# Assessing Reasonableness of Activity-based Model: Example of Work Activity Generation and Workers' Travel Scheduling Models

Hsi-Hwa Hu, Guoxiong Huang, Bayarmaa Aleksandr,
Hao Cheng, Yongping Zhang

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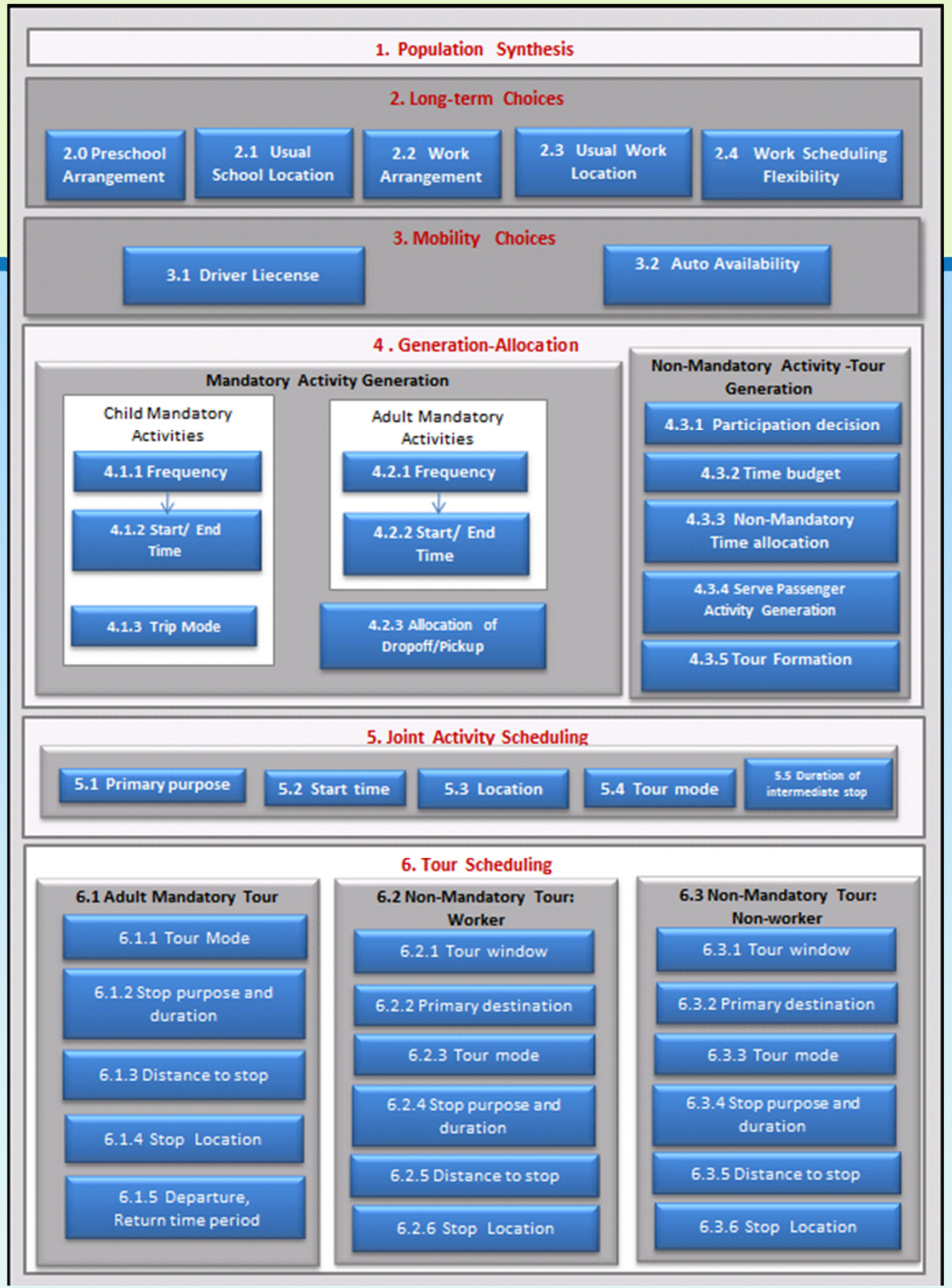
15th TRB National Transportation Planning Applications Conference


SOUTHERN CALIFORNIA
ASSOCIATION of GOVERNMENTS




# SCAG ABM Framework

Population Synthesis

Long-Term Choice

Mobility Choice

Activity Generation & Allocation

Joint Activity Scheduling

Tour Scheduling

# SCAG ABM Development Schedule

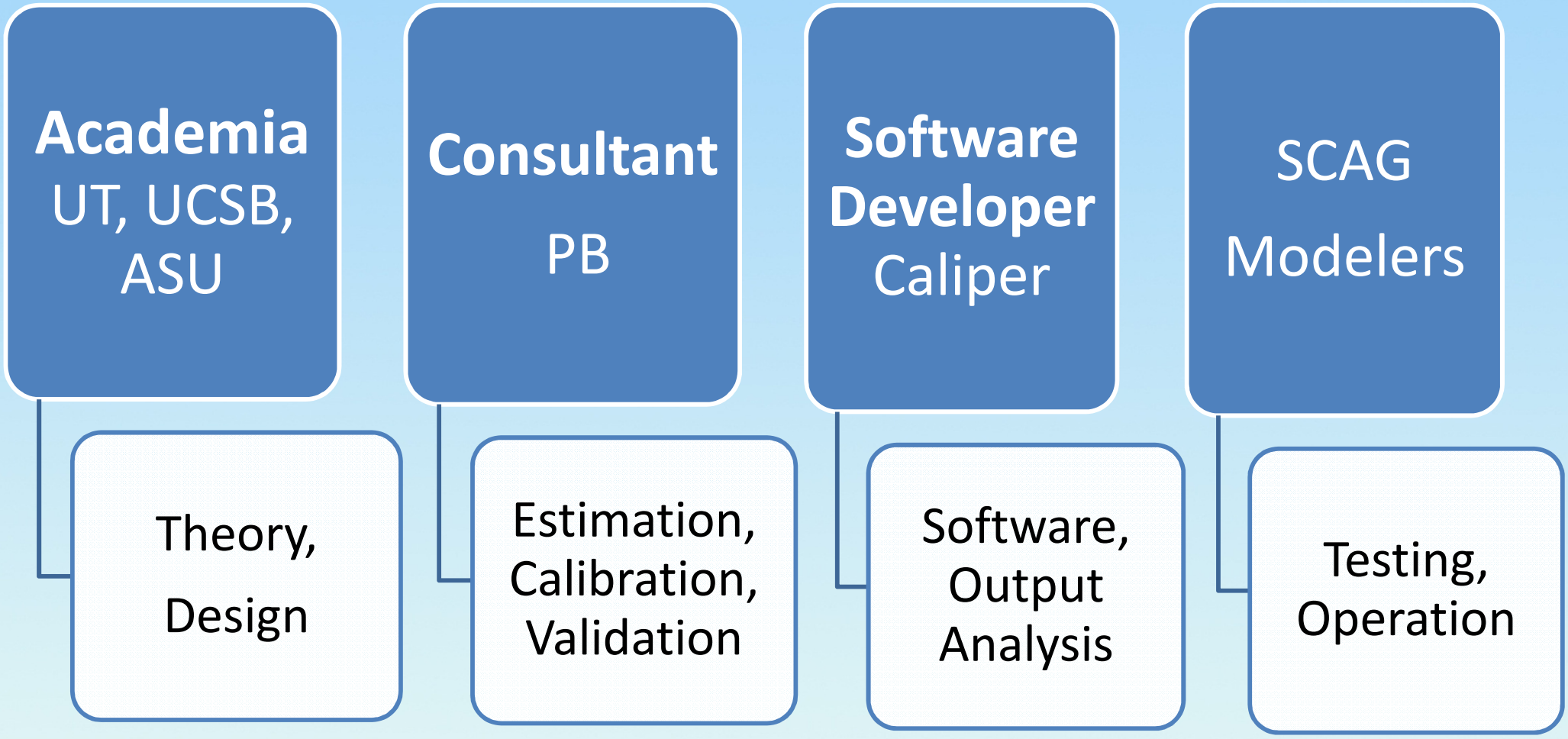
## Stage 1: 2009-2013

- Framework Design
- Model Development

## Stage 2: 2013-2015

- Model Enhancement
- Implementation
- Calibration & Validation

# SCAG ABM Development Team



# ABM Challenge to Planning Agency Modelers

- It's new
- Framework is complicated
- Many sub-models
- Estimated by advanced techniques
- Output analysis

**Question:**

**Do we fully understand our new model?**

# Model Assessment & Presentation Purpose

Model assessment procedure:

- Carried out in-house
- A self-learning procedure
- Assisted by consultants

Purpose of this presentation

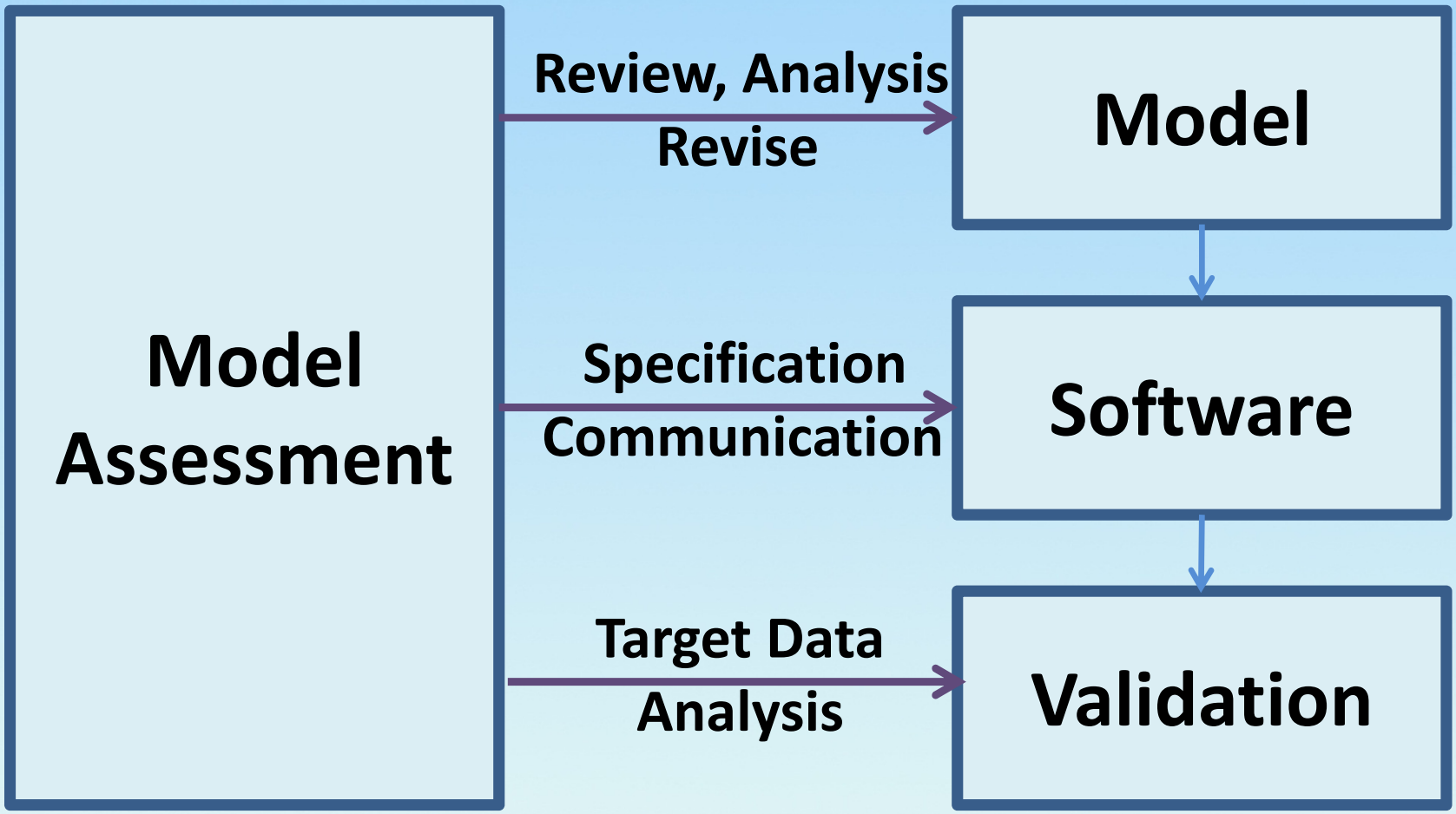
- Introduce SCAG's model assessment framework and procedure

# Goals of Model Assessment

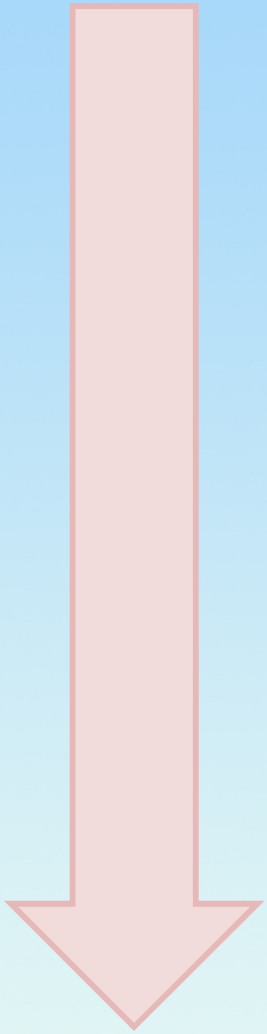
SCAG modelers should be able to:

- Fully understand each (sub)model,
- Analyze household survey,
- Re-estimate each model,
- Create model specification,
- Develop validation target, and
- Validate/Calibrate model

# Model Assessment Procedure



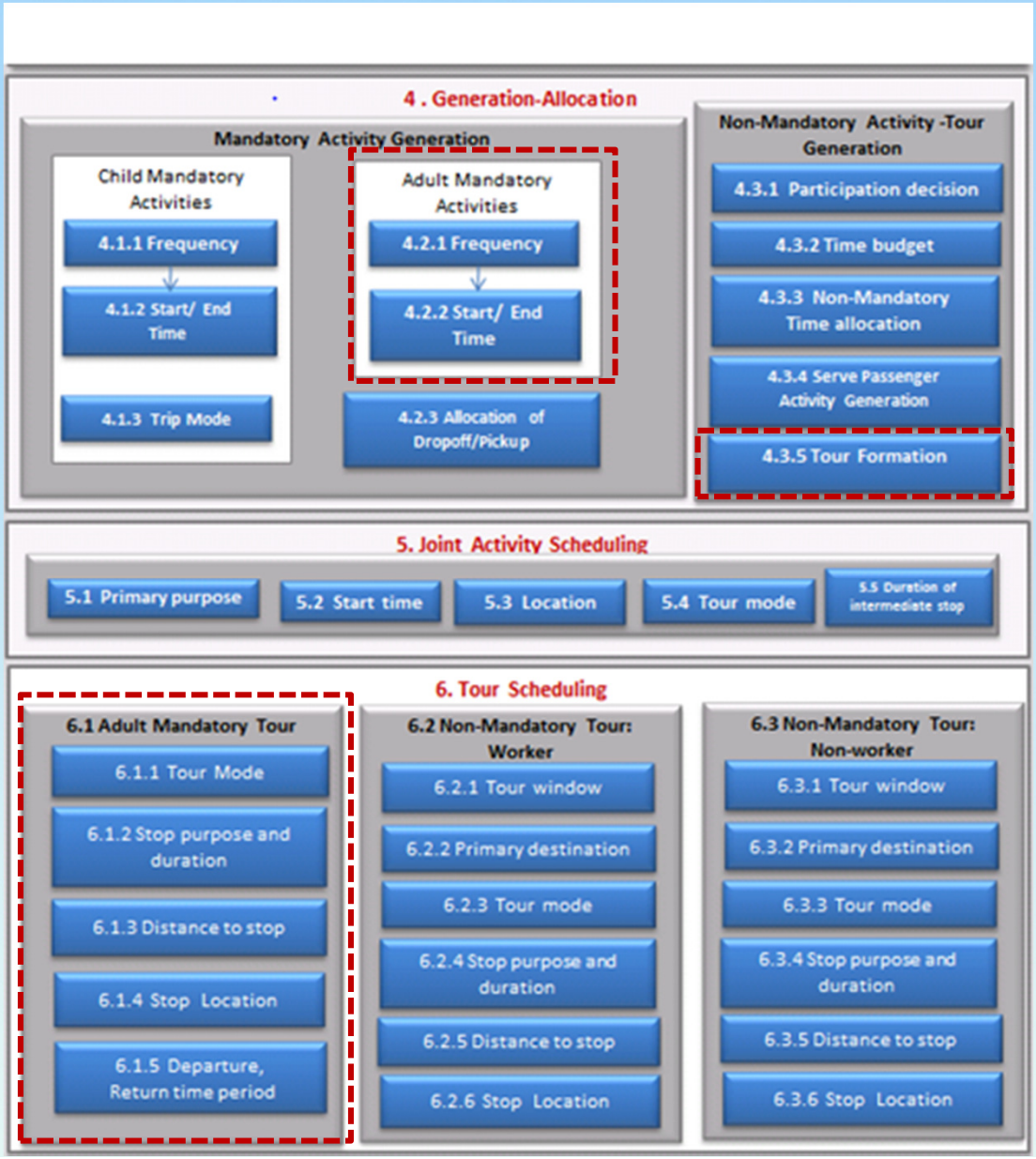
# Model Assessment Tasks



- Analyze Household Survey
- Model Review
- Model Re-estimate
- Software Implementation
- Model Output Analysis
- Model Calibration & Validation
- 1-2 meetings each week

# Example of Model Assessment

## Work Activity Generation & Travel Scheduling Models




- Frequency
- Start/ End time
- Tour duration
- Tour mode
- Stop purpose & duration
- Distance to stop
- Stop location
- Time period

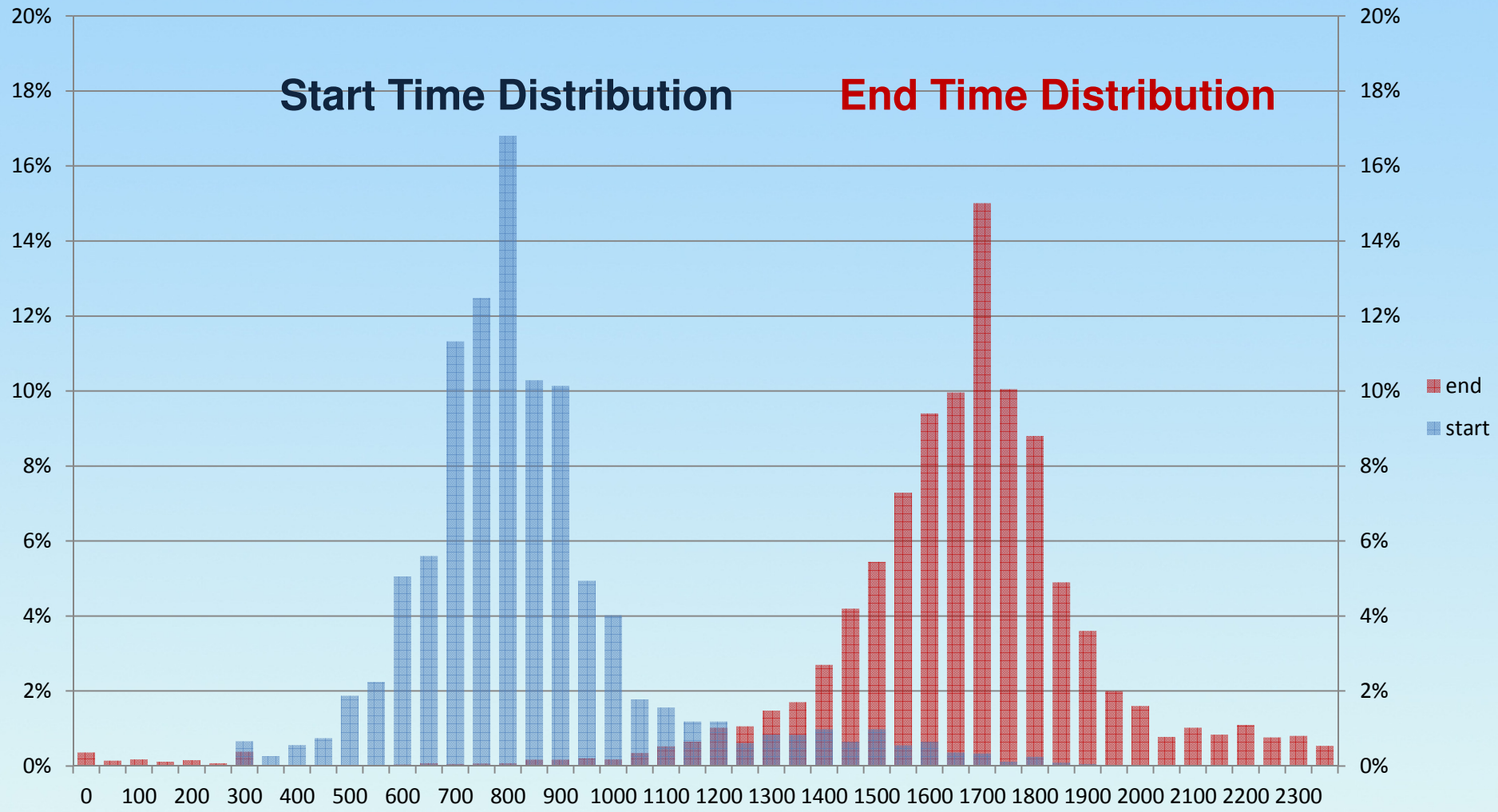
# 1. Analyze Household Survey

- Analyze variables related to the model:
  - Individual attributes
  - Household attributes
  - Work characteristics
  - Land use & built environment
  - Accessibility

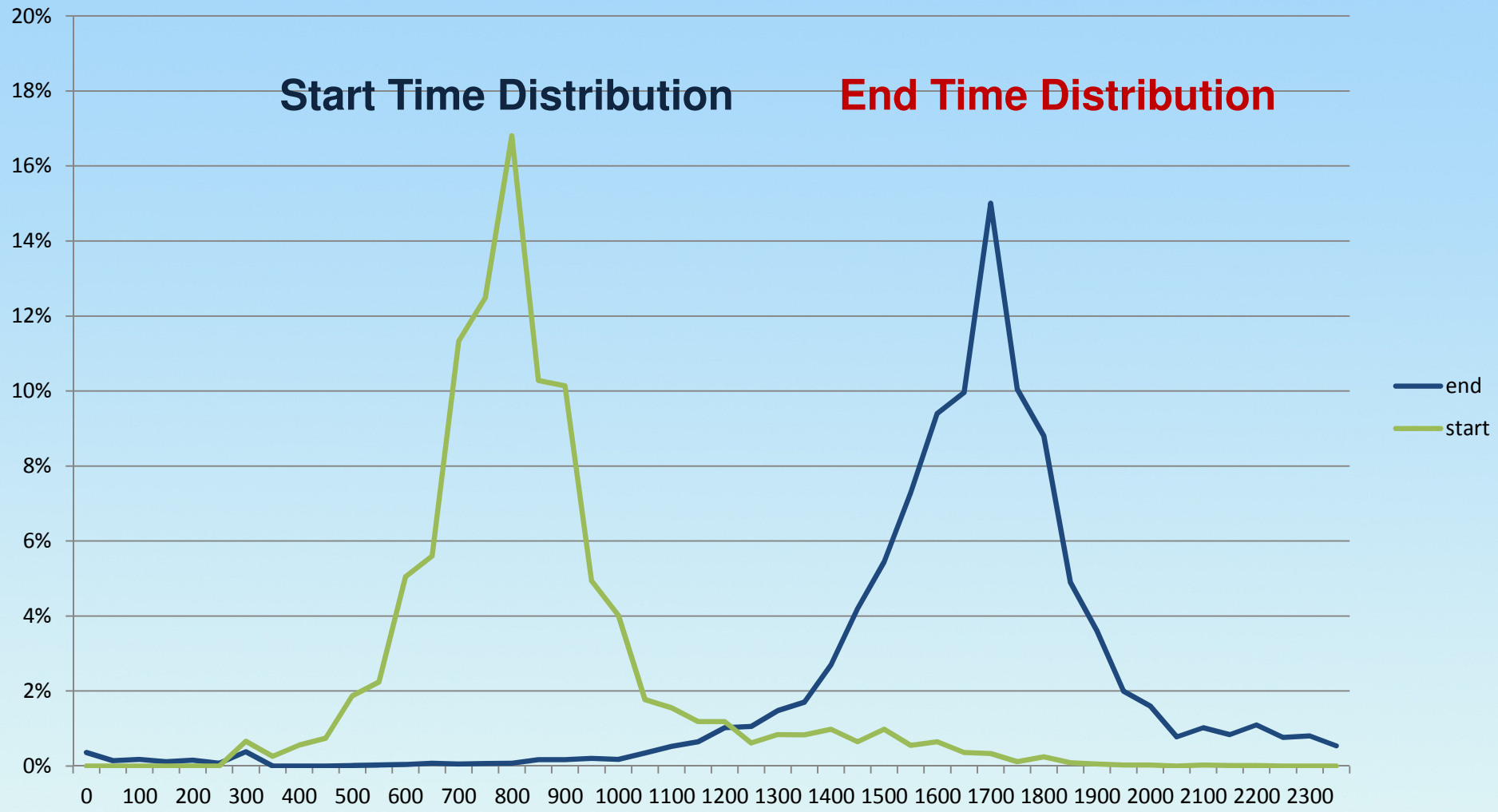
Example:

Workers' Work Start, End time, Duration

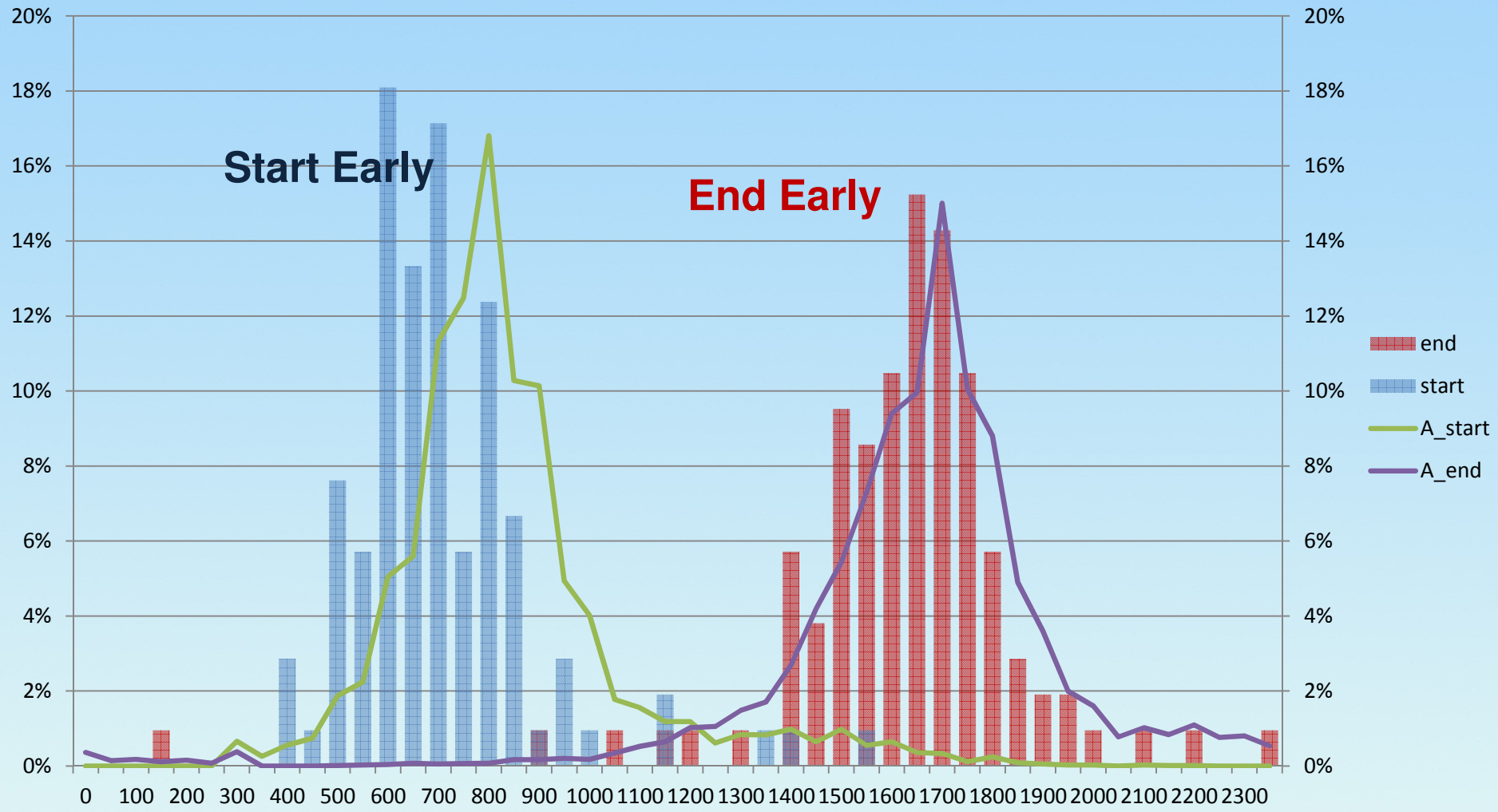
# Overall Worker's Work Start Time and End Time by 30 Minutes



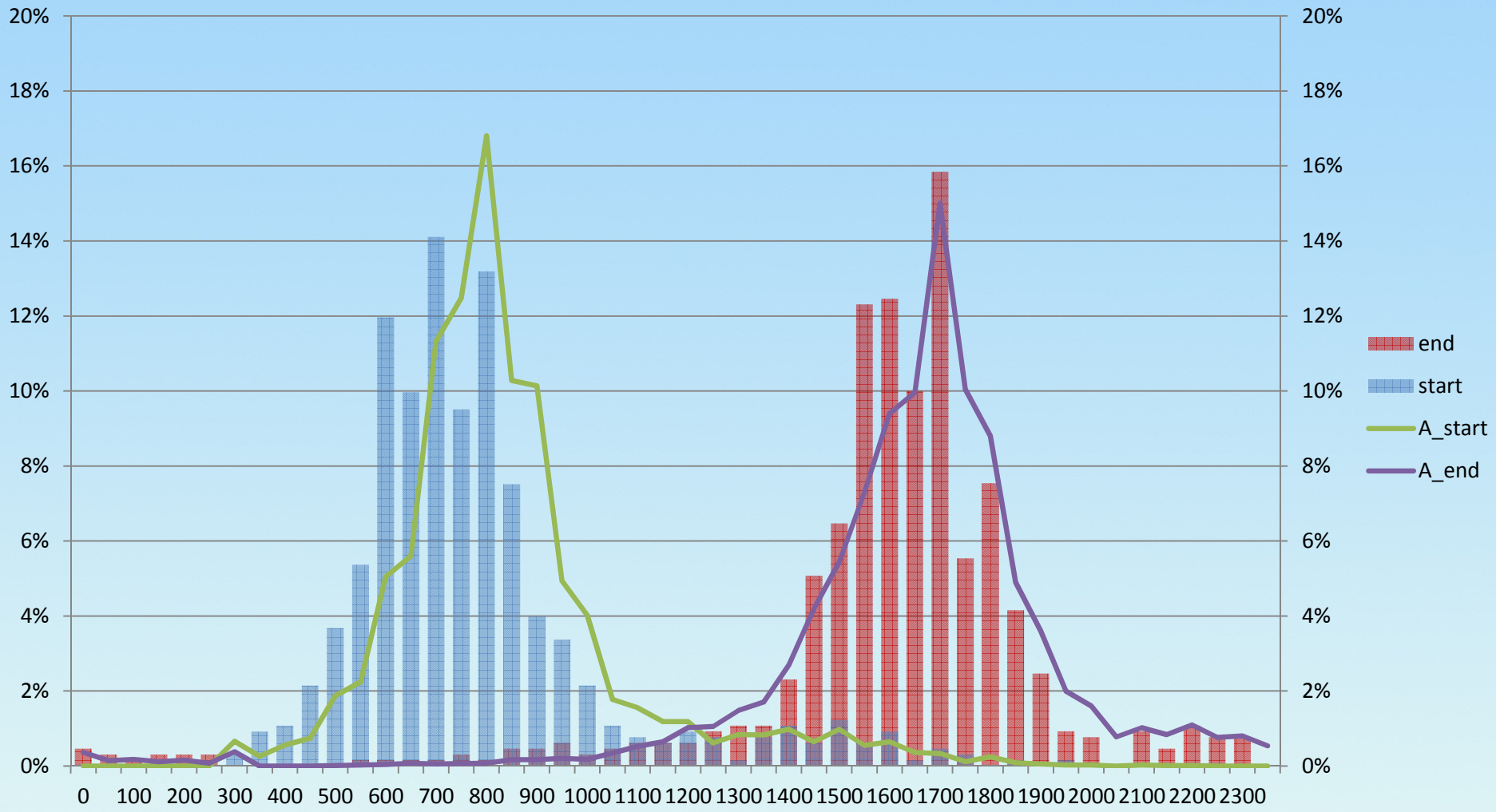
# Overall Worker's Work Start Time and End Time by 30 Minutes



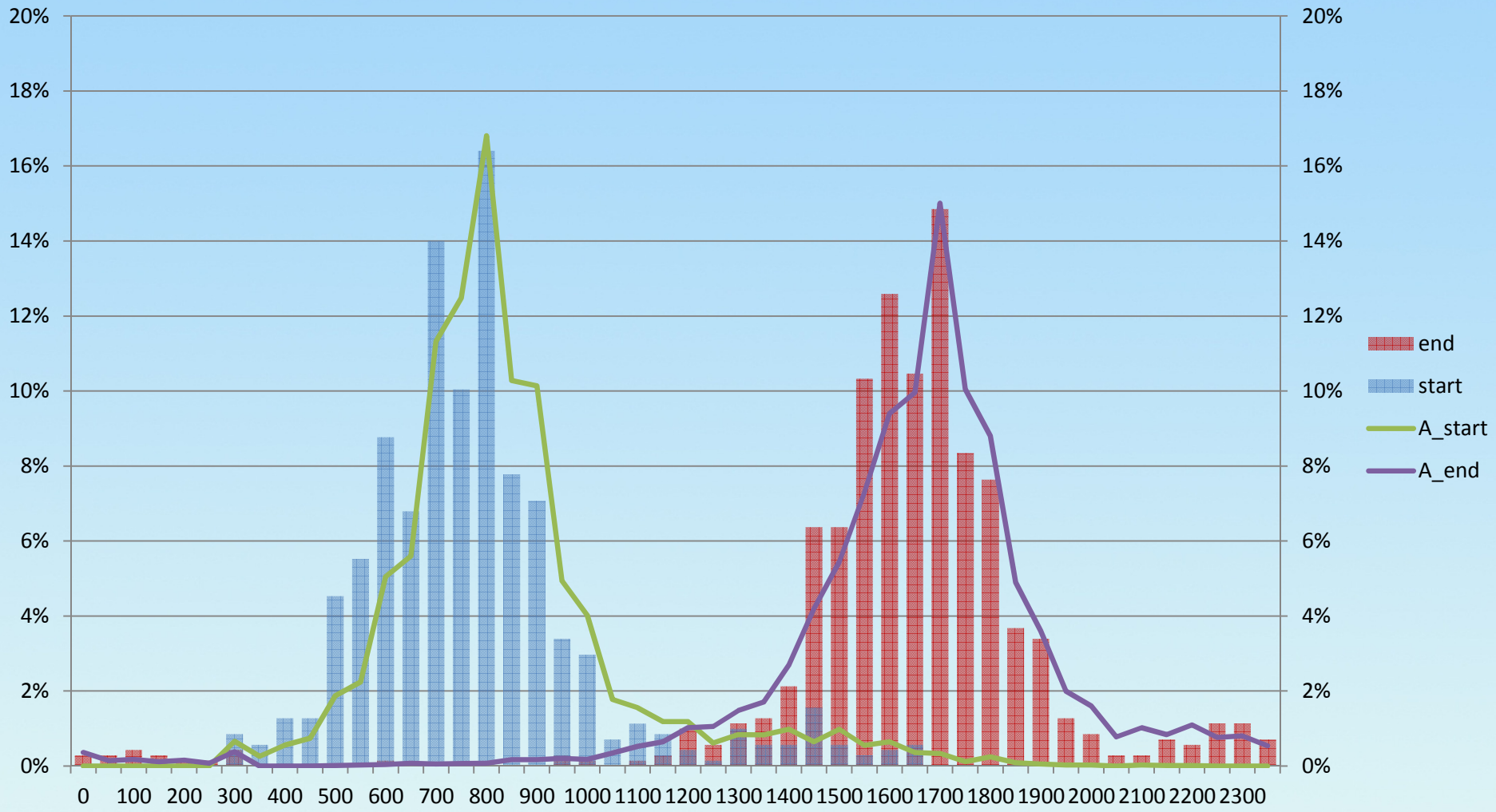
# IND1 Agriculture & Mining (start/end early)



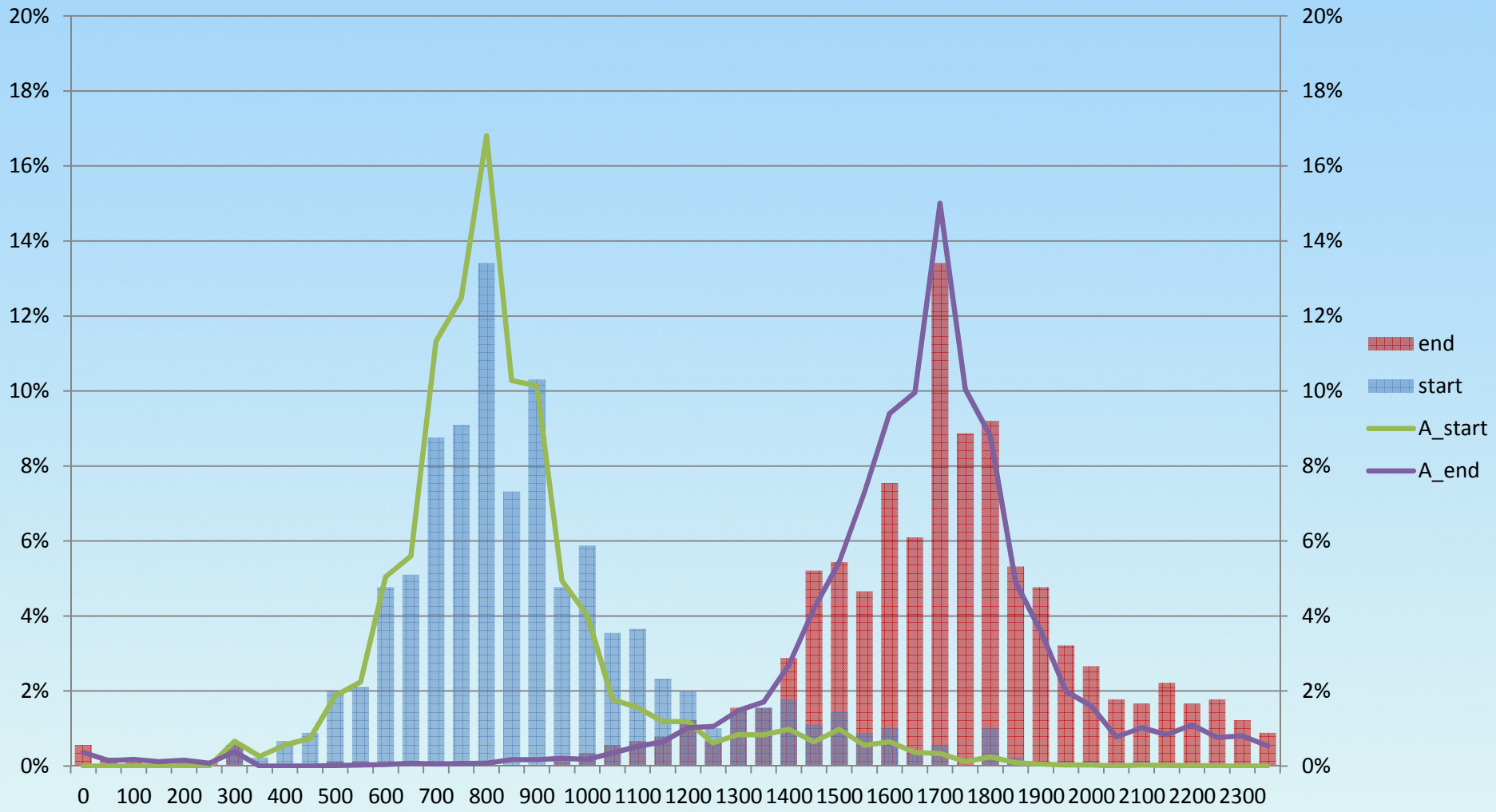
# IND2 Construction & Utility (start early, some workers end early)



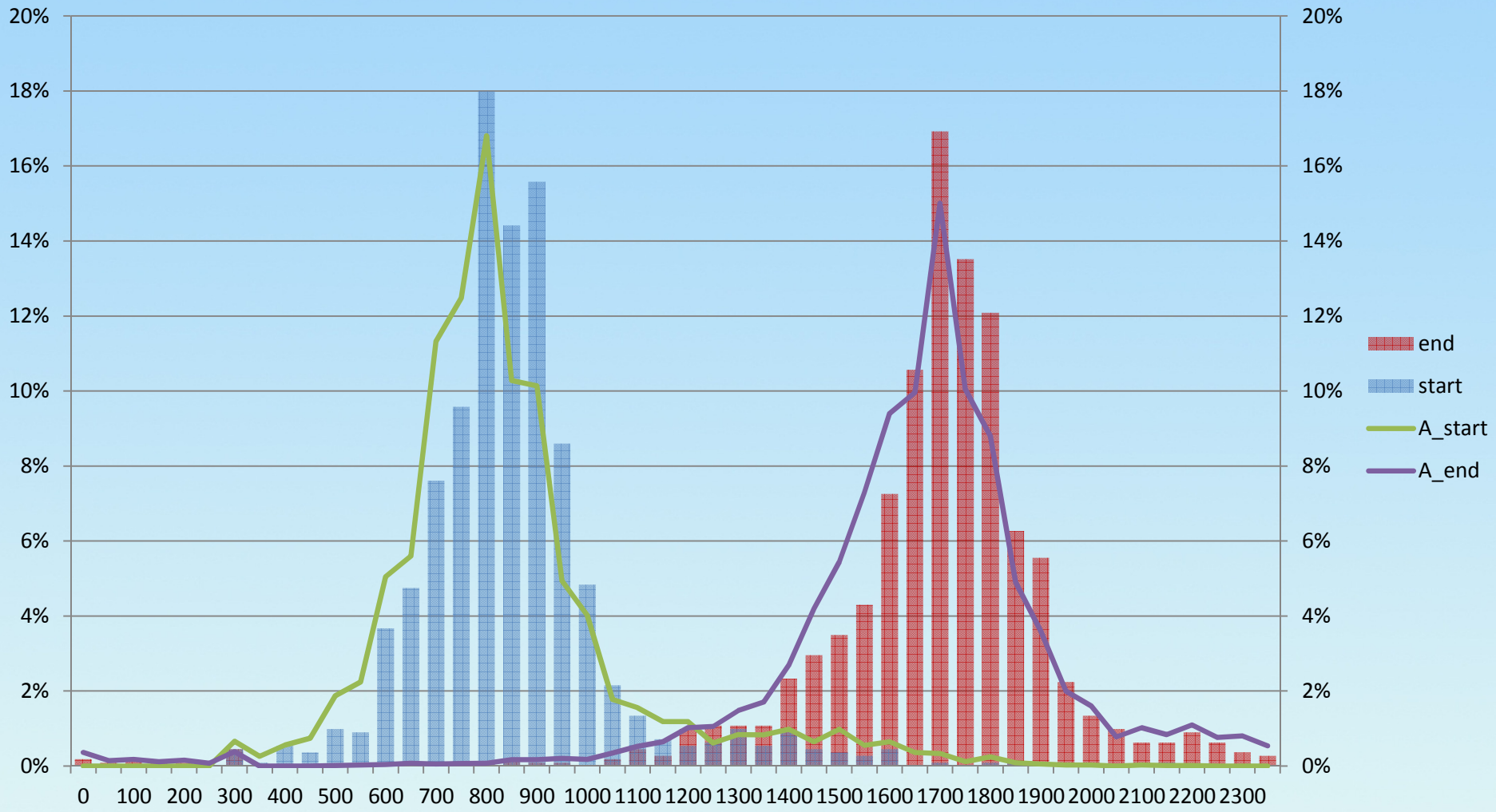
# IND3 Manufacturing & Warehousing (some start/end early)



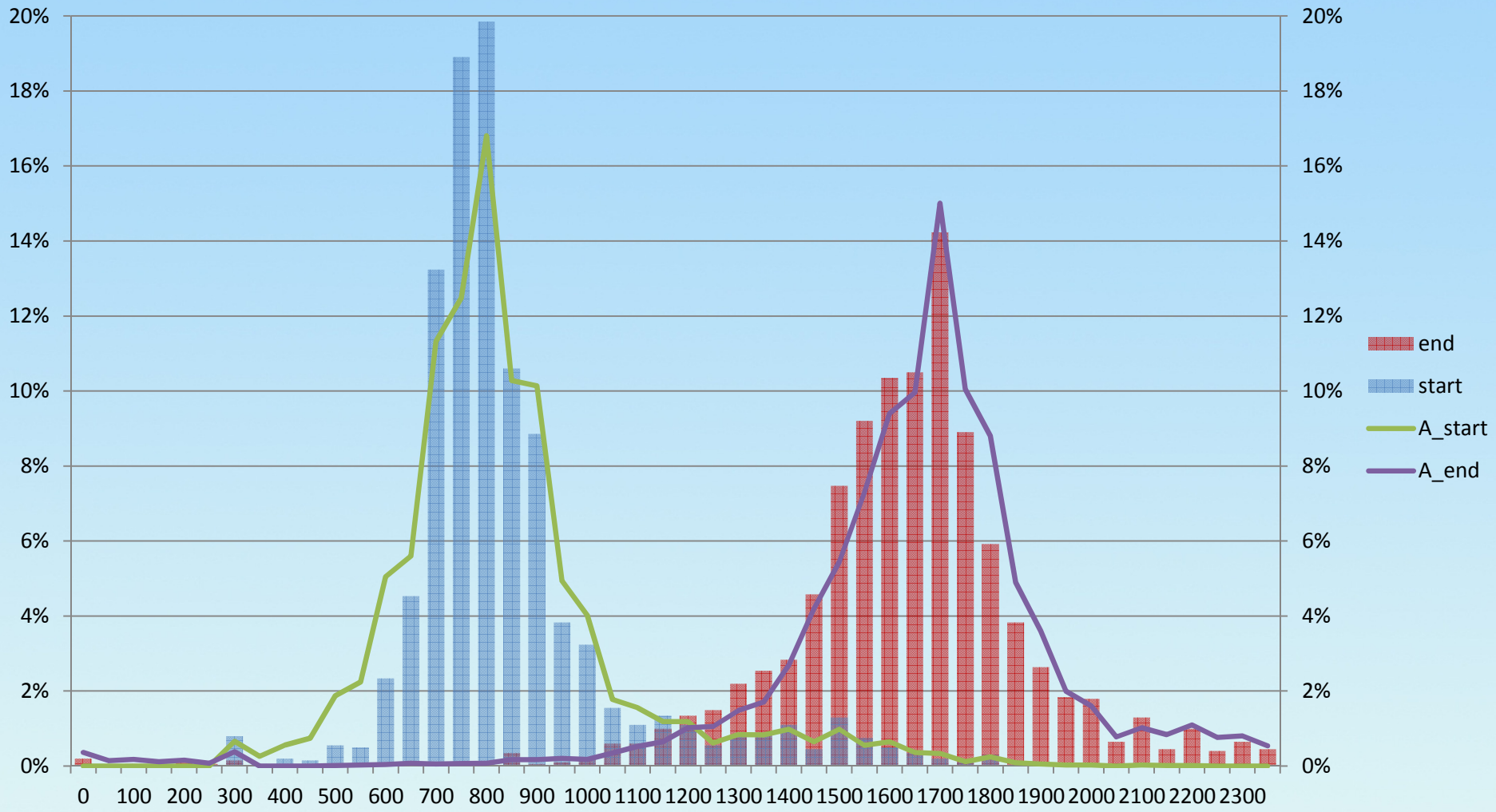
# IND4 Retail & Other Service (some start/end late)



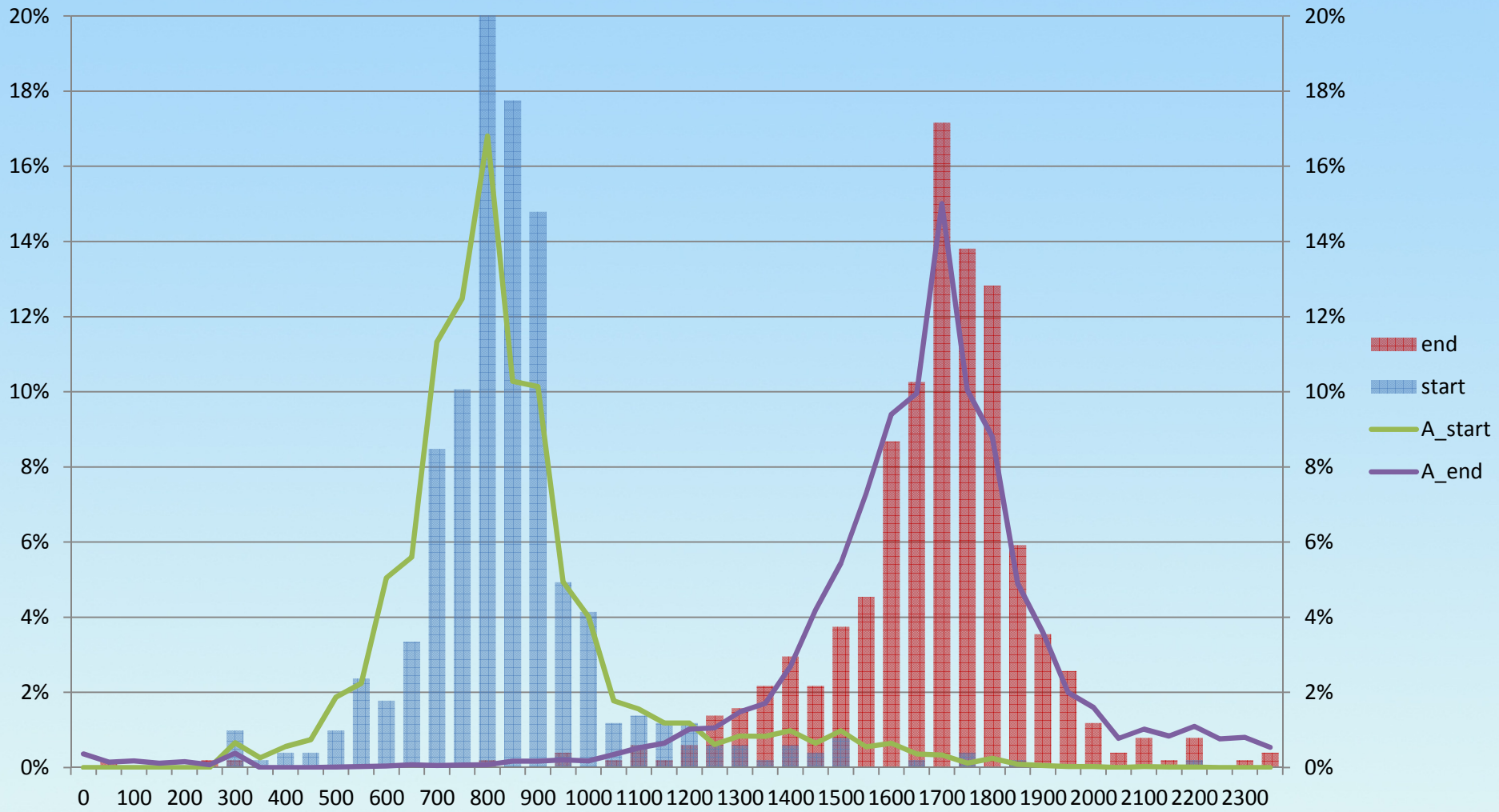
# IND5 Information & Business Service (some start/end a little late)



# IND6 Education & Health/Social Services (start/end a little early)

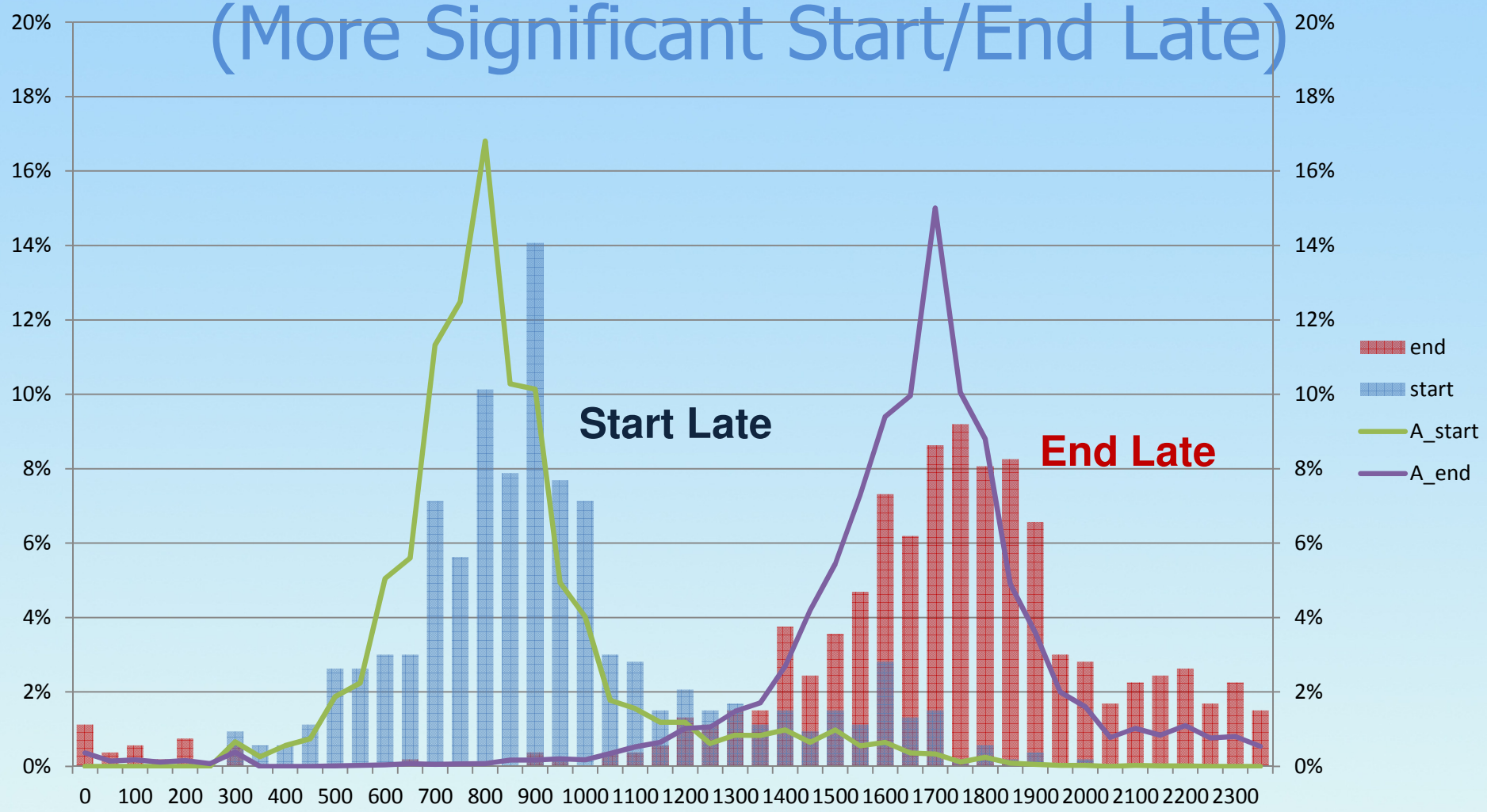


# IND7 Finance, Insurance & Real Estate (start/end a little late)

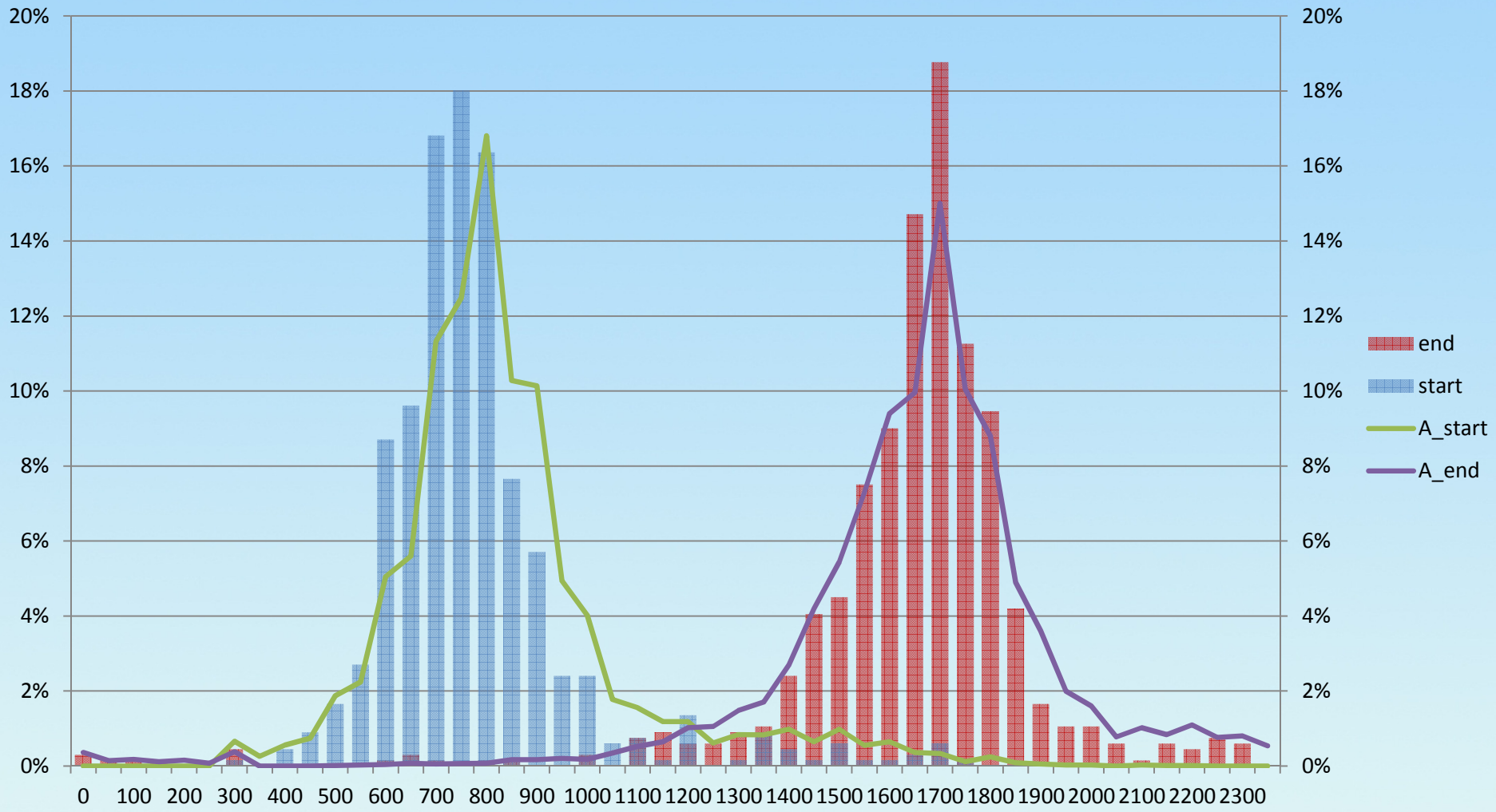


# IND8 Arts/Entertainment, Food Service/Hospitality

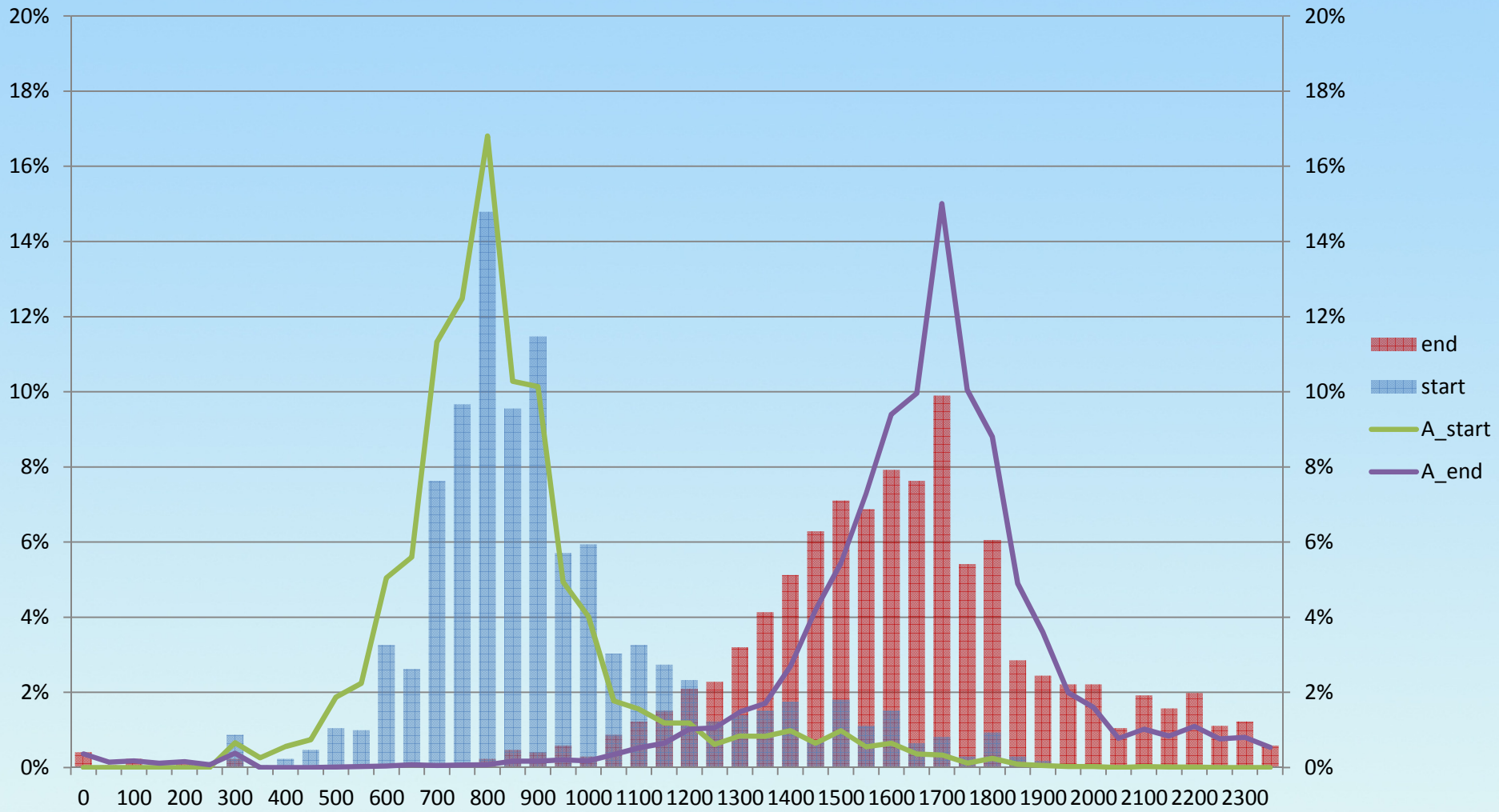
## (More Significant Start/End Late)



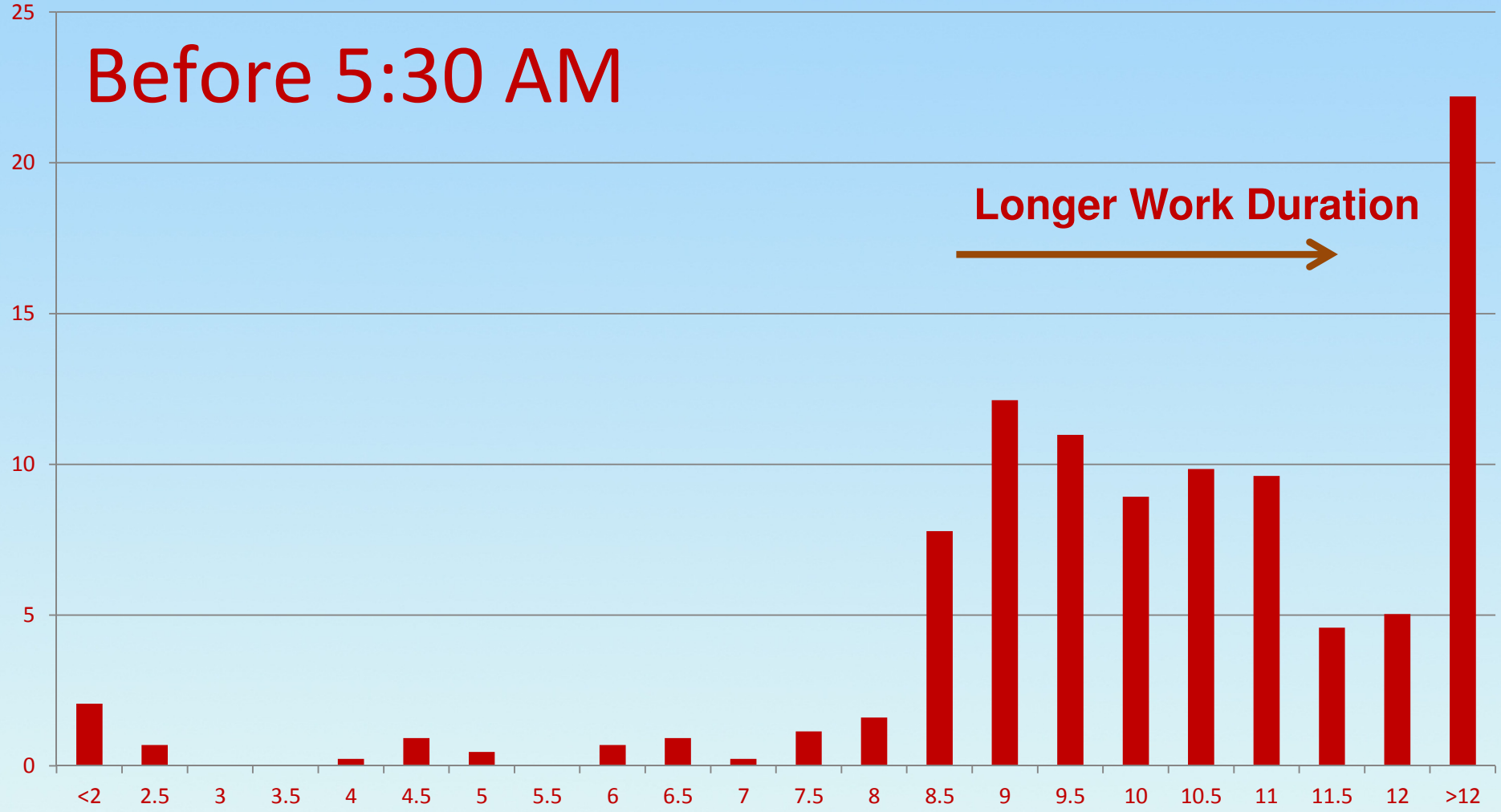
# IND9 Public Administration
# (Start/End a little early)



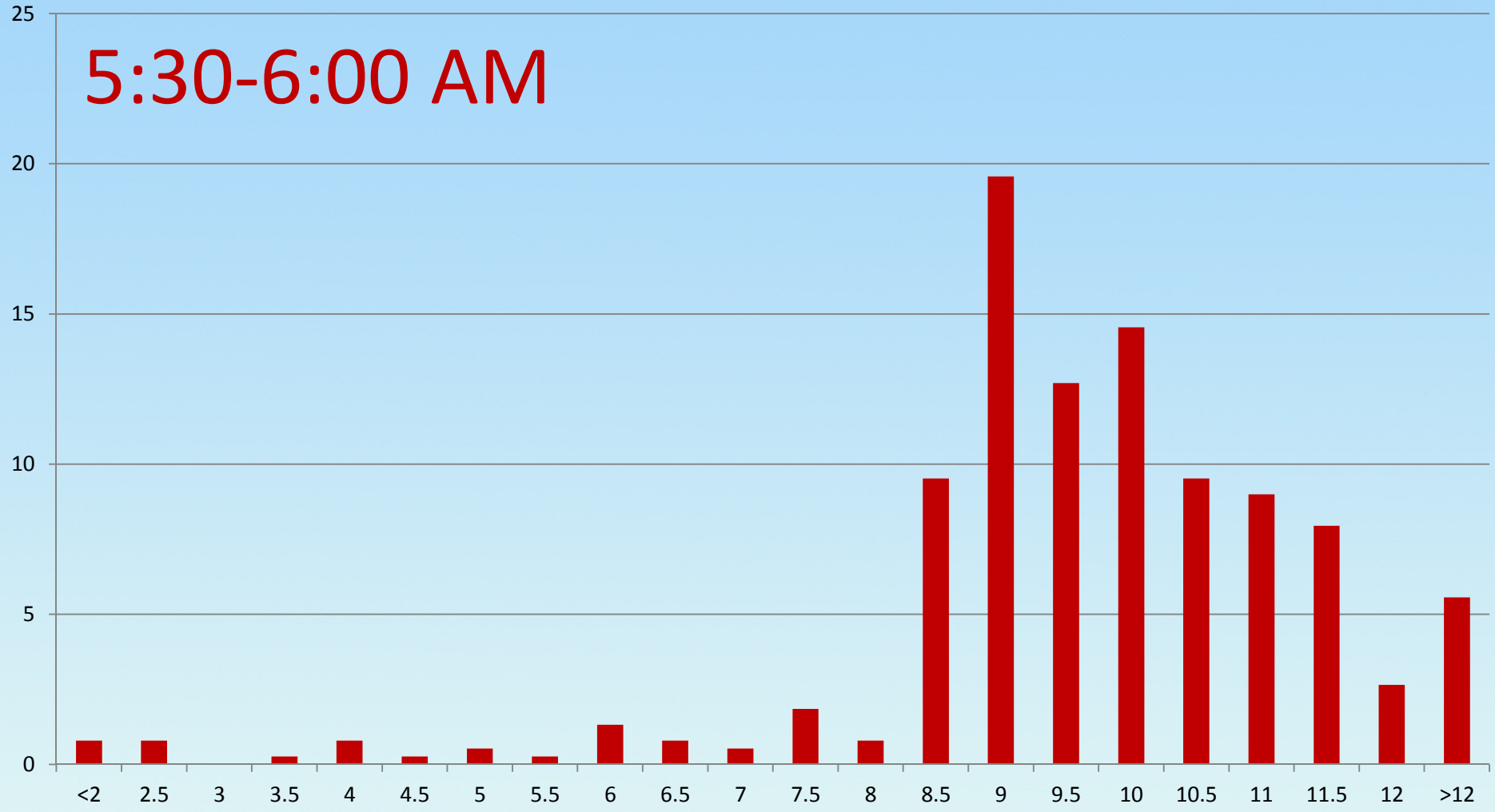
# Part-Time Workers
# (Start late, end early)



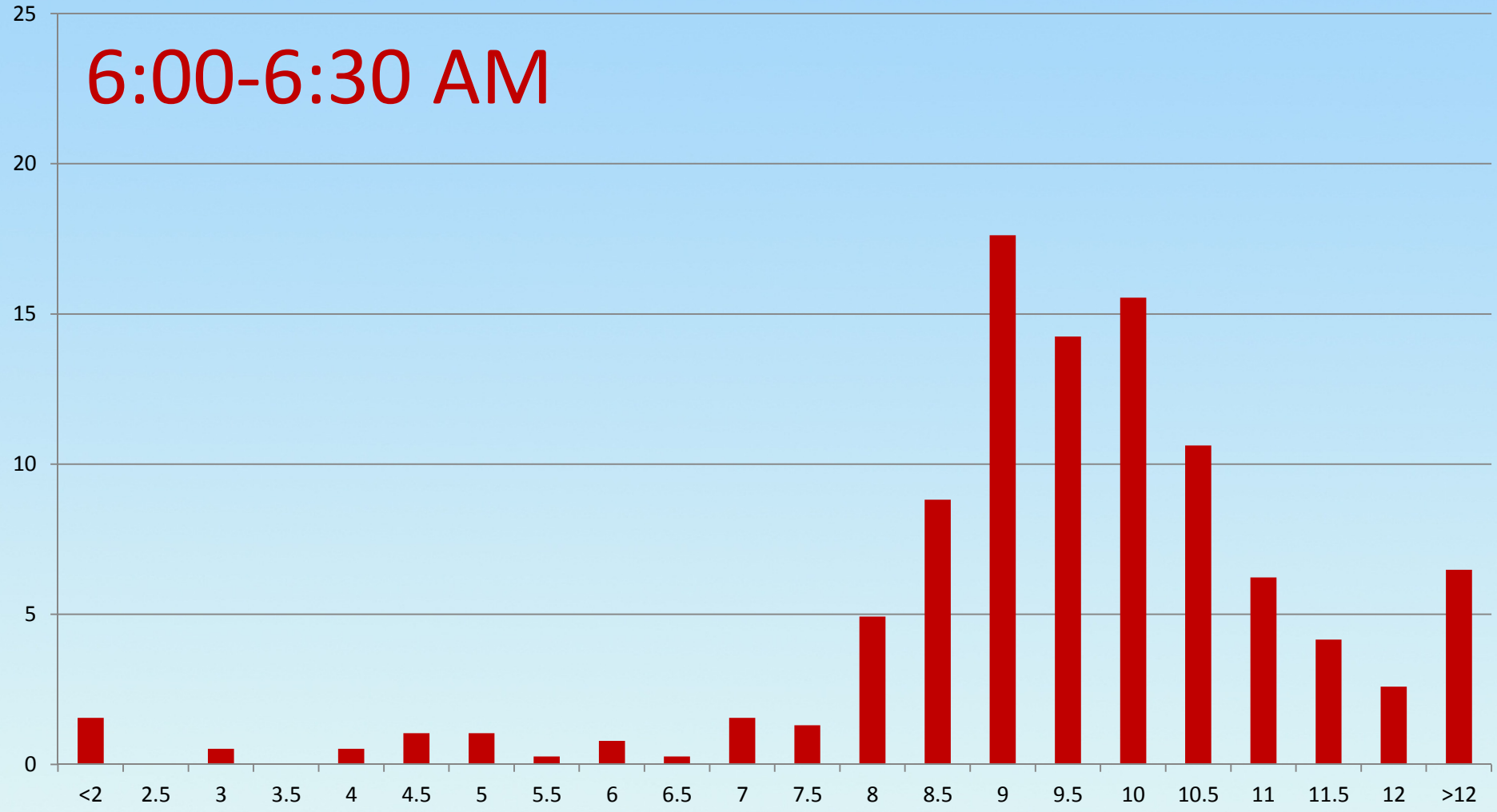
# Work Duration by Start Time
## (Start early, long hours)



# 5:30-6:00
# (long hours, but shorter than half hour ago)



# 6:00-6:30
# (long hours, but shorter than half hour ago)



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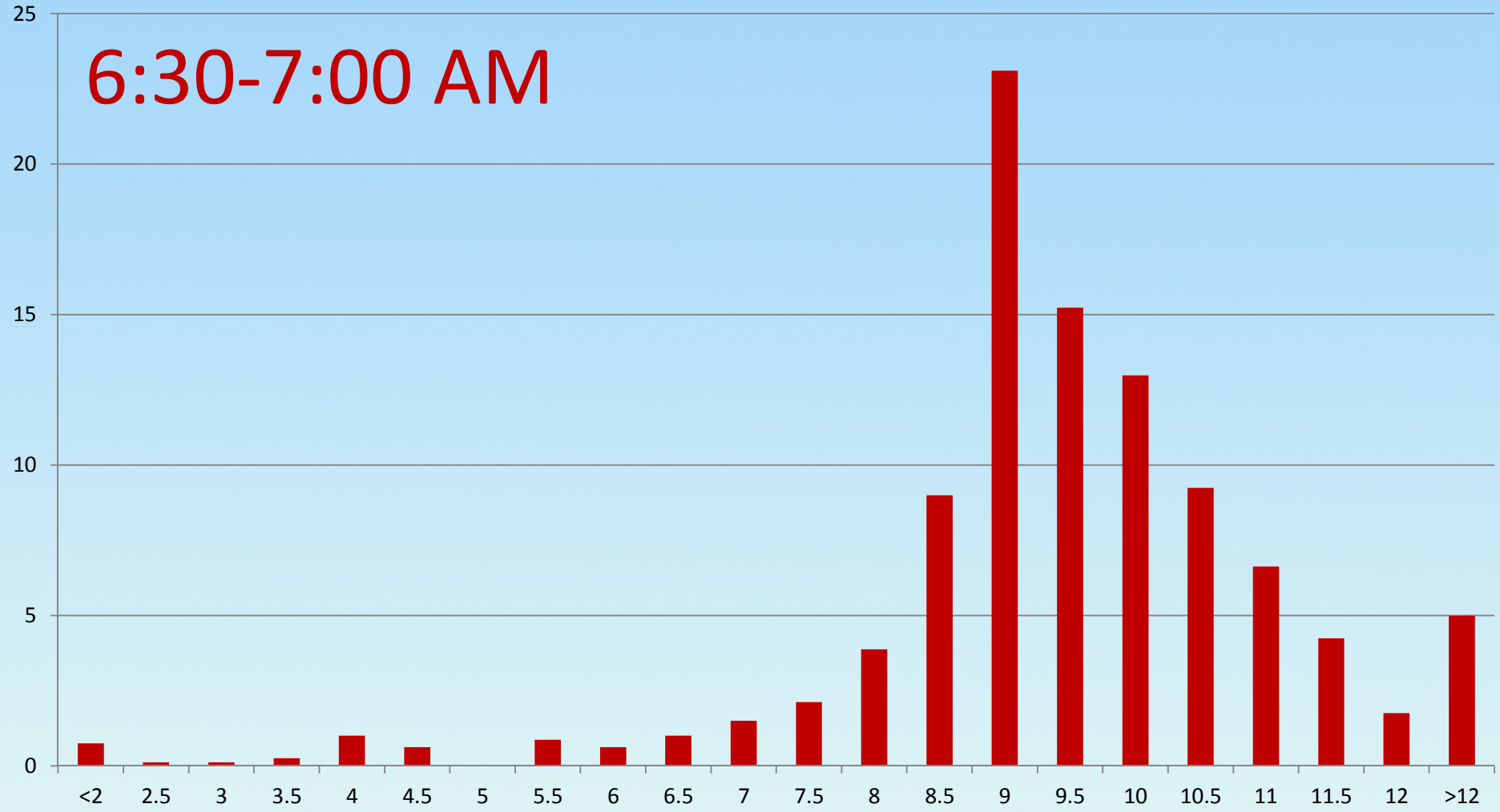
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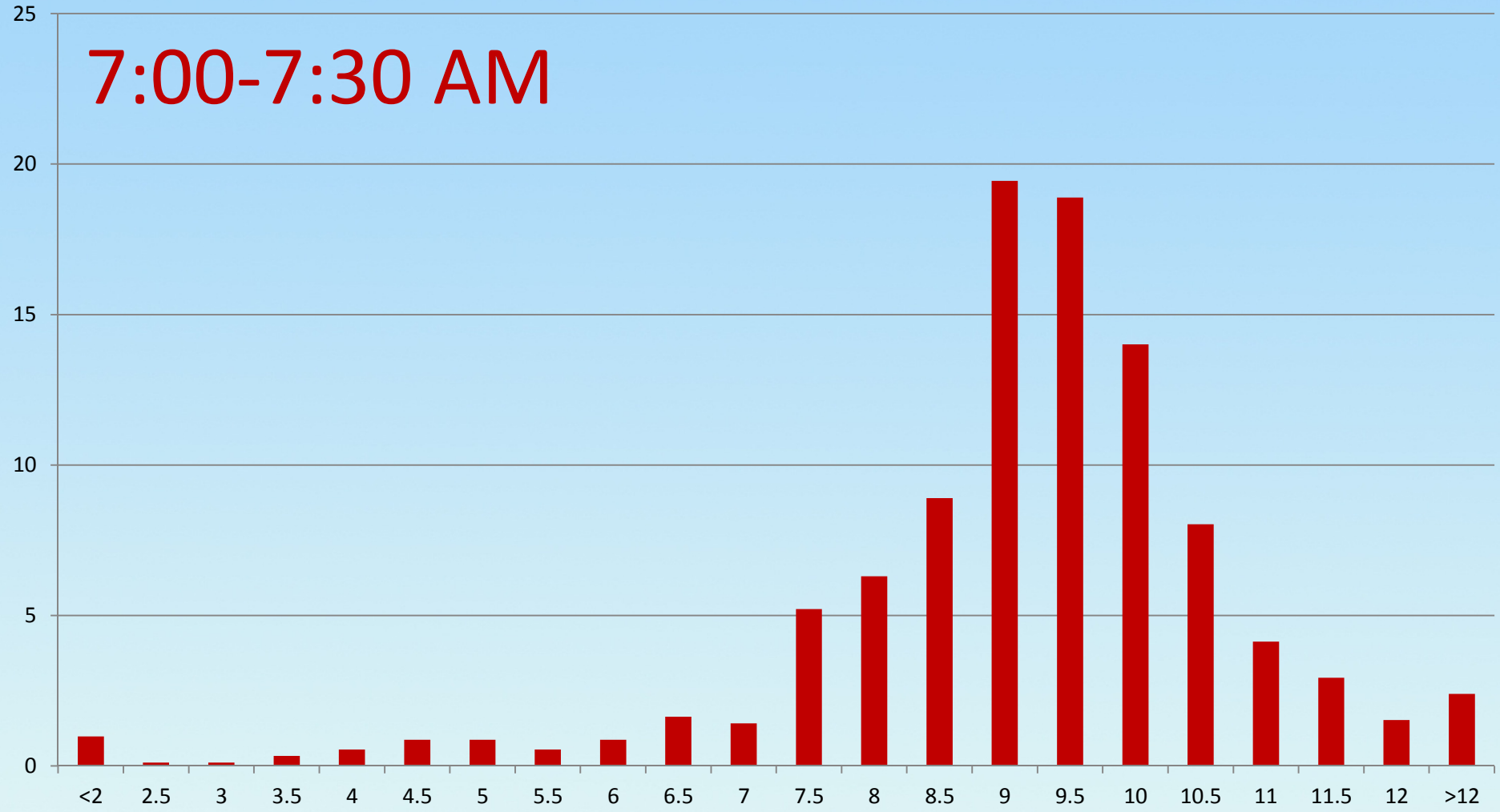
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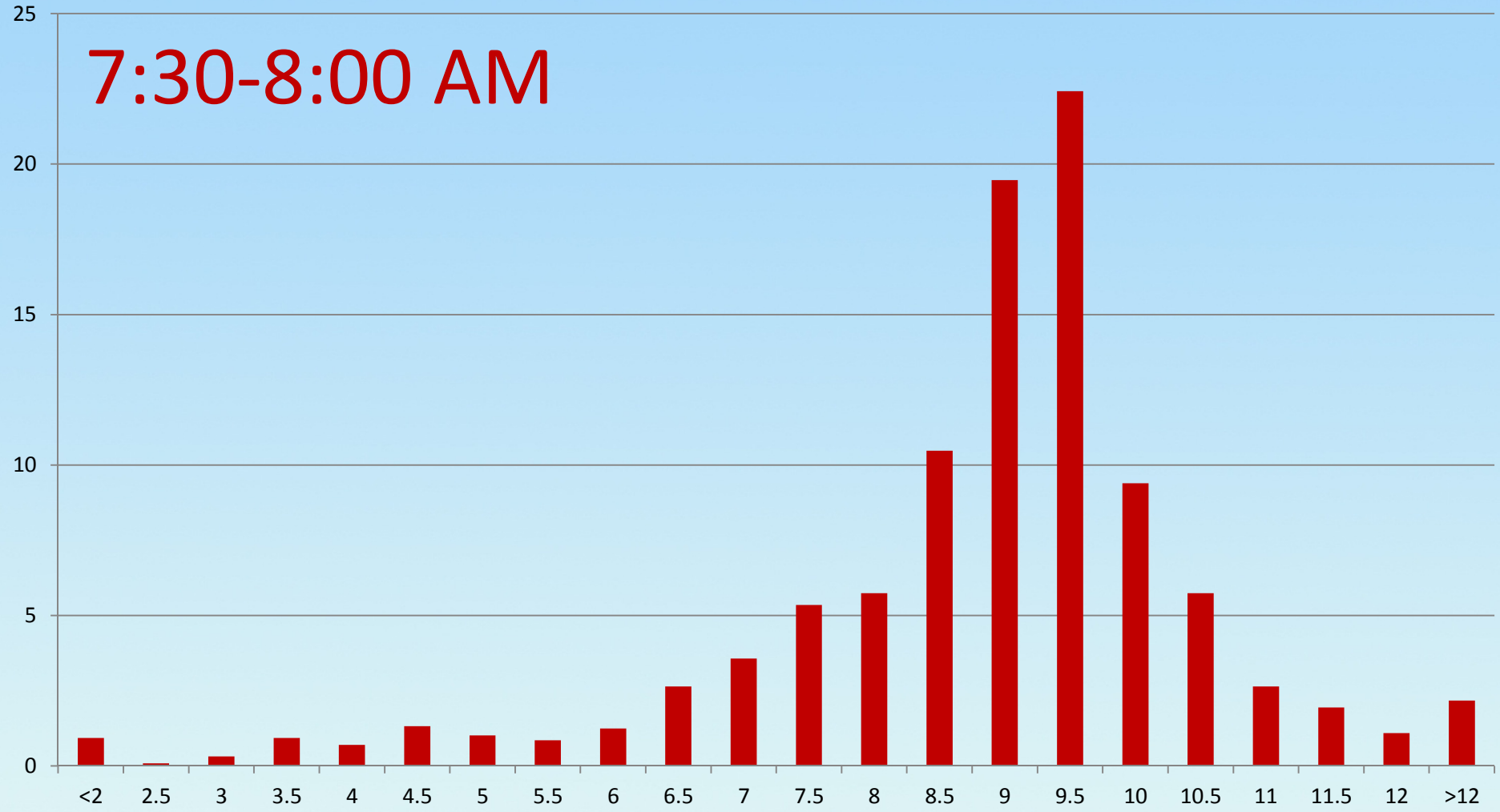
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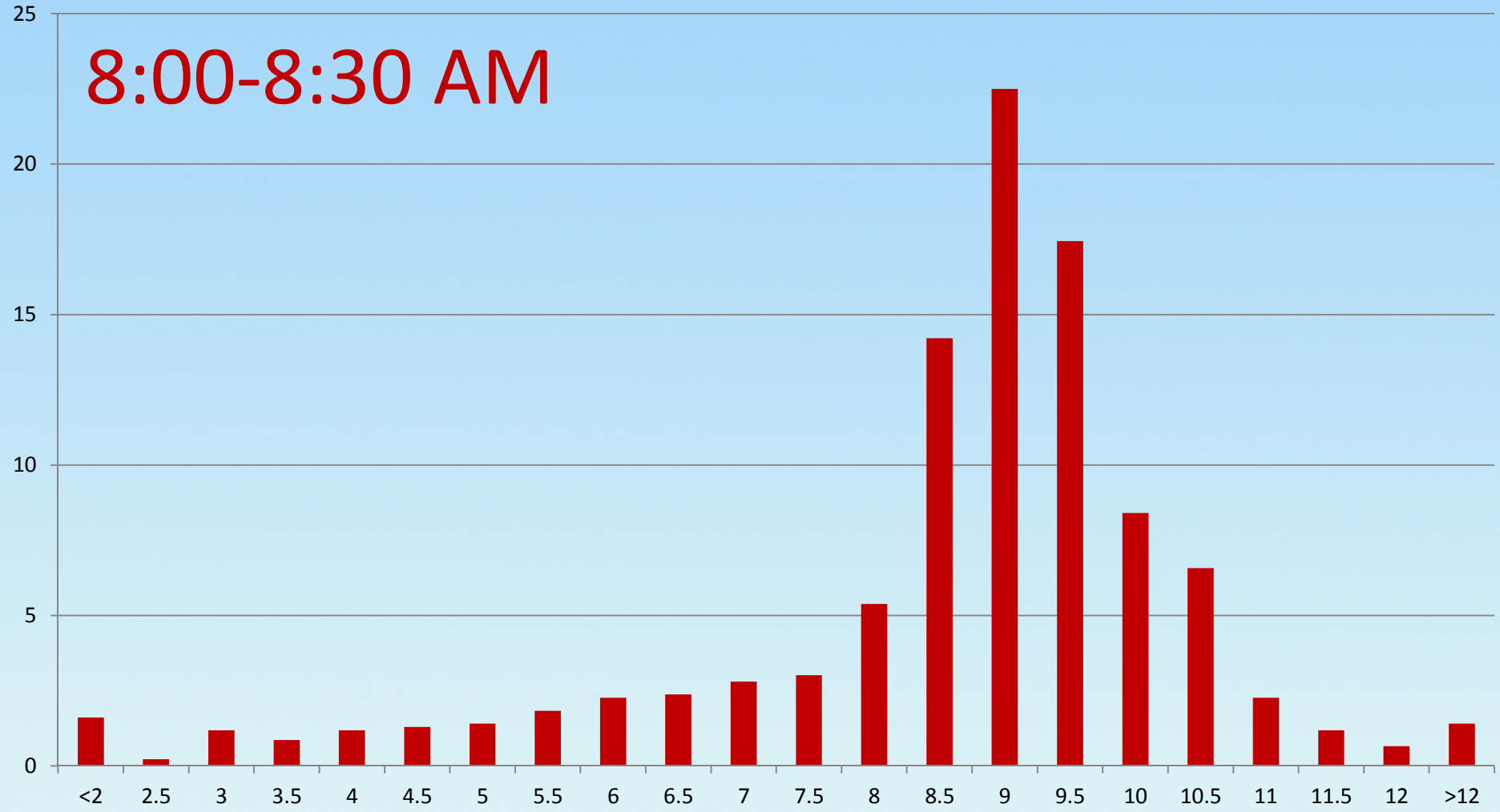
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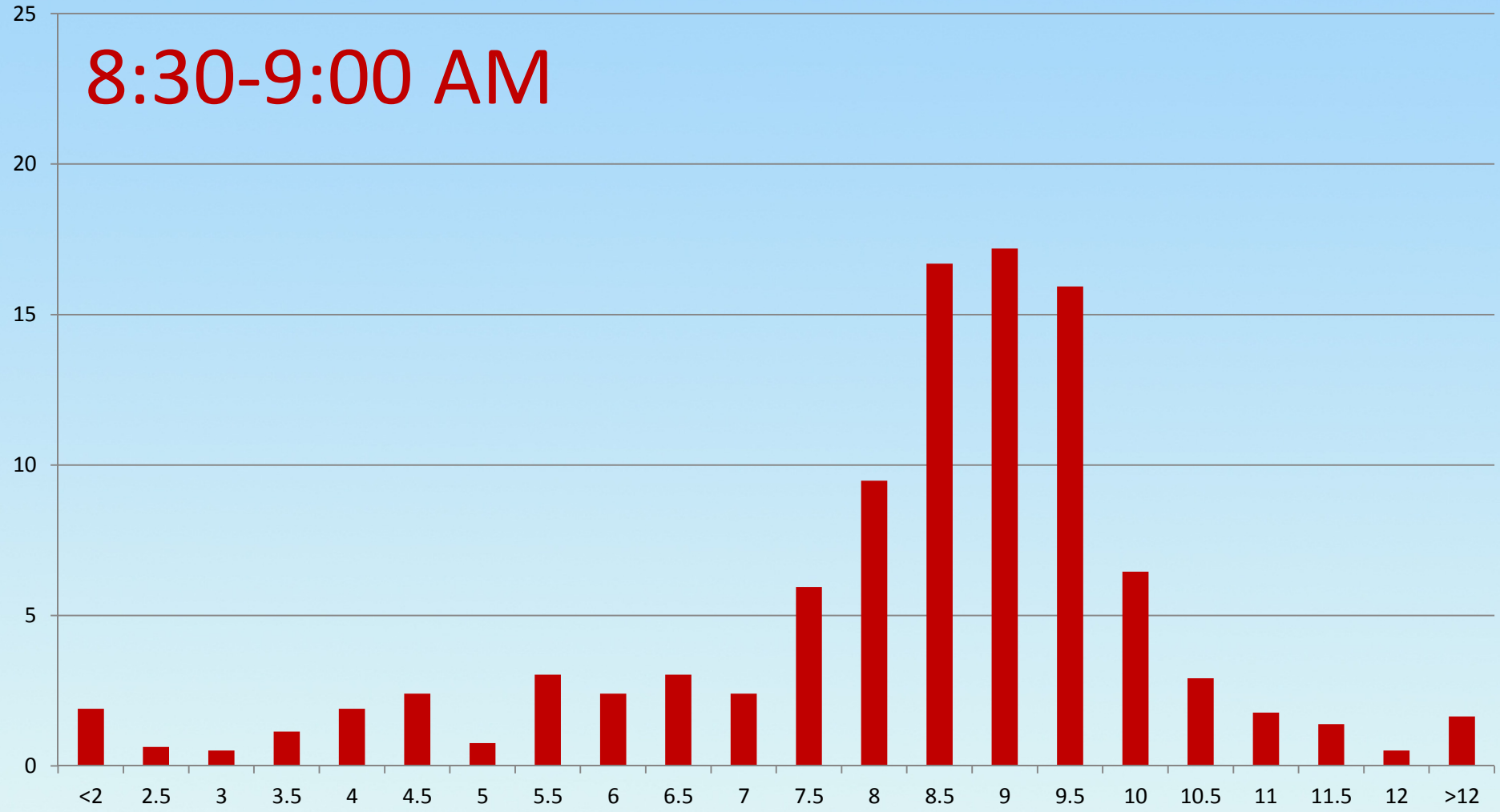

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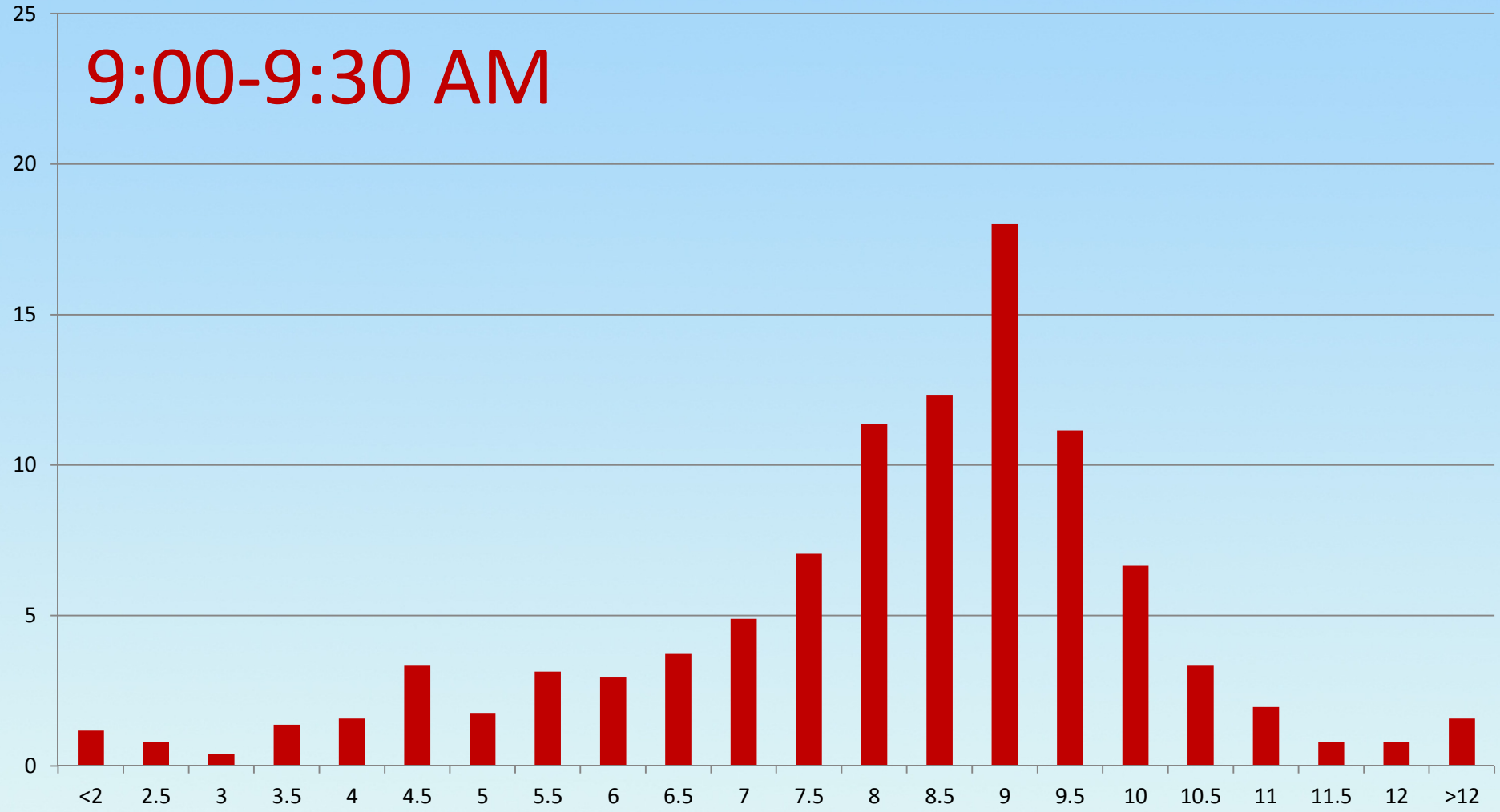
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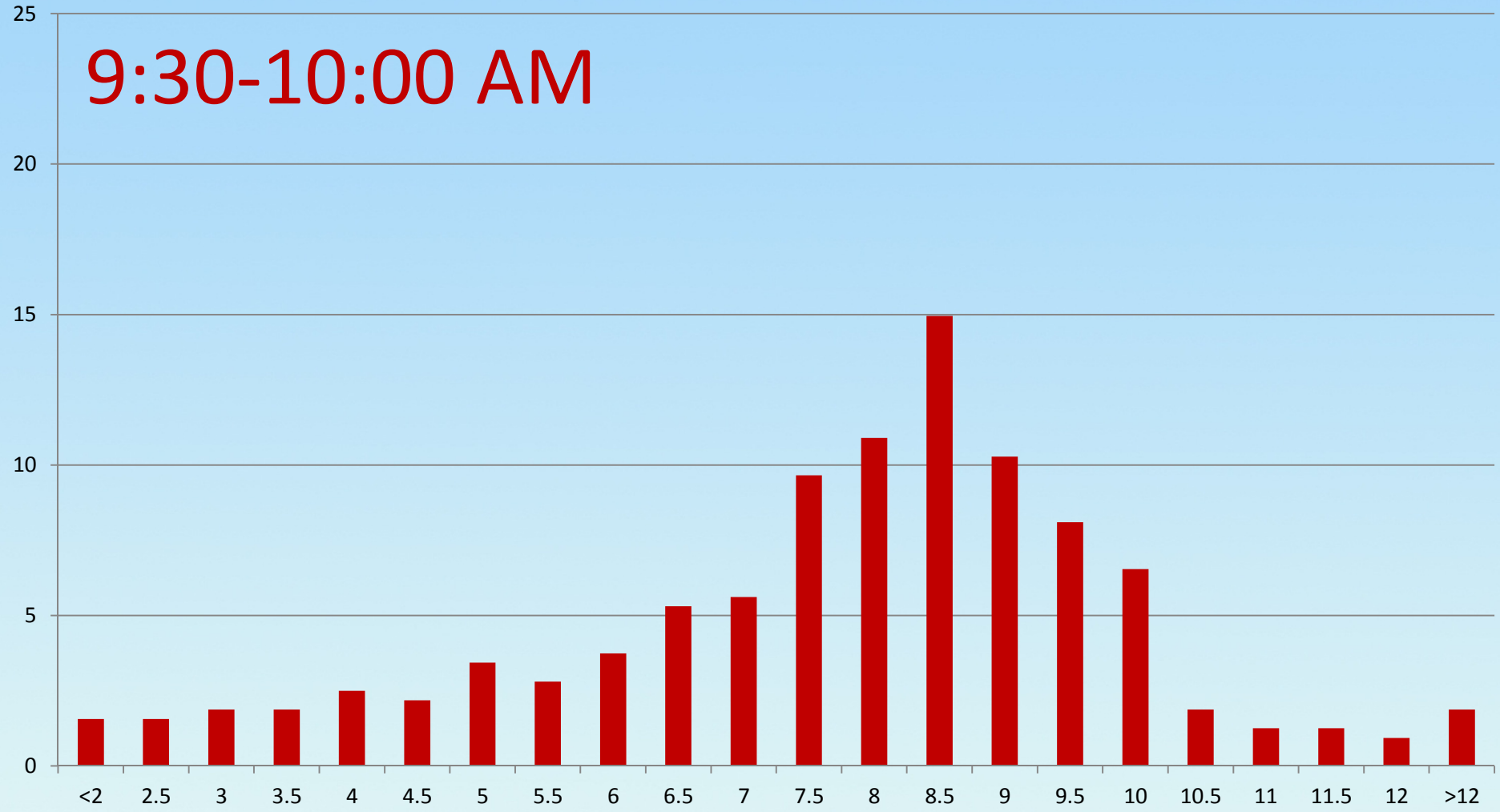

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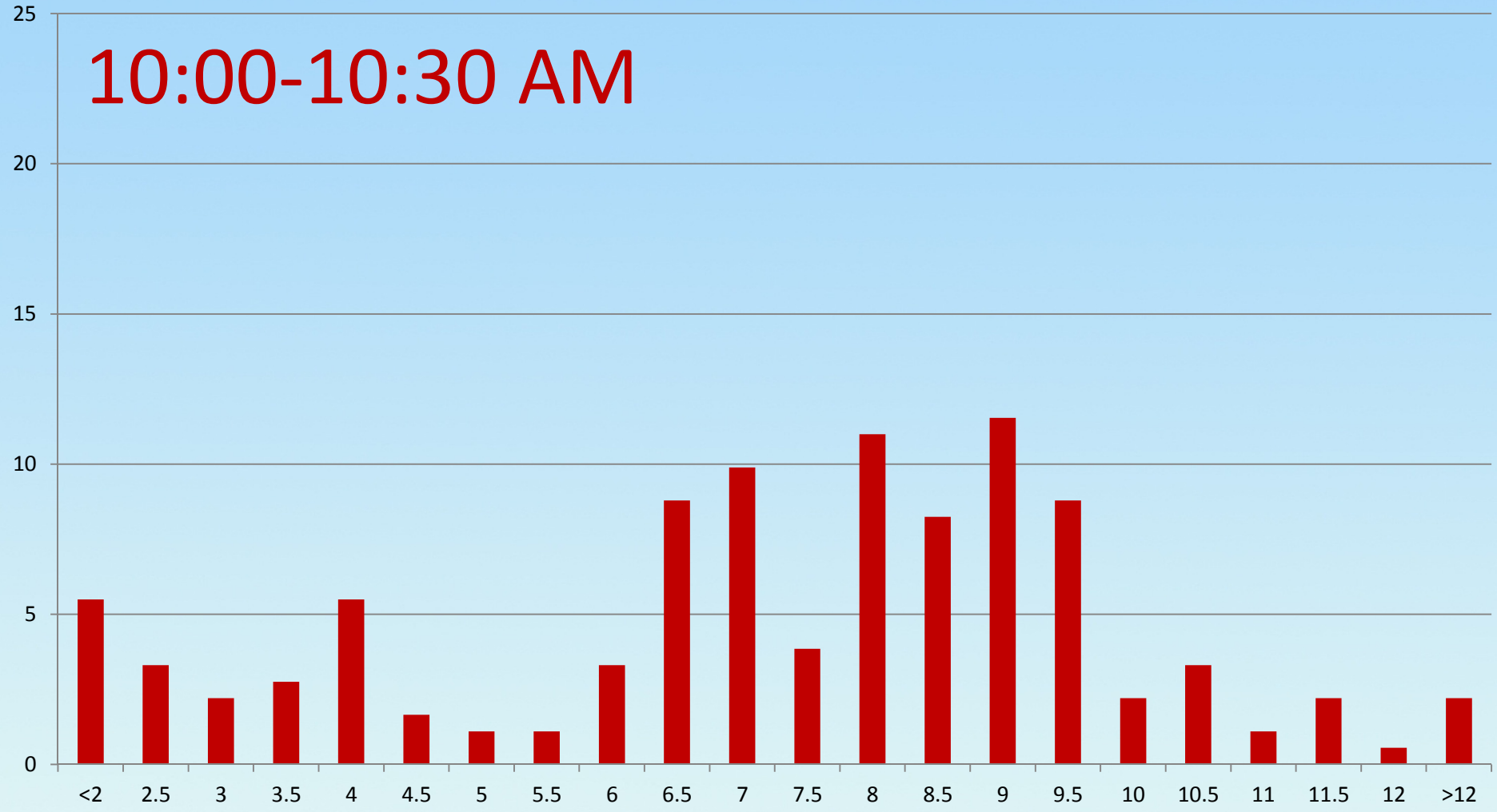

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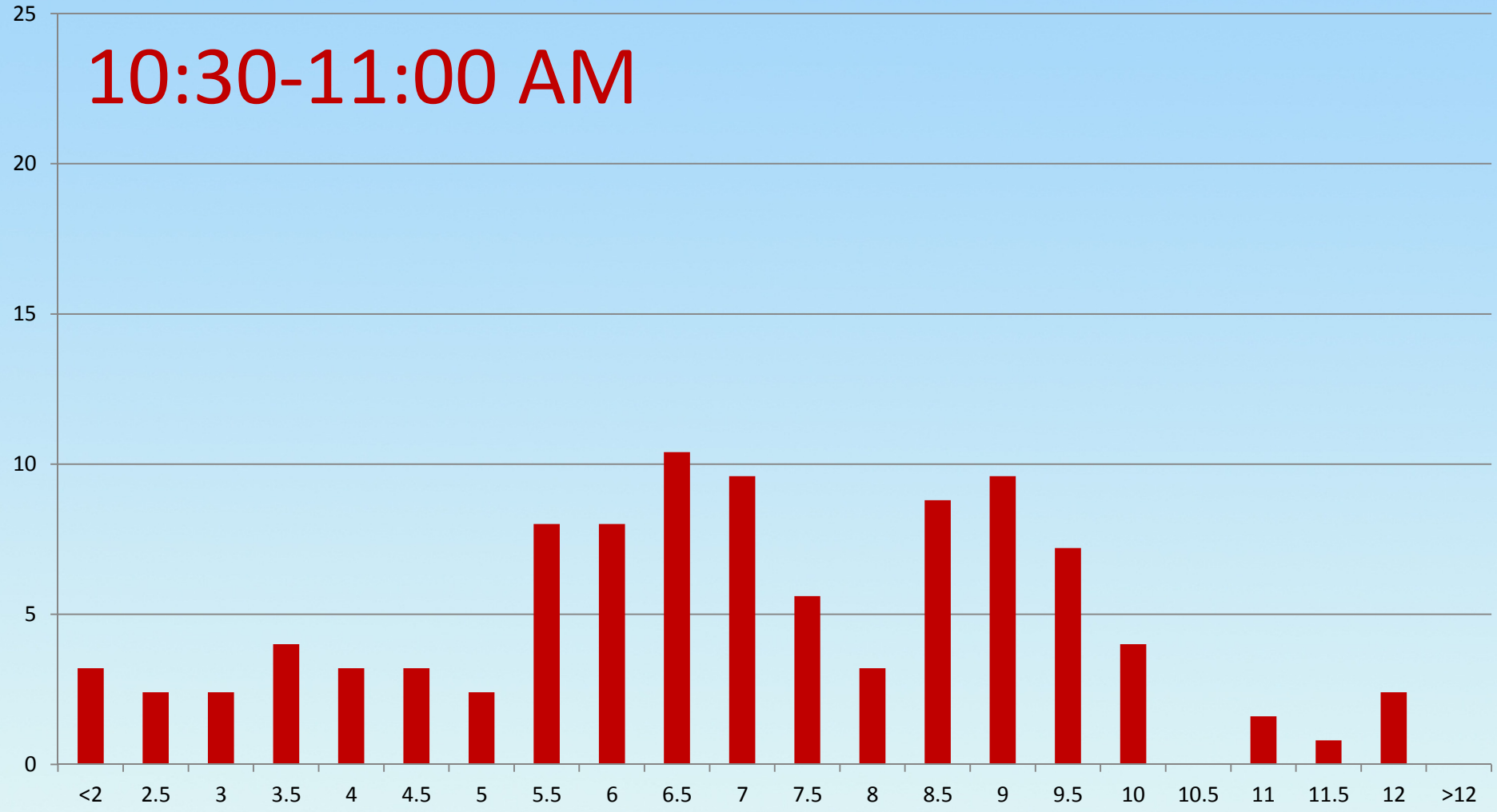
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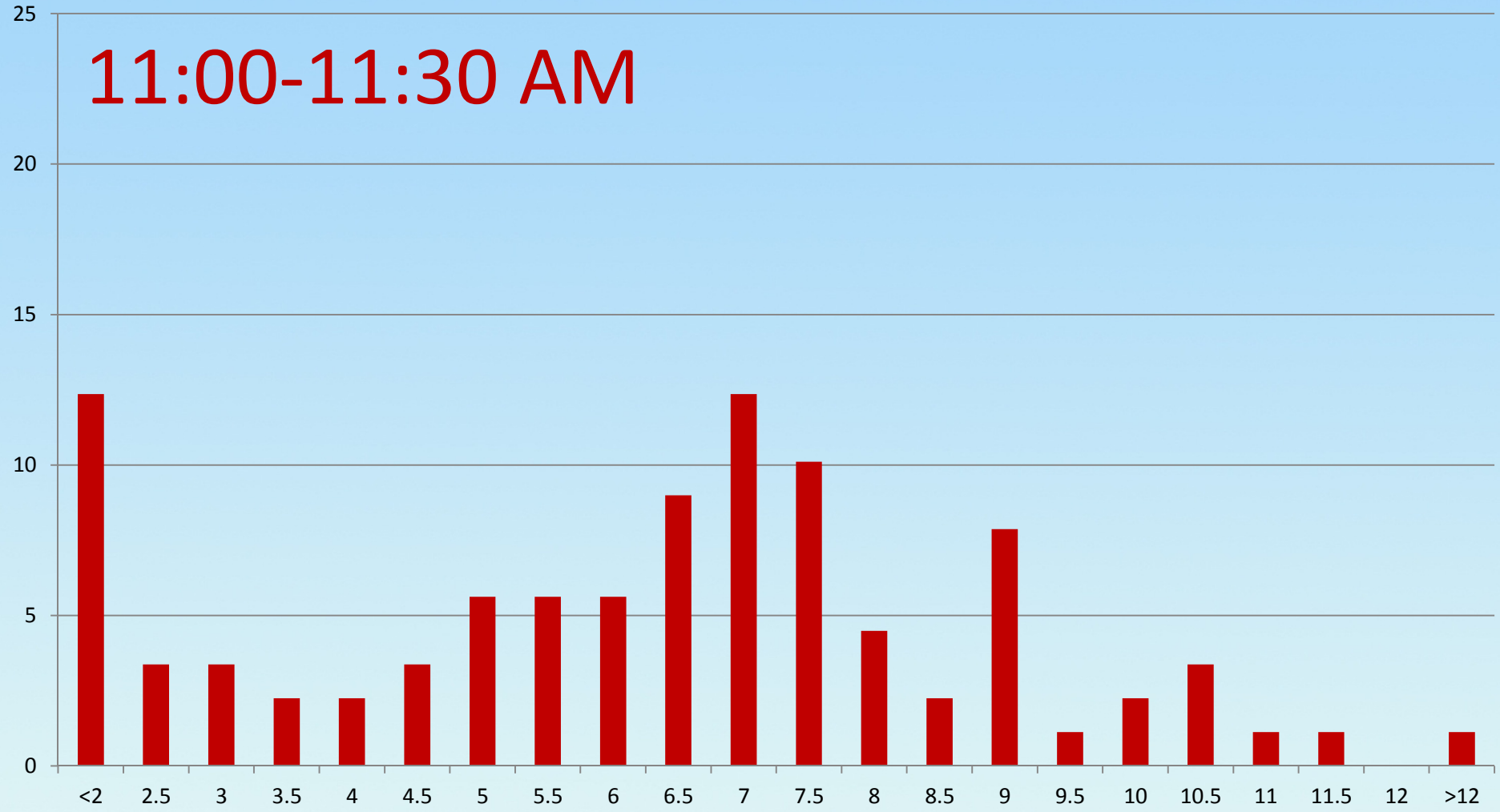
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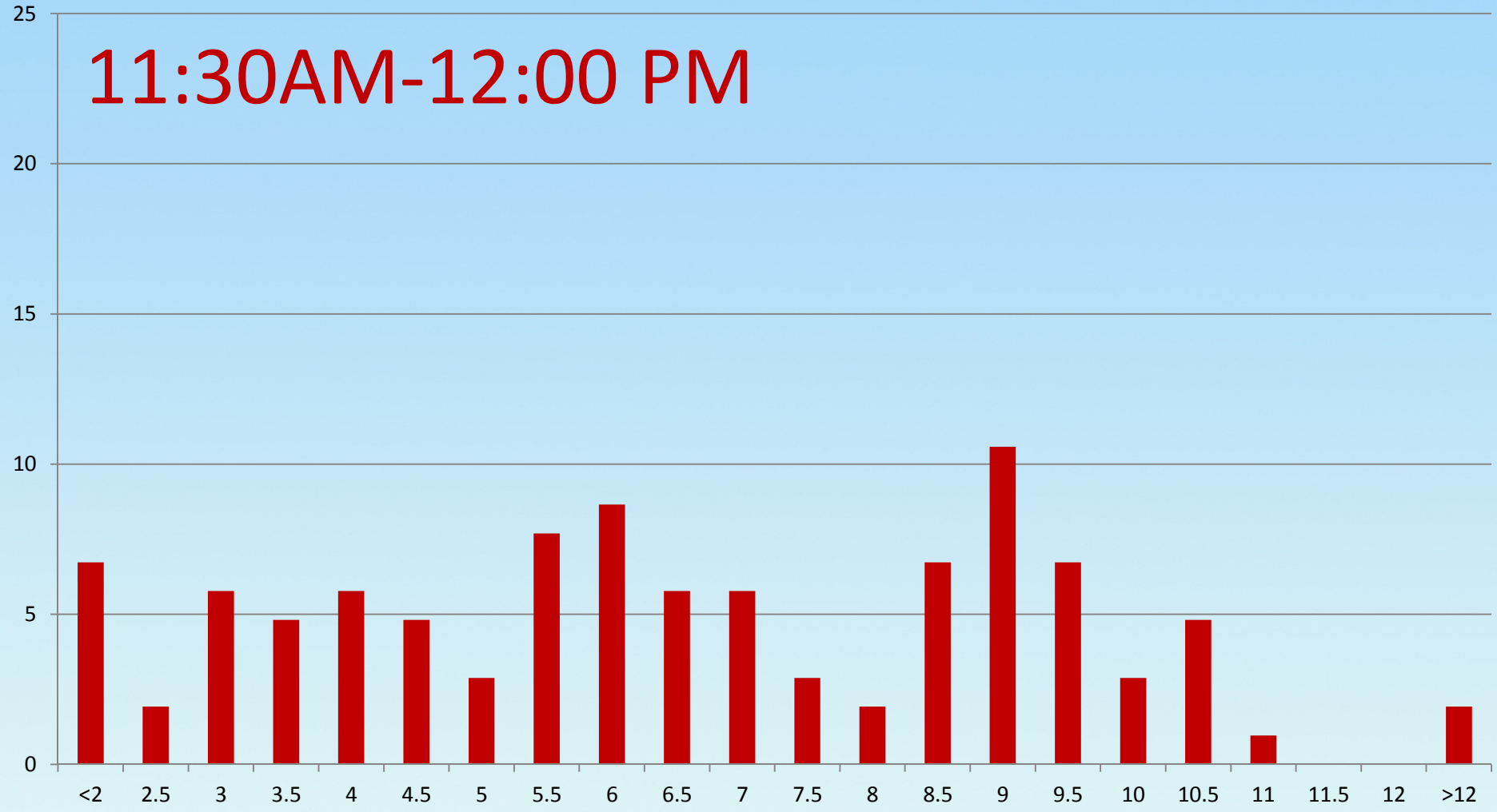
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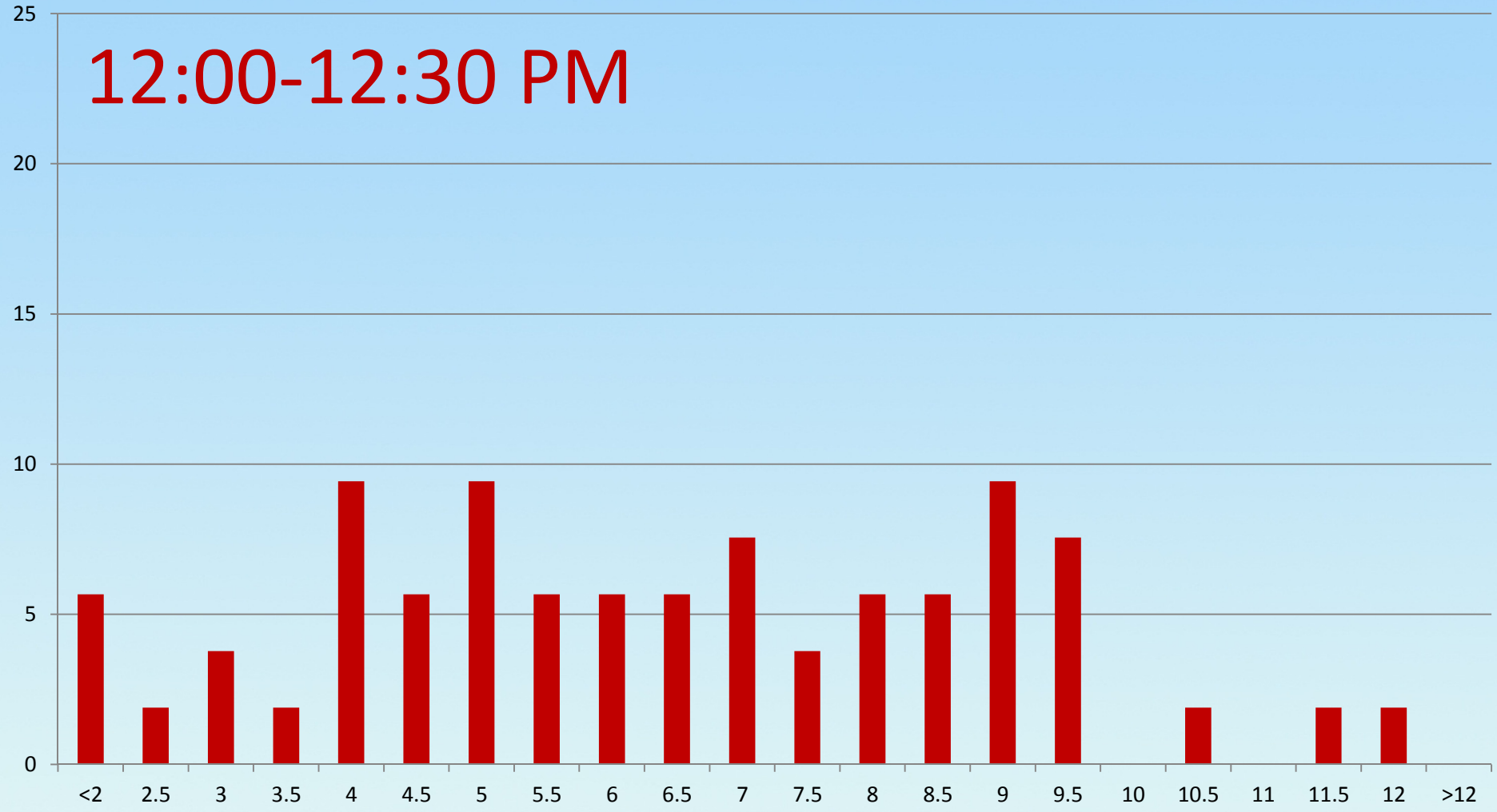
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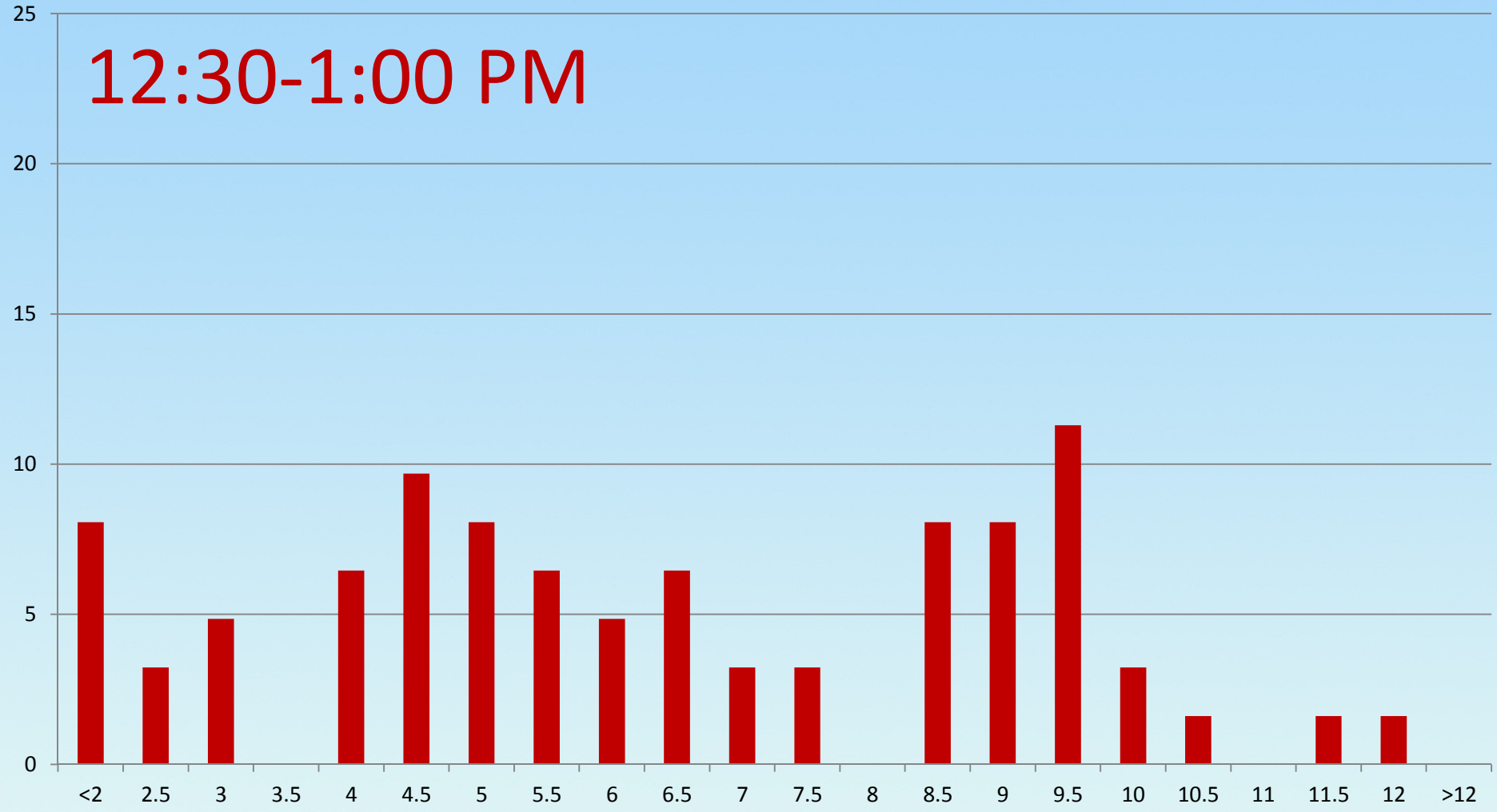
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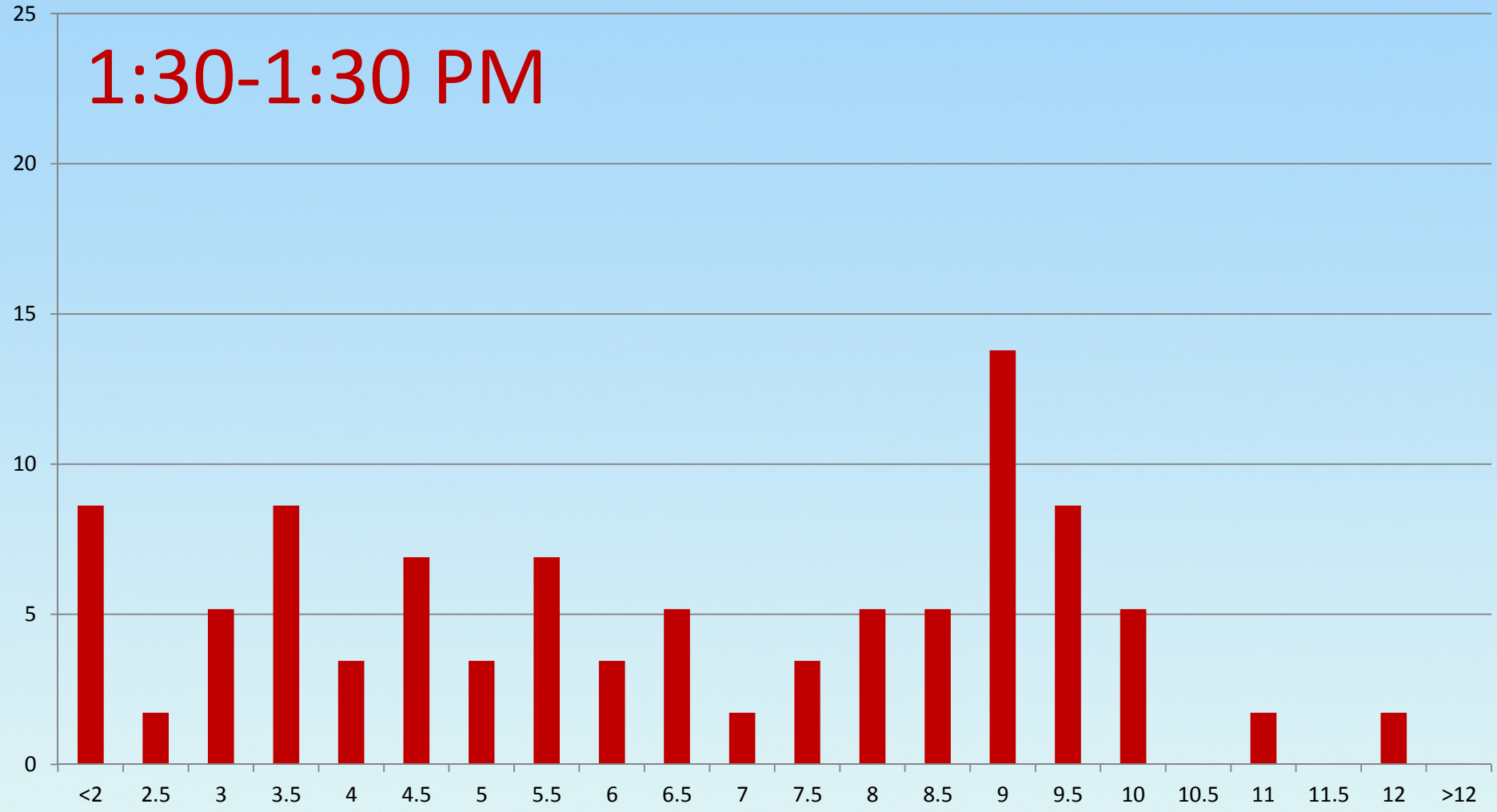
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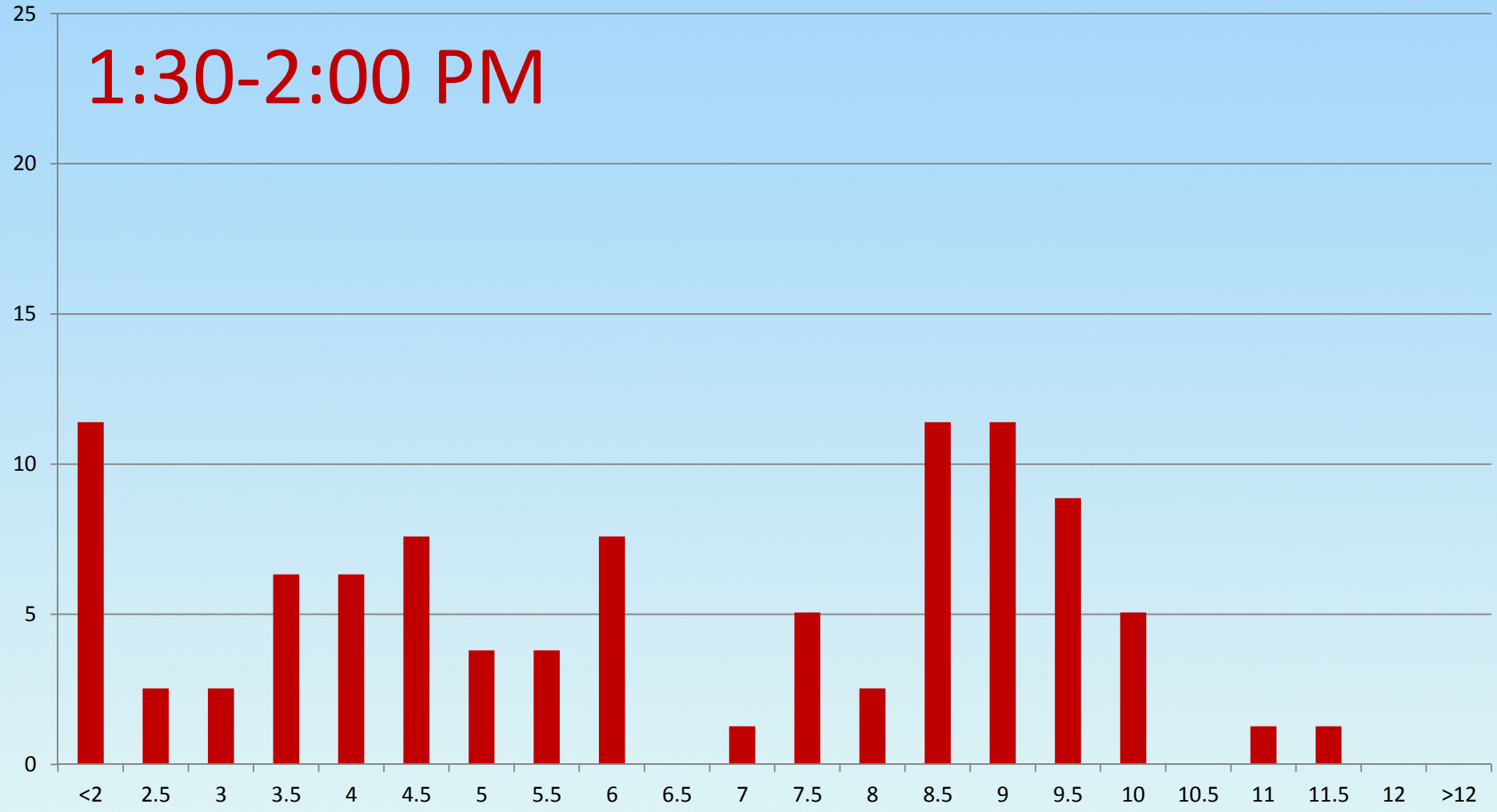
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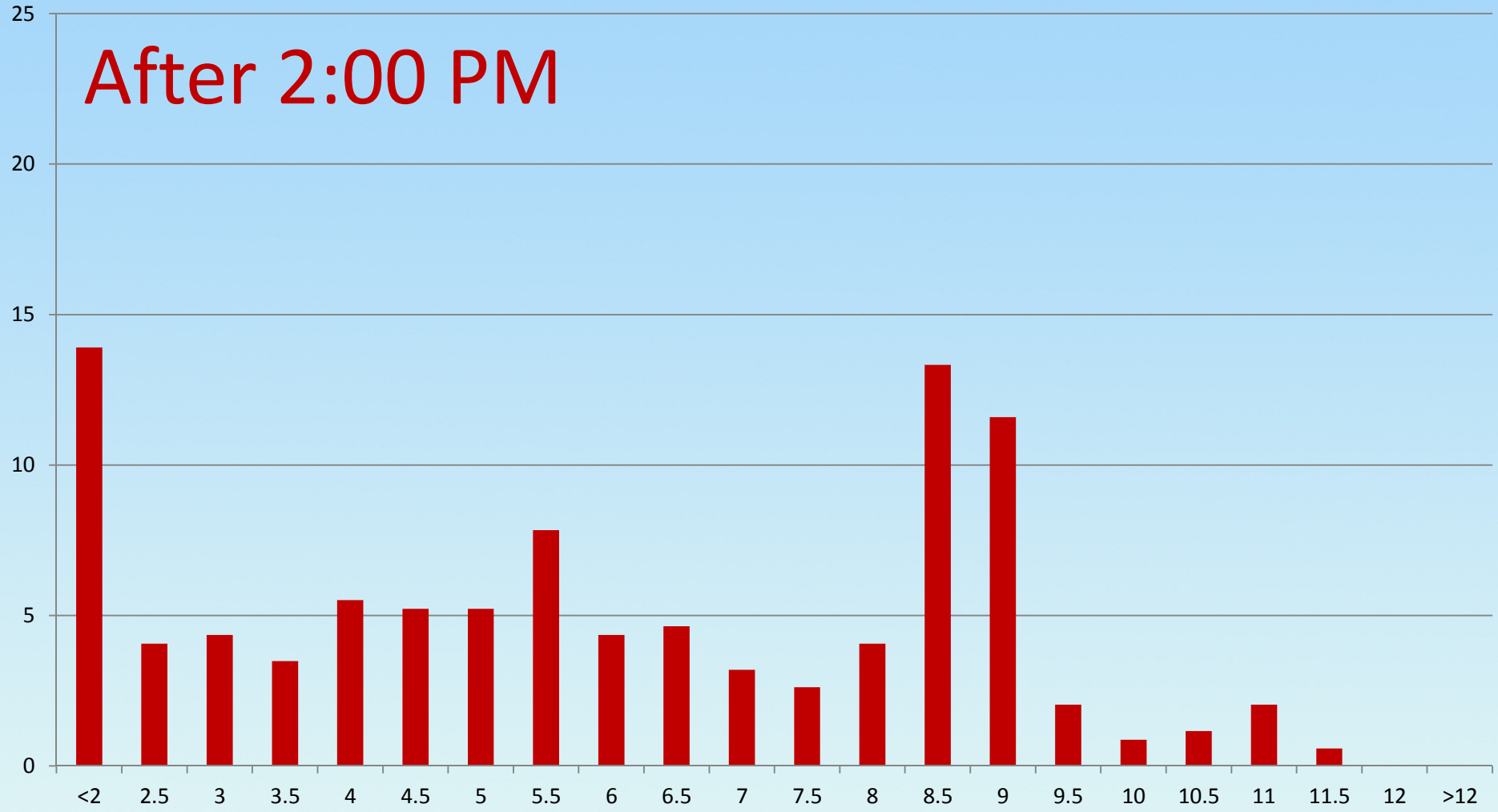
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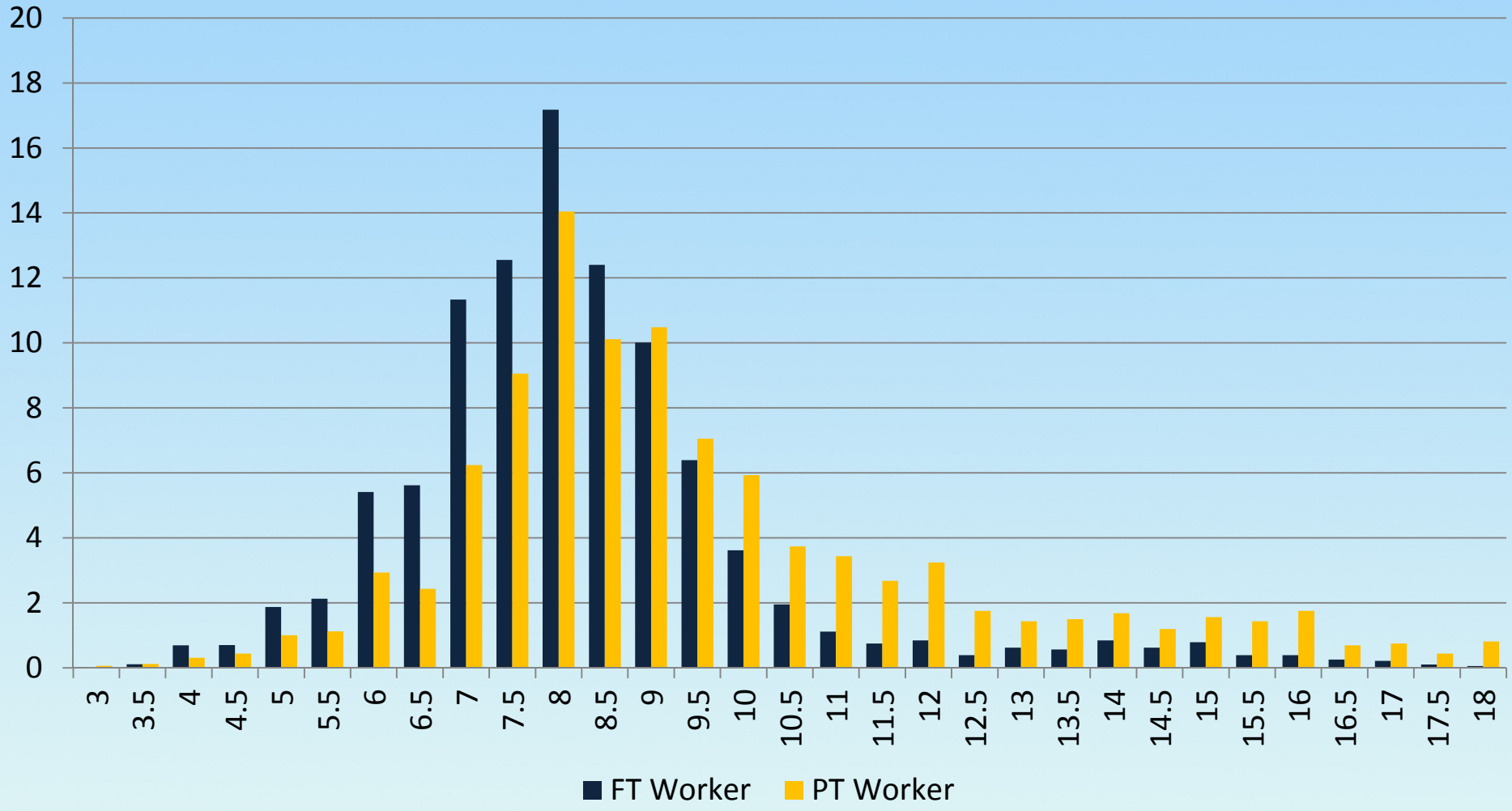
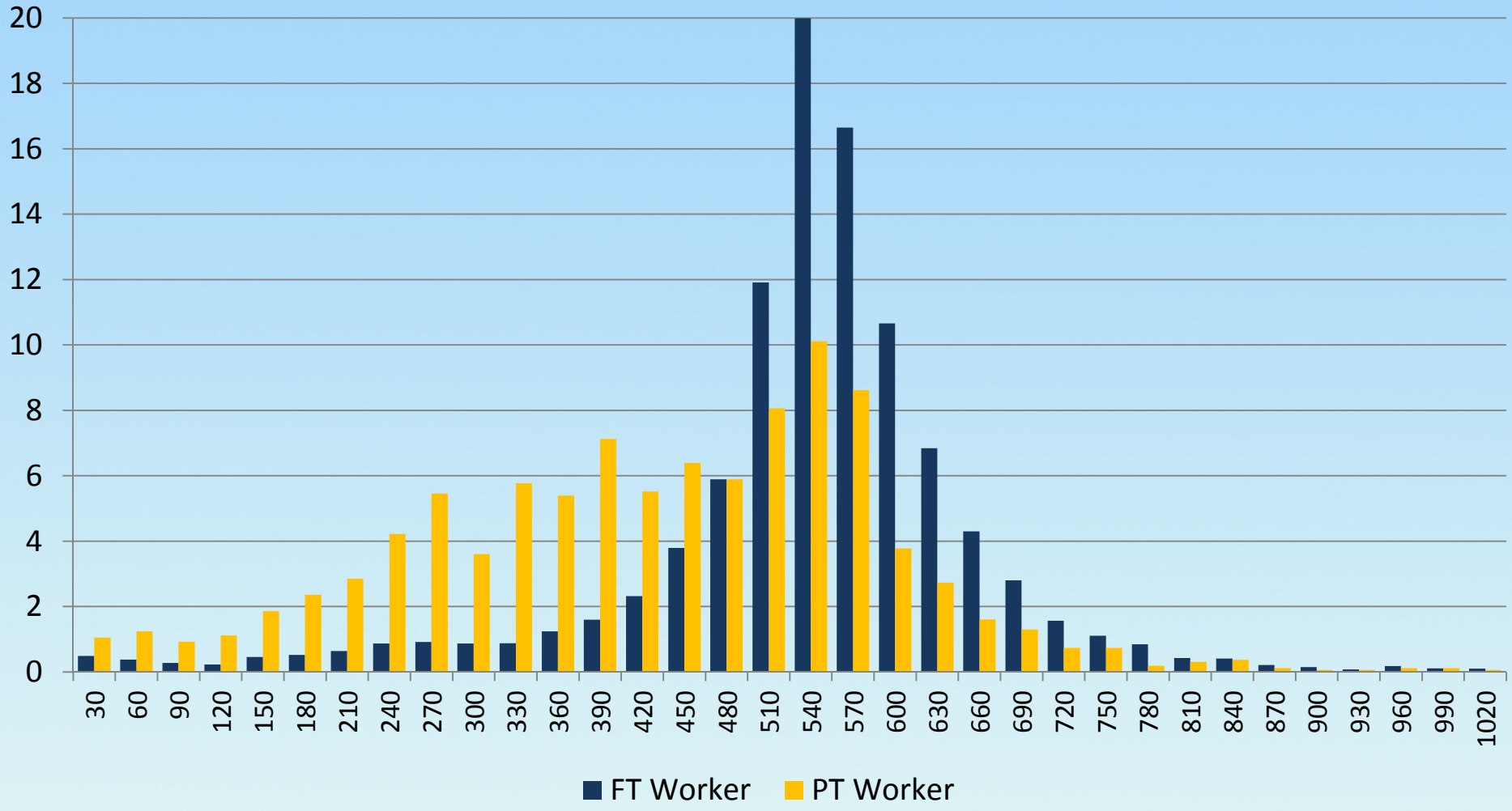
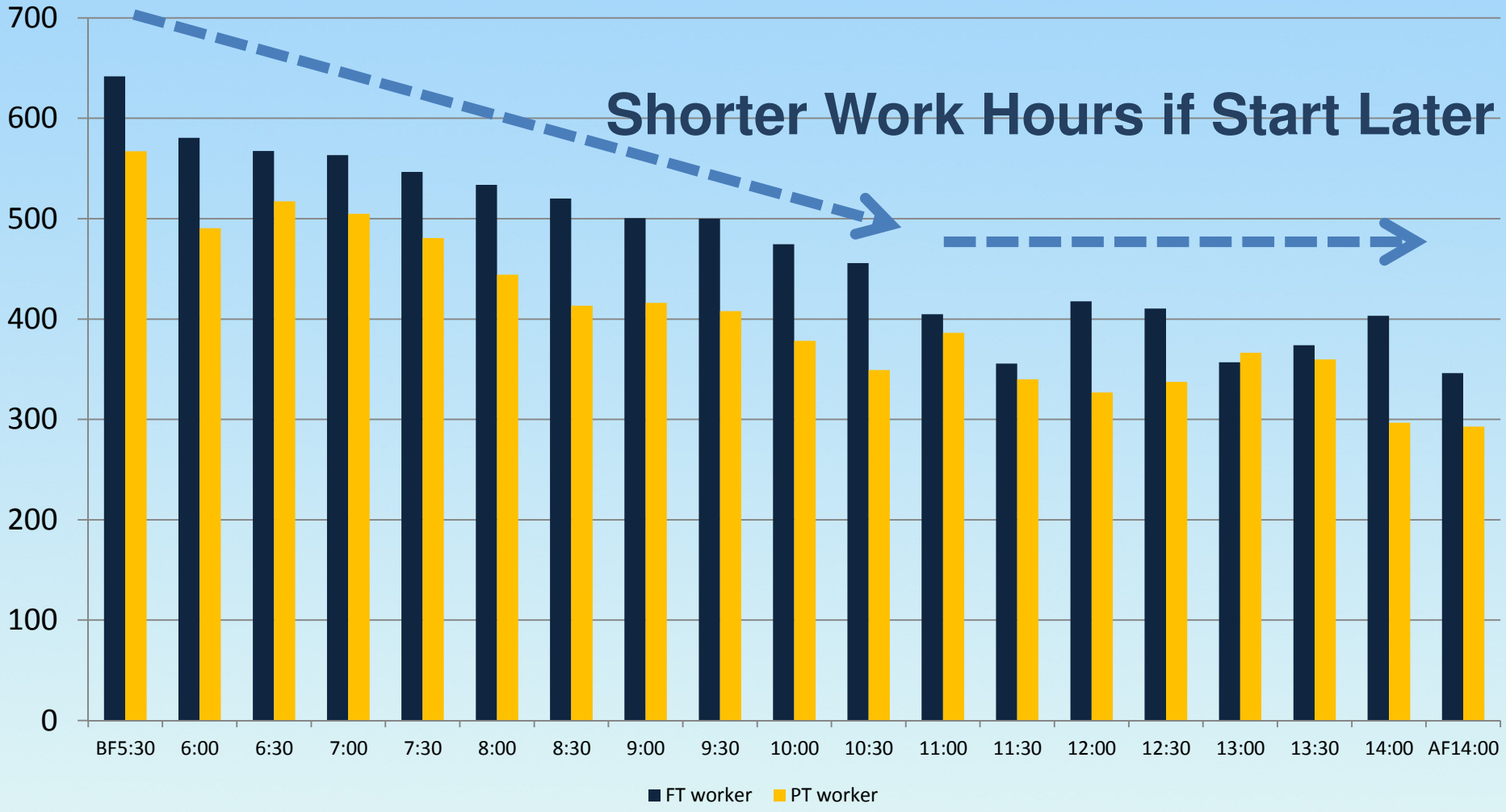
# Start Time
## (PTW tends to starts later than FTW)



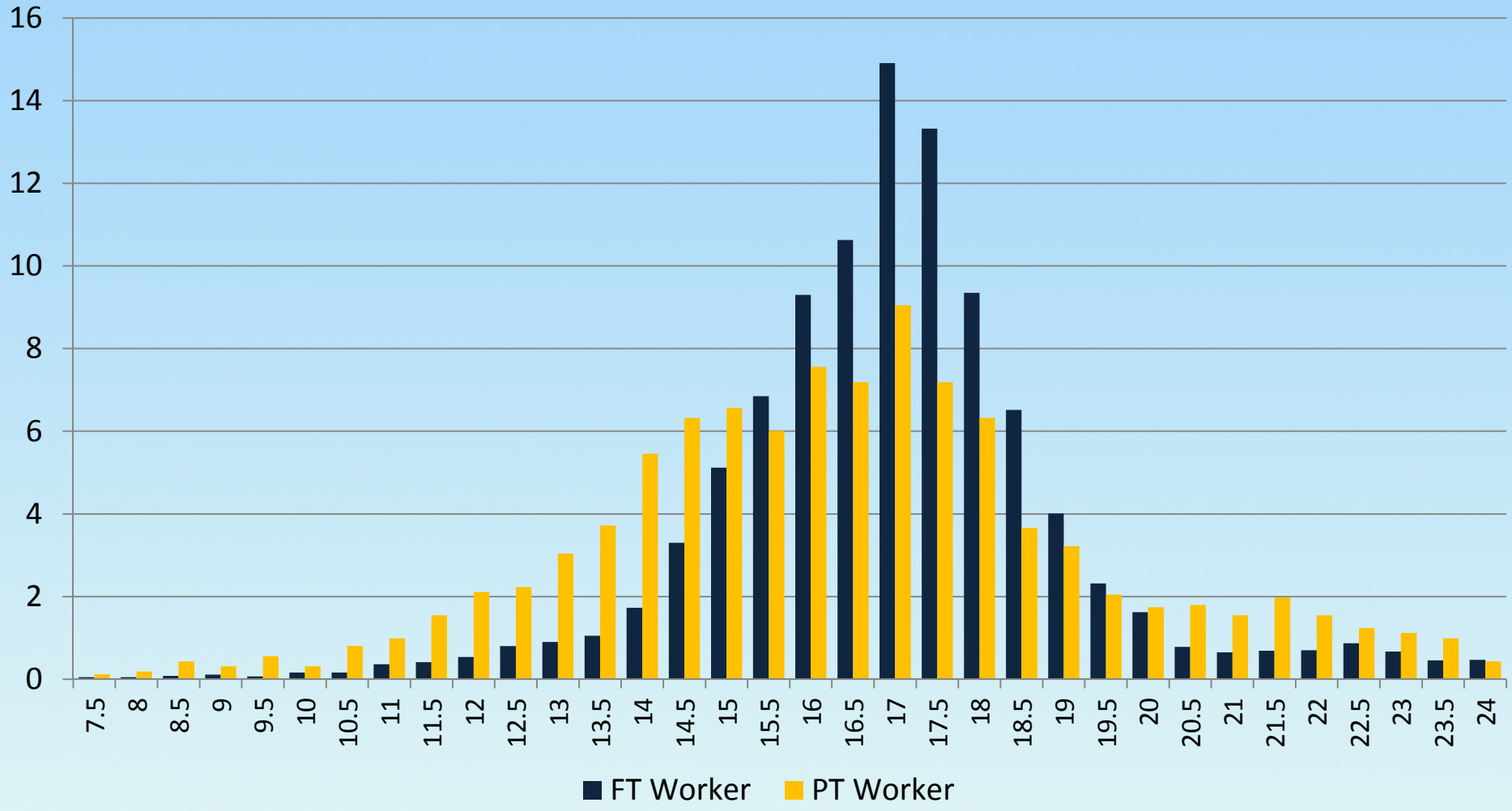
# Work Duration



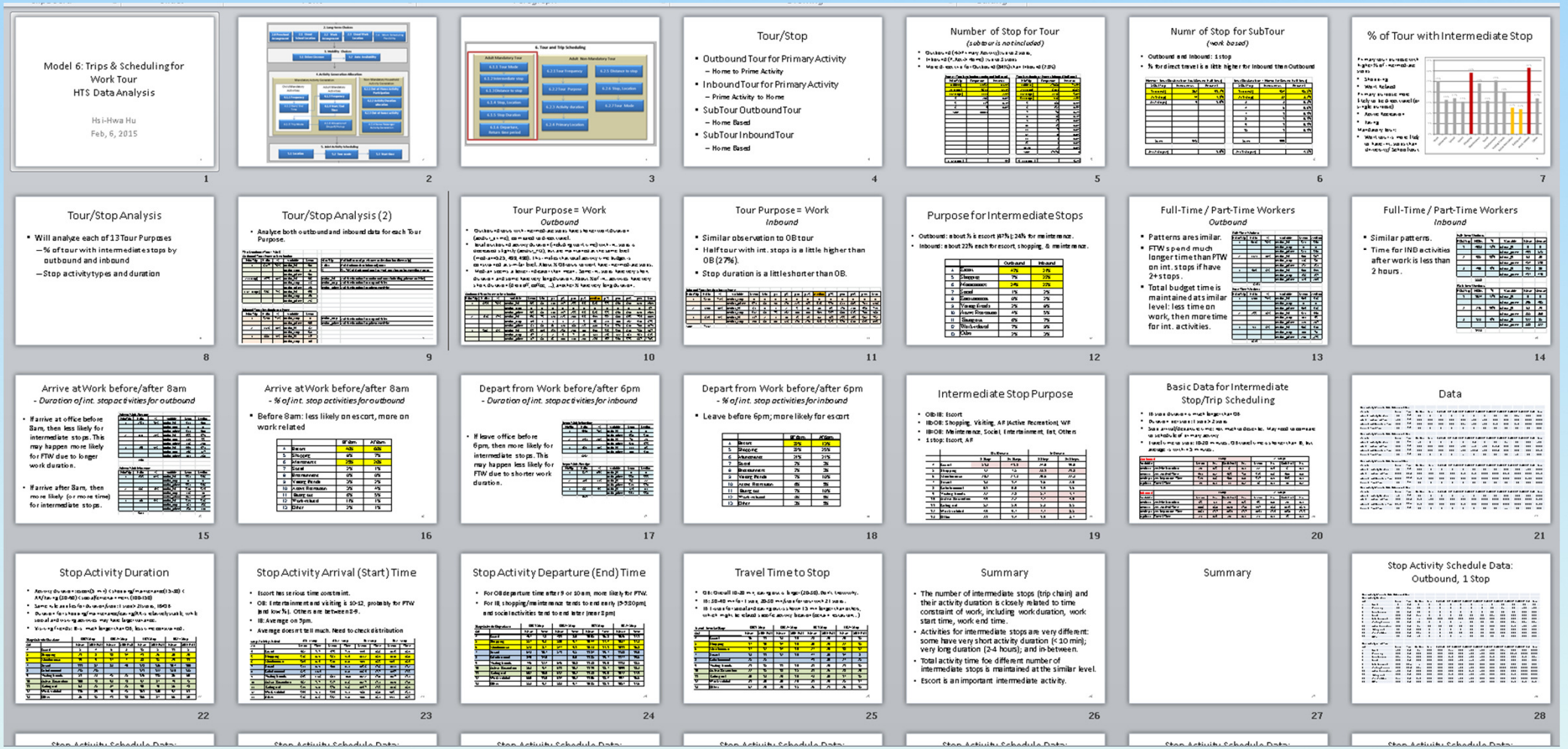
# Work Duration by Start Time



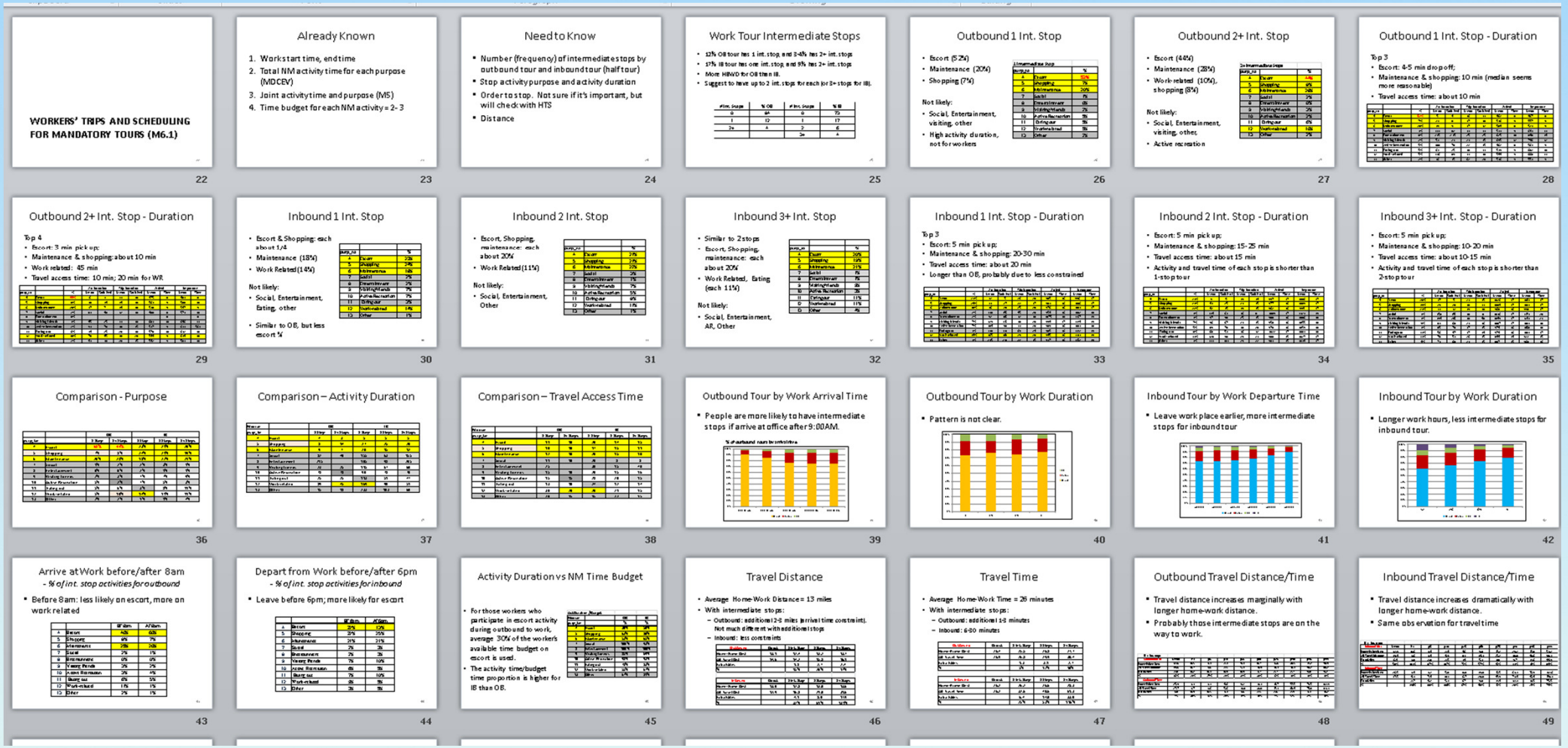
# End Time
# (similar distribution, STDEV is larger for PTW)



# Other Examples
# Worker's Trip Scheduling



# Examples
# - Worker's Tour by Time Window



**WORKERS' TRIPS AND SCHEDULING FOR MANDATORY TOURS (M6.1)**

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## Already Known

1. Work start time, end time
2. Total NM activity time for each purpose (MDCEV)
3. Joint activity time and purpose (MS)
4. Time budget for each NM activity = 2- 3

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## Need to Know

- Number (frequency) of intermediate stops by outbound tour and inbound tour (half tour)
- Stop activity purpose and activity duration
- Order to stop. Not sure if it's important, but will check with HTS
- Distance

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## Work Tour Intermediate Stops

- 12% OB tour has 1 int. stop, and 3-4% has 2+ int. stops
- 17% IB tour has one int. stop, and 9% has 2+ int. stops
- More HBWO for OB than IB.
- Suggest to have up to 2 int. stops for each for 3+ stops for IB.

| #Int. Stops | % OB | #Int. Stops | % IB |
|---|---|---|---|
| 0 | 84 | 0 | 73 |
| 1 | 12 | 1 | 17 |
| 2+ | 4 | 2 | 6 |
| | | 3+ | 4 |

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## Outbound 1 Int. Stop

- Escort (5.2%)
- Maintenance (20%)
- Shopping (7%)

Not likely:

- Social, Entertainment, visiting, other
- High activity duration, not for workers

| Intermediate Stop | |
|---|---|
| Purpose | % |
| A Escort | 5% |
| 5 Shopping | 7% |
| 6 Maintenance | 20% |
| 7 Social | 7% |
| 8 Entertainment | 6% |
| 9 Visiting/Friends | 2% |
| 10 Active Recreation | 3% |
| 11 Eating out | 6% |
| 12 Work-related | 14% |
| 13 Other | 7% |

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## Outbound 2+ Int. Stop

- Escort (4.4%)
- Maintenance (28%)
- Work-related (10%), shopping (8%)

Not likely:

- Social, Entertainment, visiting, other
- Active recreation

| 2+ Intermediate Stops | |
|---|---|
| Purpose | % |
| A Escort | 4% |
| 5 Shopping | 8% |
| 6 Maintenance | 28% |
| 7 Social | 3% |
| 8 Entertainment | 0% |
| 9 Visiting/Friends | 3% |
| 10 Active Recreation | 2% |
| 11 Eating out | 6% |
| 12 Work-related | 10% |
| 13 Other | 3% |

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## Outbound 1 Int. Stop - Duration

Top 3

- Escort: 4-5 min drop off;
- Maintenance & shopping: 10 min (median seems more reasonable)
- Travel access time: about 10 min

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## Outbound 2+ Int. Stop - Duration

Top 4

- Escort: 3 min pick up;
- Maintenance & shopping: about 10 min
- Work related: 45 min
- Travel access time: 10 min; 20 min for WR

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## Inbound 1 Int. Stop

- Escort & Shopping: each about 1/4
- Maintenance (18%)
- Work Related (14%)

Not likely:

- Social, Entertainment, Eating, other
- Similar to OB, but less escort %

| Purpose | | % |
|---|---|---|
| A | Escort | 23% |
| 5 | Shopping | 27% |
| 6 | Maintenance | 18% |
| 7 | Social | 2% |
| 8 | Entertainment | 1% |
| 9 | Visiting/Friends | 7% |
| 10 | Active Recreation | 7% |
| 11 | Eating out | 2% |
| 12 | Work-related | 14% |
| 13 | Other | 1% |

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## Inbound 2 Int. Stop

- Escort, Shopping, maintenance: each about 20%
- Work Related (11%)

Not likely:

- Social, Entertainment, Other

| Purpose | | % |
|---|---|---|
| A | Escort | 27% |
| 5 | Shopping | 27% |
| 6 | Maintenance | 20% |
| 7 | Social | 2% |
| 8 | Entertainment | 1% |
| 9 | Visiting/Friends | 7% |
| 10 | Active Recreation | 5% |
| 11 | Eating out | 6% |
| 12 | Work-related | 11% |
| 13 | Other | 1% |

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## Inbound 3+ Int. Stop

- Similar to 2 stops
- Escort, Shopping, maintenance: each about 20%
- Work Related, Eating (each 11%)

Not likely:

- Social, Entertainment, AR, Other

| Purpose | | % |
|---|---|---|
| A | Escort | 20% |
| 5 | Shopping | 19% |
| 6 | Maintenance | 21% |
| 7 | Social | 7% |
| 8 | Entertainment | 7% |
| 9 | Visiting/Friends | 3% |
| 10 | Active Recreation | 2% |
| 11 | Eating out | 11% |
| 12 | Work-related | 11% |
| 13 | Other | 4% |

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## Inbound 1 Int. Stop - Duration

Top 3

- Escort: 5 min pick up;
- Maintenance & shopping: 20-30 min
- Travel access time: about 20 min
- Longer than OB, probably due to less constrained

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## Inbound 2 Int. Stop - Duration

- Escort: 5 min pick up;
- Maintenance & shopping: 15- 25 min
- Travel access time: about 15 min
- Activity and travel time of each stop is shorter than 1-stop tour

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## Inbound 3+ Int. Stop - Duration

- Escort: 5 min pick up;
- Maintenance & shopping: 10-20 min
- Travel access time: about 10-15 min
- Activity and travel time of each stop is shorter than 2-stop tour

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## Comparison - Purpose

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## Comparison – Activity Duration

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## Comparison – Travel Access Time

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## Outbound Tour by Work Arrival Time

- People are more likely to have intermediate stops if arrive at office after 9:00AM.

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## Outbound Tour by Work Duration

- Pattern is not clear.

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## Inbound Tour by Work Departure Time

- Leave work place earlier, more intermediate stops for inbound tour

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## Inbound Tour by Work Duration

- Longer work hours, less intermediate stops for inbound tour.

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## Arrive at Work before/after 8am

*- % of int. stop activities for outbound*

- Before 8am: less likely an escort, more on work related

| | | B4am | A8am |
|---|---|---|---|
| A | Escort | 4% | 6% |
| 5 | Shopping | 6% | 7% |
| 6 | Maintenance | 25% | 20% |
| 7 | Social | 2% | 1% |
| 8 | Entertainment | 0% | 0% |
| 9 | Visiting/Friends | 3% | 2% |
| 10 | Active Recreation | 3% | 4% |
| 11 | Eating out | 6% | 5% |
| 12 | Work-related | 17% | 1% |
| 13 | Other | 2% | 1% |

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## Depart from Work before/after 6pm

*- % of int. stop activities for inbound*

- Leave before 6pm; more likely for escort

| | | B4pm | A6pm |
|---|---|---|---|
| A | Escort | 20% | 12% |
| 5 | Shopping | 37% | 35% |
| 6 | Maintenance | 21% | 21% |
| 7 | Social | 2% | 3% |
| 8 | Entertainment | 2% | 3% |
| 9 | Visiting/Friends | 7% | 10% |
| 10 | Active Recreation | 4% | 3% |
| 11 | Eating out | 7% | 10% |
| 12 | Work-related | 3% | 3% |
| 13 | Other | 3% | 3% |

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## Activity Duration vs NM Time Budget

- For those workers who participate in escort activity during outbound to work, average 30% of the worker's available time budget on escort is used.
- The activity time/budget time proportion is higher for IB than OB.

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## Travel Distance

- Average Home-Work Distance = 13 miles
- With intermediate stops:
  - Outbound: additional 2-3 miles (arrival time constraint). Not much different with additional stops
  - Inbound: less constraints

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## Travel Time

- Average Home-Work Time = 26 minutes
- With intermediate stops:
  - Outbound: additional 1-3 minutes
  - Inbound: 6-10 minutes

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## Outbound Travel Distance/Time

- Travel distance increases marginally with longer home-work distance.
- Probably those intermediate stops are on the way to work.

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## Inbound Travel Distance/Time

- Travel distance increases dramatically with longer home-work distance.
- Same observation for travel time

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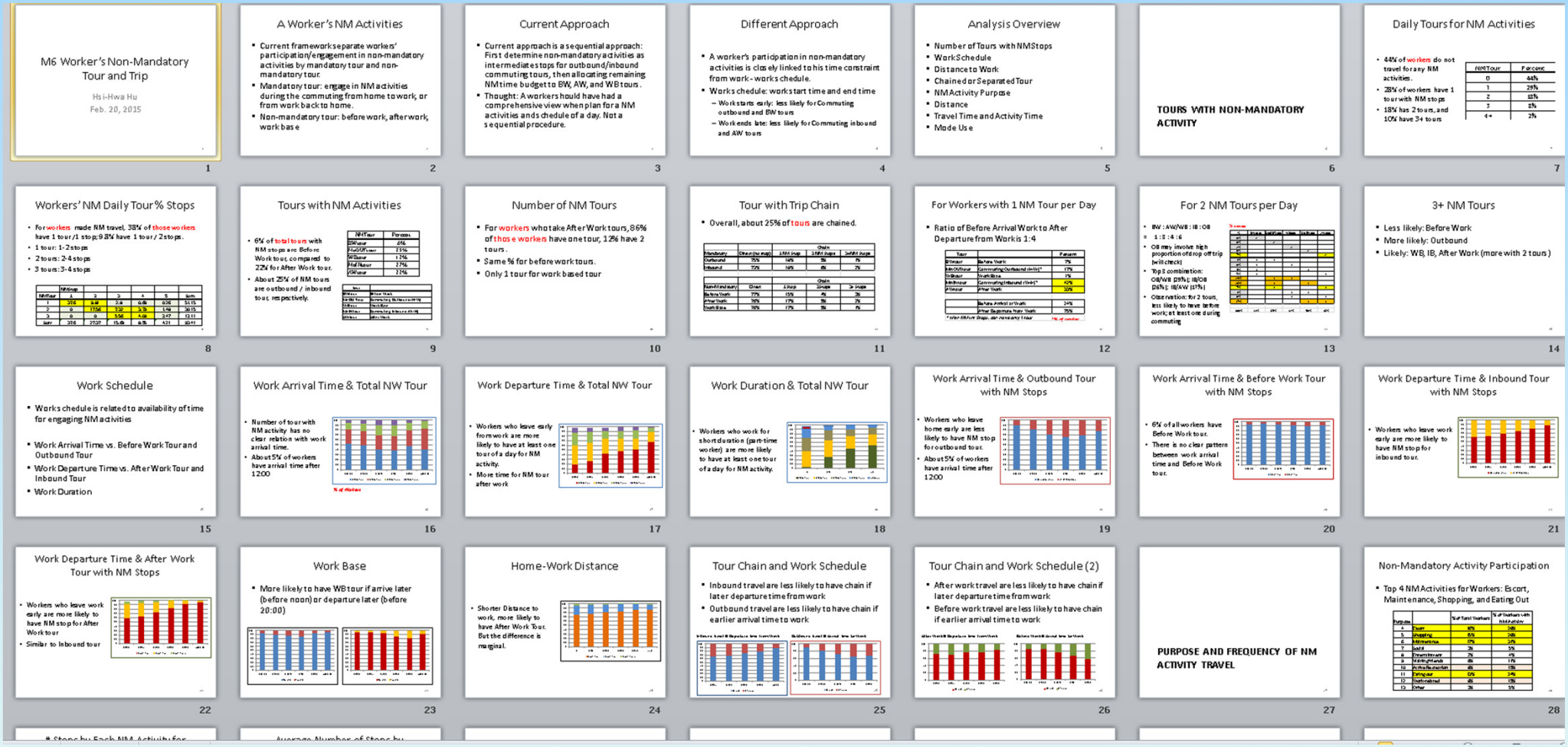
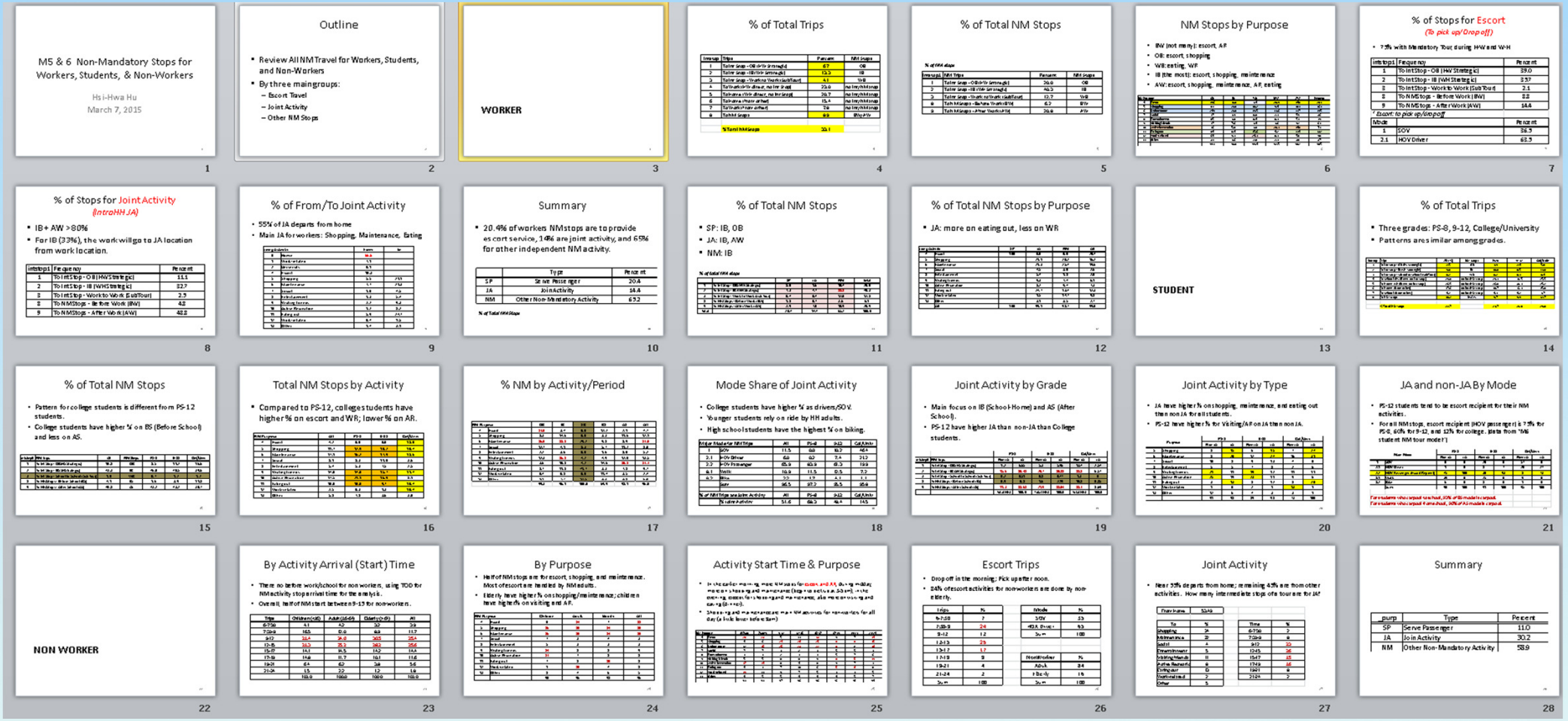
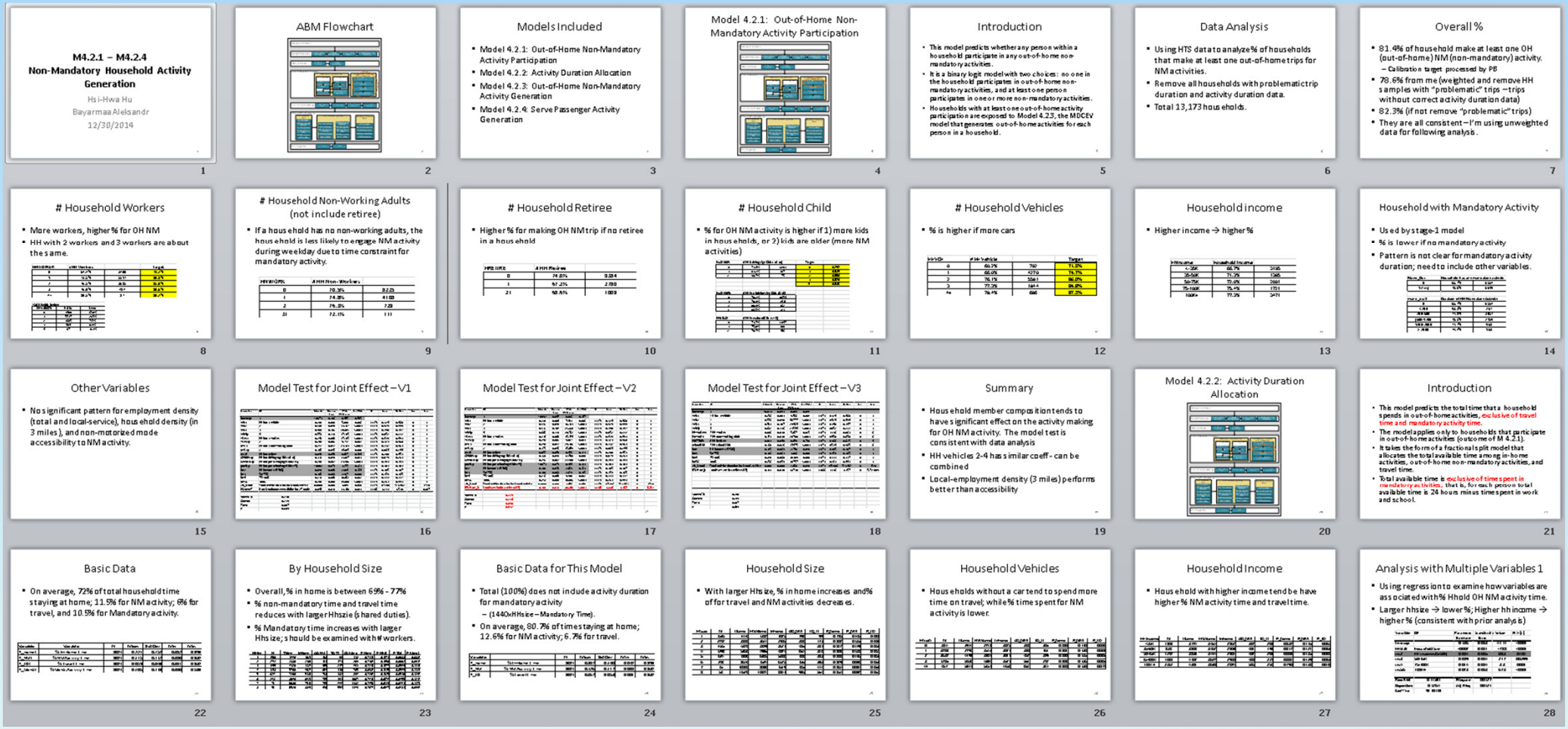
# Examples
# - Worker's Non-Mandatory Tour



# Examples
# - Worker's Intermediate Stops



# Examples
# - Household Activity Generation



# 2. Model Review

Review model estimated by consultants

Based on HTS analysis, examine the reasonableness of:

- Model assumption
- Variable definition
- Explanatory variables

# 3. Model Re-estimate

Based on model review, enhance/re-estimate a model if needed.

- Consultants:
  - Provide training
  - Provide estimation data and script
- Staff:
  - Revise estimation data
  - Re-estimate the model

# 4. Software Implementation

- Prepare model specification to software developer
- Feedback from software developer
- Staff learn software coding
- Model output analysis

# 5. Model Validation

- Staff create validation target
  - Household Survey
  - ACS
  - Other data – CTPP, ATUS, …
- Model calibration / validation

# SCAG Experience

- We started the assessment procedure in Aug, 2014.
- About 80% of models have been reviewed and re-estimated.
- All completed by SCAG staff.
- A painful procedure, but worth it.
- Understand the model much better.

# Conclusion

- The model assessment is a useful procedure for agency staff for ABM development.
- Greatly enhance the understanding of this complicated model.

# Thank you
# Question?

Hsi-Hwa Hu, hu@scag.ca.gov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