UW HFS Mobile Ordering Operations Analysis

UNIVERSITY of WASHINGTON
INDUSTRIAL & SYSTEMS ENGINEERING

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Introduction

Problem Statement

To equip the UW HFS team for mobile ordering by providing data, predictive modeling, and creative solutions to long term problems that include decreased wait time and increased customer satisfaction.

Objective

To craft our analyses into six deliverables that could provide both quantitative and qualitative guide for the HFS team to anticipate potential problems, as well as make tough decisions, during and after its transition.

Deliverables

- **8** Process Flow Maps
- **15** Failure Modes & Effects Analysis
- **3** Simulation (*Simio*) Models
- **3** Excel Verification Models
- **14** Queuing Layout Modifications
- **50+** Recommendations & Opportunities

Choice of Locations

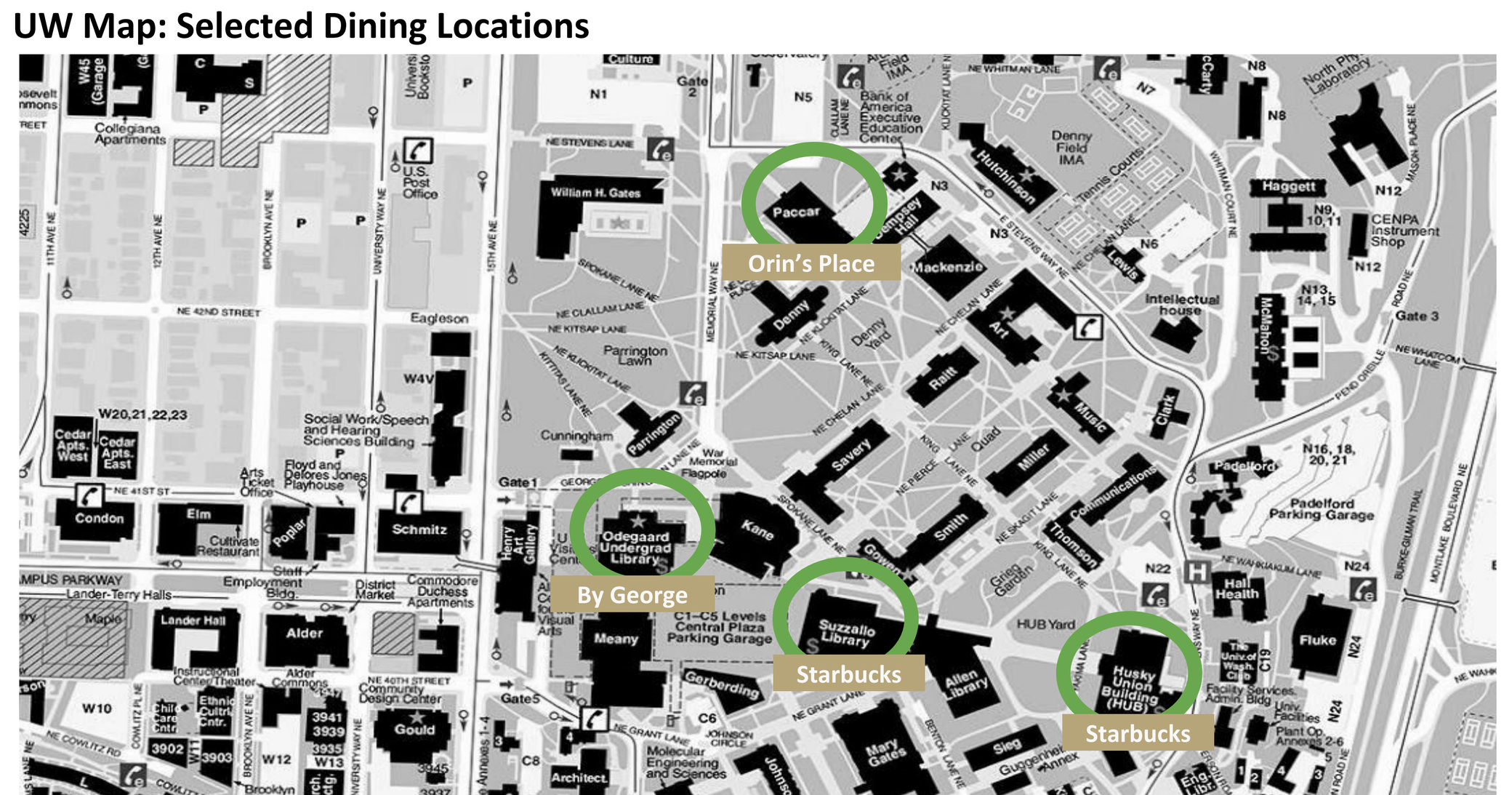
Although each dining facility on campus has its own opportunities for improvement, especially with the upcoming implementation of mobile ordering, given the limited time provided, it is impractical to conduct thorough analysis on all those locations. To provide quality over quantity, a decision was made to select locations based on the following criterias:

Selection Criteria

Length Of Queue	Revenue	Time In System	Inter-Arrival Times	Space & Pick Up Location

Based on the data collected and provided by UW HFS on the five criteria, the following four dining locations have the most potential room for mobile ordering:

UW Map: Selected Dining Locations



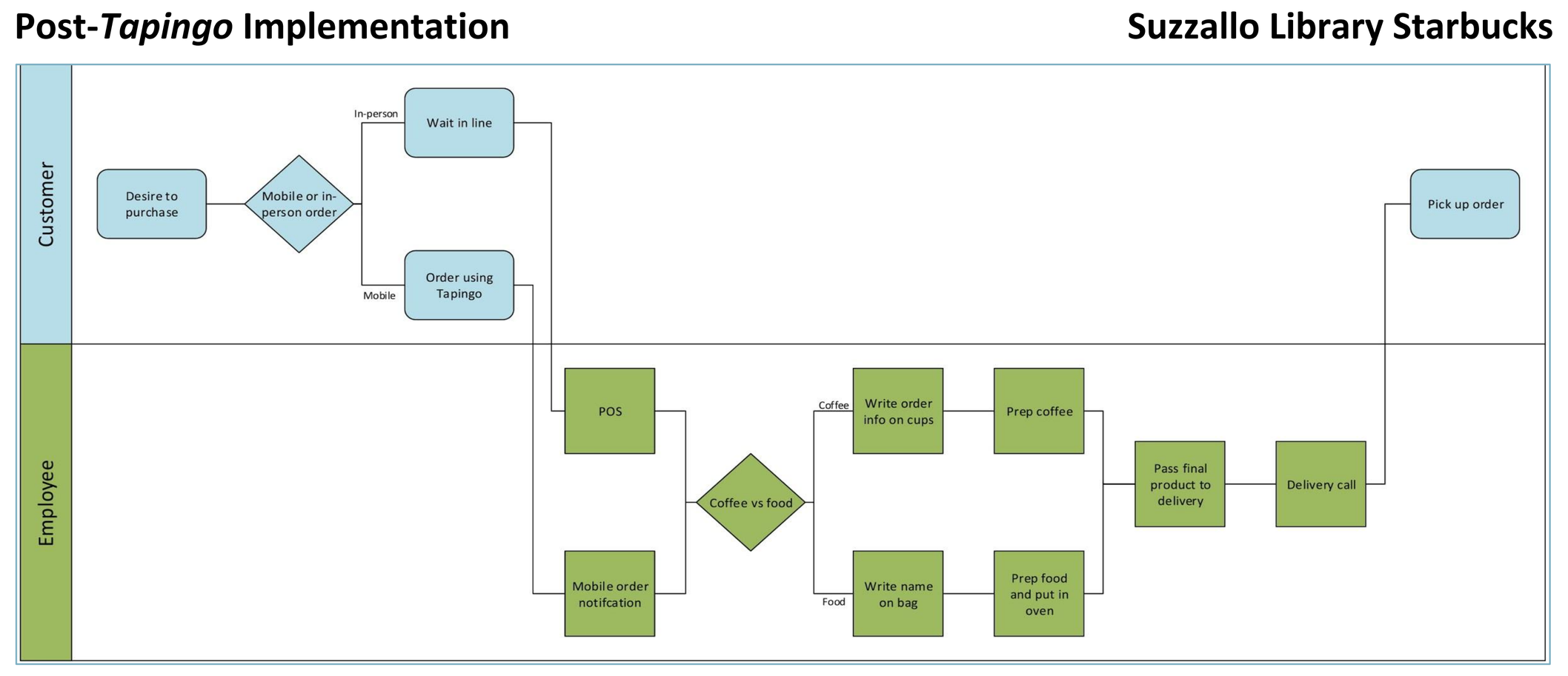
Suzzallo Library Starbucks | HUB Starbucks | Orin's Place | By George Café

Process Flow Maps

The following Process Flow Map is a sample of how of the mobile ordering application, *Tapingo*, will affect the daily flow of customers through UW's cafés & restaurants. Customers will have the opportunity to decide whether to order in person or on their mobile phones. If they choose to order using their device, the order will move past any customers in waiting in line, as well as time spent in the POS, and be printed immediately at the café.

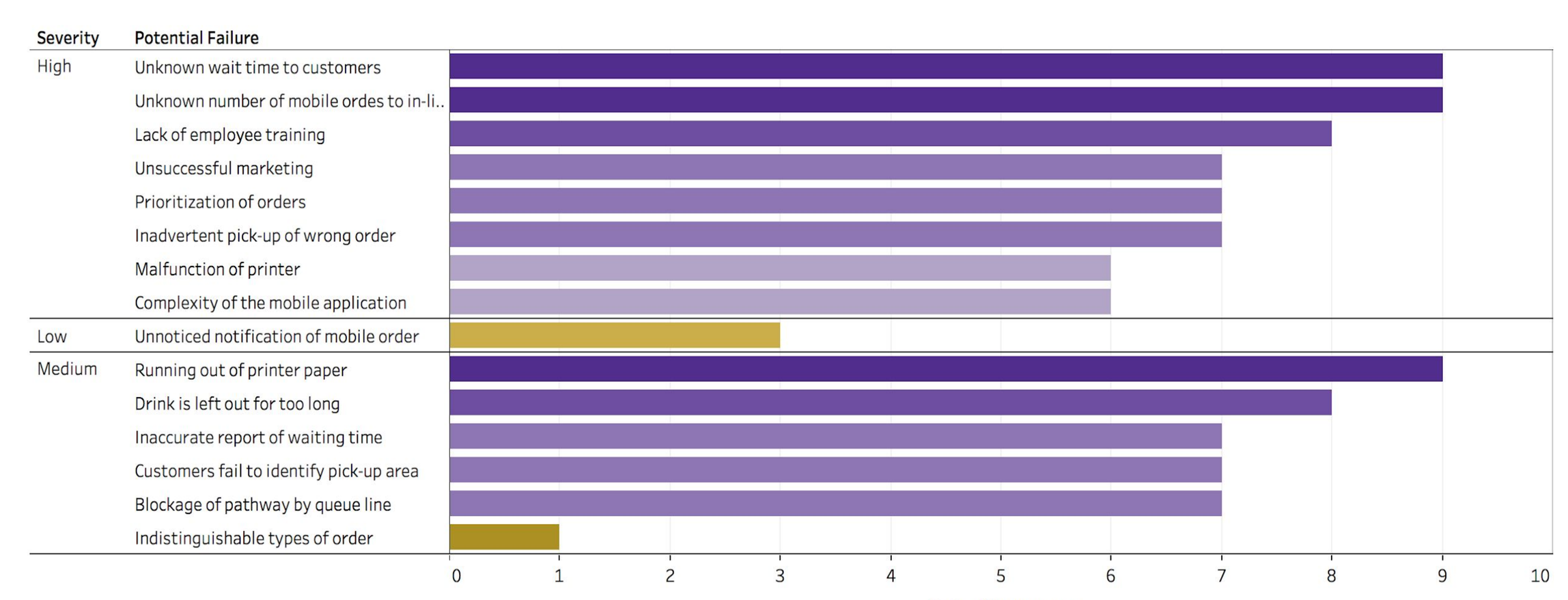
In the Starbucks example below, the employee will then be able to see from the receipt if the customer ordered a drink, food or both. They will then continue with the usual preparation of these items. The final order will be placed in a clearly identified "Tapingo" Pick Up location to prevent confusion between mobile and in-person orders.

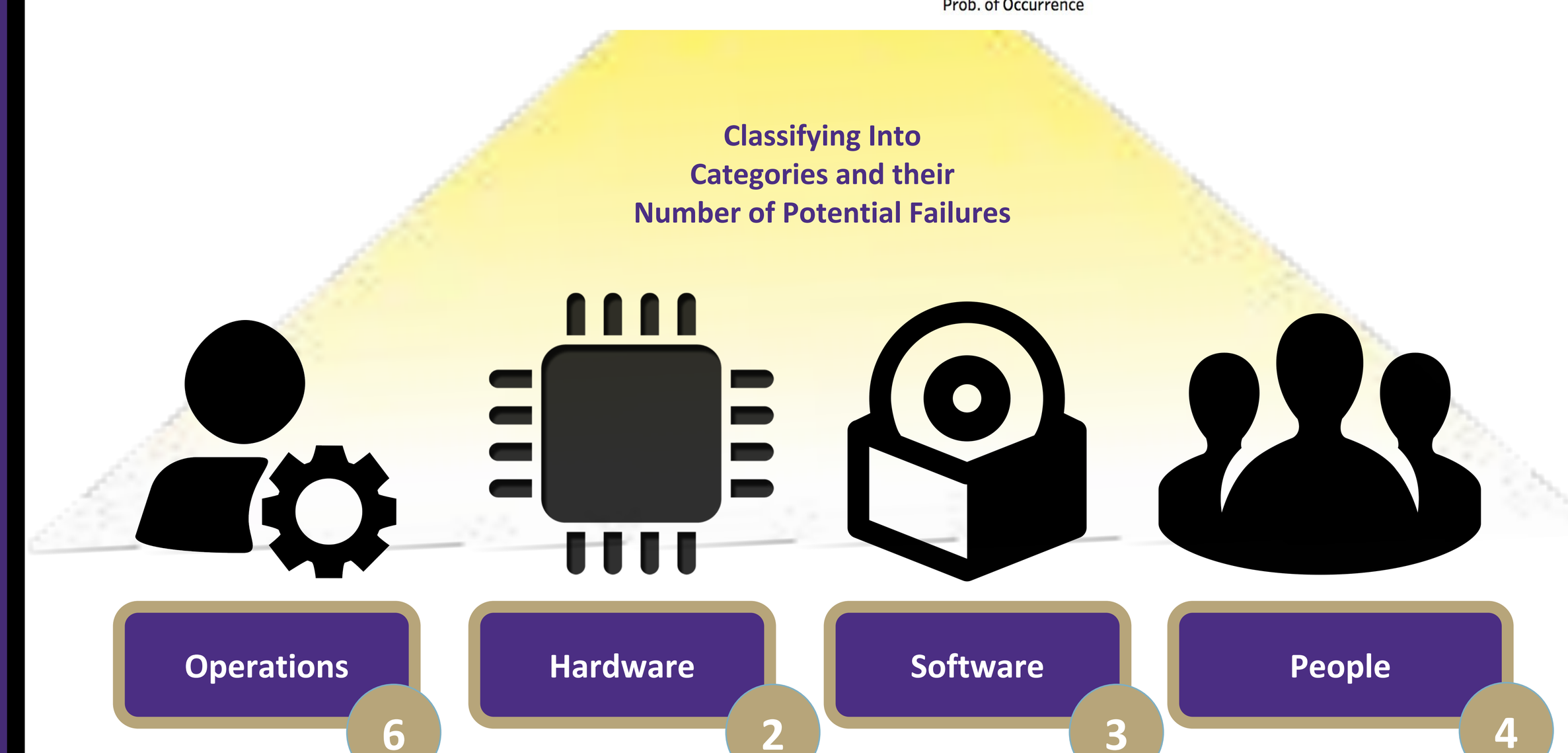
Post-*Tapingo* Implementation — **Suzzallo Library Starbucks**



FMEA Documentation

Failure Mode & Effects Analysis is a step-by-step approach for identifying all possible failures in a design, a manufacturing or assembly process, or a service. Every identified potential failure was evaluated based on three categories: Severity, Probability of Occurrence, and Probability of Detection.

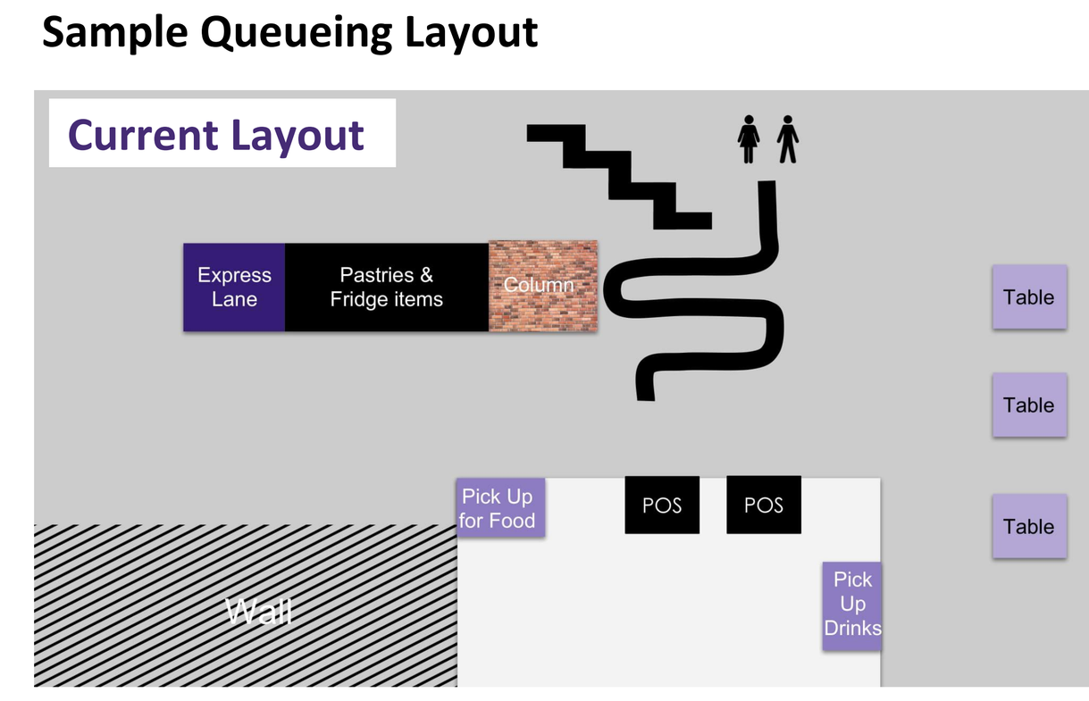




Queuing Layout Modifications

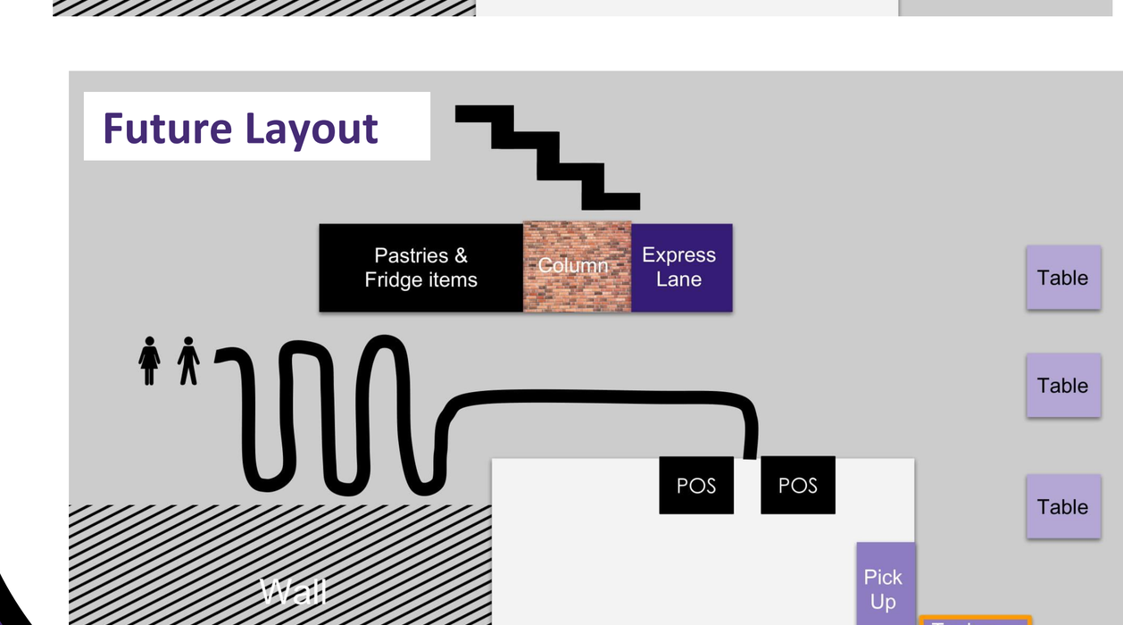
For each of the four dining locations focused on in this project, new queueing layouts were designed. The goal of these modified queues is to more efficiently contain a large quantity of people in a small space, as well as prevent balking.

Sample Queueing Layout — **Orin's Place @ Paccar Hall**



Current Issues

- Line gets *too long* and *blocks the stairs*.
- Express Lane is *far away* from the line and never used.
- Line is *separated* from the pastries/fridge items, making it inconvenient for customers to purchase those items.
- *Two separate pick-up locations* for food and drinks is inconvenient for customers ordering both.



Proposed Solutions

- Line is moved to the left so customers can <u>*easily access*</u> pastries & refrigerated items.
- Stairs are <u>*no longer blocked*</u> by customers.
- Express lane is now located next to the line, making it <u>*more convenient*</u> to use for customers and employees.
- Only <u>*one Pick Up location*</u> for food & drinks.
- New mobile ordering Pick Up location.
- <u>*Extra space*</u> for additional tables.

Simulation Model

Objective

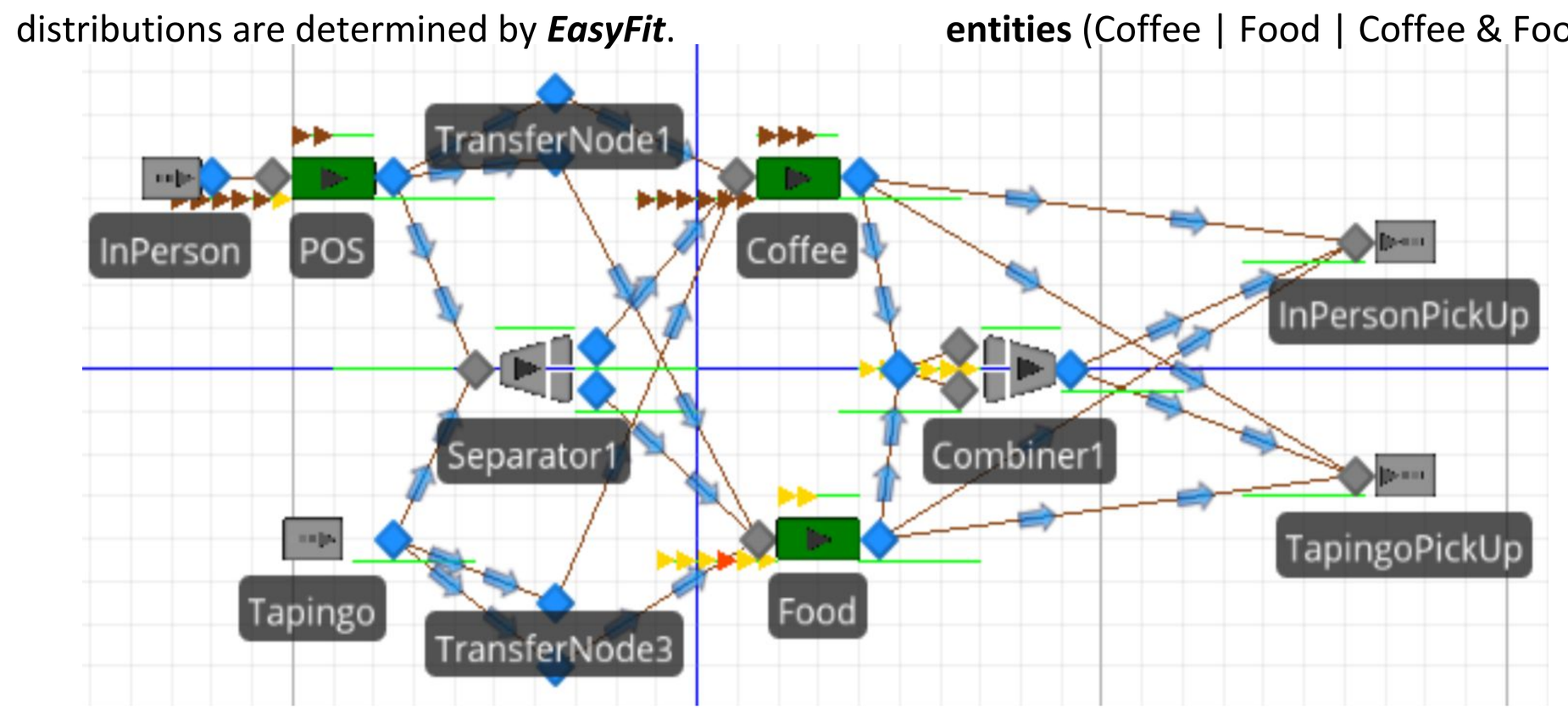
To create simulation models (Suzzallo Library Starbucks, HUB Starbucks, & By George Café) to test how different customer demands (*In-person* vs. *Mobile*) affect corresponding outputs (Customer Time in Queue, Waiting Time After Purchase, Overall Time in System, Length of Queue, Employee Utilization).

Assumptions

- Each entity is assigned to **0**, **1**, or **2** in **quantity**.
- No **cancellations**, **errors**, or **employee breaks**.
- **Negligible distances** between stations.
- No defective products and rework process.
- Interarrival Times and Process Times distributions are determined by ***EasyFit***.

Model Logic

- Experiments are conducted based on any possible combination of ordering demands (In-Person or Mobile).
- Model represents **peak hours** only.
- Customers are categorized into **three entities** (Coffee | Food | Coffee & Food).



Sample Experimentation Output

Priority	InPerson_ArrivalRate	Tapingo_ArrivalRate	In-Person_TIS (min)	In-Person_TimeInQueue (min)	In-Person_TimeAfterPurchase (min)	Tapingo_TIS (min)	Queue Length
N/A	*Current Rate*	0	20.39	14.82	5.57	0.00	20
Equal	*Current Rate*	10%	24.93	16.68	8.25	9.87	23
Equal	*Current Rate*	15%	25.40	15.98	9.42	10.96	24
Equal	*Current Rate*	20%	27.64	17.03	10.61	10.31	25
Equal	*Current Rate*	25%	28.15	17.93	10.23	11.82	26
Equal	*Current Rate*	30%	29.31	17.69	11.62	13.07	26
In-Person	*Current Rate*	10%	20.62	14.53	6.09		20
In-Person	*Current Rate*	15%	20.49	14.30	6.20		21
In-Person	*Current Rate*	20%	20.04	13.60	6.44		20
In-Person	*Current Rate*	25%	20.30	13.98	6.32		21
In-Person	*Current Rate*	30%	20.86	14.11	6.75		20
Tapingo	*Current Rate*	10%	27.90	15.93	11.97	3.11	27
Tapingo	*Current Rate*	15%	29.08	16.46	12.61	3.23	28
Tapingo	*Current Rate*	20%	31.92	19.41	12.50	3.28	30
Tapingo	*Current Rate*	25%	32.06	18.20	13.86	3.62	33
Tapingo	*Current Rate*	30%	34.12	19.54	14.59	3.94	36

Model Verification

Objective

To confirm that simulation models are implemented correctly with respect to the conceptual model.

Sample Excel Verification Model

MEASURE:	STATION:	POS 1	Coffee 2
Arrival Rate (parts/hr)	ra	150.000	150.000
Natural Process Time (hr)	t0	0.009	0.020
Number of Machines	m	2	7
MTTF (hr)	mf	0.00001	0.000001
MTTR (hr)	mr	0	0
Availability	A	1.000	1.000
Effective Process Time (failures only)	te'	0.009	0.020
Batch Size	k	1	1
Setup Time (hr)	ts	0.000	0.000
Arrival Rate of Batches	ra/k	150.000	150.000
Eff Batch Process Time (failures+setups)	te = kt0/A+ts	0.009	0.020
Eff Batch Process Time Var (failures+setups)	k*s02/A2+ 2mr(1-A)kt0/A+ss2	0.000	0.000
Utilization	**u**	**0.675**	**0.435**
Yield	y	1.000	1.000
Final Departure Rate	ra*y	150.000	150.000
Utilization	u	0.675	0.435
Throughput	TH	150.000	150.000
Queue Time (hr)	**CTq**	**0.0078**	**0.0004**
Cycle Time (hr)	**CTq+te**	**0.0168**	**0.0207**
Cumulative Cycle Time (hr)	**Si(CTq(i)+te(i))**	**0.017**	**0.038**
WIP in Queue (jobs)	raCTq	1.175	0.063
WIP (jobs)	raCT	2.525	3.106
Cumulative WIP (jobs)	Si(ra(i)CT(i))	2.525	5.631

Queuing Theory | Kingman's Formula

Key
Input
Desired Output

Desired Output

Utilization (U) $= \dfrac{\textit{Arrival Rate of Batches} \times \textit{Batch Process Time}}{\textit{Number of Machines}}$; overloads if U > 1

Queue Time (CT_Q) $= \left(\dfrac{\textit{Arrival CV} + \textit{Process SCV}}{2}\right) \times \left(\dfrac{\text{Utilization}^{\frac{\sqrt{2*(\text{Number of Machines}+1)}-1}{\text{Number of Machines}}}}{1 - \textit{Utilization}}\right) \times \textit{Batch Process Time}$

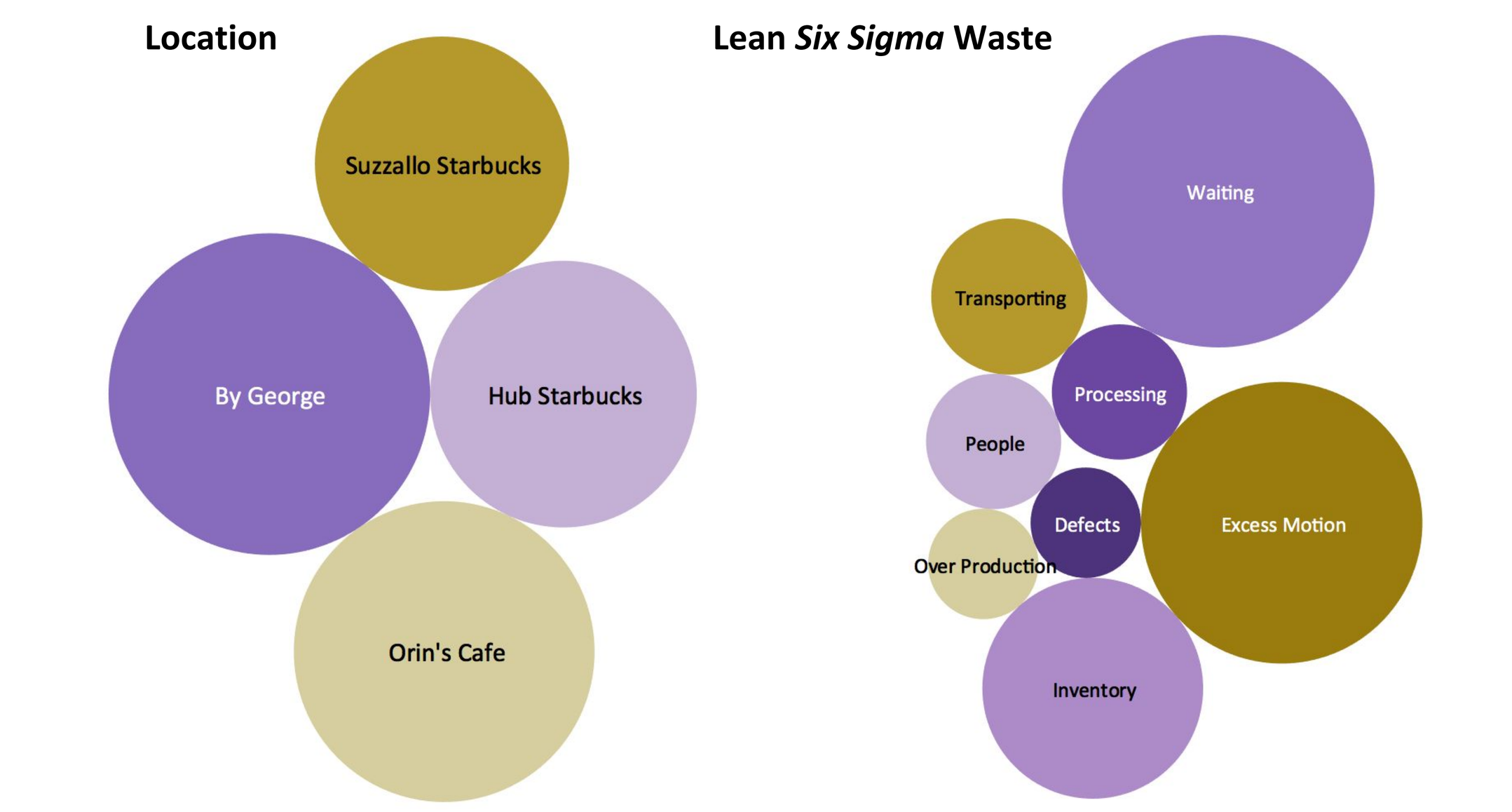
$= \left(\dfrac{c_a^2 + c_e^2}{2}\right) \times \left(\dfrac{u^{\frac{\sqrt{2*(m+1)}-1}{m}}}{1-u}\right) \times t_e$

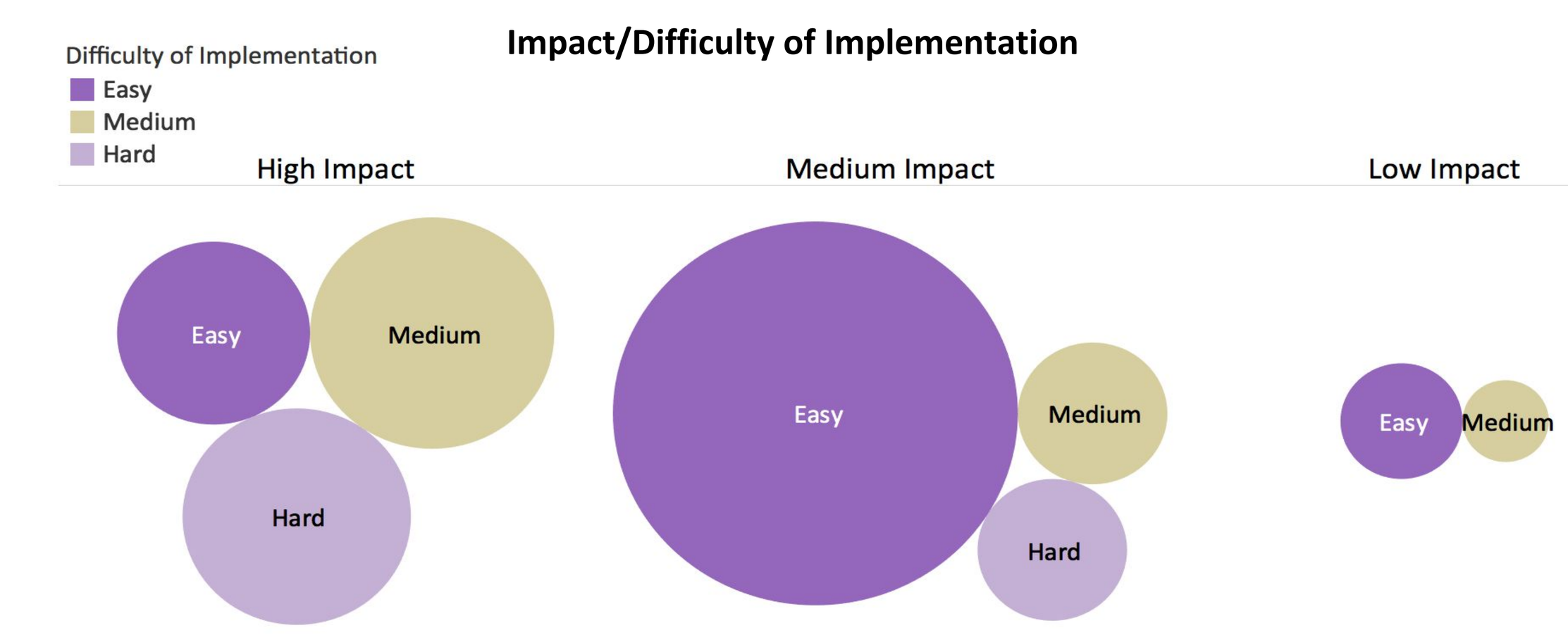
Cycle Time $= CT_q + t_e$

$= \textit{Queue Time} + \dfrac{\textit{Batch Size} \times \textit{Natural Process Time}}{\textit{Availability}} + \textit{Setup Time}$

Recommendations & Opportunities

52 recommendations were created during the course of this project to help eliminate waste in the Suzzallo Starbucks, the HUB Starbucks, Orin's Place, and By George Café. These recommendations are categorized in the following ways:





Overall Results

The Failure Modes & Effects Analysis (FMEA) has allowed the project to:

- Take actions to eliminate or reduce failures.
- Document current knowledge & actions about the risks of failure for continuous improvement.

Queuing Layout Modifications have improved the overall experience of dining locations by:

- Reaching higher utilization of nearby resource usages.
- Structuring lines to use unused space more efficiently.

Based on the Simulation (*Simio*) Models

- *HUB Starbucks*
  Replace one POS station with another Coffee Machine to reduce customer waiting time.
- *By George Café*
  Create a separate sandwich line if *Tapingo* demand is more than 10% of the current demand, as it would ensure its Sandwich Worker Utilization to be greater than 50%.

Other Results

- Created Process Flow Maps for both current and future states to analyze the overall flow of operation and identify *Kaizen* opportunities.
- Determined logical mobile ordering Pick Up locations.
- Constructed a comprehensive list of recommendations to identify opportunities for improvement of products, services, or processes, as well as to eliminate wastes in our chosen four dining locations.

Acknowledgement

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