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ORIGINAL

VR Ocstal: Development and Validation of Virtual Reality Ocean-Coastal in Maritime Higher Education

VR Ocstal: Desarrollo y Validación de la Realidad Virtual Océano-Costera en la Educación Superior Marítima

Nurul Asikin[1,2], Hadi Suwono[1,3] ✉, Sutiman Bambang Sumitro[4], Rikardus Herak[1]

[1]Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang, Malang, Indonesia.
[2]Department of Biology Education, Faculty of Teacher Training and Education, Universitas Maritim Raja Ali Haji, Tanjungpinang, Indonesia.
[3]Center of Research and Innovation on STEM Education, Faculty of mathematics and Natural Sciences, Universitas Negeri Malang, Malang, Indonesia.
[4]Department of Biology, Faculty of Mathematics and Natural Science, Universitas Brawijaya, Malang, Indonesia.

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Corresponding author: Hadi Suwono ✉

ABSTRACT

The rapid development of technology has opened opportunities to improve the quality of education, especially higher education integrated with the maritime context through immersive learning experiences. However, education in the maritime context still faces challenges in conveying abstract concepts related to marine and coastal ecosystems effectively. This research aims to develop and validate technology-based learning media in the form of Virtual Reality Ocean-Coastal (VR-Ocstal) mobile application, a VR-based learning media designed to increase students' understanding and awareness of marine and coastal ecosystems. This research uses the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation). Validation was conducted by 2 media experts and 2 material experts and evaluated by 2 learning practitioners. The validation results show that VR-Ocstal has a very high level of validity (media expert: 92 %, material expert: 93 %, practitioner: 96 %), which confirms its feasibility in learning. The results of this study indicate that VR-Ocstal is an innovative and effective technology-based learning media that is feasible to use in the learning process in higher education.

Keywords: Virtual Reality; Ocean Coastal; VR-Ocstal; Higher Education; Maritime.

RESUMEN

El rápido desarrollo de la tecnología ha abierto oportunidades para mejorar la calidad de la educación, especialmente la educación superior integrada con el contexto marítimo a través de experiencias de aprendizaje inmersivas. Sin embargo, la educación en el contexto marítimo aún enfrenta desafíos para transmitir conceptos abstractos relacionados con los ecosistemas marinos y costeros de manera efectiva. Esta investigación tiene como objetivo desarrollar y validar medios de aprendizaje basados en tecnología en forma de aplicación móvil de Realidad Virtual Océano-Costa (VR-Ocstal), un medio de aprendizaje basado en VR diseñado para aumentar la comprensión y conciencia de los estudiantes sobre los ecosistemas marinos y costeros. Esta investigación utiliza el modelo de desarrollo ADDIE (Análisis, Diseño, Desarrollo, Implementación y Evaluación). La validación corrió a cargo de 2 expertos en medios y 2 expertos en materiales, y la evaluación fue realizada por 2 profesionales del aprendizaje y 15 estudiantes. Los resultados de la validación muestran que VR-Ocstal tiene un nivel muy alto de validez (experto en medios: 92 %, experto en materiales: 93 %, profesional: 96 %), lo que confirma su viabilidad en el aprendizaje. Además, las respuestas de los

estudiantes fueron muy positivas (satisfacción general: 95,06 %), especialmente en aspectos como el atractivo, la facilidad de uso y el aumento de la motivación y el compromiso con el aprendizaje. Los resultados de este estudio indican que VR-Ocstal es un medio de aprendizaje basado en tecnología innovador y eficaz que es factible de utilizar en el proceso de aprendizaje en la educación superior.

Palabras clave: Realidad Virtual; Océano Costero; VR-Ocstal; Enseñanza Superior; Marítimo.

INTRODUCTION

A Higher education plays an important role in improving the quality of human resources in the maritime sector, especially in an archipelagic country like Indonesia. With an ocean area of 6,4 million km^2 covering two-thirds of its territory, Indonesia has great potential in the utilization of marine and coastal resources.[1,2] As a maritime country, Indonesia's water area is much larger than its land. The great potential of Indonesia's marine and coastal ecosystems needs to be protected and preserved. One thing that can be done is to change the mindset and awareness of citizens through the integration of marine context in education. However, in its implementation, learning on marine and coastal ecosystem materials still faces various challenges. Students often have difficulty in understanding abstract concepts related to coastal and marine ecosystems due to the limited learning media available. Conventional methods such as textbooks and static images are less able to present a real representation of the complexity of the material, hindering students' conceptual understanding.[3,4] Therefore, an innovative approach is needed that can provide a more interactive and immersive learning experience to improve the quality of learning in the maritime field.

One solution that can be implemented is the utilization of Virtual Reality (VR) technology in learning. VR has been shown to increase student engagement and understanding through immersive simulation-based learning experiences.[5,6] VR has been considered as one of the potential and promising learning media in improving student motivation and learning outcomes.[7,8,9] In the context of maritime education, VR can help students explore the coastal environment virtually without having to make field trips that require large costs and time.[10] However, to date, the utilization of VR in higher education in maritime countries is still limited, especially in integrating this technology into learning, especially in the context of marine and coastal ecosystems.[1,11] Thus, this research seeks to develop a VR-based solution that can bridge the gap between theory and practice in maritime learning.

Several previous studies have shown that the use of VR can be applied in various disciplines, both in education, medical, engineering, and science. The use of VR in engineering education improves students' understanding of abstract concepts.[12,13] The use of VR and gamification in medical education increases student motivation, understanding, and engagement by reducing cognitive load.[14,15] In another study on molecular chemistry learning, VR technology with feedback contributed to concept understanding, and made the learning process more interesting and interactive.[5,16] Although various studies have shown the effectiveness of VR technology in improving students' concept understanding, learning motivation, and cognitive skills in various disciplines, its application in the field of maritime education, particularly in studying marine and coastal ecosystems, is still limited. To overcome these limitations, it is necessary to develop VR applications based on marine and coastal ecosystems that can motivate students in learning and increase students' understanding and awareness to maintain a sustainable marine and coastal environment.[17]

This research aims to bridge these limitations by developing an android-based Virtual Reality Ocean-Coastal (VR-Ocstal) mobile application integrated with the maritime context as a learning media that can improve students' understanding of ocean and coastal ecosystems. In addition, this research also aims to evaluate the effectiveness of VR-Ocstal in improving students' understanding of maritime ecosystem concepts. The results of this research are expected to provide an alternative learning media that is more interesting, innovative, and immersive. With this application, students can explore the marine and coastal environment interactively, understand the relationship between organisms in the ecosystem, and develop critical thinking skills in solving problems related to marine conservation.

The significant contribution of this research in the world of education, especially in the development of technology-based learning media for the maritime field. The innovation offered through learning media in the form of VR-Ocstal mobile applications that can enrich learning methods by presenting a more immersive and interactive visual experience, so as to increase the effectiveness of learning marine and coastal ecosystems. In addition, this research also contributes to integrating VR technology into higher education learning in maritime countries, which has so far received less attention. The purpose of this research is to develop and validate learning media based on ocean-coastal virtual reality technology for learning in maritime higher education. The findings of this study have the potential to enhance the quality of learning and strengthen human resource capacity in the maritime sector to become more competent and globally competitive.

METHOD

Research design

This research is a type of research and development (R&D) using the ADDIE model as a framework to systematically develop the VR-Ocstal mobile application created in this study. The development procedure adapts from the ADDIE model.[18] The acronym ADDIE, represents the sequential stages of analysis, design, development, implementation, and evaluation. Figure 1 shows the VR-Ocstal development procedure.

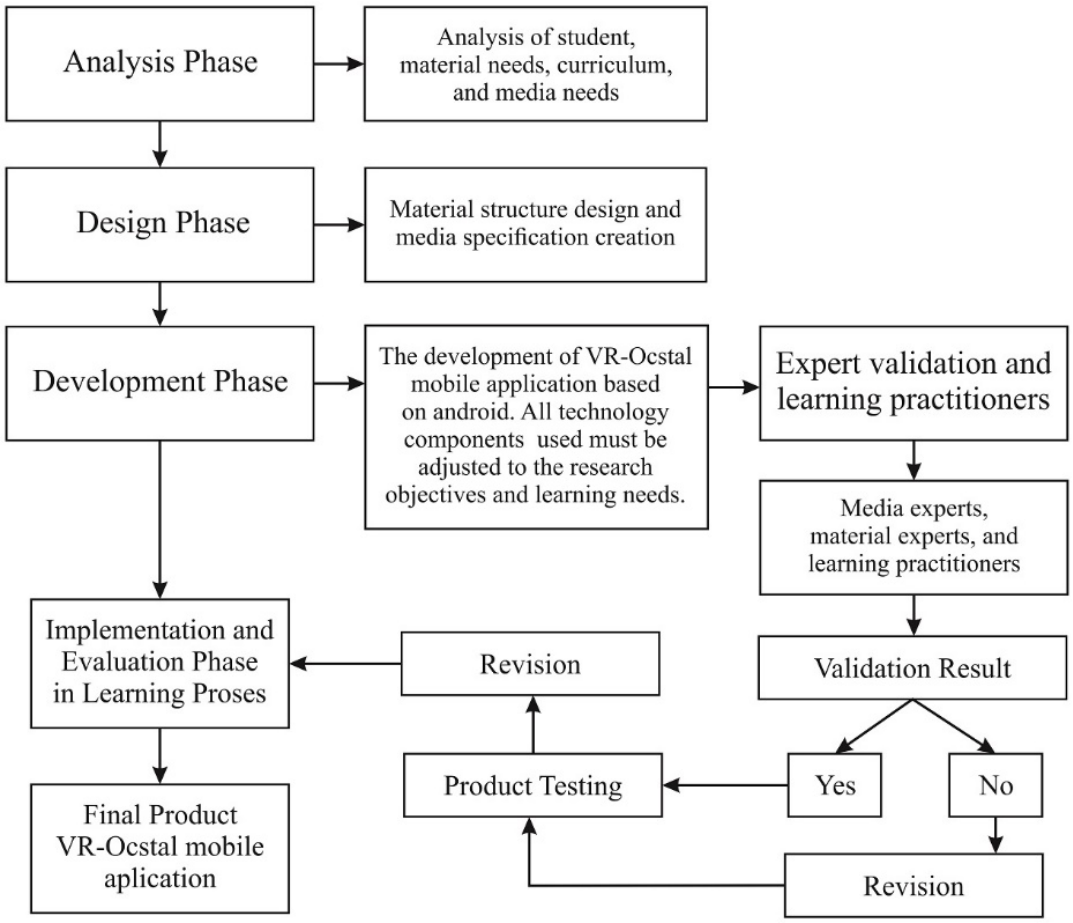

Figure 1. The VR-Ocstal development procedures

Phase of analysis

The analysis stage is the initial stage to analyze the problems that occur in the learning process. This analysis stage involves some thoughts to find out the gaps between the actual conditions and ideally, determine instructional objectives, confirm the audience, and identify the necessary resources. To find out the problems in learning related to this study, the researcher interviewed two teachers of Environmental Science (IPL) course. They raised several issues that should be considered in the learning process. One of the issues raised is that there are still few materials related to marine and coastal ecosystems, even though Indonesia is an archipelago with the second largest sea area and is the world's maritime axis country. In addition, learning resources in the form of learning media used are less interesting for students because the media used are less varied. Students generally have android smartphones that can be used as learning resources, but these smartphones are not optimally utilized. With the existence of learning media in the form of VR Ocstal mobile applications, students become motivated to learn and get an explanation of marine and coastal ecosystem material.

Phase of design

Researchers develop learning media in the form of Ocstal VR car applications that are in accordance with the theme of marine and coastal ecosystems. The design stage starts from making the structure of the material designed in such a way that it is easy to understand, and making media specifications made. The structure of the material designed consists of mangrove ecosystems, seagrass ecosystems, coral reef ecosystems, and marine ecosystems. This stage involves strategic planning to create the software and determining strategies to achieve learning objectives. Researchers use software development kits (SDK) such as Unity to develop VR for android OS, researchers only develop VR with an android base because based on the needs analysis on students

who use android more. In the Ocstal VR mobile application there is a combination of all components such as images, 3D animation, 360º video, audio, and text.

Phase of development

The development stage is the stage to get the developed product, namely learning media in the form of android-based VR-Ocstal mobile applications. Media development is carried out carefully so that all technological components used must be tailored to the research objectives and learning needs.[19] Unity was chosen as the leading software for integrating various multimedia elements, in order to create an immersive and interactive learning experience. The development process was comprehensive, with internal evaluations and feedback from media experts and subject matter experts forming the basis for improvements and refinements to the application design. This approach ensures that the final product not only meets technical standards, but is also relevant and effective in conveying marine and coastal ecosystem learning concepts.

The Ocstal VR mobile application is divided into 2 sections (figure 2). Figure 2 (a) shows the first section displaying the name of the application, information on instructions for use, and the "Play" button to start entering the main menu. Figure 2 (b) shows the second part, which displays six main features consisting of course learning outcomes (CPMK), problems in our ocean, ocean and coastal ecosystems, explore our coastals and oceans, save our coastals and oceans, and conclusion and reflection. The course learning outcomes feature displays the desired learning outcomes of the Environmental Science course. The problems in our ocean feature displays the problems that occur in each ecosystem (mangroves, seagrasses, coral reefs, and the sea). The ocean and coastal ecosystems feature in figure 2 (c) presents material related to each ecosystem starting from the definition, characteristics, roles, and solutions to the problems of each ecosystem. The explore our coastals and oceans feature displays 3D animations and 360º videos of each ecosystem. The save our coastals and oceans feature is a task that students must do in the form of a product in the form of a poster or video to find solutions to problems that occur in each marine and coastal ecosystem. In this feature students are asked to upload the work according to student creativity on social media as part of a sustainable marine and coastal conservation campaign. The display of the last feature conclusion and reflection in figure 2 (d), this feature students make conclusions and reflections related to the material and learning that has been done. The purpose of this section is to obtain student understanding after using the VR Ocstal mobile application.

Figure 2. Display of the VR-Ocstal application via mobile for (a) initial display of the VR-Ocstal application, (b) showing the six main features of the VR-Ocstal application, (c) display of ocean and coastal ecosystems feature, (d) display of conclusion and reflection feature.

After the development stage, continued with the product validation stage of the VR-Ocstal mobile application. The validation components by learning media experts consist of ease of use of the media, media content design, media display, student motivation function, and language. The validation components assessed by material experts are related to the feasibility of material content, feasibility of material presentation, language, and contextual assessment. Meanwhile, learning practitioners conduct validation related to the

presentation of media displays, presentation of 3D animation, presentation of 360º videos, use of media in learning, and learning media functions.

Phase of implementation and evaluation

At the implementation stage, the VR-Ocstal mobile application created previously is used and evaluated in its actual form. Software in the form of learning media applications is used in a practical and real environment at this stage.[20] The implementation stage is very important to identify shortcomings and errors during software development.[20,21] This stage allows researchers to identify and correct errors before users fully use the software. The implementation of learning using the VR Ocstal mobile application was carried out for eight meetings.

Participants

This study was conducted at Raja Ali Haji Maritime University in Riau Islands Province, Indonesia. Six experts with diverse work experience were selected as participants. The six experts consisted of two experts to validate the material contained in the application, two experts to validate the learning media, and two experts from learning practitioners to assess the feasibility of learning using the VR-Ocstal mobile application. Their expertise is considered important to assess the validity of learning media.

Research instruments

The main research instrument was a validation questionnaire protocol developed by the researcher. This protocol was designed to obtain validation results from experts regarding their views on the feasibility of the VR-Ocstal mobile application. The research design involved a questionnaire conducted with six experts to gain insight into the feasibility, convenience, and relevance of the VR-Ocstal mobile application. This method was chosen to explore the depth of respondents' knowledge and experience regarding the design and application of learning media content.

Data analysis

Data obtained from the results of product validation in the form of VR-Ocstal mobile applications as learning media by experts. This approach is comprehensive to get a deep understanding from the experts' point of view to assess the feasibility of learning media in the form of VR-Ocstal mobile applications. The criteria for product validity if the results of the questionnaire that has been filled out by experts exceed the predetermined standards. The interpretation of product validity is said to be valid if the level of validity is at least 80,01 %. Based on the expert evaluations, the VR-Ocstal mobile application meets the validity criteria with a validity level exceeding 80,01 %, indicating that this learning media is considered feasible and suitable for educational use.

RESULT

Validity of VR-Ocstal mobile application by learning media expert

The VR-Ocstal learning media that has been developed is validated by two learning media experts. The results of data analysis of learning media validation according to media experts can be seen in table 1. This assessment is reviewed from the aspects of ease of use, media content design, media display, motivating students, and language.

Table 1. Validity of VR-Ocstal mobile application by media experts

No.	Component	Validity (%)	Category
1	Ease of Media Use	92,5	Very Valid
2	Media Content Design	90	Very Valid
3	Media Display	91,7	Very Valid
4	Motivating Students	95,8	Very Valid
5	Language	90,6	Very Valid
Overall media expert		92	Very Valid

Validity of VR-Ocstal mobile application by material experts

The validation test of VR-Ocstal learning media was then carried out by material experts related to marine and coastal ecosystems. The results of data analysis of learning media validation according to material experts are presented in table 2. This assessment is reviewed from the aspects of content feasibility, presentation, language, and contextual assessment.

Table 2. Validity of VR-Ocstal mobile application by material experts

No.	Component	Validity (%)	Category
1	Content Feasibility	90,7	Very Valid
2	Presentation Feasibility	95,3	Very Valid
3	Language Feasibility	96,3	Very Valid
4	Contextualized Assessment	91	Very Valid
Overall material expert		93	Very Valid

Validity of VR-Ocstal mobile application by practitioners

Learning practitioners were also involved in the validation test of VR-Ocstal learning media conducted by 2 learning practitioners. The results of data analysis of learning media validation according to learning practitioners can be seen in table 3. This assessment is reviewed from the aspects of media display presentation, 3D animation presentation, 360º video presentation, media usage in learning, and media function.

Table 3. Validity of VR-Ocstal mobile application by practitioners

No.	Component	Validity (%)	Category
1	Presentation of Media Display	92,5	Very Valid
2	3D Animation Presentation	95,8	Very Valid
3	360º Video Presentation	95,8	Very Valid
4	Use of Media in Learning	95,8	Very Valid
5	Media Function	100	Very Valid
Overall practitioner		96	Very Valid

DISCUSSION

The results of validation by media experts show that the VR-Ocstal mobile application has a very high level of validity, with an overall score of 92 %, which is categorized as very valid. Of the five aspects assessed, the component of motivating students obtained the highest score, indicating that the use of VR in learning can significantly increase student learning motivation. This is in line with previous findings which state that VR-based technology is able to create a more interesting, interactive, and immersive learning experience, thus increasing learner engagement and motivation.[5,6,22] In addition, the ease of use aspect of the media also indicates that the application interface has been well designed and easy to operate by users, which is one of the important factors in the effectiveness of technology-based learning.[3,23]

In addition to motivation and ease of use, aspects of media content design and media display show that the material in the application has been arranged systematically and supported by good visualization. Strong content design is very important in the development of VR-based learning media, because the structure and presentation of content have a direct effect on the effectiveness of concept understanding by students.[24,25] Visualization in VR also plays an important role in helping students understand complex environments and concepts, which are often difficult to understand through text or two-dimensional images alone.[3,26] Therefore, the high scores on these two aspects indicate that VR-Ocstal has succeeded in effectively presenting the material in a format that is attractive and easily understood by students.

Finally, the language aspect in the application is also in the very valid category. The quality of language in learning media determines the extent to which students can understand the content of the material well. The use of language that is clear, communicative, and in accordance with the level of student understanding is an important factor in effective instructional design.[3,23] Overall, the validity of the VR-Ocstal application based on the assessment of media experts shows that this application has met the quality standards in the aspects of ease of use, content design, appearance, motivation, and language. With high scores in each aspect, VR-Ocstal has great potential to be applied as an innovative learning media in higher education in maritime countries, to improve students' understanding and engagement in studying marine and coastal ecosystems.

The results of validation by material experts show that the VR-Ocstal application has a very high level of validity, with an overall score of 93 %, which is categorized as very valid. Of the four aspects assessed, the language feasibility component obtained the highest score, indicating that the use of language in this application has met the standards of clarity, readability, and suitability to the level of understanding of students. Good language in learning media is very important because it can facilitate more effective knowledge transfer and reduce the potential for misconceptions in understanding the material.[27,28] In addition, the presentation feasibility aspect indicates that the material in the application has been organized systematically and supported

by effective presentation methods. Previous research shows that good presentation design in technology-based learning can improve students' understanding and engagement in the learning process.[3,26,29]

In addition to language and presentation feasibility, an assessment was carried out on the aspect of content feasibility which showed that the material in the application had met the standards of accuracy and relevance in the maritime context. The material presented in the VR-Ocstal application in accordance with the maritime context consists of mangrove, seagrass, coral reef, and marine ecosystems. This is important because an understanding of marine and coastal ecosystems requires the presentation of information that is not only scientifically accurate but also contextual to the environmental challenges faced today.[2,30] Furthermore, the contextual assessment aspect shows that the application has been able to connect the material with real conditions and student learning needs.[4] The integration of maritime context in VR-based learning is very important because it can increase the involvement of students' knowledge and awareness of environmental care, especially concepts related to ocean and coastal areas through direct exploration in a simulated environment.[31]

Overall, the validity of the VR-Ocstal application by the material experts shows that this application has met high quality standards in the aspects of content, presentation, language, and contextual relevance. The overall score shows that this application has great potential to improve the effectiveness of learning marine and coastal ecosystems for students. The application of VR technology in maritime higher education can help students understand ecological relationships in coastal ecosystems more interactively and immersively. Therefore, this application can be an innovative solution in improving concept understanding, student engagement, and learning effectiveness in the field of environmental science and maritime context.

The results of validation by practitioners of the VR-Ocstal mobile application show a very high level of validity, with an overall score of 96 %, which is categorized as very valid. The media function aspect indicates that this application functions optimally as a learning tool. This is in line with research showing that the application of VR technology in education can improve students' practical skills in science and engineering through an immersive and interactive learning environment.[13,22,24,32] In addition, the components of 3D animation presentation, 360° video presentation, and media usage in learning are also included in the highly valid category. The use of 3D animation and 360° video in VR-Ocstal applications provides a more immersive and realistic learning experience, which can increase students' understanding and engagement with learning materials.[33,34] VR technology has been shown to be effective in improving social skills and conceptual understanding through simulations that approximate real situations.[35,36] The presentation aspect of the media display also received a high score indicating that the interface design of this application has been well designed and user-friendly. Attractive and intuitive interface design is very important in VR-based learning media, as it can increase user engagement and comfort during the learning process.[24,25] Overall, this validation by practitioners indicates that VR-Ocstal is an effective and feasible learning media to use in the context of maritime education, capable of providing an interactive and immersive learning experience for students. VR-Ocstal technology-based learning media is positively assessed in supporting the learning process, especially in the material of marine and coastal ecosystems. The use of VR is considered capable of increasing the effectiveness and ease of delivering material, as well as providing a more interesting and interactive learning experience for students.[7,25,37] In addition, the recommendations for further development indicate that this media has the potential to be applied to other learning topics to increase student motivation and involvement in the learning process.

CONCLUSION

The results of this study indicate that the use of VR-Ocstal mobile application as VR-based learning media is effective in improving students' understanding of marine and coastal ecosystems. The implementation of VR-Ocstal is able to bridge the gap between theory and practice in education by presenting a more interactive and immersive learning experience. This is confirmed through the validation of media experts, material experts, and practitioners who show a very high level of validity. Other findings show that this application not only serves as an innovative learning tool but is also able to increase students' understanding and motivation in learning. In addition, VR-Ocstal is proven to provide efficiency in learning by reducing the limitations of access to the coastal environment directly, thus saving time and costs. For further development, future research can explore the application of VR-Ocstal in other learning contexts, such as environmental conservation or other ecosystems. In addition, the integration of VR technology with other learning methods, such as problem-based learning, gamification, and artificial intelligence, could be a potential development direction to enrich a more innovative learning experience.

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CONFLICT OF INTEREST

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AUTHORSHIP CONTRIBUTION

Conceptualization: Nurul Asikin, Hadi Suwono, Sutiman Bambang Sumitro, Rikardus Herak.
Data curation: Nurul Asikin, Hadi Suwono, Sutiman Bambang Sumitro, Rikardus Herak.
Research: Nurul Asikin, Hadi Suwono, Sutiman Bambang Sumitro, Rikardus Herak.
Methodology: Nurul Asikin, Hadi Suwono, Sutiman Bambang Sumitro, Rikardus Herak.
Project management: Nurul Asikin, Hadi Suwono, Sutiman Bambang Sumitro, Rikardus Herak.
Resources: Nurul Asikin, Hadi Suwono, Sutiman Bambang Sumitro, Rikardus Herak.
Software: Nurul Asikin, Hadi Suwono, Sutiman Bambang Sumitro, Rikardus Herak.
Supervision: Nurul Asikin, Hadi Suwono, Sutiman Bambang Sumitro, Rikardus Herak.
Validation: Nurul Asikin, Hadi Suwono, Sutiman Bambang Sumitro, Rikardus Herak.
Display: Nurul Asikin, Hadi Suwono, Sutiman Bambang Sumitro, Rikardus Herak.
Drafting-original draft: Nurul Asikin, Hadi Suwono, Sutiman Bambang Sumitro, Rikardus Herak.
Writing-proofreading and editing: Nurul Asikin, Hadi Suwono, Sutiman Bambang Sumitro, Rikardus Herak.