system will supports to generate summary reports for each project under each sub NDC.

Therefore, during this validation session end users will be shown sample report templates and collect their feedback on the content of the report.

4.2.4 Validation of excel upload templates

Digitalized MRV system for transport sector will allow the users to upload data sheets or excel templates to the system instead of entering the data. However, these excel upload templates should be in line with the data entry fields of the system. Therefore, there will a validation session to show and get agreed to a common excel template for each end user (mainly data providers).

4.2.5 Validation of mail templates

The structure and the appearance of the email template for the end users will be validated through a validation session.

4.3 Process of validating the digitalized MRV system

This section elaborates on the process of validating the necessary elements (section 4.2) of the digitalized MRV system. However, there can be changes to the general process depending on the requirements of the element and they will be explained separate to the general process.

4.3.1 General process of validation

Due to the prevailing COVID 19 pandemic situations in the country, conducting stakeholder consultation workshops become a challenge. Therefore, with the agreement from the key stakeholders such as MTSM and MEWR and ICAT a suitable online meeting platform (Ex: Zoom, Skype etc.) will be selected to engage the stakeholders for the validation process.

The invitation will be emailed to the relevant stakeholders institution for each validation session before a week for the agreed date of validation. During a validation session, stakeholders can suggest changes and provide their ideas regarding the appearance and the functionality of the user interfaces. At the end, the software development team will assess the feedback and provide a list of possible improvements that can be done during the development.

4.3.2 Process of validating the User interfaces

The validation process of user interfaces involves many steps as explained in the Figure 4-1.

Figure 4-1:Process of validating the user interfaces

Source: own work

Feedback session

There will be one or two feedback sessions to collect feedback from the stakeholders. After each feedback session, developers will assess the feedback and figure out the possible changes that could be done. Then the interfaces will be revised by integrating possible changes before the validation session.

Validation session

During the validation session, the revised interface according to the received feedback during the feedback sessions will be shown and verify whether the interfaces fulfil the end user requirements.

Customer workshop

The customer workshop will be held to present the interfaces for all the stakeholders and get a certified (Signed) copy of the interface which were agreed by the end-users during the final validation session. All these certified copies of interfaces by each stakeholder will be again certified by the owner (MTSM) and the supervisory institution (MEWR) during the workshop.

4.3.3 Stakeholder engagement plan for validating the digitalized MRV system

The Table 4-1 describes the stakeholder engagement plan to validate the digitalized MRV system which was taken from the stakeholder engagement plan attached as an Annex 3.

Table 4-1:Stakeholder engagement plan to validate the digitalized MRV system for transport sector

Date	Main Item	Sub Item	Stakeholders	Method of validation	Objectives
16th July 2020	User interface validation	1.Institution management 2. Emission factor management 3.User management	MTSM, CCS of MEWR, ClimateSI, UNEP	Skype meeting	Collect feedback on the look and feel of the interface

		4.Project creation and Management			
4th August	Feedback session on the user interfaces	1.Data collection template for activity data reporting institutions and emission factor reporting institutions 2.Home page for activity data reporting institutions and emission factor reporting institutions	MTSM and CCS	Skype meeting	Collect feedback on the look and feel of the interfaces of other stakeholders
6th & 7th August	Feedback session on the user interfaces	1.Data collection template for activity data reporting institutions and emission factor reporting institutions 2.Home page for activity data reporting institutions and emission factor reporting institutions	MTSM, MEWR, CCS, O&M company, SLR, SLSEA, NTC, DMT, SLC, CPSTL, VET	Skype meeting	Collect feedback on the look and feel of the interfaces

11th August 2020	User interface validation	3.Data collection template for activity data reporting institutions and emission factor reporting institutions 4.Home page for activity data reporting institutions and emission factor reporting institutions	MTSM, MEWR, CCS, O&M company, SLR, SLSEA, NTC, DMT, SLC, CPSTL, VET	Skype meeting	Validate the interfaces
18th August	Customer workshop to validate the user interface	1. All the interfaces of the digitalized MRV system	MTSM, CCS, MEWR, ClimateSI, UNEP O&M company, SLR, SLSEA, NTC, DMT, SLC, CPSTL, VET	Meeting	Certifying all the interfaces validated during the validation sessions
21st August 2020	Page Functionality Validation	1. Project monitoring 2. Linking baseline methodology 3. Data collection	MTSM, MEWR, CCS, O&M company, SLR, SLSEA, NTC, DMT, SLC, CPSTL, VET	Skype meeting	Collect feedback on the data collection interfaces Collect input for the final report and home page
18th September 2020	Page Functionality Validation	1. Mail and notification 2. Messaging system	MTSM, CCS, MEWR, ClimateSI, UNEP	Skype meeting	Default mail and text message template

	& Mail Templates				
16th October 2020	Page Functionality Validation & Report Templates	1.Invitation to external users 2.Project calculation 3.Verifier's page 4.Home page of MTSM 5.Report generation (only final report)	MTSM, CCS, MEWR, ClimateSI, UNEP O&M company, SLR, SLSEA, NTC, DMT, SLC, CPSTL, VET	Skype meeting	Collect feedback on home page of each type of users Feedback on report generated
13th November 2020	Page functionality validation & Excel upload templates	1.Failure reporting pages 2.Data collection templates (Excel)	MTSM ClimateSI	Skype meeting	Collect feedback on the failure reporting pages Test the data collection templates
27th November 2020	Page functionality validation	1. Dash board 2. Other missing features	MTSM, CCS, MEWR, ClimateSI, UNEP	Skype meeting	Input for the dash board

Source: Own work

4.4 Summary of the feedback from the end users

(overall feedback of the software, the positive and negative general feedback on the user friendliness and the appearance of the interface etc., The feedback sheet, detailed feedback can be annexed)

4.5 Next steps

(Acceptable changes, suggestions to integrate the changes with the interface, rejected changes should be mentioned with the reason)

Annex 1: User interfaces to be validated from the stakeholders

Annex 2: End user feedback on the MRV system

Annex 3: Stakeholder engagement plan

5 References

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