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Jospeh M. Katz Graduate Business School

Applied Simulation - Final Project

Simulation-Driven Analysis of Operational Strategies for Pizza Romano

Team 5: Naveen Srinivas Akoju, Priyam Somani

Pizza Romano - Introduction

Overview: Pizza Romano is a popular late-night pizzeria located on Atwood Street in Oakland, Pittsburgh. Surrounded by the University of Pittsburgh and Carnegie Mellon, it serves a high-volume student and local customer base.

Operating Hours:

- **Daily:** 4:00 PM – 4:00 AM

Current Set up

- **In-Person:** Walk-in orders with counter service.

Relevance to Simulation: Pizza Romano currently serves only walk-in customers. With rising demand, management is considering adding online ordering and optimizing in-store flow. This simulation explores how changes in order channels and staffing can improve efficiency and support growth.

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Business Case: Pizza Romano Simulation Project

Pizza Romano operates **exclusively through walk-in orders**, with peak business between **7:00 PM and 2:00 AM**. The store experiences high foot traffic, especially on weekends, with limited counter and kitchen capacity.

- Order Counter Bottlenecks: Single-channel intake creates long queues during peak hours.
- Kitchen Saturation: Limited staff and oven capacity struggle to keep pace with demand.
- Manual Order Handling: All orders are taken in person, slowing throughput and increasing error potential.
- Revenue loss from missed sales and unfulfilled demand (estimated $300–400/night)
- Staff burnout and reduced efficiency during the late-night rush.

Without operational changes, Pizza Romano risks continued customer dissatisfaction, negative word-of-mouth, declining sales, and unsustainable staff workloads.

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Business Case - Project Objective

The objective of this project is to analyze Pizza Romano's customer flow and operational bottlenecks using a Simio simulation model and propose actionable solutions that:

Introduce online ordering to offload peak counter traffic

Streamline walk-in flows through kiosks or layout changes

Optimize resource allocation in the kitchen to improve throughput

By implementing the optimized solutions identified through simulation, Pizza Romano can expect to improve customer satisfaction, recover lost revenue, and build a more resilient operational model capable of handling future growth.

Model Structure Overview – Base case

Simulates the original setup at Pizza Romano with **only in-person walk-in customers**.

- **Entities**: WalkInCustomer
- **Flow**: WalkInSource → OrderCounter → KitchenPrep → PickUpCounter → Exit

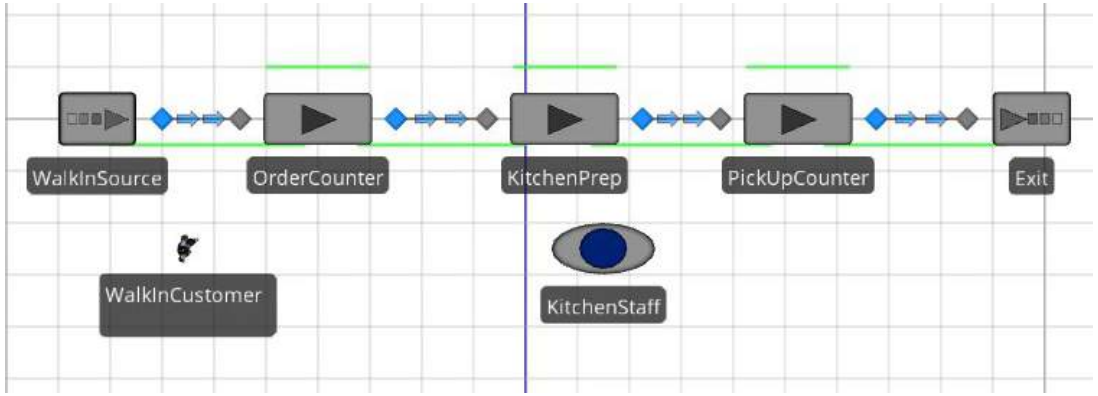
Current Staffing:

- 1 staff at **OrderCounter**
- 1 staff in **KitchenPrep** with shared kitchen staff resource
- 1 staff at **PickUpCounter**

Constraints:

- Single queue for all walk-ins
- Long wait times at OrderCounter and KitchenPrep during peak hours

Objective: Establish baseline performance and identify key bottlenecks (cashier and kitchen)



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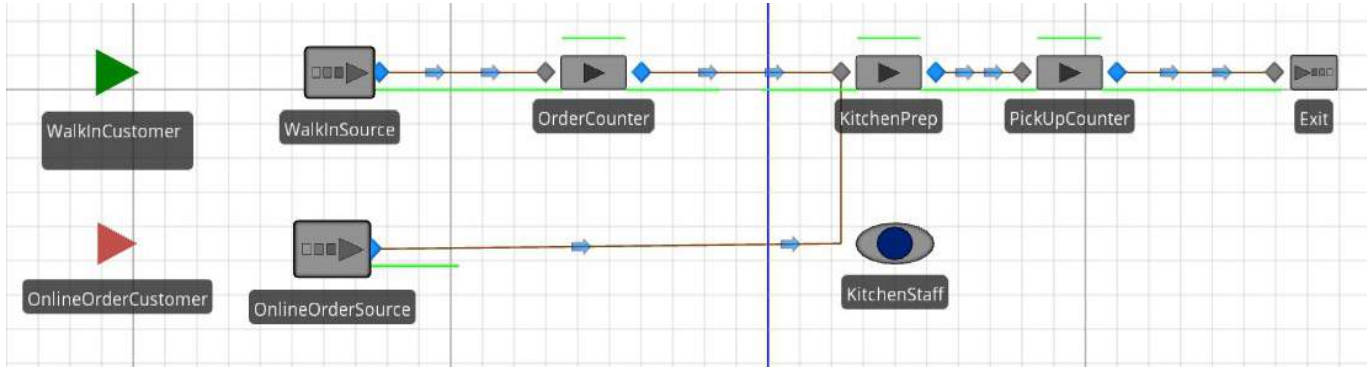
Model Structure Overview – OnlineOrder

Simulates the new setup at Pizza Romano with online & walk-in customers.

- New **entity type**: OnlineOrderCustomer,
- **Flow for Online Orders**: OnlineOrderSource → KitchenPrep → PickUpCounter → Exit
- **Walk-In flow remains unchanged**
- **Merged load** at KitchenPrep and PickUpCounter from both order types
- **Objective**: Model real-world concurrency and assess impact of online ordering on throughput and kitchen congestion



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Model Structure Overview – with Kiosk

Introducing a **SelfServiceKiosk** station for ~80% of walk-in customers

Walk-In Flow Split:

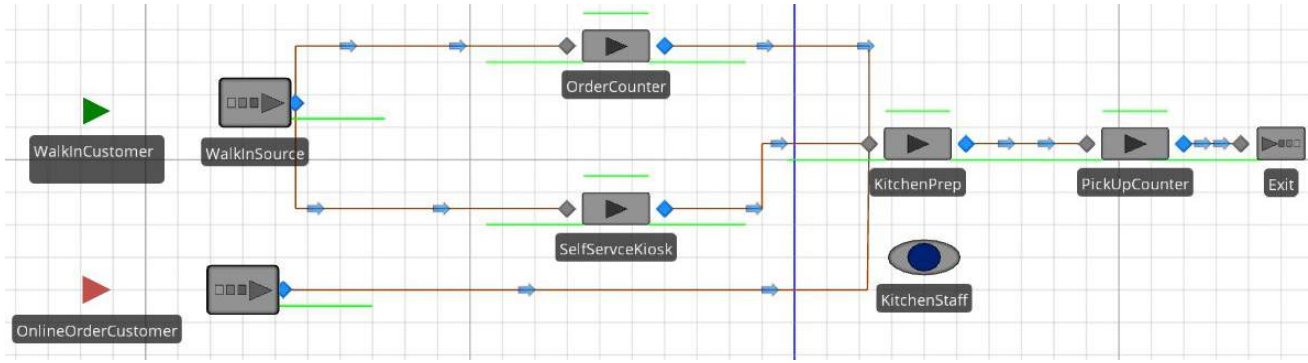
- 20% → OrderCounter (manual)
- 80% → SelfServiceKiosk (faster)

Staffing:

- Simulated for multiple staffing levels and Server Capacities.

Purpose:

- Reduce cashier wait time without hiring extra staff
- Structurally redesign flow to streamline order placement
- Maximize order fulfillment and Increase revenues



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Simio Set Up

Input Parameters and Tables

- Hourly rate tables for walk-in and online arrivals
- Separate processing times for order, kitchen prep, and pickup
- Referenced properties to control capacities and logic dynamically
- Custom revenue formula based on fulfilled orders and capacity setup

Rate Tables

ArrivalRateWalkIn

ArrivalRateOnline

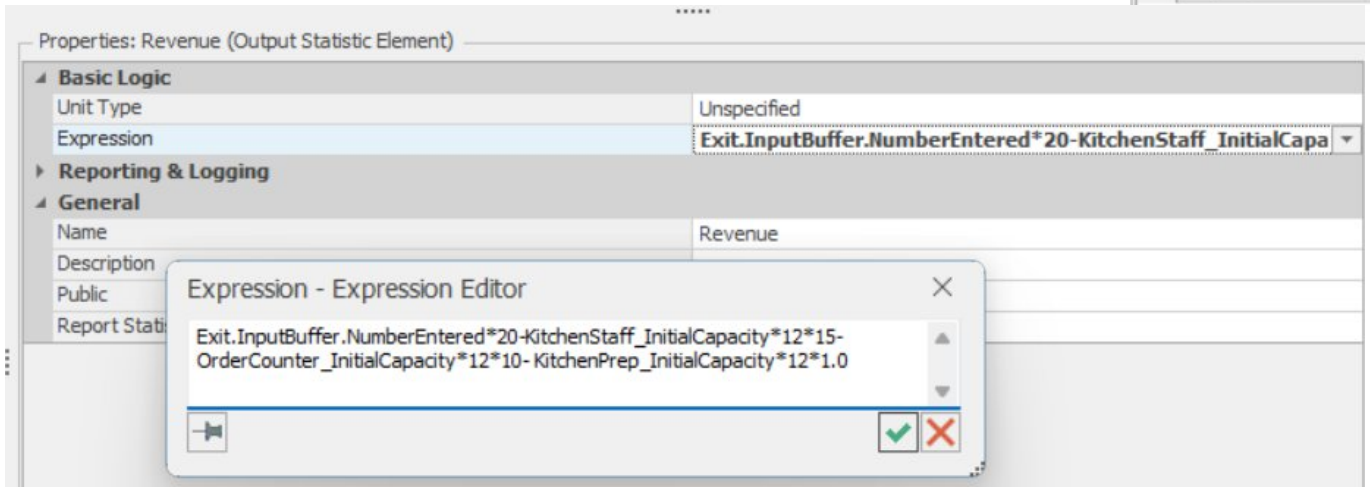
Starting Offset	Ending Offset	Rate (events per hour)
Day 1, 00:00:00	Day 1, 01:00:00	5
Day 1, 01:00:00	Day 1, 02:00:00	7
Day 1, 02:00:00	Day 1, 03:00:00	9
Day 1, 03:00:00	Day 1, 04:00:00	12
Day 1, 04:00:00	Day 1, 05:00:00	
Day 1, 05:00:00	Day 1, 06:00:00	
Day 1, 06:00:00	Day 1, 07:00:00	
Day 1, 07:00:00	Day 1, 08:00:00	
Day 1, 08:00:00	Day 1, 09:00:00	
Day 1, 09:00:00	Day 1, 10:00:00	
Day 1, 10:00:00	Day 1, 11:00:00	
Day 1, 11:00:00	Day 1, 12:00:00	

Rate Tables

ArrivalRateWalkIn

ArrivalRateOnline

Starting Offset	Ending Offset	Rate (events per hour)
Day 1, 00:00:00	Day 1, 01:00:00	5
Day 1, 01:00:00	Day 1, 02:00:00	7
Day 1, 02:00:00	Day 1, 03:00:00	10
Day 1, 03:00:00	Day 1, 04:00:00	12
Day 1, 04:00:00	Day 1, 05:00:00	15
Day 1, 05:00:00	Day 1, 06:00:00	22
Day 1, 06:00:00	Day 1, 07:00:00	32
Day 1, 07:00:00	Day 1, 08:00:00	22
Day 1, 08:00:00	Day 1, 09:00:00	20
Day 1, 09:00:00	Day 1, 10:00:00	12
Day 1, 10:00:00	Day 1, 11:00:00	10
Day 1, 11:00:00	Day 1, 12:00:00	6



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Simio Experiments - BaseCase

- Revenue remains below $1,500 across all base case scenarios.
- Order volume is consistently under 150 orders.
- Kitchen utilization exceeds 95%, indicating bottlenecks.
- Increasing kitchen staff or prep shows no significant performance gain.
- The current setup is inefficient compared to kiosk or online models.

Scenario			Repli...		Controls				Responses					
	Name	Status	...	...	OrderCounter...	KitchenPrep...	WalkInSource_Inter...	KitchenStaff_InitialCapacity	Utl_Counter	Kitchen_Utilization	OrdersEntered	FullfilledOrders	NotFullfilledOrders	Revenue
▸	003	Comple...	20	of 1	1	3	8	3	80.3321	48.1034	91	85.55	5.45	1015
	013	Comple...	20	of 1	1	2	8	2	83.1689	71.5952	91	84.35	6.65	1183
	016	Comple...	20	of 1	1	2	7.5	2	88.243	75.4903	97	88.75	8.25	1271
	029	Comple...	20	of 1	1	2	7.5	3	88.243	75.4903	97	88.75	8.25	1091
	032	Comple...	20	of 1	1	2	7	2	92.8947	78.0095	103	91.95	11.05	1335
	040	Comple...	20	of 1	1	2	7	3	92.8947	78.0095	103	91.95	11.05	1155
	005	Comple...	20	of 1	1	3	6.5	3	95.0157	55.1035	111	97.75	13.25	1259
	007	Comple...	20	of 1	1	3	6.5	2	95.4688	70.4345	111	94.7	16.3	1378
	037	Comple...	20	of 1	1	2	6.5	2	95.4688	80.1508	111	94.7	16.3	1390
	028	Comple...	20	of 1	1	3	6	3	97.8264	56.0148	121	99.3	21.7	1290
	022	Comple...	20	of 1	1	2	6	2	98.2102	81.627	121	96.3	24.7	1422
	036	Comple...	20	of 1	1	3	6	2	98.2102	71.5677	121	96.3	24.7	1410
	060	Comple...	20	of 1	1	2	6	3	98.2102	81.627	121	96.3	24.7	1242
	035	Comple...	6	of 1	1	2	8	1	83.9816	96.9794	91	59	32	856
	055	Comple...	6	of 1	1	1	8	2	83.9816	98.5794	91	59	32	688
	012	Comple...	13	of 1	1	2	5.5	2	98.7424	79.7924	131	93.9231	37.0769	1374.46
	038	Comple...	13	of 1	1	3	5.5	2	98.7424	69.589	131	93.9231	37.0769	1362.46
	046	Comple...	6	of 1	1	2	7.5	1	95.0168	95.4378	97	58.1667	38.8333	839.333
	050	Comple...	6	of 1	1	1	7.5	2	95.0168	97.7652	97	58.1667	38.8333	671.333
	051	Comple...	20	of 1	1	3	5	3	99.5249	56.9689	144	100.95	43.05	1323
	052	Comple...	6	of 1	1	2	7	1	96.9265	95.8434	103	58	45	836
	011	Comple...	9	of 1	1	2	5	2	99.5166	79.1988	144	93	51	1356
	056	Comple...	9	of 1	1	3	5	2	99.5166	68.9581	144	93	51	1344
	026	Comple...	6	of 1	1	2	6.5	1	98.6198	95.7143	111	58.6667	52.3333	849.333
	034	Comple...	6	of 1	1	3	6	1	98.0719	93.8983	121	59	62	844
	017	Comple...	10	of 1	1	2	4.5	3	99.555	79.9107	161	94.2	66.8	1200
	001	Comple...	6	of 1	1	2	4.5	2	99.7368	78.332	161	92.1667	68.8333	1339.33
	010	Comple...	6	of 1	1	1	5.5	1	99.006	97.9261	131	59	72	868
	021	Comple...	6	of 1	1	1	5.5	2	99.006	97.9261	131	59	72	688

Simio Experiments - Kiosk

- Revenue Boost: Peaks at $6,200, ~4× higher than base case.
- Reduced Congestion: Kiosks ease counter load, improving flow.
- High Fulfillment: Over 310 orders fulfilled with minimal losses.
- Efficient Utilization: Kitchen runs near capacity but stays stable.
- Top Performer: Delivers the best overall outcome across all metrics.

Scenario		Repli...		Controls							Responses								
Name	Status	...	...	KitchenPr...	SelfServ...	OrderCo...	KitchenSt...	WalkInSource_I...	OnlineOrderSource_Inter...	Kitchen_Utilization	KioskUtilization	CashierUtilization	OrderEnter...	Walkin_In	InKiosk	InCounter	OrderFullfilled	OrderNotFullfil...	Revenue
047	Comple...	20	of	3	1	1	3	9	9.5	45.6408	17.2493	5.81596	156	80	64.55	15.45	155.05	0.95	2405
025	Comple...	20	of	2	1	1	3	7	6.5	93.3928	22.2989	8.80356	214	103	81.6	21.4	211.8	2.2	3552
003	Comple...	20	of	3	2	1	3	10	10	42.128	15.4652	6.36248	146	73	57.15	15.85	143.65	2.35	2177
041	Comple...	20	of	3	1	1	1	5.5	5	80.3259	28.9719	11.0162	275	131	105.4	25.6	272.6	2.4	5116
049	Comple...	20	of	3	1	1	2	5	5	84.0551	32.117	11.0347	288	144	116.85	27.15	285.35	2.65	5191
040	Comple...	20	of	2	1	1	3	6.5	7	93.6424	24.4664	10.397	214	111	88.5	22.5	211.25	2.75	3541
021	Comple...	20	of	2	1	1	3	8	6.5	88.1811	19.3353	7.89903	202	91	72.25	18.75	199.2	2.8	3300
005	Comple...	20	of	3	2	1	3	8	8	52.8228	19.8261	7.56203	182	91	72.65	18.35	179	3	2884
019	Comple...	20	of	2	1	1	2	6	8.5	89.8446	24.6144	10.838	206	121	95.2	25.8	202.55	3.45	3547
048	Comple...	20	of	3	1	1	1	6.5	4	84.9713	24.253	10.13	292	111	88.5	22.5	288.4	3.6	5432
036	Comple...	20	of	3	1	1	1	6.5	3.5	92.6455	25.2249	9.09708	317	111	90.05	20.95	313.25	3.75	5929
007	Comple...	20	of	2	1	1	3	7	6	97.1634	22.4605	8.68733	224	103	81.9	21.1	220.15	3.85	3719
028	Comple...	20	of	2	2	1	3	7	6	97.1634	22.4605	8.68733	224	103	81.9	21.1	220.15	3.85	3719
038	Comple...	20	of	2	1	1	3	6.5	6	99.0106	23.9383	8.98749	232	111	88.65	22.35	224.05	7.95	3797
031	Comple...	20	of	2	1	1	3	7	5.5	99.1369	22.1174	8.81556	234	103	82.2	20.8	224.95	9.05	3815
044	Comple...	20	of	2	2	1	3	6.5	5.5	99.6048	22.5883	9.30028	242	111	88.1	22.9	225.2	16.8	3820
042	Comple...	20	of	2	1	1	2	6	5.5	99.5711	24.6218	10.7114	252	121	96.25	24.75	226.3	25.7	4022
043	Comple...	20	of	2	1	1	3	6	5.5	99.5711	24.6218	10.7114	252	121	96.25	24.75	226.3	25.7	3842
046	Comple...	20	of	2	2	1	3	6	5.5	99.5711	24.6218	10.7114	252	121	96.25	24.75	226.3	25.7	3842
024	Comple...	20	of	2	1	1	3	6.5	5	99.6785	23.0869	8.78999	255	111	89.2	21.8	225.85	29.15	3833
023	Comple...	20	of	3	2	1	2	3.5	4.5	99.4407	46.6156	16.8571	367	206	165.7	40.3	335.75	31.25	6199
030	Comple...	20	of	1	1	1	3	10	10	99.9411	16.391	5.68771	146	73	58.25	14.75	112.4	33.6	1576

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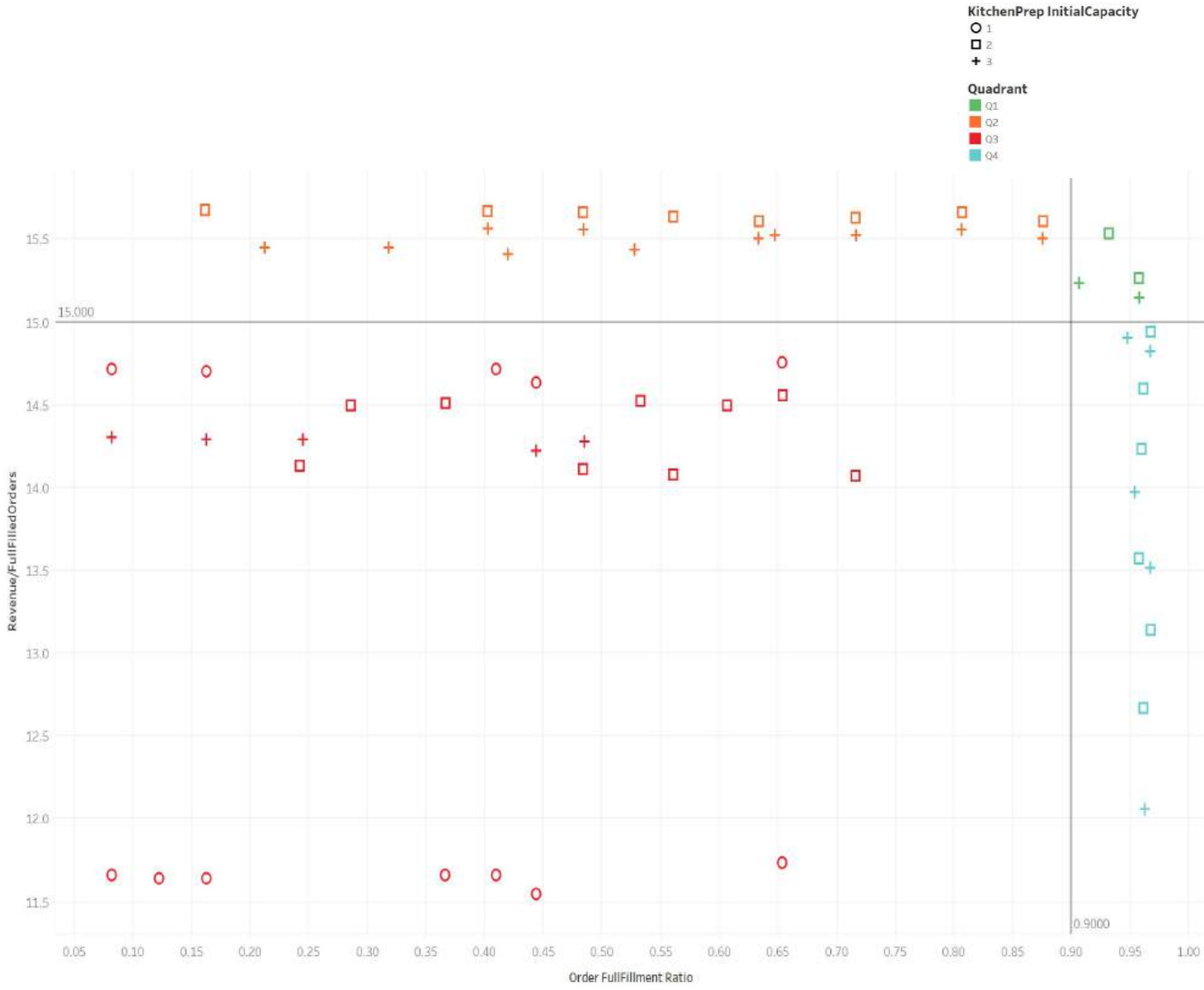
Base Scenario Performance

Scaling Alone Isn't Enough — The Real Bottleneck Is Up Front

- Most configurations fall in Quadrants 2 and 3, indicating low percentage of order fulfillment despite acceptable revenue per order.
- Scaling kitchen resources (staff, ovens) showed limited impact — major constraint remains at the Order Counter.
- Bottleneck at the front-end throttles throughput even when back-end has spare capacity.



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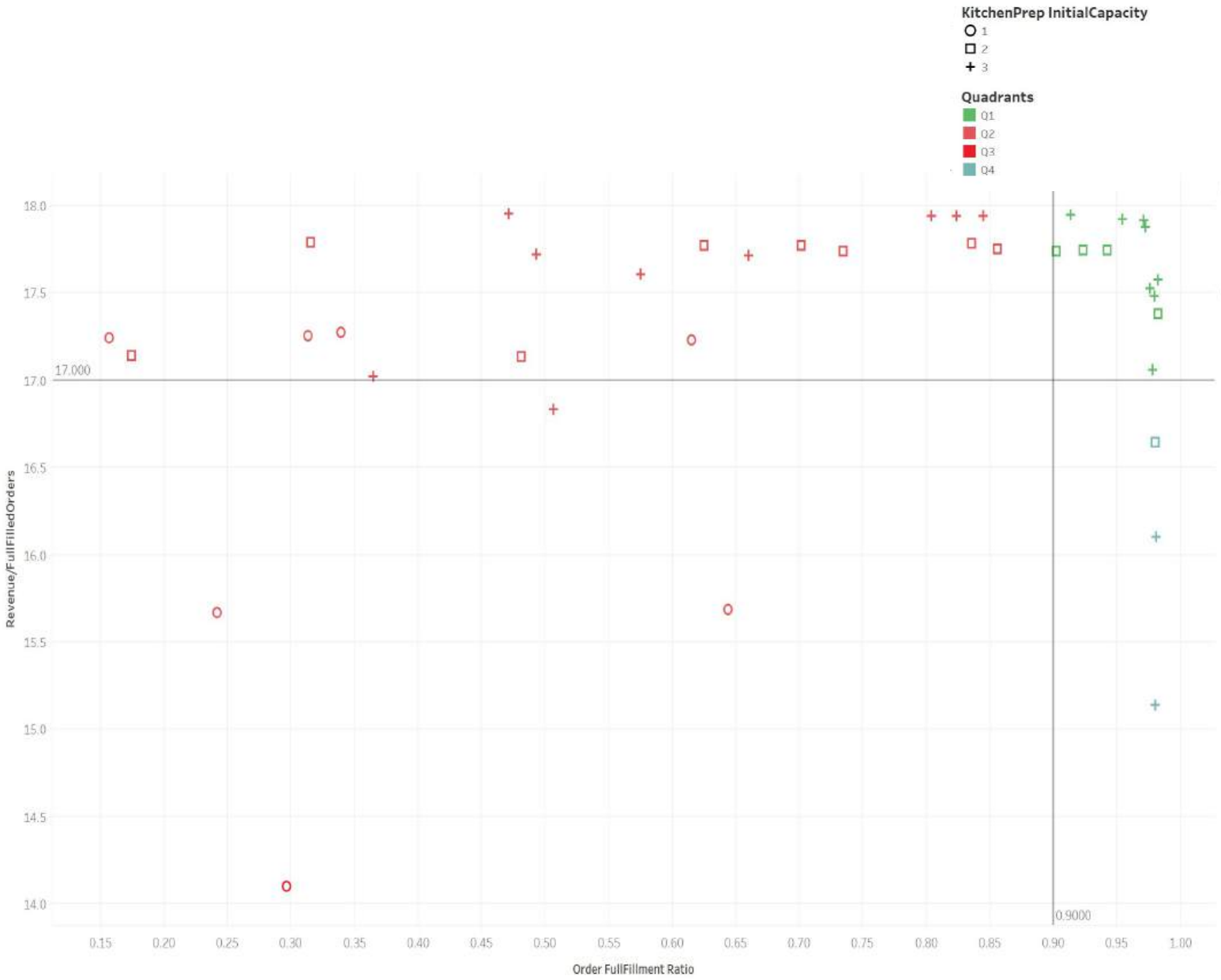
Scenario1: Walk-In + Online Orders

Online Orders Expand Reach, But Reveal Backend Vulnerabilities

- Introducing online orders increased overall volume processed but still bottlenecks at Order Counter persists.
- Performance improved: more setups move toward Quadrant 1 (high fulfillment, high profit).
- But kitchen strain becomes evident — low-staff setups suffer, highlighting the need for synchronized backend scaling.



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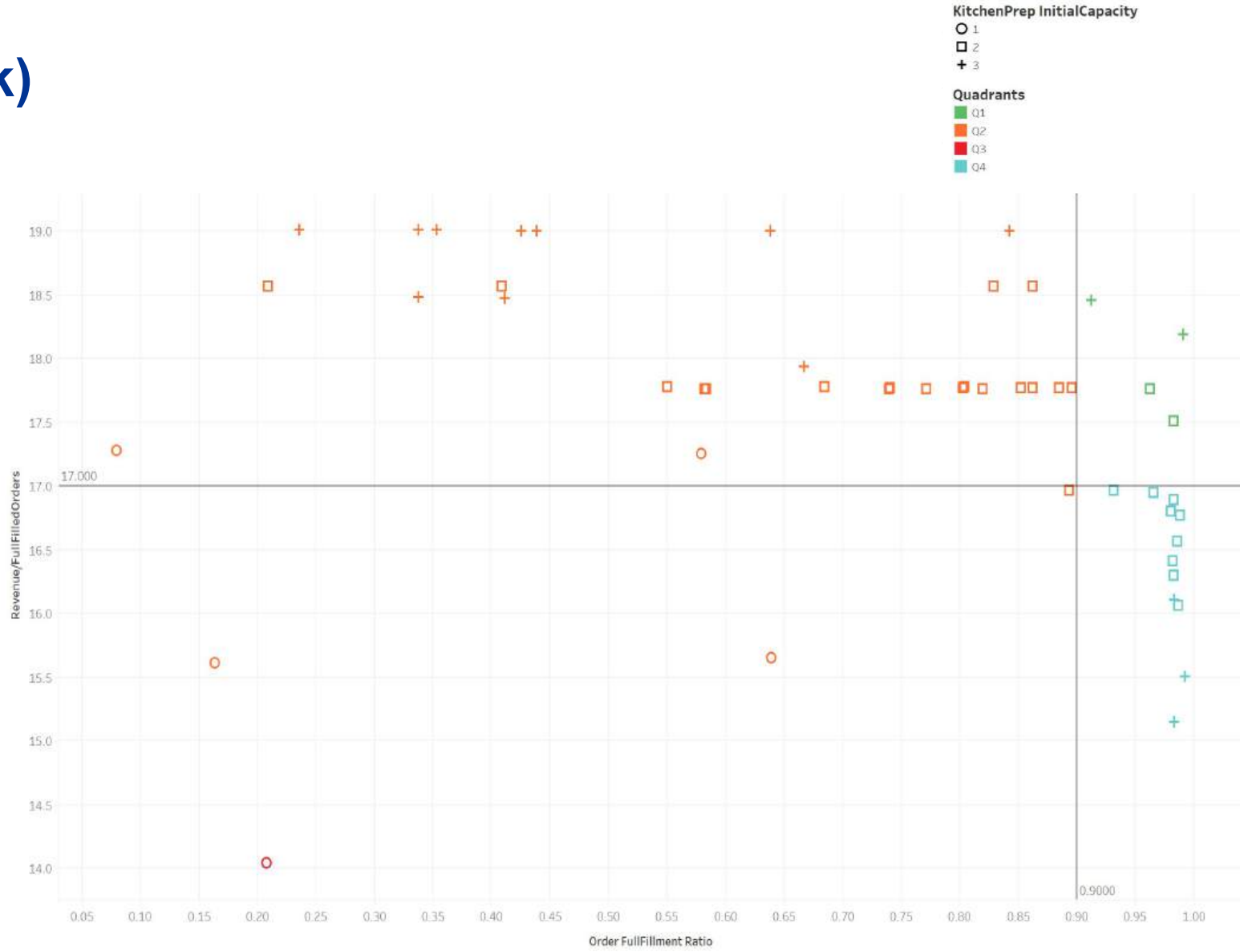
Scenario2: Walk-In(Kiosk) + Online Orders

Kiosks Unlock Efficiency Gains Without Raising Costs

- Self-service kiosks offload the Order Counter, leading to major gains in fulfillment and revenue.
- Multiple setups land in Quadrant 1, including those with only 2 staff — proves process innovation outperforms brute-force staffing.
- Best-performing scenario in terms of both service quality and profitability.



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Recommendation

💰 **Highest kiosk-only revenue**: $5,929 generated with just **1 kitchen staff**.

🔧 **Highly efficient setup**: Minimizes labor costs while maintaining strong output.

⏱️ **Reduces order counter wait times**: Self-service kiosks streamline order placement.

🎯 **Ideal for lean operations**: Maximizes profit using fewer resources—perfect during off-peak hours or staff shortages.

⚖️ **Trade-off awareness**:

- $6,199 revenue setup has **38 unfulfilled orders**.
- $6,081 revenue setup (with 3 staff) has **166 unfulfilled orders** and higher staffing cost.

🍳 **Kiosk performs best** when **online orders are offloaded**, reducing complexity and congestion.

✅ **Recommended Setup**: Stick to **Kiosk Only with 3Prep + 1Staff** for a balanced and profitable outcome.

Recommendation	2Prep+2Staff	2Prep+3Staff	3Prep+1Staff	3prep+2Staff	3prep+3staff
Revenue_Base	1271	1091	848	1410	1333
Revenue_Online	4039	3664	0	5191	5967
Revenue_Kiosk	4028	3824	5929	6199	6081.5

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