Demand Forecasting and Heuristic Aggregate Planning at Cheesecake Stori: A Case Study of Two Bakery Products

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ABSTRACT

This study examines short-term demand forecasting and heuristic aggregate production planning at Cheesecake Stori, a bakery in Wonosari, Gunungkidul, Yogyakarta, Indonesia. Daily sales records for Mini Birthday Cake and Mille Crepes from March to May 2025 were analyzed. After the reported outlier treatment, 87 observations were retained for Mini Birthday Cake and 76 for Mille Crepes. Double Moving Average (DMA) models with two- and five-period windows were compared with Brown's Double Exponential Smoothing (DES), using smoothing parameters from 0.1 to 0.9. Forecast performance was assessed using Mean Absolute Percentage Error (MAPE), and the selected point forecasts were then applied to workforce-control and overtime-control scenarios over a five-day planning horizon. Brown's DES with $\alpha = 0.1$ achieved the lowest reported MAPE for both products: 26.20% for Mini Birthday Cake and 37.13% for Mille Crepes. These results identify the best-performing method among those tested, but the remaining errors indicate meaningful uncertainty, particularly for Mille Crepes. Under the stated assumptions, daily point targets of 11 Mini Birthday Cakes and 20 Mille Crepes are below the reported daily capacities of 15 and 48 units, respectively. With three workers, a regular shift of 7.5 hours per day, and a wage assumption of Rp 63,000 per worker per day, the five-day labor cost is Rp 945,000, and no overtime is indicated by the point forecasts. However, the study's interpretation is limited by the short observation window, incomplete reporting of outlier and closure-day treatment, and the absence of a clearly reported out-of-sample validation procedure. Accordingly, the findings should be treated as a practical baseline rather than proof of highly accurate forecasting or optimal staffing. The study recommends documenting data preprocessing, tracking forecast errors regularly, evaluating MAE or RMSE alongside MAPE, and updating production targets as new sales data become available.

Keywords: demand forecasting; Brown's double exponential smoothing; double moving average; aggregate production planning; bakery operations; forecast accuracy

1. INTRODUCTION

Demand forecasting supports operational decisions by translating historical demand into estimates that can inform production, inventory, staffing, and purchasing. In food businesses, where products may be perishable and production decisions must balance availability against surplus, forecasts are useful inputs to planning rather than guarantees of future demand. Forecasting practice therefore requires attention to data quality, model choice, and ongoing evaluation (Hyndman & Athanasopoulos, 2021; Petropoulos et al., 2022).

Forecast errors can have different operational consequences for bakeries. Overproduction may increase unsold stock and waste, whereas underproduction may cause stockouts and lost sales. Production planning should consequently consider forecast error alongside capacity, labor availability, product characteristics, and the cost

of adjusting production. Aggregate production planning coordinates output and resource decisions over a defined planning horizon (Cheraghalikhani et al., 2019; Aydin & Tirkolaee, 2023).

Cheesecake Stori is a bakery located in Wonosari, Gunungkidul, Special Region of Yogyakarta, Indonesia, which opened in 2023. This case study focuses on Mini Birthday Cake and Mille Crepes. Its practical problem is to establish reasonable daily production targets from limited historical sales data while avoiding unnecessary labor costs. The study has three objectives: (1) compare Double Moving Average (DMA) and Brown's Double Exponential Smoothing (DES) for the two products; (2) identify the lowest-MAPE model among the alternatives tested; and (3) use the selected forecasts to examine the feasibility of workforce-control and overtime-control planning scenarios.

2. LITERATURE REVIEW AND RESEARCH METHODOLOGY

2.1 Research Framework

This study uses a quantitative case-study design. Daily sales records for March–May 2025 were obtained from the bakery and supplemented by interviews for operational context. After the reported outlier-treatment process, 87 observations remained for Mini Birthday Cake and 76 for Mille Crepes. The available study materials do not specify the exact outlier rule, the dates removed, or whether closure days were excluded or coded as zero demand. These preprocessing details should be verified against the original records and reported before submission because they can affect model comparison and reproducibility.

- Research problem: Uncertainty in daily product demand can contribute to overproduction, waste, or unmet customer demand.
- Data: Internal daily sales records for March–May 2025, supplemented by interviews for operational context.
    a. Mini Birthday Cake: 87 usable observations after the reported outlier treatment.
    b. Mille Crepes: 76 usable observations after the reported outlier treatment.
- Forecasting models compared:
    a. Double Moving Average (DMA), using window sizes n = 2 and n = 5.
    b. Brown's Double Exponential Smoothing (DES), using smoothing parameters $\alpha = 0.1$ to 0.9.
- Evaluation: Forecast errors were compared using Mean Absolute Percentage Error (MAPE). Because MAPE is sensitive to zero or very small actual values, its suitability depends on the demand observations included in the evaluation (Hyndman & Koehler, 2006; de Myttenaere et al., 2016).
- Aggregate planning: The selected point forecasts were applied to workforce-control and overtime-control scenarios.
- Decision focus: Assess whether the stated workforce and daily production capacities can meet the forecast point targets over a five-day planning horizon.

2.2 Theoretical Foundations

Double Moving Average (DMA). DMA applies a moving average twice to estimate the level and trend of a time series. The method can be useful when a series has a reasonably stable linear trend, although results depend on the selected window length. It has been compared with double exponential smoothing in demand-forecasting applications (Febrian et al., 2020; Hudiyanti et al., 2019). For a window of n observations, the first and second moving averages are defined as follows:

$M_t^{(1)} = (1/n) \Sigma_{i=0}^{n-1} X_{t-i}$

$M_t^{(2)} = (1/n) \Sigma_{i=0}^{n-1} M_{t-i}^{(1)}$

$a_t = 2M_t^{(1)} - M_t^{(2)}$

$b_t = [2/(n-1)] (M_t^{(1)} - M_t^{(2)}),\ n > 1$

$F_{t+m} = a_t + b_t m$

where X_t is observed demand, n is the moving-average window, and m is the forecast horizon.

Brown's Double Exponential Smoothing (DES). Brown's method smooths the series twice using the same parameter α, where $0 < \alpha < 1$, to estimate level and trend. Smaller α values generally produce smoother estimates, while larger values give more weight to recent observations. The smoothing parameter should be selected by comparing forecast performance using a clearly specified evaluation procedure (Gardner, 2006; Hyndman & Athanasopoulos, 2021).

$S_t^{(1)} = \alpha X_t + (1-\alpha) S_{t-1}^{(1)}$

$S_t^{(2)} = \alpha S_t^{(1)} + (1-\alpha) S_{t-1}^{(2)}$

$a_t = 2S_t^{(1)} - S_t^{(2)}$

$b_t = [\alpha/(1-\alpha)] (S_t^{(1)} - S_t^{(2)})$

$F_{t+m} = a_t + b_t m$

The initial values for the two smoothed series must be specified in the final methods description to ensure reproducibility.

Aggregate planning heuristic methods. Aggregate production planning coordinates demand, production, and available resources over a planning horizon, including decisions about workforce, production rates, inventory, and overtime (Cheraghalikhani et al., 2019; Aydin & Tirkolaee, 2023). Related bakery studies have combined demand forecasting with heuristic aggregate planning and compared workforce-control and overtime-control approaches (Anindita & Yotenka, 2024; Nashaa et al., 2024). This study compares two simplified scenarios:

a. Workforce-control strategy: Staffing is set to the planned production requirement. Any hiring, reduction, or adjustment costs should be included if they apply to the case.

b. Overtime-control strategy: The workforce remains constant, and overtime is used only when regular capacity is insufficient. Overtime costs should be charged only for hours actually required.

Forecast accuracy measure. MAPE expresses absolute forecast error as a percentage of actual demand. The measure is easy to interpret, but can become undefined when actual demand is zero and disproportionately large when actual demand is very small (Hyndman & Koehler, 2006; de Myttenaere et al., 2016).

$MAPE = (100\% / N) \Sigma_{t=1}^{N} |(X_t - F_t) / X_t|$, provided $X_t \neq 0$ for each evaluated observation.

3. RESULTS AND DISCUSSION

3.1 Historical Demand and Data Treatment

The dataset covers March–May 2025. After the reported outlier treatment, the analysis retained 87 observations for Mini Birthday Cake and 76 for Mille Crepes. The number of retained observations differs by product, so the preprocessing steps need to be documented separately for each series. The supplied materials do not establish the exact outlier-identification rule or how closure days were handled; these details must be

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checked against the source sales records before submission. In particular, a closure day with no opportunity to sell should not automatically be interpreted as a day with zero underlying demand.

Table 1: Metric and Bakery Products

Metric	Mini Birthday Cake	Mille Crepes
Total Usable Periods	87 days	76 days
Total Historical Sales	1,037 pcs	1,785 pcs
Average Daily Sales	11.91 pcs (~12 pcs)	23.49 pcs (~23 pcs)
Maximum Daily Sales	19 pcs	45 pcs
Minimum Daily Sales	5 pcs	10 pcs

Source: Observation Data

3.2 Forecasting Model Comparison

Table 2: Forecasting Model Comparison

Product	Method / Parameter	Forecasted Values ($m=1 \dots 5$)	MAPE (%)	Evaluation
Mini Birthday Cake				
	DMA ($n=2$)	6, 3, 0, -3, -6	40.93%	Feasible
	DMA ($n=5$)	10, 9, 9, 9, 9	31.47%	Feasible
	Brown's DES ($\alpha=0.1$)	**11, 11, 11, 11, 11**	**26.20%**	Optimal
	Brown's DES ($\alpha=0.5$)	—	30.22%	Feasible
	Brown's DES ($\alpha=0.9$)	—	43.64%	Feasible
Mille Crepes				
	DMA ($n=2$)	36, 44, 53, 61, 70	56.39%	Inaccurate
	DMA ($n=5$)	19, 19, 18, 18, 18	39.81%	Feasible
	Brown's DES ($\alpha=0.1$)	**20, 20, 20, 20, 20**	**37.13%**	Optimal
	Brown's DES ($\alpha=0.5$)	—	45.16%	Feasible
	Brown's DES ($\alpha=0.9$)	—	70.59%	Inaccurate

Source: Observation Data

For both products, Brown's DES with $\alpha = 0.1$ produced the lowest MAPE among the alternatives tested: 26.20% for Mini Birthday Cake and 37.13% for Mille Crepes. These error levels indicate meaningful remaining uncertainty, especially for Mille Crepes. The result supports selecting $\alpha = 0.1$ as the best-performing option within this comparison, not a claim that the forecasts are highly accurate. The comparison is consistent with the broader practice of evaluating competing forecasting methods empirically rather than assuming one method is universally superior (Petropoulos et al., 2022). MAPE should be interpreted with care if any actual values are zero or very small; a complementary measure such as MAE or RMSE would help provide a fuller assessment (Hyndman & Koehler, 2006; de Myttenaere et al., 2016).

Table 3: Indicators Comparison

Product Line	Demand Rate	Strategy Selected	Staffing	Overtime Hours	Total Horizon Cost (5 Days)
Mini Birthday Cake	11 pcs / day	Workforce Control	3 Workers	0 Hours	Rp 945,000
		Overtime Control	3 Workers	0 Hours	Rp 945,000
Mille Crepes	20 pcs / day	Workforce Control	3 Workers	0 Hours	Rp 945,000
		Overtime Control	3 Workers	0 Hours	Rp 945,000

Source: Observation Data

Table 4: Parameter and Value

Parameter	Value / Metric
Existing Workforce (W)	3 Workers
Regular Work Shift	7.5 Hours/day
Standard Daily Wage	Rp 63,000 / worker/day
Overtime Wage Rate	Rp 100,000 / worker/shift (max 3 hours)
Fixed Daily Capacity (Mini Cake)	15 Pcs/day
Fixed Daily Capacity (Mille Crepes)	48 Pcs/day

Source: Observation Data

Under the stated assumptions, the labor cost for five days is Rp 945,000 for either planning scenario: 3 workers × Rp 63,000 per worker per day × 5 days. The reported daily point targets are 11 Mini Birthday Cakes and 20 Mille Crepes, compared with stated daily capacities of 15 and 48 units, respectively. On a product-by-product comparison, the point targets are below the stated capacities, so the scenario does not require overtime. This is a preliminary feasibility result rather than proof that the staffing level is optimal. Before drawing a stronger conclusion, the authors should verify whether the capacity estimates account for shared labor across both products, preparation and packaging time, setup, and demand variability.

Capacity caveat: the comparison assumes that the stated daily capacities are achievable while producing both product lines. Shared labor time, preparation, setup, packaging, and demand variability were not separately modeled; therefore, the result indicates preliminary feasibility, not optimal staffing.

4. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

1. Among the models tested, Brown's DES with $\alpha = 0.1$ achieved the lowest MAPE: 26.20% for Mini Birthday Cake and 37.13% for Mille Crepes. These errors remain material, so the forecasts should be treated as a baseline for short-term planning rather than consistently accurate predictions.

2. The selected point forecasts suggest daily production targets of approximately 11 Mini Birthday Cakes and 20 Mille Crepes for the short planning horizon. These targets should be reviewed as additional sales observations become available.

3. Under the stated capacity and wage assumptions, three workers working 7.5 regular hours per day appear sufficient to meet the point forecasts without overtime. Because shared labor capacity and demand uncertainty have not been fully modeled, the analysis does not establish that this staffing level is optimal under all operating conditions.

4.2 Recommendations

1. Implementation: Use Brown's DES with $\alpha = 0.1$ as a benchmark, record forecast errors weekly, and update production targets as new sales data become available. If stockouts are costly, do not rely only on a point forecast; consider demand scenarios or a modest safety buffer informed by operating experience.

2. Further research: Extend the dataset to cover at least one full seasonal cycle; document the outlier and closure-day treatment; compare models using a rolling-origin or holdout evaluation; and report MAE or RMSE alongside MAPE. Where the data support them, future comparisons could include Holt's trend method, seasonal models, or ARIMA. A more complete aggregate-planning model should incorporate labor-time requirements for both products, material constraints, waste and stockout costs, and demand scenarios.

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REFERENCES

1. Anindita, S., & Yotenka, R. (2024). Integrated forecasting and aggregate planning for production optimization: A comparative analysis of overtime and subcontracting controls. BAREKENG: Journal of Mathematics and Its Applications, 18(4), 2263–2272. https://doi.org/10.30598/barekengvol18iss4pp2263-2272
2. Aydin, N. S., & Tirkolaee, E. B. (2023). A systematic review of aggregate production planning literature with an outlook for sustainability and circularity. Environment, Development and Sustainability. https://doi.org/10.1007/s10668-022-02304-8
3. Cheraghalikhani, A., Khoshalhan, F., & Mokhtari, H. (2019). Aggregate production planning: A literature review and future research directions. International Journal of Industrial Engineering Computations, 10(2), 309–330. https://doi.org/10.5267/j.ijiec.2018.6.002
4. Febrian, D., Al Idrus, S. I., & Nainggolan, D. A. J. (2020). The comparison of double moving average and double exponential smoothing methods in forecasting the number of foreign tourists coming to North Sumatera. Journal of Physics: Conference Series, 1462, 012046. https://doi.org/10.1088/1742-6596/1462/1/012046
5. Gardner, E. S., Jr. (2006). Exponential smoothing: The state of the art—Part II. International Journal of Forecasting, 22(4), 637–666. https://doi.org/10.1016/j.ijforecast.2006.03.005

6. Hudiyanti, C. V., Bachtiar, F. A., & Setiawan, B. D. (2019). Perbandingan Double Moving Average dan Double Exponential Smoothing untuk peramalan jumlah kedatangan wisatawan mancanegara di Bandara Ngurah Rai. Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer, 3(3), 2667–2672.
7. Hyndman, R. J., & Athanasopoulos, G. (2021). Forecasting: Principles and Practice (3rd ed.). OTexts. https://otexts.com/fpp3/
8. Hyndman, R. J., & Koehler, A. B. (2006). Another look at measures of forecast accuracy. International Journal of Forecasting, 22(4), 679–688. https://doi.org/10.1016/j.ijforecast.2006.03.001
9. de Myttenaere, A., Golden, B., Le Grand, B., & Rossi, F. (2016). Mean absolute percentage error for regression models. Neurocomputing, 192, 38–48. https://doi.org/10.1016/j.neucom.2015.12.011
10. Nashaa, K. S., Hidayat, S., & Nurhasanah, N. (2024). Planning daily bread production using forecasting method and heuristic aggregate method on CV. Delia Bakery. Jurnal Teknik Industri, 14(1), 17–34. https://doi.org/10.25105/jti.v14i1.19855
11. Petropoulos, F., Apiletti, D., Assimakopoulos, V., Babai, M. Z., Barrow, D. K., Ben Taieb, S., Bergmeir, C., Bessa, R. J., Bijak, J., Boylan, J. E., Browell, J., Carnevale, C., Castle, J., Clements, M. P., Cordeiro, C., Cyrino Oliveira, F. L., De Baets, S., Dokumentov, A., Ellison, J., ... Ziel, F. (2022). Forecasting: Theory and practice. International Journal of Forecasting, 38(3), 705–871. https://doi.org/10.1016/j.ijforecast.2021.11.001