Simulation Operations Problem-Solving Tool: Anticipate, Act, Amend

Authors
Amy Follmer, CHSE, CHSOS-A, FSSH[1], Amanda Carmack, DNP, MBA, RN, CNE[2], Sean Cavanaugh, MBA, CHSE, CHSOS, FSSH[3], Melissa Lowther, CHSOS-A, FSSH[4], Jamie Stiner, CHSOS-A[5]

[1]Zamierowski Institute for Experiential Learning, Kansas City, KS
[2]Indiana University East, Richmond, IN
[3]NYU Grossman Long Island School of Medicine, Mineola, NY
[4]Elevate Healthcare, Sarasota, FL
[5]UT Southwest Medical Center, Dallas, TX

Conflict of Interest Statement
The authors have no conflicts of interest to declare.

Corresponding Author
Amy Follmer, CHSE, CHSOS-A, FSSH, Zamierowski Institute for Experiential Learning, Kansas City, KS
(Email: a357f308@kumc.edu)

Brief Description
Problem-solving is essential for success as a simulation operations and technology professional; gaining this skill comes with experience on the job over time. Critical thinking during problem-solving is necessary to support success, but limited tools exist to develop this skill for simulation operations and technology professionals. Steps for problem prevention, solving, and corrective action are necessary, regardless of the simulation environment and available resources. This paper outlines the development of a tool that integrates best practices in simulation operations, specifically designed to assist with problem-solving in the design and delivery of healthcare simulation activities.

Introduction
Problem-solving is a desirable trait and a fundamental skill for healthcare simulation operationists and technicians (Roche et al., 2022). This desire is emphasized by the inclusion of problem-solving, corrective action, and maintenance as integral components of the Certified Healthcare Simulation Operations Specialist (CHSOS) Blueprint, a competency framework for simulation operations specialists with two years of experience (Society for Simulation in Healthcare, 2023). The CHSOS Blueprint defines problem-solving as the ability to "apply processes and procedures to identify technical problems/errors and initiate corrective action" (Society for Simulation in Healthcare, 2023). Enhancing the problem-solving skills of simulation operationists will improve simulation quality and enhance team satisfaction. This article delves into the pivotal role of problem-solving in the healthcare simulation field and presents a tool to enhance these skills.

Healthcare simulation professionals share a responsibility beyond addressing simulation failures. Healthcare simulation users entrust simulationists with implementing problem-prevention and problem-solving strategies. Problem-prevention and problem-solving strategies are not individual tasks but shared responsibilities among simulationists, such as technicians, operations specialists, and educators. In 2019, this group united as a community of simulation

experts to present at the SimOps conference on simulation operations failures and share our collective problem-prevention and problem-solving strategies. A collaborative approach to problem-solving is a defining characteristic of the field of simulation operations.

As a collective of healthcare simulation professionals, the group recognized the need for a tool to enhance problem-solving skills in simulation operations for simulationists. The group identified gaps in the critical thinking and problem-solving skills of both experienced and newer simulation operations specialists. Our shared objective was to develop a tool that would support problem-solving collaboratively during a simulation activity by applying a standardized process. With this tool's introduction, the group hopes to bridge the skill gap between experienced and newer simulation operations specialists, fostering a sense of community and shared learning.

The team created this tool to apply a comprehensive approach to the critical thinking process of problem-solving to prevent, prepare for, and follow up on problems no matter when or where they occur. The tool's development was guided by best practices in healthcare simulation to ensure its relevance and applicability. Developing the problem-solving skills of simulation operations professionals may improve the quality of simulation events and enhance learner experiences and team satisfaction. The Simulation Operations Problem-Solving Tool supports the link between learning objectives and problem-solving prioritization during a simulation activity, fostering a sense of community and shared learning.

Methods
Simulation Operations Problem-Solving Tool Design
The development of the Simulation Operations Problem-Solving Tool was a rigorous process. The group reviewed existing technology troubleshooting tools, checklists, and algorithms. Existing problem-solving tools were reviewed from Lean methodologies, CompTIA, and CHSOS review materials (Bassuk & Washington, 2013; Chartered Management Institute, 2020; Ferrill, 2015; Society for Simulation in Healthcare, 2023). The team created two options for a problem-solving tool framework from this extensive research. The first option was a walkthrough of the troubleshooting process in chronological order. The second option was to divide the troubleshooting into categories with specific prompts most relevant to each category. The team chose to fully build the first option, presenting a chronological framework.

When building the tool, problem-solving steps were generalized to all potential problem categories, making it versatile for various simulation environments. The team identified four categories:
- Things and Technology
- Ideas and Planning
- People and Communication
- Places and Environment

The tool provides suggestions relevant to challenges in the identified categories. It supports a comprehensive approach to preventing, preparing for, and following up on problems by supporting critical thinking skills. The team then organized the tool chronologically, providing different steps and suggestions based on whether the issue occurred before, during or after an event. The timeline was divided into three phases:
- Anticipate Challenges in Advance of a Simulation Event
- Act to Solve Problems During an Event
- Amend Problem Causing Issues After an Event

Each section continues to support the development of critical thinking skills, so when the unplanned happens, and the simulation must go on, the problem-solving toolbox is ready to support the success of the education session.

Simulation Operations Problem-Solving Tool Revision

The tool was revised based on feedback from several rounds of presenting the tool. Each time the tool was shared, the team collected survey data and audience feedback. The team carefully analyzed the feedback and updated the tool address the specific needs and suggestions of the users, ensuring it remains a relevant problem-solving tool for healthcare simulation operations.

A Google Forms survey was utilized to collect feedback regarding the tool following each presentation. Course attendees were not required to complete the survey, which was distributed using a QR code at the end of each course. The number of survey responses is as follows (Table 1).

Table 1

Number of survey responses for each presentation of the tool

Event	Number of Responses
IMSH 2020	29
SimGHOSTS 2020	9
IMSH 2021	16
SimOps 2022	22
Total Number of Responses	**76**

An open-ended question on the survey asked for additional feedback or comments on the Simulation Operations Problem-Solving Tool. The team collected many comments and suggestions for improvement. Suggestions included additional prompts, space for documentation, and an electronic or app version of the checklist (Table 2). As detailed below, the team updated the checklist to incorporate as much of this feedback as possible. The group reviewed the feedback to determine which suggestions were feasible and beneficial based on the goals of the tool.

Table 2

Additional feedback from survey

Positive feedback	Suggested changes
Great interactive meeting. So many creative minds and scenarios but also many unique cases to learn from.	The checklist format is a little confusing to follow…in theory not all checks would be crossed off which for basic users can indicate incompleteness. Maybe incorporate a flow chart with check boxes so that it's a more flowy
Would you allow others to amend the tool but still cite your work?	
I will try using it and see if it makes a difference. Thanks for the work out into developing the checklist	The Amend (green) section needs a "Who needs to be told?" Blank so the right person is informed of the issue.
Very well done and interesting on the small stuff	Middle section needs room to write stuff down.
This checklist looks to be a great asset to our program!	I think finding the time to fill this out with each problem is difficult. I think this is great for larger scale problems and great in theory for the small everyday problems but difficult to do when sims are back-to-back/filled schedule if that makes sense
I am the sole person in my Simulation Center and so any tools I use are used only by me.	
Will probably adapt but this is a fantastic approach	Create an electronic/tablet version or app that allows for real time completion. And then a place to store the sim type and solutions that everyone can access. We can see how others solved the problem and hopefully won't need to reinvent the wheel
I like the categories of timing	
Will be good if we add more simulation staff to our team	
Sim Hacks Online Blog may be helpful for facilitators, operationists, faculty and coordinators - especially novice ones - for managing failures! Thank you for your session today!	

   The team first shared the tool during a workshop course at IMSH 2020. Feedback was collected in a survey and directly from participants during the workshop. From this, the tool was updated to include space to list learning objectives and a problem-solving notes section.

   The tool was then presented at a SimGHOSTS 2020 virtual workshop and an IMSH 2021 virtual course. After these presentations, the tool's title was updated from "Simulation Operations Specialist Problem Solving Checklist" to "Simulation Operations Problem Solving Checklist" to be more inclusive of potential tool users. The team also created a version without full-color boxes to reduce the ink needed to print the tool.

Finally, the team shared the tool at an in-person workshop course at SimOps 2022. Based on feedback, the name was updated from "Simulation Operations Problem Solving Checklist" to "Simulation Operations Problem-Solving Tool" to better represent its function.

To gauge the need for the Simulation Operations Problem-Solving Tool, survey respondents were asked the frequency of problems in their simulation experience. The results from all four surveys showed that the most common answer was "Weekly," with 38 responses. The highest response was "Monthly," with 17 responses, followed closely by "Daily," with 15 responses. Less than Monthly received six responses (Figure 1).

Figure 1

Frequency of problems related to technology, people, planning, and environment
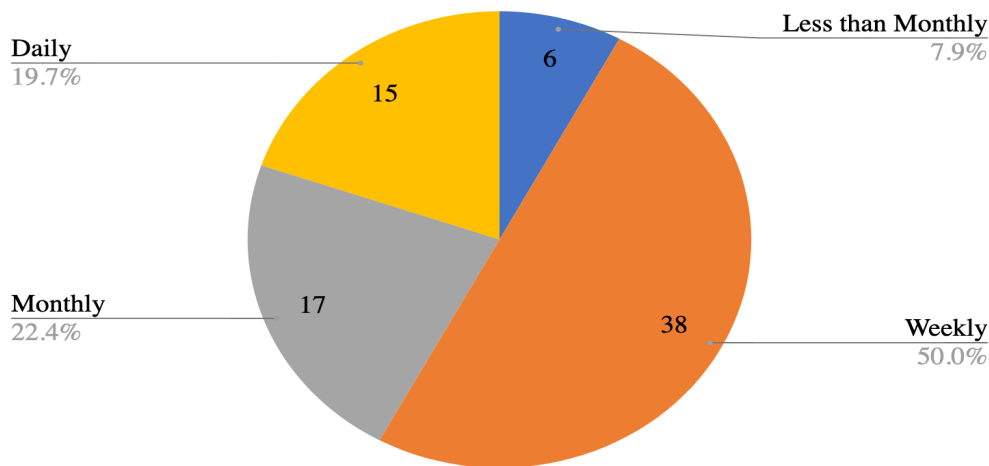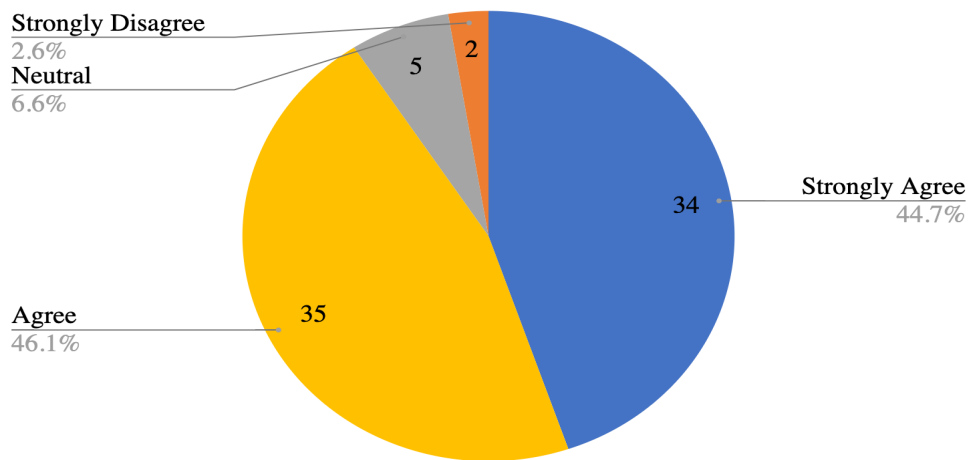

Note. This pie chart represents survey responses to the question: "What is the frequency of the occurrence of problems related to technology, people, planning, and environment in your simulation experience?"

To assess the relevance of the Simulation Operations Problem-Solving Tool, course attendees were asked if it applies to their jobs. "Agree" received 35 responses, and "Strongly Agree" received 34 responses. "Neutral" received five responses, and "Strongly Disagree" received two responses (Figure 2).

(Continued on next page)

Figure 2

This simulations operations problem-solving checklist is applicable to my job

Note. This pie chart represents survey responses to the statement: "This simulations operations problem-solving checklist is applicable to my job."

Results
How to Use the Tool

The Simulation Operations Problem-Solving Tool is setup in chronological order, starting with *Anticipate Challenges in Advance of a Simulation Event* (Appendix A). The tool is intended to be used for a specific case or simulation event. This is because the backup strategies and threshold to make changes is tied to the learning objectives for each specific simulation event.

The tool's planning section identifies potential problems before a simulation activity and develops solutions. For instance, if a specific manikin is known to have issues connecting to the monitor, the tool prompts you to plan workarounds, such as printing an image of the vitals to display or communicating vitals to an embedded participant. These proactive measures can help prevent disruptions during the simulation and support the learning objectives.

Another key element of the *Anticipate Challenges in Advance of a Simulation Event* section is communication with other members of the team in advance. This communication provides opportunity for other team members to share additional back-up plans. This section recommends the team determines a threshold for implementing a back-up plan. Continuing with the previous example, the backup plan of using printed vitals would be implemented if the connectivity issues are still occurring two minutes before the learners arrive.

The *Act to Solve Problems During an Event* section of the tool is designed to empower users to take practical steps when a problem occurs during simulation event delivery. The first item listed in this section is the learning objectives for the event. Maintaining alignment with the learning objectives of a simulation activity is crucial for the subsequent steps in the tool. The impact of a problem on these objectives encourages users to consider the urgency and timeline for resolution. Recommendations indicate when the problem should be addressed: immediately between cases, or by the end of the day.

The importance of communication continues during active problem-solving. The tool prompts users to communicate with the team, providing suggested topics. The communication prompts include identifying if team members are needed to get extra supplies or equipment, assist with the instructors or learners, or provide support based on their experience with the

issue. Additional communication with instructors or learners may be necessary depending on the impact of the issues on the event.

The final section of the tool *Amend Problem Causing Issues After an Event* contains steps often missed after a challenge has been resolved. This section of the tool is designed to carry the user through the iterative process of establishing a theory of probable cause, testing the theory, and adapting it as necessary. The goal is to identify the roof cause of an issue and determine options for preventing it from recurring.

A theory of probable cause is identified and tested until enough information is gained to establish an action plan to fully resolve or prevent a challenge. This verification should include full system functionality. Communication and documentation are essential steps to resolving and preventing problems. Without these steps, there is no record of how previous issues were solved, making it difficult to prevent similar challenges from arising in the future.

Benefits of Using the Tool

Using the tool to brainstorm and communicate about potential issues prior to a simulation activity provides contingency plans in the event of challenges for all team members involved. Completing the *Anticipate Challenges in Advance of a Simulation Event* supports critical thinking when considering alternative options to challenges in advance. This proactive approach provides more time and reduces stress compared to problem-solving as challenges arise during the simulation. Documenting proactive solutions with the tool creates a valuable resource to refer to during the event, as it can be difficult to remember them in the moment.

When challenges occur during a simulation event, it can be difficult to think clearly about next steps or potential solutions. The *Act to Solve Problems During an Event* section reminds users of the learning objectives to align problem-solving action with learner group needs. The prompts can help both new and experienced simulationists who struggle when issues occur during an event. This sections also provides guidance on next steps for the timing and communication required for problem-solving.

The *Amend Problem Causing Issues After an Event* section of the tool supports full system resolution and prevention of problems in the future. It is easy to perceive a problem as resolved without considering how it affects the broader system. This section leads users to identify the underlying cause of an issue and communicate and document as needed. Effective documentation and communication can help ensure solutions do not just live with one person but are available to a full simulation team.

Discussion

Half of the survey respondents reported troubleshooting problems on at least a weekly basis, with an additional 20 percent experiencing problems daily (Figure 1). This frequency of problems in simulation operations suggests a need for a problem-solving tool. Ninety percent of survey respondents agree or strongly agree that the Simulation Operations Problem-Solving Tool described in this paper applies to their job (Figure 2), making it widely applicable for the simulation operations community.

The Zamierowski Institute for Experiential Learning (ZIEL) simulation team is using the Simulation Operations Problem-Solving Tool in standardized course planning documents for simulation activity delivery. It has been added as the last page of the document, so it is easily accessible to everyone delivering a simulation activity. The no color version of the checklist was designed to be printed in black and white and use less ink for this purpose (Appendix B).

Before a simulation, the assigned simulation operations technologist completes the *Anticipate Challenges in Advance of a Simulation Event* section and fills in potential solutions for possible problems. Common problems the ZIEL team creates back-up plans for include problems with audio playback, simulated vitals monitor connection, patient voice microphone

and manikin presentation of symptoms. This tool is particularly beneficial for large-scale simulation activities involving all ZIEL technical operations team members. For large-scale simulation events, completing the *Anticipate Challenges in Advance of a Simulation Event* section with backup options, along with filling in the *Act to Solve Problems During an Event* section with the learning objectives, allows team members who were not involved in the initial planning or who lack background knowledge on those details to effectively contribute to problem-solving efforts.

For ZIEL, the inclusion of the Simulation Operations Problem-Solving Tool in standardized course planning documents starts the conversation between the technical operations team and the learning and design team on potential challenges related to events. This leads to early collaboration on back-up plans and thresholds for implementing solutions during an event. Communicating challenges and back-up plans involves instructor team members who will be impacted by problems during a simulation event. This promotes acceptance from all stakeholders when adapting the initial simulation plan. The Simulation Operations Problem Solving Tool has improved the simulation operations problem-solving communication and process in ZIEL.

The University of Texas Southwestern Medical Center's High Reliability Team (HRT) conducts in-situ simulations to improve teamwork and communication with interdisciplinary teams throughout their healthcare system. The team aims to promptly capture and report any safety threats or knowledge gaps observed during the simulation to the appropriate leadership.

The HRT's modern approach is evident in their use of the Simulation Operations Problem-Solving Tool. They have adapted the tool by adjusting questions to support the program's objectives and to collect valuable data. The tool was converted into a Microsoft Forms "Debriefing" survey to support the team's mobility and completion rate after each group of learners. After each simulation, the team fills out the form and uses this time for a team debrief, creating a shared mental model for those responsible for action items.

For each simulation group, the HRT diligently answers questions about the need to file event reports, open service tickets, address manikin issues, or improve the simulation modality. If any action items are identified, the task is assigned to a team member based on their expertise and availability. The team member then takes responsibility for the task and promptly completes it. This approach focuses on any issues with the equipment, instructional design, knowledge gaps, or safety threats.

The data collected by HRT catalyzed positive change across the organization. It has been used in several ways to support individual units, specialized disciplines, hospital administration, code blue teams, and education departments. For instance, it aided in identifying and addressing specific knowledge gaps in different units, improve the efficiency of code blue teams, and enhance the quality of education and training programs. It has also been presented at hospital-wide committees to improve patient safety. Implementing this form has positively affected the HRT dynamics and their goal of supporting a highly reliable organization, our colleagues, and improving patient care.

Limitations

A limitation of the research study was the small sample size. Although the data was collected from conference audiences nationwide, this is a small sample of simulation operation specialists in practice. This article provides an editable version of the Simulation Operations Problem-Solving Tool to reach a wider audience and improve the sample size. The goal is to reach a wider variety of simulationists worldwide who can use the tool to enhance their practice.

Conclusion

Although problem-solving in simulation operations is critical, limited tools exist to support it. The Simulation Operations Problem-Solving Tool may be relevant for various simulation problems. Future iterations of the tool could include an electronic version, allowing modifications to fit multiple problems. Furthermore, an electronic version would allow for easy adaptation to support simulationists in various ways and languages. Expanding its use in simulation centers and collecting feedback for improvement will allow for the continuation of feedback to be gathered on this tool. Future plans for the Simulation Operations Problem-Solving Tool include a webinar presentation aimed at promoting the resource within the simulation operations community and gathering additional feedback for ongoing improvements.

References

Bassuk, J. A., & Washington, I. M. (2013). The A3 problem-solving report: A 10-step scientific method to execute performance improvements in an academic research vivarium. *PloS one*, 8(10), e76833. https://doi.org/10.1371/journal.pone.0076833

Chartered Management Institute. (2020). Solving problems. In *Chartered Management Institute* (Checklist 012). Retrieved December 19, 2022, from https://www.managers.org.uk/wp-content/uploads/2020/03/CHK-012-Solving_Problems.pdf

Ferrill, B. (2015, March 17). *Pace IT Troubleshooting Theory* [Slide show]. SlideShare. https://www.slideshare.net/paceitonline/pace-it-troubleshootingtheoryswnm

Roche, A. F., Condron, C. M., Eppich, W. J., & O'Connor, P. E. (2023). A mixed methods study identifying the competencies of health care simulation technicians. Simulation in healthcare: *The Journal of the Society for Simulation in Healthcare*, 18(5), 293–298. https://doi.org/10.1097/SIH.0000000000000682

Society for Simulation in Healthcare. (2023). *CHSOS*. https://www.ssih.org/Credentialing/Certification/CHSOS

Appendix A

Simulations Operations Problem Solving Tool with color

Simulation Operations Problem Solving Tool

Anticipate Challenges in Advance of a Simulation Event

Simulation Event Name/Case:_____

❏ Consider element(s) of event most likely to fail
   Examples: Vitals monitor, manikin pupil dilation, learner schedule, inexperienced faculty

   _____

   _____

❏ Plan for possible backup strategies for issues identified above

   _____

   _____

❏ Communicate with instructors in advance on possible issues and backup plans identified above
❏ Agree on threshold to move to backup plan

   _____

   _____

Act to Solve Problems During an Event

❏ Always consider the learning objectives for the event.

   _____

   _____

❏ If problem(s) don't impact learning objectives or safety, continue with the event.
❏ If backup plan exists from planning, move to it as necessary.
❏ If problem(s) impact learning objectives and/or safety, determine the ideal time to attempt a solution.
   ❏ Immediately, in between cases, end of day

   _____

   _____

❏ Communicate with the team as necessary.
   ❏ Is someone needed to get extra supplies or equipment?
   ❏ Is someone needed to help with instructors/learners?
   ❏ Is there someone that has experience with the issue and can help?

   _____

❏ Communicate with instructors/learners on impact issues have on the event.

Amend Problem Causing Issues After an Event

❏ Establish a theory of probable cause.

   _____

   _____

❏ Test theory of probable cause to determine actual cause.
   ❏ If probable cause proves to not be the actual cause, start again with new probable cause.
❏ Establish action plan and execute it.

   _____

   _____

❏ Verify full system functionality.
❏ Document the process to resolve or prevent the problem in future events.
❏ Communicate the problem and solution to the team.

Note. The document is available for download as a pdf at:
https://drive.google.com/file/d/1lmLU6ca3VMPsbZXoPCX32jwOQjEHLlY9/view?usp=sharing
The document is available for download as word document at:
https://docs.google.com/document/d/1qrEiCGHH_vLmRQnJunDIwtsNs8NMxYCh/edit?usp=sharing
&ouid=113041553607474554404&rtpof=true&sd=true

Appendix B

Simulation Operations Problem Solving Tool without color

Simulation Operations Problem Solving Tool

Anticipate Challenges in Advance of a Simulation Event

Simulation Event Name/Case:_____

- ❏ Consider element(s) of event most likely to fail
  Examples: Vitals monitor, manikin pupil dilation, learner schedule, inexperienced faculty
  _____
  _____

- ❏ Plan for possible backup strategies for issues identified above
  _____
  _____

- ❏ Communicate with instructors in advance on possible issues and backup plans identified above
- ❏ Agree on threshold to move to backup plan
  _____
  _____

Act to Solve Problems During an Event

- ❏ Always consider the learning objectives for the event.
  _____
  _____

- ❏ If problem(s) don't impact learning objectives or safety, continue with the event.
- ❏ If backup plan exists from planning, move to it as necessary.
- ❏ If problem(s) impact learning objectives and/or safety, determine the ideal time to attempt a solution.
  - ❏ Immediately, in between cases, end of day
  _____
  _____

- ❏ Communicate with the team as necessary.
  - ❏ Is someone needed to get extra supplies or equipment?
  - ❏ Is someone needed to help with instructors/learners?
  - ❏ Is there someone that has experience with the issue and can help?
  _____
- ❏ Communicate with instructors/learners on impact issues have on the event.

Amend Problem Causing Issues After an Event

- ❏ Establish a theory of probable cause.
  _____
  _____

- ❏ Test theory of probable cause to determine actual cause.
  - ❏ If probable cause proves to not be the actual cause, start again with new probable cause.
- ❏ Establish action plan and execute it.
  _____
  _____

- ❏ Verify full system functionality.
- ❏ Document the process to resolve or prevent the problem in future events.
- ❏ Communicate the problem and solution to the team.

Note. The document is available for download as a pdf at:
https://drive.google.com/file/d/1QL8o6jWyYcmY8kYbWTM27gGQrejMF-R_/view?usp=sharing
The document is available for download as a word document at:
https://docs.google.com/document/d/1j9w27Nf7YW5erbfmvc-
1l2iQsQqEeSA5/edit?usp=sharing&ouid=113041553607474554404&rtpof=true&sd=true