

Executive Summary

Purpose:

As part of the Simulation Modeling for an Immersive Learning Experience (SMILE) project, the Delayed Openings & Temporary Shutdowns module investigates the effect of Election Day interruptions and considers the benefit of adding resources to a polling location in response to a delay. Through computer simulation, voter wait times are estimated for polling locations experiencing delayed openings and experiencing temporary shutdowns at points throughout the Election Day. Here we will consider the effects of increasing voting equipment one hour after a delay and present recommendations of which equipment to allocate.

Voting Process:

The voting process investigated here consists of a check-in step using electronic poll books (i.e., 3 devices), a ballot marking step using pen and paper at a voting booth (i.e., 9 booths) or an accessible ballot marking device (i.e., 1 device), and a ballot submission step at a digital ballot scanner (i.e., 1 device). It is assumed that 1,500 voters turnout to the polling location following an arrival pattern exhibiting a peak in the morning, a reduction in arrivals at mid-day, and another peak in the afternoon.

Election Day Interruption Scenarios:

1. Delayed Opening: investigates a two hour delay, from 7AM to 9AM, in the opening of a polling location. In this scenario, voters continue to arrive at the polling location between 7AM and 9AM, choosing to wait for the polling location to open rather than leaving or returning at another time. A simulated scenario in which a polling location experiences a delayed opening indicates that voter wait times are one hour and eight minutes when no intervention is made.
2. Temporary Shutdowns: investigates a one hour interruption to voting at some point during the Election Day. To simulate this scenario, one-hour long interruptions are independently considered with starting times between 8AM and 5PM. Voters continue arriving at the polling location during the time of the interruption, and choose to wait until the interruption is resolved rather than leaving or returning at another time. A simulated scenario in which a polling location experiences a temporary shutdown indicates that voter wait times are between twenty and thirty five minutes when no intervention is made, depending on the time of the shutdown.

Results:

Each form of Election Day interruption is investigated: when there is no response to the delay (i.e., 'No Change') and when election officials respond with additional resources one hour after the delay is resolved. The simulated one hour delay in increasing equipment represents the time anticipated to acknowledge the need for additional resources and the corresponding transportation and setup time of the equipment. Using simulated voter wait times, the effect of adding resources one hour after an interruption are estimated and compared to identify strategies to reduce long lines caused by the interruption. Below are four tables showing the effect of adding several combinations of resources in each voting interruption scenario on voter wait times.

Delayed Openings - One Type of Voting Equipment Added: Table 1 shows simulated voter wait times when one and two pieces of one type of voting equipment (e.g., one electronic pollbook or two privacy booths) are added to a polling location experiencing a delayed opening. Findings show that adding one to two voting booths or accessible ballot marking devices an hour after a delayed opening may reduce voter wait times by between 11.5 and 18 minutes. However, increasing the number of electronic pollbooks or ballot scanners after a delayed opening offers minimal reductions in wait times or increases wait times.

Delayed Openings - Multiple Types of Voting Equipment Added: Table 2 shows simulated voter wait times when combinations of voting equipment types (e.g., one electronic pollbook and one privacy booth) are transported to a polling location one hour after a delayed opening. Findings show that adding combinations of resources is most effective when an additional accessible ballot marking device and privacy booth are among the added resources. Combinations of resources added to a polling location that include an additional privacy booth and accessible ballot marking device may reduce wait times by between 24.8 and 27 minutes. When one privacy booth and one accessible ballot marking device are transported to a polling location experiencing a delayed opening, voter wait times are reduced by almost 25 minutes.

Temporary Shutdown - One Type of Voting Equipment Added: Table 3 shows simulated voter wait times when one and two pieces of one type of voting equipment (e.g., one electronic pollbook or two privacy booths) are added to a polling location one hour after it has experienced a temporary shutdown. Findings show that by adding a single accessible ballot marking device to a polling location after a temporary shutdown, voter wait times may be reduced by between 0.5 to 6.8 minutes depending on the time of the shutdown. Adding one additional voting booth may reduce voter wait times by between 0 and 5 minutes. Increasing the number of accessible ballot marking devices or privacy booths by two offers similar reductions in voter wait times. Increasing the number of ballot scanners or electronic pollbooks after a shutdown offers minimal reductions in voter wait times or increases wait times.

Temporary Shutdown - Multiple Types of Voting Equipment Added: Table 4 shows simulated voter wait times when a combination of resources (e.g., one electronic pollbook and one privacy booth) are added to a polling location that has experienced a temporary shutdown. Findings indicate that simultaneously increasing the number of privacy booths and accessible ballot marking devices by one an hour after the temporary shutdown has been resolved may reduce voter wait times by between 0.8 and 10 minutes, depending on the time of the temporary shutdown. Adding one electronic pollbook and one accessible ballot marking device or one ballot scanner and one accessible ballot marking device may reduce wait times by between 0.5 and 6.8 minutes. A combination of one privacy booth and one ballot scanner offers a reduction in voter wait times of between 0.3 and 4.4 minutes. However, increasing the number of electronic poll books and ballot scanners in combination or increasing the number of electronic pollbooks and privacy booths in combination minimally reduces wait times or increases wait times.

Additional considerations:

- The simulated scenario experienced a process bottleneck at the ballot marking step. Voting processes that experience bottlenecks at different points in the voting process may need to increase other types of voting equipment to reduce voter wait times.
- Increasing certain equipment, such as electronic pollbooks, may require additional staff to operate.
- This strategy is dependent on the availability of voting equipment, which may need to be reallocated from less busy polling locations or may be impossible to implement.
- Increasing resources in a polling location may be challenging or impossible to implement due to the physical size of a polling location. Additional attention may be needed when laying out and setting up voting equipment in a polling location to maximize the number of devices that can fit in the available space. In addition to physical capacity, electrical capacity may limit the number of electronic devices that can be set up within a polling location.

Table 1

Delayed Openings - One Type of Voting Equipment Added

Added Voting Equipment	Quantity Added	Average Wait Time
None	-	1 hour 8.1 minutes
Electronic Pollbook	1	1 hour 14.5 minutes
	2	1 hour 18.4 minutes
Privacy Booth	1	56.6 minutes
	2	50.1 minutes
Accessible Ballot Marking Device	1	52.9 minutes
	2	56.3 minutes
Ballot Scanner	1	1 hour 9.4 minutes
	2	1 hour 5.9 minutes

Table 2

Delayed Openings - Multiple Types of Voting Equipment Added

Added Voting Equipment	Average Wait Time
None	1 hour 8.1 minutes
Electronic Pollbook & Privacy Booth	1 hour 0.3 minutes
Electronic Pollbook & Accessible Ballot Marking Device	56.4 minutes
Electronic Pollbook & Ballot Scanner	1 hour 11.6 minutes
Privacy Booth & Accessible Ballot Marking Device	43.3 minutes
Privacy Booth & Ballot Scanner	55.2 minutes
Accessible Ballot Marking Device & Ballot Scanner	57.4 minutes
Electronic Pollbook & Privacy Booth & Accessible Ballot Marking Device	41.8 minutes
Electronic Pollbook & Privacy Booth & Ballot Scanner	60.3 minutes
Electronic Pollbook & Accessible Ballot Marking Device & Ballot Scanner	54.7 minutes
Privacy Booth & Accessible Ballot Marking Device & Ballot Scanner	42.8 minutes
Electronic Pollbook & Privacy Booth & Accessible Ballot Marking Device & Ballot Scanner	41.1 minutes

Table 3**Temporary Shutdown - One Type of Voting Equipment Added**

Added Voting Equipment	Quantity Added	Average Wait Time (minutes)									
		Time of Shutdown									
		8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00
None	-	25.0	22.8	20.4	21.4	21.4	27.1	32.9	35.3	28.4	21.2
Electronic Pollbook	1	27.3	21.3	20.3	20.8	22.2	27.0	36.5	39.0	29.0	21.1
	2	26.5	20.8	22.9	21.9	21.3	25.7	33.8	40.2	29.4	21.5
Privacy Booth	1	22.8	19.5	19.0	19.5	20.9	22.5	27.9	35.5	27.9	21.1
	2	20.7	19.4	18.3	21.2	21.9	21.9	26.8	31.8	26.7	20.9
Accessible Ballot Marking Device	1	18.8	16.0	15.5	16.6	16.6	21.0	26.1	31.1	25.6	20.6
	2	18.2	15.5	15.4	16.6	16.5	21.5	26.9	31.3	25.2	20.4
Ballot Scanner	1	24.3	22.9	22.2	21.6	21.7	26.3	31.8	34.6	28.4	21.0
	2	26.7	21.7	20.2	20.1	20.8	27.2	31.7	35.3	28.8	20.9

Table 4**Temporary Shutdown - Multiple Types of Voting Equipment Added**

Added Voting Equipment	Average Wait Time (minutes)									
	Time of Shutdown									
	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00
None	25.0	22.8	20.4	21.4	21.4	27.1	32.9	35.3	28.4	21.2
Electronic Pollbook & Privacy Booth	22	19.8	17.9	19.9	20.5	23.2	30.2	35.9	28.6	21.1
Electronic Pollbook & Accessible Ballot Marking Device	18.6	16.2	15.4	16.2	16.9	20.6	27.1	31.2	25.8	20.6
Electronic Pollbook & Ballot Scanner	25.9	21.6	18.1	22.5	21.7	27.2	34.8	37.4	29.4	21.2
Privacy Booth & Accessible Ballot Marking Device	14.9	13.3	13.5	14.4	14.9	17	23.1	28.9	24.6	20.4
Privacy Booth & Ballot Scanner	23.3	19.7	17.2	19.2	19.1	22.7	29.2	32.4	27.3	20.9
Accessible Ballot Marking Device & Ballot Scanner	18.2	16.1	15.5	16.8	16.7	20.5	26.5	31.2	25.3	20.5

**These results are determined from simulated voting processes. While real election data were used, these results may not directly apply to voting processes that include more or fewer steps to vote or contain processes that are particularly quick or slow to complete (e.g., ballots with many questions or ballots with few questions).*