Assessing Spatial Digital Twin Model Using ISO/IEC 25010 Framework: A Case Study of Oil and Gas Project in Australia

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Key words: ISO/IEC 25010, spatial digital twin, oil and gas field design

SUMMARY

ISO/IEC 25010 framework is being widely accepted as it encompasses all the necessary metrics to evaluate the system/model/software from various dimensions. The main objective of this study was to assess the spatial digital twin model using ISO/IEC 25010 framework. To accomplish the objective of the study, a case of land survey data model (LSDM) based digital twin for oil and gas field design was selected. LSDM is developed by the Geomatics Committee of International Association of Oil and Gas Producers (IOGP) which serves as a geodatabase data template and a guiding principle of data dictionary for all the projects around the world for various purposes including field design. ISO/IEC 25010 framework includes eight metrices such as functional suitability, performance efficiency, compatibility, usability, security, reliability, maintainability, and portability. This study has utilised all eight metrices except "security" because most commonly security parameters of the prototype are evaluated when the prototype/system/software is deployed to the market for real business purposes since the prototype used in this study was just in a beta version. The results generated from the evaluation indicate the prototype has successfully achieved functional completeness, correctness, and appropriateness within the scope of this study. Further, in terms of rendering time and resource utilisation, the prototype was able to achieve standard performance. In addition to this, an evaluation demonstrated that the prototype was compatible when assessing it against the Digital Twin Victoria (DTV) platform. Similarly, usability assessments verified its suitability for oil and gas projects in the field design process. The prototype was successfully able to execute essential field design functionalities based on LSDM. Further, the evaluation of security parameters was not assessed as a prototype as it was in the beta version. Moreover, the evaluation indicates that the prototype is portable as it enables its replication in the field design processes of O & G projects. In a nutshell, the prototype encompasses a standard level of all parameters in the ISO/IEC 25010 framework within the scope of the study. The key significance of the study is it's methodological contribution to evaluating the spatial digital twin models when there are limitations in regulatory requirements and information accessibility. It is recommended that, to achieve a more comprehensive assessment, employing additional evaluation methods, such as conducting interviews with subject matter experts (SMEs), would be crucial to facilitate broader industry acceptance and implementation.

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1. INTRODUCTION

According to the policy report of WGIC (2022); spatial digital twuin (DT) can be defined by the three parameters that includes definition, attributes, and benefits. A spatial digital twin (DT) is the virtual representation of real-world entities and processes by using positioning and dimensions to uplift the value, insight, and integrity of the virtual model which, in many instances, may be continuously updated at a synchronised frequency and fidelity (ANZLIC, 2019). Similarly, the parameters of the attribute state, "Whether implicitly or explicitly, most DT include in their virtual representations, the precise location and relative dimensions of elements included in their models" (WGIC, 2022). Additionally, spatial DTs enhance visualisation, facilitate faster interpretation, enable socioeconomic applications, and provide insights at a scale that outweighs the additional investment of a spatially accurate and positioned digital model of physical entities and processes" (ANZLIC, 2019).

Most of the existing studies that have adopted the design science approach to developed DT related framework and have utilised the survey approach (interviewing the relevant subject matter experts) witin the framework to evaluate their framework/model. For instance, Atazadeh (2017) interviewed 12 participants to evaluate the BIM model. Similarly, Cemellini (2018) in his Master's dissertation, recruited 20 users to test the usability of the developed 3D cadastral model. Furthermore, Broekhuizen (2021) has utilised the feedback process to validate the conceptual 3D LAS system. Therefore, it can be certainly said that interviewing the stakeholders is considered a reliable method of evaluation. However, Johannesson & Perjons (2021) highlights that the evaluation of framework/model is always based on the context and goal. For insatnce, a study carried out by Kang et al. (2022) adopted financial modelling (cost-benefit analysis) to evaluate the framework for BIM integrated waste management system. Similarly, another study was carried out by Sharafat et al. (2021) evaluating the BIM-GIS underground utility management system by comparing it with the traditional 2D-based methods. Similarly, a study conducted by Li et al. (2017) developed the web-based GIS system and compared it with other existing systems as part of the evaluation process. In addition to this, Atazadeh (2017) used objective assessment (comparing with other existing models) to evaluate the developed BIM model using different parameters as part of his PhD study. This indicates there are several methods that have been practiced within the research domain to evaluate the framewoeks/models which solely depend on the type of framework and available resources.

Thus, this study aims to explore the feasibility of the widely accepted ISO/IEC 25010 framework to assess the spatial digital twin model. To accomplish the objective of the study, a case of land survey data model (LSDM) based digital twin for oil and gas field design was selected. LSDM is developed by the Geomatics Committee of International Association of Oil and Gas Producers (IOGP) which serves as a geodatabase data template and a guiding principle of data dictionary for all the projects around the world for various purposes including the field design. The key significance of the study is that it explores and developed the approach to evaluate the spatial digital twin models when there are limitations in regulatory requirements and information accessibility. Perhaps, it is recommended that to achieve a more comprehensive assessment, employing additional evaluation methods, such as conducting interviews with SMEs, is crucial for achieving broader industry acceptance and implementation.

1.1 Field Design Process and LSDM

The field design for any O & G project must adhere to the rules and regulations of the host country (IOGP, 2020). It involves the design of various infrastructures that include well infrastructure, rigs, access roads, gathering pipeline networks, and various other facilities such as utility features, culverts, pipeline tie-ins, fences, sumps, laydown areas, borrow pits, camps, tanks, and sewage treatment plants (IOGP, 2020; Gasfields Comissions Queensland, 2022). Each O & G project has its own specific procedures and workflow and depends upon the nature of the project. Based on the information provided by Adedeji and Samuel (2013); IOGP (2022); and Shell QGC (2017), field design typically entails four key steps, conceptual engineering design, detailed engineering design, approval from various stakeholders, and finally storing the design spatial data into the central spatial inforamtion system (SIS) of the oil and gas project based on LSDM. The conceptual engineering design is considered the initial phase in the design of infrastructure in any oil and gas project. Its primary objective is to develop and validate the feasibility of various alternatives (Paul et al., 2008). Simialrly, detailed engineering design is the second step in the field design of any typical O & G project. The goal of the detailed engineering design process is to refine and communicate the preliminary design in a set of drawings/3D models, and specifications (Sabri et al., 2015). Furthermore, detailed engineering needs to be approved from all relevant authorities for further field layout and construction (VIVA Energy, 2020). Once all stakeholders involved in the field design process have reviewed and approved the detailed engineering design of the proposed infrastructure, the final crucial step involves migrating the spatial data of the infrastructure design into the SIS using LSDM (IOGP, 2022).

LSDM was developed by the Geomatics Committee of IOGP (IOGP, 2022). It serves as a geodatabase data template and serves as a guiding principle of data dictionary for all the projects around the world for various purposes that incorporate infrastructure design, topographic surveys, geodetic networks, UAV/LiDAR operations, vegetation surveys, imagery sources, Right of Way (ROW) assessments, cultural data, geological studies, environmental surveys, and infrastructure monitoring (IOGP, 2022). LSDM is specifically tailored for contractors providing surveying and mapping support, and oil and gas companies managing onshore exploration licences, production facilities, and related infrastructure. IOGP (2022) advised that as part of utilising LSDM survey contractors should supply the geodatabase of the infrastructure design based on the LSDM geodatabase template. This approach minimises data replication and redundancy. Further, LSDM facilitates the storage of crucial geospatial and non-geospatial details within land-based survey activities for the design of any infrastructure.

2. CASE STUDY AND METHODOLOGY

2.1 Case Study

The case study area was selected based on data accessibility. Figure 1 illustrates the chosen case study area along with its elevation range. It is located in Queensland, Australia within the Dalby mining district, in accordance with the regulations of the Department of Resources, Queensland Government. Furthermore, it is situated within the Western Downs Regional Council. This case study area is located at lot number 2RP108045 petroleum lease 229, registered under the Department of Resources, Queensland Government.

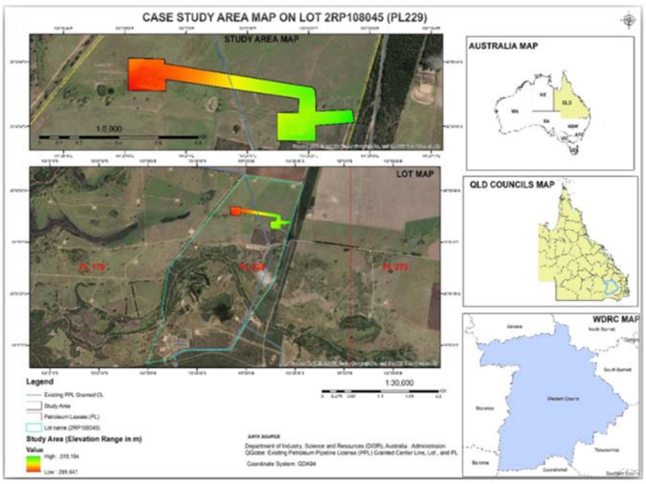


Figure 1: Case Study Area

Source: Bhandari et al., 2024

To explore the feasibility of the widely accepted ISO/IEC 25010 framework for assessing the spatial digital twin model , the LSDM based digital twin for oil and gas field design was selected as shown in Figure 2. This is the digital twin model (prototype) developed by Bhandari et al. (2024). The key reason for selecting this prototype as a case study was due to the accessibility of the prototype and its relevant datasets.

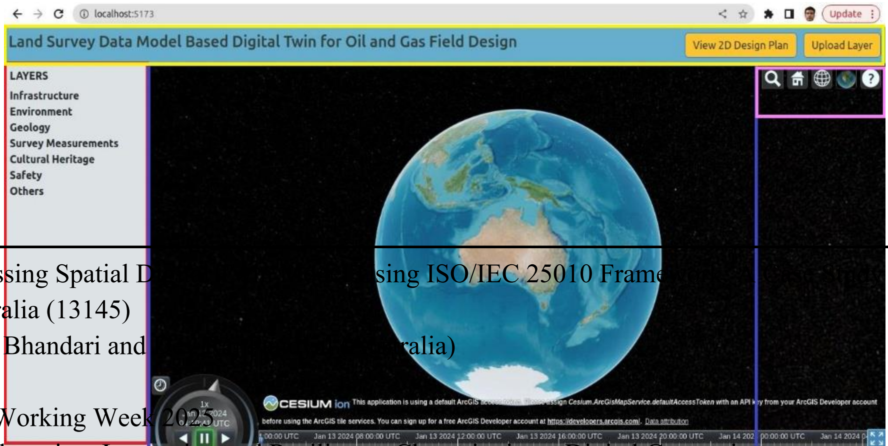


Figure 2: LSDM Based DT

Source: Bhandari et al., 2024

2.2 Methodology

ISO/IEC 25010 framework includes eight metrices such as functional suitability, performance efficiency, compatibility, usability, security, reliability, maintainability, and portability as shown in Figure 3. This study has utilised all eight metrices except "Security" because most commonly security parameters of the prototype are evaluated when the prototype/system/software is deployed to the market for real business purposes since the prototype used in this study was just in a beta version. Eight assessments were carried out separately against respective metrices of the framework through self-assessment approach. Due to time constraints, regulatory requirements, and resources O & G stakeholders' inputs were not incorporated during the assessment.

Figure 3: ISO/IEC 25010 Framework

2.2.1 Functional Suitability

This parameter is defined by three key criteria: functional completeness, correctness, and appropriateness (Abu Bakar et al., 2022). Functional completeness evaluates the extent to which a system includes all necessary functions to meet defined objectives comprehensively (Ali et al., 2022). Similarly, functional correctness ensures that the system generates accurate outcomes aligned with expected results. Further, functional appropriateness assesses how well these functions support users in achieving specific objectives, considering usability and efficiency in task accomplishment (Echeverria et al., 2021). Together, they ensure a system that not only encompasses required functions but also delivers accurate results and effectively aids users in reaching their goals.

2.2.2 Performance Efficiency

This parameter is defined through three key criteria that include time performance, resource utilisation, and capacity (Keibach & Shayesteh, 2022). Time performance measures how well a system meets requirements in terms of response time, processing speed, and throughput rates while executing its functions (Al-Mohamadsaleh & Alzahrani, 2023). Similarly, resource utilisation evaluates how effectively a system utilises various resources in quantity and type while carrying out its functions to meet specified requirements (Kato & Ishikawa, 2024). Finally, capacity assesses how well the system meets stipulated requirements concerning its maximum thresholds or limits for specific parameters.

2.2.3 Compatibility

Compatibility is explained to the extent to which a system is capable of both sharing information with other systems and executing its intended functions within a common hardware or software environment (ISO, 2022). This attribute consists of the two key underlying criteria that include co-existence and interoperability (Kato & Ishikawa, 2024). Co-existence refers to the level at which a system maintains efficient functionality while sharing resources and an environment with other systems without causing any negative impact on those other systems (Galli et al., 2021). Interoperability, on the other hand, signifies the extent to which multiple systems can effectively exchange information and utilise the exchanged information for their respective purposes (Abu Bakar et al., 2022).

2.2.4 Usability

The extent to which a system, within a specified context of use, enables specified users to achieve predefined goals with effectiveness, efficiency, and satisfaction (Fahmy et al., 2012). This parameter comprises criteria which are appropriateness, learnability, operability, user error protection, user interface aesthetics, and accessibility (Keibach & Shayesteh, 2022a). The definitions of each criterion are illustrated in Table 1.

Table 1: Usability Criteria

Criteria	Definition
Source: ISO/IEC 25010	
Appropriateness (Ap)	The extent to which users can determine if a system aligns with their requirements and is suitable for fulfilling their needs.
Learnability (L)	The extent to which specified users can achieve their intended goals of learning to use a system effectively, efficiently, safely, and with satisfaction within a specific context of use.
Operability (O)	The extent to which a system possesses characteristics that facilitate its ease of use and management.
User error protection (UE)	The level at which a system safeguards users from making mistakes or errors.
User interface aesthetics (UIA)	The extent to which a user interface allows for enjoyable and satisfying interaction from the user.
Accessibility (Ac)	The level to which a system can be utilised by individuals with diverse characteristics and abilities to accomplish a defined objective within a specific context of use.

2.2.5 Reliability

The extent to which a system fulfils specific functions within predefined conditions and over a specified duration is referred to as its reliability (ISO, 2022). This parameter can be assessed by maturity, availability, fault tolerance, and recoverability (Ali et al., 2022). The level to which a system satisfies reliability requirements during regular operation is defined as maturity. Similarly, availability can be defined as the extent to which a system is available and accessible as needed for its intended use (Galli et al., 2021). The degree to which a system continues to function according to its intended design despite the existence of hardware or software faults is termed fault tolerance (Echeverria et al., 2021). Further, the level at which a system when facing an interruption or failure, can retrieve the affected data and restore the system to its desired state is known as recoverability (ISO, 2022).

2.2.6 Security

This parameter signifies the extent to which a system safeguards information and data, ensuring appropriate access levels based on authorisation types and levels (ISO, 2022). The parameter needs to be assessed through confidentiality, integrity, non-repudiation, accountability, and authenticity.

- **Integrity:** The level at which a system prevents unauthorised access to or alteration of computer programs or data (Kato & Ishikawa, 2024).
- **Nonrepudiation:** The degree to which actions or events can be reliably proven to have occurred, eliminating the possibility of later denial (Ali et al., 2022).
- **Accountability:** The level at which the actions of an entity can be distinctly traced back to that specific entity (ISO, 2022).
- **Authenticity:** The extent to which the claimed identity of a subject or resource can be convincingly verified or proven (Abu Bakar et al., 2022).

2.2.7 Maintainability

This parameter denotes the level of effectiveness and efficiency in modifying, correcting, or adapting a system to enhance its performance or align it with changes in the environment and evolving requirements (Kato & Ishikawa, 2024). It encompasses several criteria which are modularity, reusability, analysability, modifiability, and testability (ISO, 2022).

- **Modularity:** The extent to which a system comprises distinct components, ensuring that changes to one component have minimal impact on others (Abu Bakar et al., 2022).
- **Reusability:** Degree to which an asset can be utilised across multiple systems or can be employed in constructing other assets (Echeverria et al., 2021).
- **Analysability:** Effectiveness and efficiency in evaluating the effects of intended changes to parts within a system (ISO, 2022). It involves diagnosing deficiencies or causes of failures and identifying areas for modification (Ali et al., 2022).
- **Modifiability:** The level at which a product or system can be modified effectively and efficiently without introducing defects or compromising existing quality (Galli et al., 2021).

- **Testability:** The effectiveness and efficiency in establishing test criteria for a system, product, or component and conducting tests to verify whether those criteria are met (Kato & Ishikawa, 2024)

2.2.8 Portability

The degree of effectiveness and efficiency in which a system can be shifted from one hardware, software, or operational environment to another is called explanation (ISO, 2022). This characteristic encompasses adaptability, ‘installability’, and replaceability (Al-Mohamadsaleh & Alzahrani, 2023). The extent to which a system can be efficiently and effectively adjusted to suit diverse or changing hardware, software, or operational environments is called adaptability (Keibach & Shayesteh, 2022a). Similarly, ‘installability’ is the level of effectiveness and efficiency in successfully installing and/or uninstalling a system within a specified environment (ISO, 2022). The degree to which a system can replace another specified software for the same purpose within the same operational environment is called replaceability (Ali et al., 2022).

3. RESULTS

3.1 Functional Suitability

The developed prototype was successfully capable of storing 3D spatial data of the infrastructure design in a virtual 3D environment for enhancing visualisation along with storing the associated spatial information based on the LSDM as shown in Figure 4. This indicates prototypes have accomplished functional suitability within the scope of the study.

Figure 4: Visulisation of Digital Twins

Source: Bhandari et al., 2024

3.2 Performance Efficiency

To evaluate the performance efficiency, the prototype was compared with a similar existing DT platform (Digital Twin Victoria) developed in the context of Australia. The comparison was made based on the three criteria (time, resource utilisation, and capacity) outlined in the methodology section.

An experiment was carried out to compare the rendering times of 3D objects on two systems: the prototype and the Digital Twin Victoria (DTV) platform. Rendering times, influenced by factors like response time, processing speed, and throughput, were recorded using a stopwatch app on a Dell Intel i7-10700 system. Results (Figure 5) showed the prototype rendered the most complex object (facilities) in 10.7 seconds, while the DTV took 13.3 seconds, likely due to the DTV's extensive dataset. Other objects, like roads and pipelines, showed minor differences of about 1 second, potentially due to varying internet bandwidths. Overall, the prototype demonstrated efficient rendering capabilities comparable to the DTV platform.

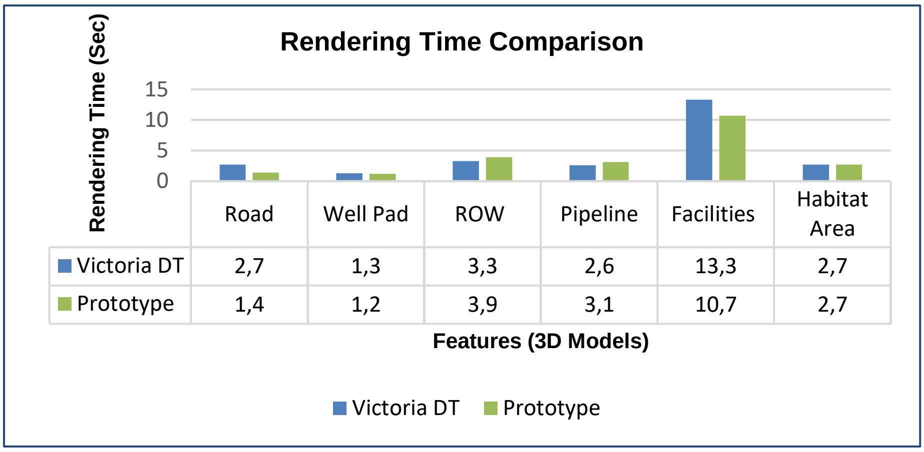


Figure 5: Rendering Time Comparison

Data Source: Bhandari et al., 2024

The resources (libraries) utilised in the prototype are free and open-source libraries such as Geoserver, CesiumIon (free subscription), and PostgreSQL for visualisation and populating the LSDM attributes. On the other hand, the Victoria DT core components are also built using free and open-source libraries. In terms of capacity, the prototype can visualise the 3D objects and associated spatial information involved in field design based on LSDM attributes for specific O & G projects. This is significantly important. However, the DTV is more focused on the built environment and the public sector. Currently, prototype has a maximum of 5GB storage to hold the datasets through CesiumIon free subscription. DTV can manage various themes of data in the context of the built environment ranging from cadastre, land administration, transportation, railways, etc as shown in Table 2. The reason for this is, DTV is based on CesiumIon (Commercial license).

3.3 Compatibility

To evaluate the compatibility, the developed prototype was again compared with the Digital Twin Victoria (DTV). The comparison was made based on two criteria that encompass co-existence and interoperability. Victoria DT can access and visualise the datasets from other sources if the URL is given, whereas the prototype can store the datasets on CesiumIon through Asset ID as presented in Table 3. In the context of interoperability, the prototype and Victoria

DT accessed all types of 3D data formats to store the 3D objects that are accepted by CesiumIon. This signifies the prototype is compatible while assessing with Victoria DT.

Table 2: Capacity of Prototype

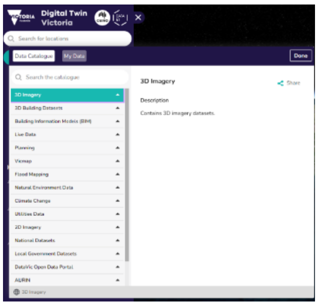
<table>
<tr><th>Prototype</th><th>Victoria DT</th></tr>
<tr><td>
</td><td>
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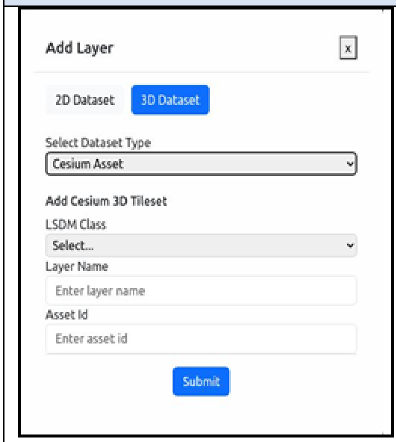
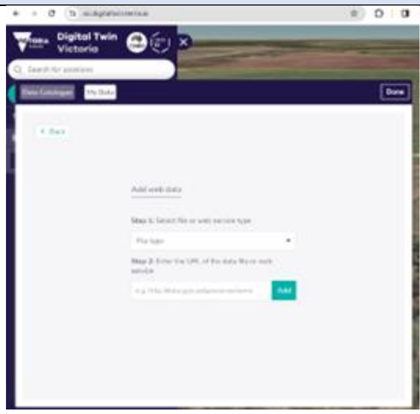
Table 3: Compatibility of Prototype

<table>
<tr><th>Prototype</th><th>Victoria DT</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

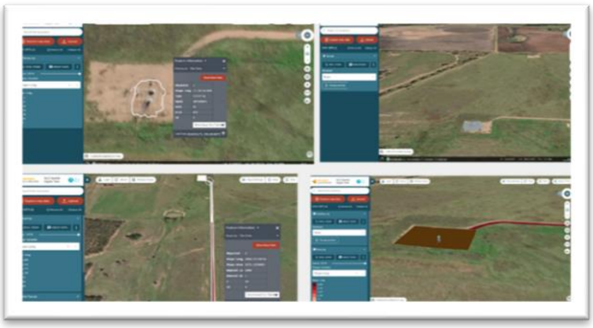
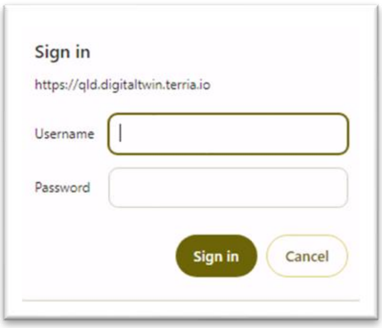
3.4 Usability

To evaluate the usability, the prototype was assessed against the six criteria as outlined in methodology section. Firstly, it could be certainly stated that the prototype is appropriate for the field design process of the O & G project and developed focusing on specific industry-standard LSDM. Therefore, the prototype is appropriate (Ap) and learnability (L). Secondly, the prototype only contains the datasets that are specifically relevant to the O & G project. For instance, DTV entails a large set of the built environment, cadastre, and urban planning datasets which might not be useful for the field design process. Therefore, the prototype is simple to operate (O) in the context of the O & G project. Following this, the user interface aesthetics (UIA) of the prototype is decent. It contains 3D zoom-in/zoom-out functionalities, 3D format selection, and an LSDM class section. Further, Accessibility (Ac) can be easily enhanced by hosting it on a cloud/web server. User error protection (UE) is not in the scope of the evaluation because this parameter is not assessed in the beta version (prototype). This assessment signifies prototypes are usable for the field design process in the oil and gas project.

3.5 Reliability

To evaluate the reliability of the prototype, it was again compared with the Digital Twin Victoria (DTV) using the criteria that include maturity, availability, fault tolerance, and recoverability. In terms of maturity, the prototype is mature within the scope of the study. However, DTV is better in terms of maturity as it is developed through government-funded projects and encompasses various functionalities such as georeferencing capabilities, access control, etc. Perhaps, the prototype can perform the specific required functions (visualisation of the 3D object based on LSDM). In terms of availability, the Victoria models might not be very reliable in the future, and it is not open to the public. For instance, there was a similar DT platform (QLD DT) which is no longer accessible to public users as demonstrated in Table 4. It is uncertain that how long these government-funded projects are accessible to the public. On the other hand, the prototype cannot be accessed against availability as it is limited to the local server. In terms of fault tolerance and recoverability, the existing DTV has a data backup system in case of system faults/system crashes. The prototype is also capable of backing up the datasets in the localhost.

Table 4: QLD DT Accessibility

Before Accessible	After Inaccessible
	

3.6 Security

This parameter is mostly evaluated when the system is sent to the market for real business purposes. The prototype in this study is just a beta version. This implies this parameter is not relevant to compare within the scope of this study.

3.7 Maintainability

The developed prototype was assessed with the criteria as mentioned in the methodology scetion. In the context of modularity, the developed prototype has discrete components such as a database management system, map, server, and visualisation components which are independently handled through the backend and frontend systems. Similarly, in the context of reusability and modifiability, the prototype developed through this study can be easily replicated and modified by other oil and gas companies and enhanced the prototype as per their requirements in the field design process as it is specifically designed for this purpose. Similarly, analysability and testability are the criteria that need to be assessed when the prototype is tested across the stakeholders of the field design process of the O & G project.

3.8 Portability

In terms of adaptability and replaceability the developed prototype can be easily deployed to the O & G field design project context to store the 2D and 3D spatial data of the infrastructure designs. The developed prototype is based on LSDM attributes therefore it can exactly replace the current 2D central SIS that is currently used in the field design process of the O & G project. As this is a web-based model, the 'installability' is not relevant in this context. This assessment indicate the prototype has been developed in a way that can be portable if it is needed to be replicated in the field design process of an O & G project. A real-world demonstration has been also done which justifies that the prototype can be used to store and visualise the LSDM attributes of the 3D object.

4. DISCUSSIONS

The findings of this study revealed the developed prototype is fully capable in terms of functional, performance, compatibility, usability, reliability, security, maintainability, and portability. While comparing with the Digital Twin Victoria (DTV), the prototype demonstrated higher performance with faster rendering times for complex 3D models of infrastructures. Further, the compatibility of the prototype was assessed through its ability to store datasets on CesiumIon and support multiple 3D data formats. Similarly, usability assessments of this study confirmed that the prototype is appropriate for O&G projects due to LSDM class categorization. Perhaps, reliability assessments indicated that DTV has greater maturity due to extensive government funded support, but the prototype effectively fulfills its intended functions. Security aspects were not within the study's scope. Security parameters of the prototype are mostly evaluated when the system is deployed to the market for real business purposes since the prototype is just a beta version. Maintainability was ensured that it allows for easy modifications and enhancements. Additionally, the web-based nature of the prototype enhances portability, making it a feasible alternative to existing 2D central SIS systems used in O&G field design projects. Overall, this study establishes a strong foundation for future research, including cloud-based deployment and real time datasets to enhance its applicability.

5. CONCLUSIONS AND RECOMMENDATIONS

This study has explored the feasibility of the widely accepted ISO/IEC 25010 framework to assess the spatial digital twin model using a case of land survey data model (LSDM) based digital twin for oil and gas field design. The study revealed that the prototype has achieved a standard level of all parameters defined witin ISO/IEC 25010 framework. This study has developed a methodology to evaluate the artefact/system/model when there are limitations in regulatory requirements and information accessibility. Currently, the prototype was evaluated through the informed argument method using ISO/IEC 25010 parameters, primarily due to constraints in time and resources. To achieve a more comprehensive assessment, it becomes imperative to assess the developed conceptual framework and prototype by subject matter experts (SMEs), who constitute the authentic end users of the prototype. Employing additional evaluation methods, such as conducting interviews with SMEs, is crucial for achieving broader industry acceptance and implementation. This evaluation approach ensures a genuine business perspective, determining the feasibility of investing in further enhancements to this prototype, especially in the context of O & G projects.

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BIOGRAPHICAL NOTES

Mr. Sijan Bhandari is a surveyor currently employed at DSQ Land Surveyors working in regional resources project and has been mainly involved in cadastral surveying, topographic surveying, and control surveying. Mr. Bhandari is a registered graduate surveyor with the Surveyors Board of Queensland, Australia, and also holds the Geomatics 'A' category registration from the Nepal Engineering Council. Mr. Bhandari obtained a four-year Bachelor's degree in Geomatics Engineering from Kathmandu University, Nepal, and recently completed a Master by Research degree in Geomatics Engineering from the University of Southern Queensland, Australia. He has nearly four years of professional experience in the surveying industry. Mr. Bhadari has experience of working in GNSS surveying, LiDAR surveying, GIS, UAV surveying, and spatial digital twins. Mr. Bhandari has also published six research papers in the geospatial field. Mr. Bhandari is also a professional member of the Geospatial Council of Australia and currently serves as the National Deputy Chair of the Young and Emerging Professionals (YEP) Committee of the Geospatial Council of Australia.

Dr. Dev Raj Paudyal has been working as a Full Time Faculty Member at the School of Surveying and Built Environment, University of Southern Queensland (UniSQ), Australia, since 2010. Dr. Paudyal is teaching mine surveying, terrrestrial mapping, spatial digital twins, spatial science for engineers, and core surveying/spatial science subjects including surveying pracs. Dr. Paudyal is also working as a Visiting Professor at the Nepal Open University (NOU), Nepal. Dr. Paudyal has also collaborated with the Kathmandu University of Nepal and currently supervising two PhD projects. Additionally, he worked as a Research Scholar at the Graduate School of Design, Harvard University, USA (2015-2016). Dr. Paudyal completed his Ph.D. at the University of Southern Queensland (UniSQ), Australia, and M.Sc. (specialization in land administration) at the International Institute for Geo-Information Science and Earth Observation (ITC), the Netherlands. He has more than 25 years of professional and research experience, which includes 10 years of full-time industry experience in the Survey Department

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