Comparison between simulation and conventional training: Expanding the concept of social fidelity

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Abstract
Daily operations onboard ships are very challenging due to man–machine interactions. To improve daily operational safety and to prevent losses due to machinery breakdown, effective risk management techniques need to be developed, considering various operational and environmental factors affecting the seafarers' performance. The current study explains the comparison between simulation and conventional classroom training to enhance safety in maritime operations in compromised environments. The contribution of this study lies in introducing the concept of social fidelity in simulator-based training. This study bridges the gap between computer technology and collaborative learning activities in simulator-based training. The result obtained through the simulation improves marine engineers' training and enhances the reliability of marine engines. This paper concludes by proposing a set of recommendations for the future design of simulator-based training for marine engineers.

KEYWORDS
collaborative learning, human error, loss prevention, marine engineering education, simulator-based training

1 INTRODUCTION

The aviation community has been using a simulator crew training program since the 1970s due to the high number of fatal accidents in the aviation industry, which were known to be caused by human error. Human error is something that is unintentional, also known as skill-based error. Simulator training has been a part of the aviation industry in order to improve crew skills and decision-making. The Maritime industry started using a similar approach, that is, simulator-based training, in the 1990s after several accidents were caused by human error. Simulator-based training and its history in providing opportunities for training in all crucial professions such as marine, aviation, and healthcare in a safer environment have surfaced due to the low-risk factor. In the marine industry, time-consuming and otherwise costly skills are provided through simulator-based training that provides an actual feel of the ship. The controlled simulator environment also has academic advantages, as exercises can be designed to train and gauge specific learning outcomes, which are adjusted to the student's level of competence. It has not only improved student understanding but has also assisted in their learning experiences. Creating the Engine room learning environment is a challenging task, but with the increased development of communication technology, it has become comparatively easier and achievable. The reliability of the training system increases as the environment becomes more like the actual physical work environment, for example, mimicking the ship's engine room along with the audio or visual effects. In simulator training, a prior assumption has been that higher simulator fidelity corresponds to a higher resemblance of the technological attributes that represent a work environment and that physical analogy is a prerequisite for high-quality training of professionals.
This study explains the conventional understanding of the concept of simulator fidelity and finds out how additional factors may or may not influence discerned training quality among professional maritime officers. Simulator fidelity is defined as how close a simulator emulates reality. Student-centric teaching is the recommended approach to modern-day pedagogy, especially in outcome-based education; students get immediate feedback while the teachers serve as facilitators of learning activities rather than physically applying the traditional lecture. Classrooms may need to be equipped with a complete simulator and sound system that would stimulate the students’ enthusiasm to learn the lessons with interactive sounds from the teachers’ presentations. Acquiring software applications for simulator-based courses would provide hands-on experience for them to learn certain skills directly.

The main objective of this paper, as stated above and in accordance with the initial literature used, is to expand the existing understanding of the simulator and social fidelity and to explore other factors that may aid perceived training quality. Also, this paper will assess if the physical resemblance between the engine room simulator and the real engine room environment correlates at any level, bringing students to achieve a better understanding of the vessel.

It is analyzed from two angles: the first one is the comparison between simulator-based training and conventional classroom training. The second one is Social Fidelity.

2 | METHODOLOGY

In this study, the exploratory approach is used as two different training programs are observed for training, that is, simulator-based training and conventional classroom training. The study explains how trainer-trainee interactions, task factors, and simulator technology effects perceived level of fidelity and the quality of training. Focused feedback from the engine officers is also an integral part of the whole process. After developing daily engine room operational scenarios and identifying human-related activities, we will derive the human error probability (HEP) using the SLIM methodology, as shown in Figure 1.

2.1 | Step 1: Develop daily operational scenarios

The first step of the methodology is developing the engine room daily operational framework and identifying the operational marine activities. Each activity is designed in such a way that it starts with a basic skill level and gradually increases to an advanced level based on the difficulty of performing the task, leading to the completion of the task with a higher level of proficiency and critical thinking.

2.2 | Step 2: Identify human-related activities

A very prominent factor of this research is to recognize human-related activities. All the tasks are divided into two categories: Critical Tasks and Noncritical Tasks. Critical tasks are those that are to be completed in a specific guided sequence in order to avoid accidents led by human error. All tasks, other than critical, are known as noncritical tasks. Human error is a critical factor in the shipping industry, and the numerous human errors that occur during the maintenance of marine engines cannot be ignored. The motive behind identifying the human-related activities is to later incorporate them in simulator training to minimize the occurrences of human error and prevent accidents, which will be achieved through the evaluation of operational performance on the simulator.

2.3 | Step 3: Training and data collection

The sample we have is divided into two groups: Group A and Group B. Group A will receive the simulator-based training, whereas Group B will be given conventional classroom training by the marine experts. An expert questionnaire is also developed, which will aid in acquiring results from quantitative and qualitative data collected from both the training groups.

2.4 | Step 4: Evaluation of results

This study explains how technology amplifies learning in simulator-based training characterized by advanced computer technology and an elaborated use of collaborative activities. Factors that may have an effect on the perceived training quality are examined from two perspectives:

1. Simulator-based training versus Conventional Training: All volunteers are divided into two groups, and each participant is allocated to one of two groups for training, namely, Group A (GA) and Group B (GB). GA receives simulator-based training, whereas GB receives conventional/traditional classroom training. Participants in both groups attend training sessions. Despite teaching methods being different, the content for both the groups remains the same.

In GA, a teacher plays the role of a facilitator to develop the student’s critical thinking. Teachers initiate individual and collective training and provide feedback to the participants. Moreover, performance records of the engine room’s daily operation are also maintained, and a replay system is used for measuring student performance. However, in training sessions, GA is provided feedback on their performance in simulator testing scenarios in each session. This is done in a well-structured way as part of a continuous process during the whole training course with the notion of making the participants conscious and reflective about their behavior and decision-making.

In GB, a teacher plays the role of an expert. The participants in this training method acquire different concepts, principles, and facts. GB is provided feedback after an examination. GB received additional simulator familiarization training before the final assessment. After training, both groups are assessed with the same operational
task in the simulator. All participants fill out the PSFs questionnaire before the final assessment, and experts rate the influence of each PIF to perform the same operational task on board. Results of GA and GB are compared to see the effect of simulator-based and conventional classroom training.

2. Simulator Fidelity: The effect of physical resonance between the bridge simulator and the actual work environment. Due to the lack of relevant and productive HEP data, an expert judgment technique is used to minimize human error. In this second part of the methodology, highly qualified and experienced chief engineers and marine engineers provided their responses. An experienced panel of marine engineers was selected to help design the questionnaire that includes rating and weighting of performance influencing factors. Due to the involvement of human subjects, ethical approval was obtained from the University of Tasmania’s human research ethics committee (Ethics Ref No: H0015701).

Upon selecting a relevant panel of experts who carried out the
assessment, selection, rating, and weighting of PSFs, ascertaining the consensus of expert judgment is essential in this study as the rating of PSF is very important for calculating SLI in the SLIM process. The “ideal 9 rating” for each PSF was then selected, ranging from 0 to 9 (9 mean maximum value and zero mean minimum value). As mentioned above, marine operational activities are rated first, and then weighing has been done for these performance shaping variables to develop SLI. This study selected marine engineers with at least 10 years of industry experience for weighing and rating.

HEP is measured using the relevancy of the figures, which represent the relative importance of each task. These ratings are then multiplied by weighing to produce SLI for each task. To enhance the accuracy of the outcome, HEP was estimated after acquiring SLI for each activity. However, “a” and “b” constants are then calculated by measuring the lowest (0.15) and highest (105) HEP values along with the measurement of SLIs. The final equation is as follows:\(^{15}\)

\[
\text{Log (HEP)} = -0.16367 \times \text{SLI} - 0.27142
\]  

By using Equation (1), HEP values are estimated for the above five operational activities, which contain 65 tasks. Simulator HEP is compared with Experts HEP to find the correlation between simulator-based training and real ship experience.

3 | CASE STUDY (APPLICATION OF METHODOLOGY)

One of the most important and critical daily operations is starting the diesel generator and synchronizing it with the running generator. In an alternating current electric power system, electrical synchronization is the process of matching the speed and frequency of a Diesel Generator (D.G.) to a running network or an existing power supply system.\(^{16}\) D.G. Synchronization panels work both manually and automatically, synchronizing function using PLC for two or more generators. With the advancement of technology, the synchronization process is made easier now. Nowadays, synchronizing could be easily achieved with the help of a D.G synchronizing controller without any manual intervention. Manual synchronization requires a high level of training, skill, and confidence. Lack of synchronizing or below par synchronizing can thus damage the generator and the prime mover because of fluctuating mechanical stresses caused by quick acceleration or deceleration of speed, bringing the rotating masses into synchronism (exactly matched speed and rotor angle) with the power system.

The considered operational process is starting DG number 2 and manually synchronizing it with DG number 1. For completing this process, it is necessary to complete five activities, as shown in Figure 2, and each activity has its critical and noncritical task.

The complexity of task increases with each step.
3.1 Human-related activities

Manual synchronization of a diesel generator has five activities and 65 tasks, as shown in Table 1. Furthermore, all tasks are divided into critical and noncritical tasks.

### Table 1: Human related activities

| No. | Human-related activities                      | No. | Human-related activities                      |
|-----|---------------------------------------------|-----|---------------------------------------------|
| L.O. system | F.W. system |
| 1 | Open L.O. filling valve | 34 | Open inlet and outlet valve of high sea chest |
| 2 | Fill L.O. sump tank up to 80%–90% | 35 | Open suct. and disch. valve of all seawater pump |
| 3 | Close L.O. filling valve | 36 | Open inlet and outlet valve of one central cooler |
| 4 | Open both pump suct. valve | 37 | Open inlet and outlet valve of DG 2 F.W cooler |
| 5 | Open both pump disch. valve | 38 | Open seawater over board valve |
| 6 | Open inlet and outlet valve of L.O. cooler | 39 | Start one pump and set all at auto mode |
| 7 | Adjust set point of L.O. cooler temperature | 40 | Set the temperature pid controller at 35°C |
| 8 | Open only one filter inlet and outlet valve | 41 | Preparing freshwater system |
| 9 | Make sure sludge tank valve is close | 42 | Open suct. and disch. valve of hydrophore pump |
| 10 | Start L.O. pump | 43 | Open inlet and disch. valve of hydrophore tank |
| 11 | Check L.O. pressure and temperature | 44 | Start hydrophore pump and set in auto mode |
| 12 | Change L.O. pump into auto mode | 45 | Open F.W. make up valve |
| 13 | Make sure L.O. relief valve is not lifted | 46 | Fill F.W. expansion tank up to 80%–90% |
| 14 | Sludge tank valve open (critical penalty) | 47 | Close F.W. make up valve |
| 15 | Penalty if both filters open | 48 | Open inlet and outlet valves of high temp freshwater (HTFW) |
| 16 | Open D.O. Storage tank disch. valve | 49 | Open inlet and outlet valves of low temp freshwater (LTFW) |
| 17 | Start purifier motor | 50 | Set the HTFWPid controller at 85°C |
| 18 | Open suct. and disch. valve of purifier heater | 51 | Set the HTFWPid controller at 35°C |
| 19 | Start purifier pump | 52 | Check temp. and press. of F.W system of DG 2 |
| 20 | Open D.O. service tank inlet valve | 53 | Penalty if H/Tk water level low |
| 21 | Start purifier and set in auto | 54 | Penalty If No S/W Flow (Critical Penalty) |
| 22 | Once D.O. service tank is filled up to 80%–90% | 55 | Check starting air pressure between 20 to 30 bar |
| 23 | Open D.O. storage inlet valve and close service tank inlet V/V | 56 | Check engine light ready to start |
| 24 | Open D.O. service tank shut off valve | 57 | Check trips (make sure there is no trip activated) |
| 25 | Open D.O. supply valve to DG 2 | 58 | Press start button |
| 26 | Change three-way inlet valve in do position | 59 | Once it is started then check all temp and pressure |
| 27 | Change three-way outlet valve in D.O. position | 60 | Change control from local to remote position |
| 28 | Open inlet and outlet valve of only 1 D.O./F.O. filter | 61 | Synchronizing D.G. 2 with D.G. 1 manually |
| 29 | Set ViscoTherm at 12 Cst | 62 | Switching on excitation |
| 30 | Start D.O./F.O. pump | 63 | Selecting DG 2 on synchroscope |
| 31 | Check pressure and temperature | 64 | Adjusting DG 1 and 2 voltages |
| 32 | D.O. settling overfilled | 65 | Adjusting DG 1 and 2 frequency |
| 33 | Check all parameter | |

Abbreviation: DG, diesel generator.

3.1.1 Lube oil system tasks

The main purpose of the lubricating oil is to keep two surfaces apart, preventing their surface asperities from coming into contact with each other while allowing smooth relative motion. The lubricating oil must
also carry away the heat generated due to friction. In medium-speed engines, the cylinder head and liner are cooled by distilled water, while the piston crown is cooled by the lubricating oil flowing through to the gudgeon pin bearing, and also heat is transferred through the piston walls to the cylinder liner.

In order to fill the sump tank, open the outlet valve of the lube oil settling tank. The lube oil sump tank must be filled up 80%–90%. After closing the lube oil sump tank valve, start all pump suction and discharge valves. Then, move to the opening inlet and outlet valves of the lube oil cooler. The temperature of the lube oil cooler must be set to 50 degrees centigrade. Now move toward opening a single filter inlet and outlet valve keeping in mind the sludge tank valve is closed. Start the lube oil pump; check both its pressure and temperature. Switch the lube oil valve to automatic mode and make sure the lube oil relief valve is not lifted. The situation might get critical if the sump is overfilled or the sludge tank outlet cooler are open. Figure 3 shows all the processes, including critical tasks.

3.1.2 Do system tasks

Most diesel engines are designed in a way that heavy fuel oil or diesel fuel oil can be used. The system is arranged in such a way that it operates main and auxiliary machinery on either heavy fuel or diesel fuel independent of each other. With reference to Figure 4, the fuel flows to the circulating pumps from the fuel oil service tank. The circulating pumps maintain a pressure of approximately 4.0 bar in the low-pressure side of the fuel system. The fuel is circulated through the fuel pumps and fuel valves through the built-in circulating system in the pumps and the valves.
Open the diesel oil storage tank discharge valve starting the purifier motor, and once the purifier motor is started, open the suction and discharge valve of the purifier heater and start the pump. Now move toward opening the diesel oil service tank’s inlet valve, starting the purifier setting in auto mode. Once the diesel tank is 80%-90% full, open the diesel oil storage inlet valve and close the service tank inlet valve. After that, pull the diesel oil service tank “shut off” valve, opening the supply valve to DG 2. First, change the three-way inlet valve in diesel oil position followed by changing the three-way outlet valve the same way. Open the inlet and outlet valves of only one diesel oil or fuel oil filter and set the viscotherm at 12 cst. Start diesel oil/fuel oil pump, check pressure and temperature. It gets critical if the diesel oil is overfilled. There comes a penalty if both (diesel oil and fuel oil) filters open.

3.1.3 | F.W. system tasks

The diesel engines are subjected to various forms of thermal stresses due to temperature variations. The combustion process creates an excessive amount of heat, and the temperatures in the combustion chamber elevate up to 2000°C. When exposed to such high temperatures, the metal of cylinder heads, liners, and pistons heat up excessively and eventually weaken and are unable to withstand the high cylinder pressures. Heat extraction from diesel engine components must be such that they operate at optimum temperatures within the strength limits of the materials used by the jacket water system.

In the engine jacket cooling water system shown in Figure 2, freshwater is circulated by the cooling water pumps. At the outlet from the jacket water cooler, a thermostatically controlled 3-valve regulates the cooling water flow either through the cooler or bypasses it depending on the coolant temperature. Seawater circulating through the jacket cooler cools the freshwater. The temperature sensor for the controller is located at the main engine cooling water outlet. In the above system, the temperature controller maintains the engine cooling water outlet temperature at approximately 80°C.

To prepare the seawater system, the seafarer must open inlet and outlet valves of the high sea chest. Start suction and discharge valves of all seawater pumps, opening the inlet and outlet valves of one central cooler. Open the inlet and outlet valves of DG 2 FW cooler. Now, carefully open the seawater overboard valve; it may not sound as critical as it is. Start one pump and set all on automatic mode setting the temperature PID controller at 35°C.

To prepare the freshwater system, open the suction and discharge valves of the hydrophore pump. Then open the inlet and discharge valves of the hydrophore tank, starting the hydrophore pump and setting it on auto mode. Open the freshwater makeup valve, fill the freshwater expansion tank to 80%-90%, and close the makeup valve. First, open the high-temperature freshwater inlet and outlet valves of the PID controller setting it at 85°C and then open the inlet and outlet low-temperature freshwater valves of the PID controller, setting it at 35°C. Recheck the temperature and pressure of the freshwater system once DG 2 is started. There is a serious penalty if the high-temperature tank water level is low and if no seawater flow is present. It all becomes critical then (Figures 5 and 6).

3.1.4 | Starting DG 2 tasks

Begin the DG 2 tasks by checking the initial air pressure between 20 to 30 bar. Check the engine light ready to start and check trips making sure none are activated. Press the start button. Once it is started and reaches a normal rpm, recheck all temperatures and pressures. Further, change control from local to remote position (Figure 7).

3.1.5 | Synchronizing DG 2 with DG 1 manually tasks

Diesel Generator synchronization is the procedure of matching technical electrical parameters such as voltage, frequency, phase angle, phase sequence, and waveform of the Diesel generator with a healthy or running power system. This is required to be done just before the generator is reconnected to the power system. Lack of synchronizing or poor synchronizing can trip the reverse power relay, thus damaging the generator and the prime mover (Figure 8).
3.2 Training and data collection

Thirty-six volunteers with zero or few months of sailing experience participated in this study. The steps adopted for collecting data are illustrated in Figure 3. For training and parametric testing, two groups were designed and each participant was allocated to one of two groups for the training, namely, GA and GB. GA was simulator-based training, whereas GB was conventional/traditional classroom training. Participants in both groups attended 10 weekly sessions. The teaching method was different for both the groups, whereas content was the same.

In GA, a teacher played their role as a facilitator, in order to develop the critical thinking of the student. They initiated and
facilitated individual and collective training. Feedback mechanism was used in this study. Moreover, records of performance were also maintained and a replay system was used for measuring student’s performance. However, in training sessions, GA was provided feedback on their performance in simulator testing scenarios in each session. This was done in an organized manner as part of a continuous process during the whole training course with the motive of making the participants conscious and reflective about their behavior and decision process, as shown in Figure 3.

In GB, a teacher played their role as an expert. Different concepts, principles and facts were explained to the participants in this training method. GB was provided feedback from the trainer after each assessment. After 10 weeks of training, both the groups were assessed in the same operational task. GB received additional 1-week simulator familiarization training before assessment. Thirty-six experts with marine engineering unlimited license and 10 years’ experience took part in this experiment. Each expert rated the influence of each PIF to perform the same operational task on board.

4 | RESULTS AND DISCUSSION

The result shows how technology increases learning and retaining ability in a simulator-based training environment along with advanced computer technology and other extensive collaborative activities.

4.1 | Comparison between simulator and conventional training

The level of complexity in developed scenarios increased gradually with each exercise. Fuel oil system and Lube oil system required a low-competency level. Freshwater and seawater systems required a medium competency level. Starting DG and synchronizing DG required a high-competency level.

Figure 4 illustrates the performance of both the groups in F.O. and L.O. tasks. It shows a good performance because it was a basic assessment and these two tasks need basic knowledge only. Figure 4 also illustrates fluctuation in scores, and both groups show variation in numbers as the complexity increases from F.W to D.G. Sync operational tasks. The reason is that the initial two activities require less involvement of human training and experience, so the performance level was good. Starting DG 1 and synchronizing with DG 2 manually are complex tasks requiring more skill and critical thinking, and hence, it was not easy to handle by the traditional classroom training group, that is, Group B.

However, GB’s failures are more numerous as compared to GA, which explains the value of debriefing after each simulator’s exercise. Hence, the developed methodology is very advantageous (i.e., providing training and then practicing on simulators) in increasing the performance of marine engineers and the reliability of marine engines. Simulators could be useful as guiding instruments for ship management authorities and societies to better prepare seafarers for specific marine operations in advance.

Here in Figure 9, based on our statistical analysis, it has been confirmed that GA performed better in critical tasks than GB considering the extra week of training before assessment.

The descriptive statistics again take us to our explanation that the critical thinking and emergency tasks were carried out better by GA than GB showing a ratio of 6:1 (Table 2).

Result of Groups A and B show that the last task, which required critical thinking and engineering skill, including confidence, was completed by 6 Group A students and 1 Group B student.

4.2 | Simulator-based training

Figures 10 and 11 show that simulator training has a significant positive correlation with expert’s HEP (r = 0.871, N = 20, p < 0.01). The “r” value signifies the prediction of a variable based on the value of another variable. “N” denotes the number of valid observations for the specific variable, while “p” value determines the probability or significance of the study’s assumption. Based on the above values, it is quite evident that the simulator’s training is very close to reality, which is actual daily operation of the ship.
TABLE 2 Descriptive statistics

|                  | Group | Mean  | SD    | Number of valid observations used in calculating |
|------------------|-------|-------|-------|-----------------------------------------------|
| L.O. system      | A     | 83.46 | 3.755 | 13                                             |
|                  | B     | 79.64 | 9.700 | 14                                             |
|                  | Total | 81.48 | 7.572 | 27                                             |
| F.O. system      | A     | 85.00 | 0.000 | 13                                             |
|                  | B     | 82.50 | 9.354 | 14                                             |
|                  | Total | 83.70 | 6.736 | 27                                             |
| F.W. system      | A     | 82.31 | 9.707 | 13                                             |
|                  | B     | 76.43 | 12.157| 14                                             |
|                  | Total | 79.26 | 11.241| 27                                             |
| DG start         | A     | 65.38 | 37.275| 13                                             |
|                  | B     | 30.36 | 42.266| 14                                             |
|                  | Total | 47.22 | 43.041| 27                                             |
| DG synchronization| A    | 39.23 | 44.104| 13                                             |
|                  | B    | 6.07  | 22.717| 14                                             |
|                  | Total| 22.04 | 37.959| 27                                             |

Abbreviation: DG, diesel generator.

Correlations

|                  | Experts HEP | SIM HEP |
|------------------|-------------|---------|
| Experts HEP      |             |         |
| Pearson correlation | 1          | 0.871** |
| Sig. (2-tailed)  |             | 0.000   |
| N                | 20          | 11      |
| SIM HEP          |             |         |
| Pearson correlation | 0.871**   | 1       |
| Sig. (2-tailed)  | 0.000       |         |
| N                | 11          | 11      |

Correlation is significant at the 0.01 level (2 tailed)
Providing training in a risk-free environment where repetition of challenging situations can be recreated and then discussed in depth so the performance error reduces in an actual onshore scenario, the simulator-based training proves to be advantageous for trainees as per the results obtained from our data. Implementation of this methodology helps in making a decision instantly, which, in turn, supports the internal safety program. It also ensures industrial maintenance safety of the maritime field.

For this, we used the Pearson two-tailed correlation test in order to determine the correlation between the simulator and expert HEP. The two-tailed test was used so we could see the positive and negative approaches to our hypothesis. The table denotes that the experts’ human error probability and SIM human error probability are significantly correlated at 0.01 level that corresponds to a 99% result, proving that simulator-based training is much more helpful in decreasing the amount of human error and other problems faced by seafarers than the conventional training.

It is best for maritime officers to train under simulator training based on the above results derived from the Pearson two-tailed correlation test as the significance of simulator-based training and better performance of students GA than GB, which we showed in the graph Figure 4. There is a need to structure the program in accordance with the technical requirements and challenges for both critical and non-critical tasks. The simulator training gives a unique opportunity to students, and it is very effective in creating a training environment that is close to actual maintenance procedures that accompany real events. Literature used in this study and other similar studies have shown that simulators are considered as important tools for maritime training as training tools are developed to produce specific learning outcomes. Consistent and significant results were seen in the service and training institutions because of simulator training, as per the research.

5 | CONCLUSIONS

The focus of this study was to elaborate the concept of simulator fidelity and its understanding. Our analysis proved, based on the results obtained from statistical analysis, how the collaborative and technical factors collectively contribute to simulator fidelity and the quality of training given out by the marine relevant professionals. The analysis indicated that a complicated and challenging task like synchronizing the diesel generator can be well trained in a simulator. These suggestions draw us to the conclusion that the general implications of this research will help both in the shipping industry and the training of other professionals such as powerplant engineers. As per the development and increasing technology, it has been predicted how in coming years the marine system will become completely autonomous and to cope with that, future training of marine engineers needs to be upgraded so the margin of human error decreases. Simulator training may highly aid their expertise if implemented further on.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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