Optimal Resources for a POD Unit

Colby Craig
Purdue University
craigcr@purdue.edu

J. Eric Dietz
Purdue University
jedietz@purdue.edu

Adam Kirby
Purdue University
kirbya@purdue.edu

Abstract

This research paper was created to explore the possible optimizations a point of dispensing unit would require to be the most effective. Utilizing every resource effectively is very important when responding to disasters as well as attacks on the country. This optimization should help to better utilize volunteers as well as non-government organizations (NGO), when in a time of need. My hope is that this optimization research will be able to cut down on the time it take to not only find volunteers and staff, but select the amount of professionals needed for each POD unit. This will hopefully serve to decrease the amount of healthcare professionals needed for each POD, while still maintaining efficiency.

Review of Literature

Staffing is of the utmost importance when developing a successful POD. Spitzer developed a study addressing these needs to address the optimal number of healthcare professionals needed to efficiently run a POD. Spitzer's exercise assumed that there was a plague that would require the just-in-time training of leaders and staff in as little as twenty-four hours. The staff would contain only sixteen percent of healthcare professionals. The remainder of the staff would be high school student volunteers who would receive JIT training only an hour before the exercise began.

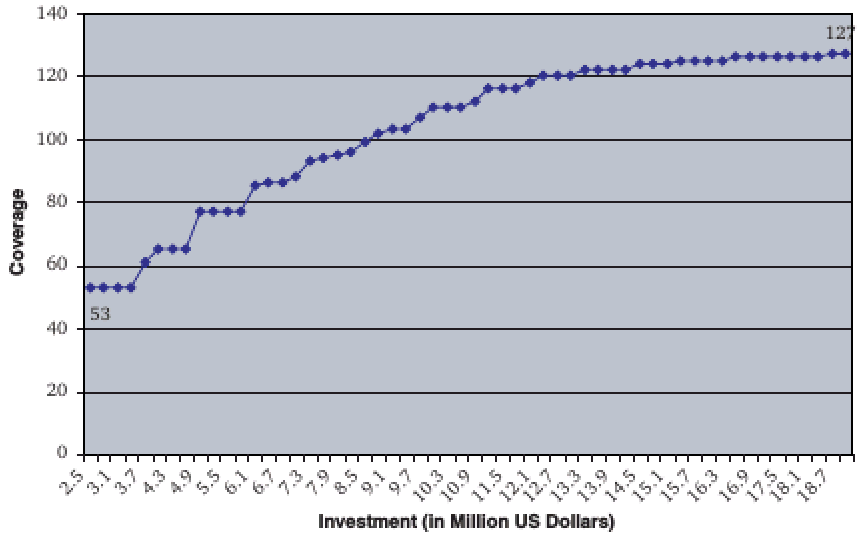
Table 1: Observed Times of Point of Dispensing Unit

Station	Active exercise staff	Observed service times (lower bound to upper bound, in minutes)	Computer model results: Model-based staff utilization rate at observed service times—lower bound to upper bound (percent)	Computer model results: Proposed optimal staffing based on 85% utilization goal (lower bound to upper bound)
Greeting	4	0.17–0.25	36–55	2–3
Triage (Medical Screen 1)	9	0.17–0.33	16–32	2–3
Evaluation (Medical Screen 2)				
First half-hour	1	0.5–1.67 (mean 1.08)	192–640 (417 at mean service time)	3–7 (5 at mean service time)
Remainder of exercise	1	0.17–1.42 (mean 0.52)	64–544 (192 at mean service time)	1–6 (3 at mean service time)
	2	0.17–1.42 (mean 0.52)	32–272 (96 at mean service time)	
Medicine Dispensing	23	0.33–0.67	13–25	3–7
Checkout	5	0.25–0.33	44–58	3–4

This table contains the observed times of the exercise in addition to the optimal staff used for each station. Notably, the vast amount of staff can be seen deployed to the dispensing sections of the POD. The dispensing checkpoints as observed in other literature, is the biggest bottleneck of the entire POD. The greatest amount of volunteers would be needed here in order to keep process time minimal and efficient. In order to exceed throughput of six minutes for each patient, these dispensing volunteers would need to be rapidly trained as well as skilled individuals. This station is where a majority of the healthcare professionals would need to be located in order to oversee the safe dispensing of the antibiotics. Spitzer's model helps to shed some light on the possible staffing requirements needed in order to process 300,000 people in as little as twenty-four hours. This optimization was noted to save an average of 2.6 hours, though actual patient arrival rates could affect this outcome.

Optimal allocation of emergency resources is critical in order to keep the public safe, while also helping to provide guidelines to the agencies involved in the disaster. Optimal facility locations help to provide the most coverage of a given area. Huang's study helps us to identify location models that can be used to develop areas that can be equipped with different resources to enable a community to respond more efficiently. Though each environment can have a certain level of uncertainty, this model helps to employ different strategies for maintain the maximum coverage of a given area. This study tried to maximize the allocation of three different types of resources related to fire stations, though the modeling is not limited to only these resources. This model will be more or less successful depending on the infrastructure of a given area, with regards to the implementation processes used. (Huang, 2007) This study also examined the relationship between investments and the coverage it provides in 0.3 million dollar increments. What can be seen in the tables related to this

Table 2: Coverage Cap of Investment



analysis is that 12.7 million dollars, the coverage only slightly increases. Though these observations are based on a small sample referring to Singapore and its resources, there is an assumption that the U.S. has a likely cap to the coverage gained based on their investment. This can serve as a pilot study in order to help us find the optimal investment amount, which would be based on the different levels of coverage each increment of funding provides.

Preparedness in these emergencies is an important part of the planning process, and must be applied in any given situation. Perry developed a study looking at the optimal guidelines pertaining to this preparedness given a terrorist attack like the event of September 11th. The investments that the government makes in order to provide security to its people does not go unnoticed, though it needs to be optimized in order to reach higher levels of protection. The key to preparedness is forming an optimal structure that that can maintain ongoing processes while simultaneously responding to the emergency at hand. The failure to produce the needed resources combined with the incorrect knowledge during an incident can lead to the failure of this planning process. Perry outlines three components attributed to the successful preparedness of a given situation. The first step is planning, which is the most crucial when relating to preparedness level of a given situation. There needs to be a plan for any threat and disaster no matter how likely it is to occur. Without a plan across these national systems, the rest of the guidelines fall apart. Options need to be discussed before an incident occurs in order to be able to utilize the resources needed in an efficient manner. The next step is the training of the individuals and organizations who will be involved in the plan. This training can be given to the professional beforehand in order to achieve maximum proficiency given each scenario. The volunteers that will need to be utilized can be flash trained give each type of disaster. However, this training will need to be created beforehand in order to achieve the desired preparedness level, as well as quick response times. The most crucial aspect in any disaster is the response time of emergency personnel. The more rapidly a team can respond to a situation, the more lives they save. The third component of effectively preparing pertains to the written plans and documents that need to be created in order to synergize the organizations responding to the incident. There are a multitude of agencies that will be responding to any given incident, and each of them need to be on the same page and know what each is responsible for. These plans serve to help clarify each organizations responsibilities as well as the demands each incident might involve. Though a variation in incidents can occur, the jurisdiction of each organization must be known in order to know who leads during each type of threat. Incident command must be established and efficient in order to provide an optimal amount of protection and recovery. Exercises are normally developed to help with the synergy of the organizations in any given community. Each community will be different based on their resources and demographic, which makes this exercises all the more important.

Being able to pre-position supplies for a given disaster can serve to alleviate some of the stress and hardships that occur. Rawls conducted a study to see if there was a need for different facilities to be developed in order to mitigate the amount of damage a disaster would have. She created a strategy that would help to model an optimal location for these facilities based on the incident and demographics of the area. The tool that was developed was shown to be adept at locating the optimal resource locations of any given area. (Rawls, 2010) It is my thought, that this same program could be used to locate the best possible POD locations as well as locating the best possible resource locations for them. This model could help to decrease the amount of time it takes for the response teams to arrive at any given location as well. Though this model has only been tested on a small scale problem to date, future research has already been started to test the limitations of the model and how well it can allocate resources successfully.

Data

The data was gathered by using a program called Anylogic. Anylogic allows a user to simulate different events within three major paradigms (agent based modeling, discrete even modeling, and system dynamics). This software enabled our research to be completed in a timelier manner, without having to actually set up another POD. Below is what the main sequence of events looks like in the Anylogic program.

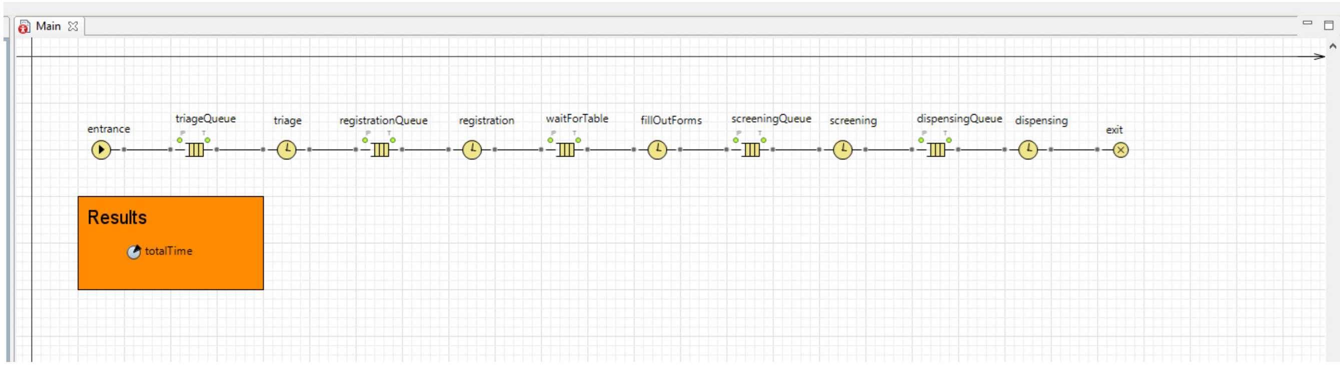


Figure 1: Anylogic Flow Diagram

Each one of these points represented in the simulation POD, represents the actual sequence of sections and que times observed through our experiments and research. Each que time had data inserted into it, which was based on previous times and averages recorded during earlier POD exercises. With this data inserted, it is now performing much like an actual POD exercise, without having to gather all of the volunteers and resources. One the POD was set up in Anylogic, Adam Kirby constructed a set up page that would allow the user to input the number of workers each section of the POD would have. Below is an image of what the last stage of the model looks like before you run the program.

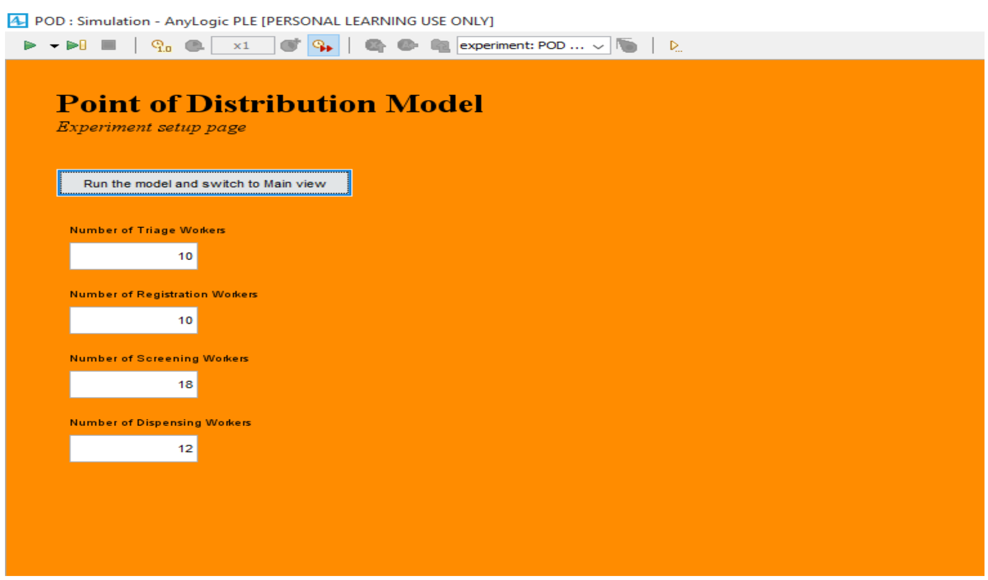
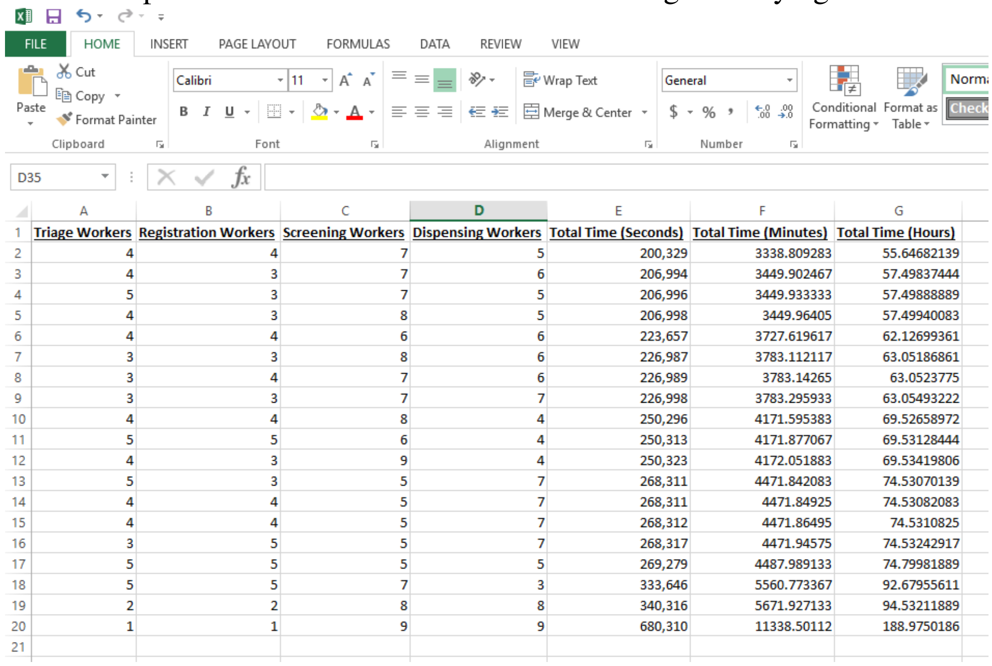


Figure 2: Anylogic Setup Page

This research used a possible of twenty individuals as the total amount of staff which could be used so that each individual would represent five percent of a POD's volunteer force. This model stopped once 20,000 individuals had been completely and successfully ran through the POD. Once this had completed the model would give a time of completion in seconds, which was later reduced to minutes and hours for convenience. Each relevant combination was entered into an excel sheet, based on the total time it took to complete the POD. The picture below shows the top combinations that were observed during the Anylogic simulations.



Triage Workers	Registration Workers	Screening Workers	Dispensing Workers	Total Time (Seconds)	Total Time (Minutes)	Total Time (Hours)
4	4	7	5	200,329	3338.809283	55.64682139
4	3	7	6	206,994	3449.902467	57.49837444
5	3	7	5	206,996	3449.933333	57.49888889
4	3	8	5	206,998	3449.96405	57.49940083
4	4	6	6	223,657	3727.619617	62.12699361
3	3	8	6	226,987	3783.112117	63.05186861
3	4	7	6	226,989	3783.14265	63.0523775
3	3	7	7	226,998	3783.295933	63.05493222
4	4	8	4	250,296	4171.595383	69.52658972
5	5	6	4	250,313	4171.877067	69.53128444
4	3	9	4	250,323	4172.051883	69.53419806
5	3	5	7	268,311	4471.842083	74.53070139
4	4	5	7	268,311	4471.84925	74.53082083
4	4	5	7	268,312	4471.86495	74.5310825
3	5	5	7	268,317	4471.94575	74.53242917
5	5	5	5	269,279	4487.989133	74.79981889
5	5	7	3	333,646	5560.773367	92.67955611
2	2	8	8	340,316	5671.927133	94.53211889
1	1	9	9	680,310	11338.50112	188.9750186

Figure 3: Completion Times of Simulation

The quickest completion times were noticed with four triage, four registration, seven screening, and five dispensing workers. This outcome is not all that surprising due to the bottle neck that occurred at our screening tables a couple of mounts ago. Our volunteers would have an unusually high wait time at the screening tables before being able to proceed to dispensing. This bottleneck would be detrimental to que times and the POD as a whole in a real life situation. Using the percentages from the best combination that was observed in this study we can see that twenty percent triage, twenty percent registration, thirty-five percent screening, and twenty-five percent of dispensing workers should be allocated to each station for the fastest que times. Once again these percentages are based on twenty possible workers, running through 20,000 people.

Conclusion

This research was developed in order to find the optimal resource allocation in a POD. This also helps to show possible allocation percentages based on volunteer base and population of POD community. For future research and an even more accurate review of optimal resource allocation, it would be great to have more averages and data of times observed in actual POD exercises to see if this sways the results that were observed. Furthermore, constructing an Anylogic model where the researcher could see every possible combination input into an excel sheet would also be beneficial. This could make it easier to observe the number of volunteers each community has to offer so that they could just input the number of volunteers they have while the program show the most optimal allocation based on their resources. With a little more research and tweaking to Anylogic, I believe this program would be a tool of great importance during an epidemic.

References

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Biographies

Colby Craig is currently a masters student in the department of computer and information technology. Colby's research interests are just-in-time training (JITT) and the measurements of how effective this training can be. Colby came into the program focused on the different point of dispensing (POD) units training times. Colby has begun research into the assessment of the effective training and the instruments that could help businesses better train their employees and clients with software. Colby Craig may be reached at craigcr@purdue.edu

J. Eric Dietz, PhD, PE earned Chemical Engineering BS and MS degrees from Rose-Hulman Institute of Technology and PhD from Purdue. Now director of the Purdue Homeland Security Institute and professor of Computer and Information Technology, Eric formerly served on the Cabinet of Indiana's Governor as the founding executive director for the Indiana Department of Homeland Security. J. Eric Dietz may be reached at jedietz@purdue.edu.

Adam Kirby is in his 5th year at Purdue and hopes to graduate with his PhD in May 2016. He has worked as a research assistant at PHSI all 5 years and has used his expertise in AnyLogic simulation modeling to study homeland security problems. His research has resulted in several major publications. Adam's PhD dissertation examines mitigation techniques for active shooter situations and attempts to answer the question "How many lives can be saved?" in order to help justify policy decisions for schools and businesses. After graduation in May, Adam hopes to acquire a faculty position at a research university which allows him to continue his focus on homeland security. Adam Kirby may be reached at kirbya@purdue.edu