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# Managed Access to Cultural Tourism Attractions and the Distribution of Visitor Waiting Time

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**ABSTRACT**

Managed access can enhance in-venue conditions and make visitors spend a significant amount of time outside the venue at a cultural attraction. This paper is interested in that trade-off, not as a technology-performance issue, but rather a tourism policy issue. The 1,856 visit segments and 6,773 exhibit engagements recorded at the MUSE, Trento, in 2022 are published here. An empirically based event simulation examines the difference between unrestricted access, paced admission, a limit on the number of people allowed in the gallery, limits on exhibits and a combination of the two and the original access under the same demand. Two hundred replications are used for each demand condition to measure queue location, completion and illustrative itinerary time budgets. Combined control is optimal in terms of gallery attendance, eighteen active visits at 180 entries/h, but with a mean waiting time for the tail of the distribution of 66.59 min, 63.84% of visits last more than 30 min from arrival to exit. Exhibit control results in 1.11 min of tail waiting without enforcing the gallery control. Later-period visit patterns result in a combined-control tail waiting time of 93.87 min. The results indicate the importance of considering access costs distribution along with loading reductions for destination and attraction authorities. The proposed policy solution ties up capacity to clear booking data, facilitates access, and records visitor results. The effects of policies and capacities of safety are not observed, but rather simulated.

**Keywords:** Cultural Tourism, Visitor Management, Managed Access, Tourism Carrying Capacity, Visitor Experience, Destination Governance
**JEL Classifications:** M14, L83

## 1. INTRODUCTION

People are waiting elsewhere and a cultural attraction looks less crowded. This prospect adds to the difficulties of using admission quotas as a tool for sustainable tourism. The people outside of the destination still experience the destination, use up some of their available time at the destination, and may have to arrange for the next mode of transport or booking at the destination. A policy that offers a positive impact on the interior count can thus have a significant access cost without being explicit in its headline policy performance measure.

The understanding of capacity and crowding in tourism has been developing more differentiated. Bang and Jang (2025) call for using visitor utility in carrying-capacity analysis. Luo et al. (2025) draw together the studies about the perceived crowding and tourist satisfaction, and Mashkov and Shoval (2025) differentiate between subjective and objective reactions to crowd. These studies make it difficult to justify a simple, one-size-fits-all target for visitors as a measure of success. They also pose a practical question: how should a destination assess a control that enhances one aspect of their visit and detracts from another?

Managed-access systems are appropriate places to address that question. In the article, Creany et al. (2024) examine attitudes towards timed entry at Rocky Mountain National Park. Wheeler et al. (2025) explore the relationship between experience characteristics and coping strategies and support for access management at Arches National Park. They have settings that are not the same as an indoor attraction, but both integrate access

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control into the visitor's experience, not as a purely administrative action. An admission cap is another form of opportunity allocation, one that is imposed upon a museum that can be visited by both the tourist and the resident as well as the educational visitor.

This paper explores access control's effect on the distribution of waiting time in a cultural attraction journey. The empirical setting is one of the exhibition rooms of the science museum MUSE (Museo della scienza) in Trento, Italy. Public tracking data enables fully formed and completed visit templates, such as exhibit selections, engagement time and time between engagements. Those templates are utilized in controlled policy scenarios when analysis is used. It poses the question of whether the reduction in loading of the gallery/exhibit is coupled with an increased visit-time waiting time to enter, delay in completion time, or increased likelihood of violating an illustrative visit-time budget.

The findings highlight very distinct policy mechanisms. Exhibit level controls generate a relatively small amount of extra wait time but do not impose any limits on the number of people able to be present in the gallery. Its limited occupancy requirement is enforced by a gallery admission limit, but shifts much of the burden to the entrance when there is a high demand. The trade-off mentioned above does not go away when you use both controls together. Nearly two thirds of the simulated visits exceed the 30-min arrival-to-exit budget in combined control compared to approximately one per cent in unrestricted access.

The tourism contribution is related to the appraisal boundary. This includes a full arrived cohort, unfinished visits after the demand window and separates local control engagement from overall gallery presence. The operational results are then linked to the role of attraction managers and destination organizations. The study does not assume that the presence of a queue equals tourists' satisfaction, nor suggest that there is an optimum carrying capacity, nor even state that all museum visitors are tourists. It provides information on how a tourism policy will impact on access, which it should reflect before embarking on a tourism policy that involves a reservation or admission.

## 2. MANAGED ACCESS AS A TOURISM GOVERNANCE PROBLEM

### 2.1. Capacity Decisions and the Quality of the Visit

Capacity is also a form of judgement as to which conditions a destination is looking to protect. Indicators may vary for space, conservation, accessibility and opportunity to engage with an attraction. That judgement can be enforced with a numerical limit, but it cannot be legitimate because of the limit's enforceability. Dilshan and Nakabasami (2025) integrate management strategies into the broader context of economic, environmental and sociocultural issues related to overtourism. The takeaway message for an individual attraction is to define a problem to be addressed by a control before choosing the number that will be enforced by the control.

Engagement opportunities are especially relevant in the context of cultural tourism. Even if the gallery area is large enough for more visitors, an exhibit may have only a limited number of interactions at any one time. That opportunity can be arranged by a local queue. But the same queue also takes a longer time to serve the people in the common space, and can even be counterproductive to another goal, such as reducing the number of persons in the gallery. The distinction between an engagement opportunity and a common space constraint is the impetus for the policy comparison developed in the next section.

An additional dimension is the visitor's interpretation. The adaptive responses to perceived tourist crowding are explored by Yin et al. (2024), who suggest that individuals might alter their actions or behaviors instead of simply enduring a predetermined visit. Our model keeps the planned visit in place so as to isolate the rules mechanism. It does not therefore estimate satisfaction nor do it estimate an empirical behavioural response to new controls. The importance of this is to reveal the quantity and whereabouts of the waiting that would occur if the intended engagement were to remain.

### 2.2. Waiting Time and Access to Destination Experiences

Waiting time can diminish the benefit of admission. A delayed arrival may have different repercussions for different visitors who have scheduled a return trip, have a companion who cannot depart at the same time or are otherwise scheduled to arrive later. These examples illustrate reasons why it is important for a destination to track the length of its visitors' stay, but the source data do not identify those constraints for individual persons. Here the 30 and 60 min budgets are illustrative scenarios for the monitored gallery visit and do not represent preferences, or standards for acceptable waiting.

Access also does not stop at those who do manage to access. The researchers Smith et al. (2024) focus on the perceptions of protected-area management actions by stakeholders in gateway communities. Their research warns against using the site operator's internal indicators as the boundary of governance. Any potential impact to nearby businesses, public space and residents would be an additional observation for an urban attraction. The present model does not register waiting time on the street when entering and does not estimate the impact of this waiting time on other streets.

It is not a self-evident policy option to divert people away. In an investigation of the potential of alternative local tours as a dispersal strategy, Zuckerman Farkash et al. (2024) conclude that there are several constraints. There is no guarantee that a visitor, who loses an hour at the door of a museum, will get a comparable cultural experience in the proximity of that museum. Any alternative that is proposed needs to have appropriate activities, credible information and realistic consideration of visitor choice. This study therefore keeps all of the demand that arrives, instead of considering the visitors who are displaced or do not finish the visit as a gain.

### 2.3. Responsibilities Across the Attraction and Destination

The conditions which control admission and service arrangements are governed by attraction operators, whilst destination

organizations coordinate a broader range of actors and communicate an offer of the destination. Governance, work of destination management organizations and the use of data are among the concerns of destination management today, as highlighted by Laesser et al. (2025). This is a point of division of responsibility since an attraction can impose a restriction, but the destination may be promoting a frictionless travel itinerary, which is not helpful.

A useful preliminary diagnostic compares offered visit work with the selected gallery allowance. Let λ denote arrivals per hour, *E[S]* the mean intended visit duration in minutes and *C* the permitted active gallery population. The dimensionless load index is

$$\rho = \frac{\lambda E[S]}{60C} \quad (1)$$

For the empirical mean E[S] = 7.743 min and experimental bound C = 18, the designed arrival rates $\lambda \in \{60, 120, 180\}$ imply $\rho \approx 0.43, 0.86, 1.29$, respectively. The condition $\rho > 1$ means that average intended visit work exceeds the available gallery place-time before exhibit waiting is added. With continued stationary inflow, no abandonment and preserved intended visits, a lossless admission rule cannot sustain a bounded entrance backlog in that case. The actual experiment has a finite arrival window, so the corresponding consequence is accumulated waiting followed by clearance. Conversely, $\rho > 1$ does not guarantee a short queue because arrival variability and internal delays remain relevant. This diagnostic explains a mechanism; it does not estimate a safety capacity or replace the event simulation.

The real issue isn't whether simulation should take the place of public judgement. It is the number of quantities that decision makers should look at before making a decision. Bukhari (2025) shows the importance of the visitor-journey simulation in a limited tourism environment. In this case the analysis is focused on three policy questions: first, where is waiting building up, second, what proportion of the incoming patient population is completing within the demand window and third, how responsive is the level of demand to visit patterns. Even with the preferred rule, a capacity objective is needed that is independently justified, and an assessment of visitors acceptance must be made.

## 3. RESEARCH DESIGN

### 3.1. Cultural Attraction Data and Observation Boundaries

The data have been provided by the public release of MUSE along with the paper by Vecchia et al. (2026). Observation dates are June 21, 2022 - September 08, 2022. Because the analysis is not about the operations of the museum, release and collection dates are explicitly indicated as separate. The area being monitored has forty two exhibits and is not the entire area or museum visit.

One thousand eight hundred fifty six continuous visit segments were created from one thousand three hundred ninety six anonymized identifiers over fifty seven recording days. The first and last known position of a segment is the start and end points. These boundaries have been joined to 6,773 exhibit engagements labelled by providers. The mean segment duration is 7.743 min, the median is 6.110 min and the mean number of recorded engagements per segment is 3.649. The 403 segments that did not have engagement recorded are included in the analysis as they continue to be present in the common space.

All of the exhibit sequence, engagement times, time before the first engagement, gaps between engagements and time before exit remain on each template. This will keep the observed relationship between route and duration when a template is sampled. The public engagement records were compared with the reconstructed segment boundaries to ensure positive duration, chronological consistency and containment. Providers' labels are considered measures of engagement and not all moments spent waiting are considered independently as perceived crowding.

The source tracking campaign was voluntary, and informed consent and no personal information was collected in the source study (Vecchia et al., 2026). The cohort released is not necessarily an attendance census. The present analysis does not include the information on residency, travel purpose, income, disability and group relationships. As a result, we talk of observed units as visits or visit segments rather than a representative sample of international tourists. The policy application is cultural tourism and the empirical behavioural sample is the use of attractions.

### 3.2. Policy Instruments and Experimental Assumptions

Matched Demand is used to compare five policies. When access is unrestricted, there is no waiting added to the sampled template. Paced admission is a method that adds a minimum of 30 s of headway. The most visits in a gallery are eighteen, with a limit imposed due to admission. Exhibit service limits are two simultaneous engagement places per exhibit with a local "first-in-first-out" queue. Combined control is the application of both the gallery limit and the exhibit service limits. Table 1 distinguishes the mechanism of each instrument.

The numbers of active visits (18) and exhibit places (2) are experimental numbers used for comparison with the effects of common and local constraints. They are not capacities as required by the legislation, engineering limits or anything otherwise that represents MUSE's actual rules. Moving, engaged or waiting inside takes place during an active simulated visit. An exhibit service place is a chance to engage, not a measured square metre of space. These differences make it difficult for the mechanical service limit to be interpreted as a physical safety or visitor comfort level.

The event simulator accepts and processes visits as they arrive, and keeps their scheduled engagement time until the last visitor leaves the cohort. A person not in the gallery is still counted as being in the gallery for the gallery limit. When an engagement is completed, its service place is released, next waiting visit can start, and previous visit's next movement is scheduled. Routes are not redirected, engagements are not shortened and no visitor abandons a queue. The assumptions take into account the results of the chosen rules: They are relaxed in the specified period comparison only.

**Table 1: Managed-access instruments in the simulation**

| Policy | Admission mechanism | Exhibit mechanism | Policy interpretation |
|---|---|---|---|
| Unrestricted | No added constraint | No added constraint | Reference visit pattern |
| Paced entry | 30-s minimum headway | No added constraint | Controls entry rate |
| Gallery limit | At most 18 active visits | No added constraint | Controls total presence |
| Exhibit limits | No gallery constraint | Two simultaneous service places per exhibit | Controls engagement opportunities |
| Combined | At most 18 active visits | Two simultaneous service places per exhibit | Applies common and local constraints |

All limits are experimental assumptions. They are not measured safety capacities or descriptions of actual museum policy

### 3.3. Visitor Outcomes and Scenario Design

Total added waiting is the sum of entrance waiting and all internal exhibit waits. Equation (2) distinguishes requested gallery arrival a, admission g and internal waits q for visit i under policy P:

$$W_{ip} = \frac{g_{ip} - a_i + \sum_{k=1}^{Ki} q_{ikp}}{60} \quad (2)$$

Arrival, admission and internal waiting are recorded in seconds; W is expressed in minutes, and K is the number of exhibit engagements in a visit. The analysis reports the mean entrance and internal components separately. Tail waiting is the mean across replications of each run's within-cohort 95$^{th}$ percentile; it is not a percentile calculated by pooling all simulated people. Arrival-to-exit elapsed time adds the template's original duration to the added waiting. For budget B minutes, the scenario exceedance rate is

$$R_p(B) = \frac{100}{N} \sum_{i=1}^{N} I(T_{ip} > B) \quad (3)$$

Here N is the number of arrivals and T is elapsed time in minutes. Exceedance does not necessarily mean that a visitor actually misses transport or leaves dissatisfied. It measures how often the simulated gallery visit would overrun a declared amount of available time. Both 30- and 60-min budgets are used to avoid making a policy conclusion depend on one illustrative threshold.

Other outcomes are maximum active gallery visitors, >2 simultaneous visitors to an exhibit, completion within the end of an arrival window and additional time needed for the cohort to be cleared. Under all policies the completion is gauged for the same cohort arriving at the start of the policy. Service that is completed later is considered "delayed," not "removed by policy. The simulator continues to run after the arrival traffic has stopped, allowing the load to become visible when it is cleared.

Arrivals follow a homogeneous Poisson process during a 4-h window at sixty, 120 or 180 designed visits per hour. These are simulation inputs, not estimated museum inflows. Two hundred replications use seed 2026102701. Each replication resamples the source identifiers as clusters, then samples complete templates from the resulting population. Within a demand condition, all policies receive the same cohort, arrival times and intended visits. Reported 2.5$^{th}$-97.5$^{th}$ percentile ranges describe simulation-input variation rather than confidence intervals for an implemented tourism intervention.

A separate comparison uses the first thirty-nine recording days and the final eighteen recording days as alternative template populations. They contain 1,277 and 579 segments, respectively, without identifiers crossing the split. One hundred replications, seed 2026102702, hold the high-demand arrival stream identical across the two periods and compare exhibit control with combined control. This tests transfer of complete visit patterns; it does not isolate a causal effect of one behavioural characteristic.

### 3.4. Verification and Limits of Inference

Each visit made to arrive must be outside, inside or completed at each visited event to verify. All gallery and exhibit limits must be adhered to, and all visits must have a definite end time. Conserved intended engagement work across matched policies. The total of each person's time in must equal the total of the time in the gallery. These tests are designed to determine if the stated access rules are being followed, but not to approve or disapprove visitors' responses to the rules.

The main inferential restriction is the lack of an observed policy intervention. A fixed route could overestimate waiting time if visitors do not visit the exhibits or are going to leave, while a change might also result in the loss of planned cultural engagement. The model can't determine people's preference. It is used for prospective policy comparison, under explicit assumptions, and reaches conclusions based on access burdens and service completion, but not on unmeasured satisfaction, welfare or equitable treatment.

## 4. RESULTS

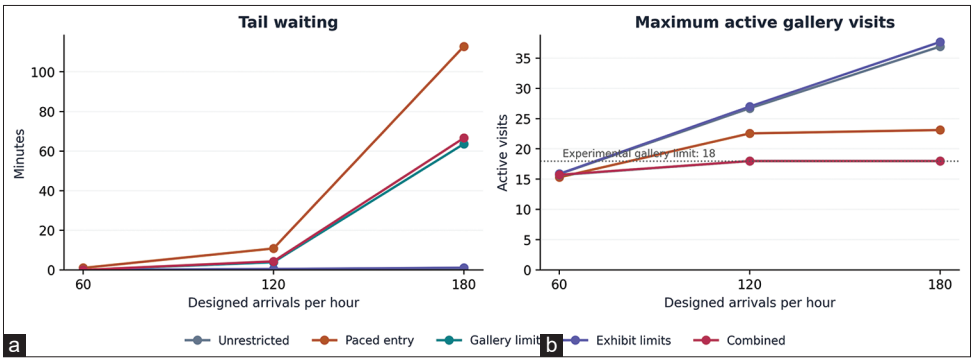
### 4.1. Demand Changes the Cost of an Admission Rule

At sixty designed arrivals per hour, every control has relatively small tail waiting. Combined control produces 0.02 min, while paced admission produces 0.99 min. At 120 arrivals/h, combined-control tail waiting rises to 4.32 min and paced-admission waiting to 10.83 min. At 180 arrivals per hour, the corresponding values are 66.59 and 112.85 min. Figure 1 shows that the access cost of the same rule changes substantially with demand.

The paced rule has a nominal admission capacity of 120 visits/h because of its 30-s headway. High designed demand exceeds that rate, so a large entrance queue is a predictable consequence of the rule. At the intermediate demand, random arrival concentration still creates waiting even though the expected inflow equals the nominal rate. A destination should therefore not treat a rule's hourly allowance as a guarantee of a short queue throughout the day.

A gallery limit works through visit duration as well as arrival timing. Under unrestricted high demand, mean peak gallery presence is 36.92 active visits. The eighteen-visit rule reduces

**Figure 1:** Demand sensitivity of access burdens and gallery presence. Points are means across 200 replications at each designed arrival rate. Tail waiting is calculated within each run before averaging. The dotted line is the experimental gallery limit, not an established safety capacity




that peak to eighteen in every replication, but incoming visits wait for current visits to finish. Adding exhibit controls extends some stays inside and slightly delays release of the same scarce gallery places. The occupancy result and the entrance burden arise from the same service mechanism.

## 4.2. Entrance Waiting Dominates Under Combined Control

Table 2 compares the five policies at 180 designed arrivals per hour. Under gallery-only control, mean entrance waiting is 32.38 min and tail waiting is 63.59 min. Under combined control, entrance waiting increases to 33.85 min and tail waiting to 66.59 min. The combined-control simulation interval for tail waiting is 37.65-93.41 min. Thus, keeping both types of loading below their experimental limits requires a substantial external waiting burden in this scenario.

Exhibit service limits alone yield a different result. Mean internal waiting is 0.17 min and tail waiting is 1.11 min, with no entrance waiting. Mean peak gallery presence is 37.68, slightly above 36.92 under unrestricted access. The local queue delays exit for some visits and therefore increases concurrent presence even though the controlled exhibit overlap becomes zero. That zero is imposed by the service rule; it is not independent evidence that visitors feel less crowded.

Completion by the 4-h endpoint is 96.77% without control and 96.71% with exhibit controls. Gallery-only and combined control reduce it to 76.18% and 75.40%, respectively. Paced entry produces 64.86% completion. All visits eventually exit, but combined control requires a mean of 90.62 additional minutes after the arrival window, compared with 22.14 min without control. A dashboard ending at the 4-h mark would omit much of that postponed service.

Matched replications permit a direct comparison of the same arriving cohorts. Write $Q_{pr}$ for the within-run 95$^{th}$ percentile of total waiting under policy $p$ in replication $r$, and let R = 200. The mean paired increment from exhibit-only control $e$ to combined control $c$ is

$$\Delta\bar{Q}=\frac{1}{R}\sum_{r=1}^{R}(Q_{cr}-Q_{er}) \quad (4)$$

At high demand, $\Delta\bar{Q}$ = 65.49 min, with a 2.5$^{th}$-97.5$^{th}$ percentile range of 37.19-91.97 min across paired differences. This range describes simulated input variation, not a confidence interval for an observed intervention. Over the same runs, mean peak presence falls from 37.675 to 18.000, a reduction of 52.22%. Four-hour completion under combined control is 21.37% points below unrestricted access. These calculations quantify distinct consequences of a rule; the reduction in peak presence does not cancel the additional waiting or completion loss.

Figure 2 examines the variation concealed by policy means. Panel (a) shows the paired tail-wait increment rather than a mixture of unrelated cohorts. Its median is 64.91 min and its middle half spans 56.69-76.53 min. The sample standard deviation is 14.66 min, giving a coefficient of variation of approximately 14.66/65.49 = 0.224. The additional burden is therefore substantial across the central distribution, although individual designed runs differ materially. All 200 high-demand differences are positive. That frequency concerns these simulated runs; it is not a population probability of policy success or an empirical significance test.

Panel (b) expresses postponed completion as a cumulative distribution. Let *Dr* be unrestricted completion minus combined-control completion, in percentage points, for replication *r*. The empirical cumulative distribution is

$$\hat{H}(z)=\frac{1}{R}\sum_{r=1}^{R}I(D_r\le z) \quad (5)$$

The completion-loss median is 21.44% points, and its central 95% simulation range is 12.88-27.93% points. Because $\hat{H}(0)=0$, none of the 200 designed runs produces a zero or negative loss. The mean of 21.37% points is consequently not driven by a small set of adverse runs. Operationally, the figure distinguishes two burdens: Some people experience especially long waits, while a wider portion of the cohort finishes after the reporting endpoint. The distributional evidence strengthens the case for reporting completion alongside waiting, while remaining conditional on preserved visits and no abandonment.

These examples explain the regulation of engagement versus the control of shared gallery use. Policy covering individual exhibits regulates gallery wait times. At their present values, both exhibit and combined policies are unable to fulfill the eighteen gallery visits policy. In addition, the combined policy

**Figure 2:** Variation in paired waiting and completion outcomes. Designed demand: 180 arrivals/h; 200 matched replications. Panel (a) compares combined with exhibit-only control. Panel (b) compares unrestricted with combined completion by 4 h; pp denotes percentage points. These are simulation distributions, not observed intervention effects

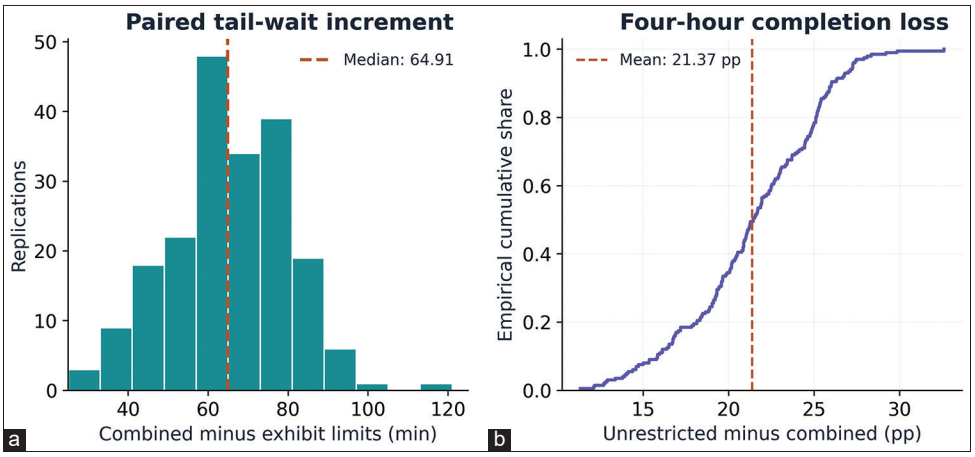



**Table 2: High-demand operational outcomes**

| Policy | Peak active visits | Entrance wait (min) | Internal wait (min) | Tail wait (min) | Completed by 4 h (%) |
|---|---|---|---|---|---|
| Unrestricted | 36.92 | 0.00 | 0.00 | 0.00 | 96.77 |
| Paced entry | 23.12 | 59.66 | 0.00 | 112.85 | 64.86 |
| Gallery limit | 18.00 | 32.38 | 0.00 | 63.59 | 76.18 |
| Exhibit limits | 37.67 | 0.00 | 0.17 | 1.11 | 96.70 |
| Combined | 18.00 | 33.85 | 0.08 | 66.59 | 75.40 |

Designed demand: 180 arrivals per hour for 4 h; 200 matched replications. Entries are replication means. Tail wait is the mean of run-specific 95$^{th}$ percentiles. Every arriving visit is retained until completion

requires a significantly higher cost of gallery use. Independent value judgments on the appropriateness of gallery bounds and the burden imposed by their regulations will need to be made to decide between the policies.

### 4.3. Illustrative Itinerary Budgets Reveal the Scale of Postponed Access

At high designed demand, 1.18% of unrestricted visits exceed a 30-min arrival-to-exit budget. The corresponding share is 1.23% with exhibit controls, 62.15% with gallery-only control and 63.84% with combined control. Paced admission raises it to 80.92%. Table 3 shows that the policy ranking concerns practical access time, not simply whether a visit can eventually occur.

Using a 60-min budget changes the size of the burden but not the broad contrast. Combined control has an exceedance rate of 24.11%, gallery-only control 21.59% and paced entry 55.66%. No unrestricted or exhibit-only visit exceeds 60 min in these replications. The lower benchmark is therefore not solely responsible for the finding that common admission constraints can consume a large part of a visitor's available time.

The added-wait indicator gives a complementary view. Under combined control, 73.64% of visits wait more than 15 min, compared with approximately zero under exhibit controls alone. The available-time scenarios include the original visit duration; the waiting indicator excludes it. Keeping both avoids attributing every long visit to poor access management when some visitors intentionally spend longer engaging with the attraction.

**Table 3: High-demand waiting and itinerary-budget exceedance**

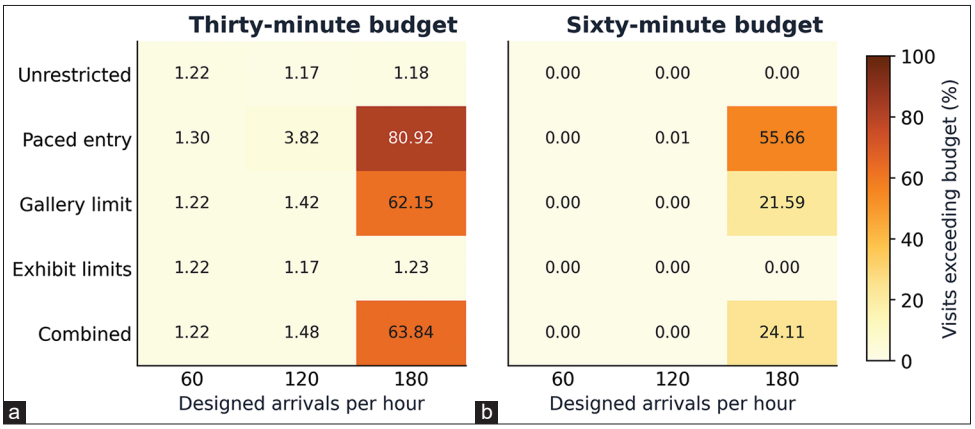
| Policy | Added wait >15 min (%) | Elapsed time >30 min (%) | Elapsed time >60 min (%) |
|---|---|---|---|
| Unrestricted | 0.00 | 1.18 | 0.00 |
| Paced entry | 87.19 | 80.92 | 55.66 |
| Gallery limit | 72.58 | 62.15 | 21.59 |
| Exhibit limits | 0.00 | 1.23 | 0.00 |
| Combined | 73.64 | 63.84 | 24.11 |

Percentages are means across 200 replications. Elapsed time includes original visit duration and added waiting. The 30- and 60-min budgets are illustrative gallery-itinerary scenarios, not measured visitor preferences

A 30-min gallery budget is not a recommended visit length. It is a way to examine the consequences for someone who allocates that amount of time to this part of an itinerary. Tourists may allocate more time, while residents or educational groups may face different constraints. The analysis establishes the size of a simulated overrun for a stated budget, leaving the prevalence and valuation of real itinerary constraints for visitor research.

Figure 3 compares itinerary exceedance across both demand and policy. Each cell is the replication mean of the run-specific share, not a pooled percentage with larger cohorts receiving more weight. Under combined control, 30-min exceedance changes from 1.22% at sixty arrivals per hour to 1.48% at 120 and 63.84% at 180. The first sixty-arrival increase adds only 0.26% points, whereas the second adds 62.36% points. This sharp contrast is consistent with the load diagnostic crossing one between the two upper demand scenarios; it does not identify a statistically estimated threshold.

**Figure 3:** Itinerary-budget exceedance across access policies and designed demand. Cells report run-specific exceedance shares averaged across 200 replications at each designed demand. Colour scales are identical across panels. Original visit duration and added waiting enter both budgets. All values are simulated percentages




Let $\bar{R}_p(B;\lambda)$ denote the replication mean budget-exceedance percentage for policy $p$, budget $B$ and designed demand $\lambda$. A finite-difference response is

$$m_p(B;\lambda_0,\lambda_1)=\frac{\bar{R}_p(B;\lambda_1)-\bar{R}_p(B;\lambda_0)}{\lambda_1-\lambda_0} \quad (6)$$

For combined control with B = 30, the response is 0.00435% points per additional hourly arrival between sixty and 120, compared with 1.03928 between 120 and 180. These are secant slopes across designed scenarios, not derivatives of an estimated demand curve. Their difference shows why a linear extrapolation from the lower-demand setting would understate high-demand overruns. The 60-min panel provides a second check: combined-control exceedance is zero in the two lower-demand scenarios but 24.11% at high demand. Paced admission is particularly sensitive, reaching 55.66% under the longer budget, while exhibit-only control remains at zero. A longer itinerary allowance reduces the measured burden but does not remove the distinction between entrance constraints and local exhibit regulation.

## 4.4. Visit Patterns Affect the Portability of Policy Results

With earlier-period templates, combined-control tail waiting is 55.36 min at the high arrival rate. With later-period templates, it is 93.87 min. The share exceeding the 30-min budget rises from 56.66% to 73.14%, and 4-h completion falls from 78.39% to 69.16%. Figure 4 reports the difference alongside the exhibit-only comparison.

Exhibit-only tail waiting also increases, from 1.01 to 1.83 min, while 30-min exceedance rises from 0.49% to 2.87%. The later template population changes complete visit patterns, including route and duration; the result does not attribute the difference to one behaviour. It shows that a rule calibrated to one observation period can have materially different access consequences when the attraction's visit population changes.

The proportional change in mean tail waiting provides a compact transfer diagnostic. With $\bar{Q}_{early}$ and $\bar{Q}_{late}$ denoting period-specific simulation means under combined control, define

$$s_Q = 100 \times \frac{\bar{Q}_{late} - \bar{Q}_{early}}{\bar{Q}_{early}} \quad (7)$$

The calculated value is $SQ = 69.56\%$, using 55.362 and 93.872 min before rounding. Identical designed arrivals therefore coexist with a substantial change in the burden generated by the two template populations. The ratio is a descriptive comparison of complete visit patterns, not an elasticity with respect to one behavioural parameter or an estimated seasonal effect.

The period comparison is especially important for tourism planning because forecasts of arrivals alone leave part of service demand unspecified. Expected entries can remain the same while time spent at exhibits or elsewhere inside changes. Under a binding common-space constraint, those changes alter how quickly waiting visitors can enter. Updating arrival estimates without checking the visit-duration distribution can consequently leave a destination's waiting-time information misleading.

## 4.5. Multiple Objectives and Conditional Policy Dominance

Figure 5 relates the operational results to explicit decision criteria. In panel (a), a policy has a better two-outcome profile when neither mean peak presence nor mean tail waiting is higher, and at least one is lower. Under that restricted comparison, gallery-only control has the same mean peak of eighteen as combined control but 3.00 min less tail waiting. Unrestricted access also has lower values of both summaries than exhibit-only control: 36.920 < 37.675 active visits and 0 < 1.106 min. Thus, more restrictive controls need not improve every operational measure. The two non-dominated summaries are unrestricted access and the gallery limit.

This ordering is incomplete when exhibit engagement is an additional requirement. Gallery-only control does not enforce the two-place exhibit rule, and unrestricted access enforces neither limit. Their apparent advantage on the plotted pair therefore cannot establish overall policy superiority. A feasibility screen must precede any ranking. The figure deliberately retains the dominated summaries because they expose the consequence of

**Figure 4:** Transfer of visitor outcomes between observation periods. Designed demand is 180 arrivals/h. Points are means; whiskers show the 2.5th-97.5th percentiles across 100 replications, not causal-effect confidence intervals. Earlier and later template populations share arrivals within each replication

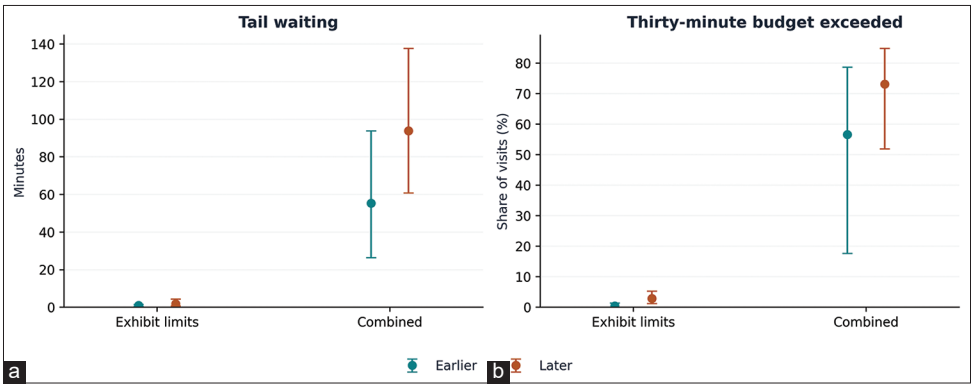
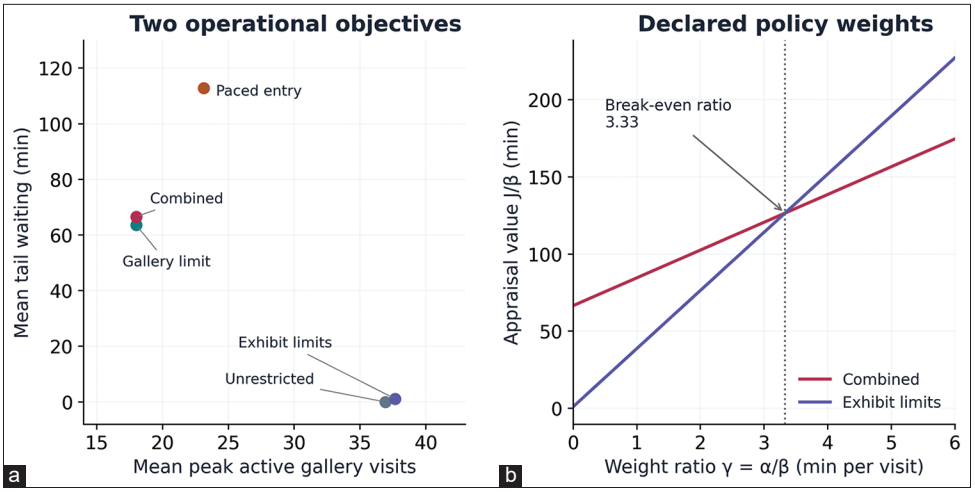



**Figure 5:** Operational trade-offs and sensitivity to declared policy weights. Panel (a) displays replication means at 180 designed arrivals per hour. Panel (b) compares two selected alternatives under an illustrative appraisal function. The two-outcome ordering omits exhibit engagement constraints; feasibility must be assessed separately. The weight ratio is not an estimated visitor valuation




adding an omitted constraint; they should not be silently discarded from destination appraisal.

For choices that are discretionary, the operational trade-off can be stated explicitly. Let $\bar{L}_p$ be mean maximum active presence and $\bar{Q}_p$ mean tail waiting. A transparent, illustrative appraisal function is

$$J_p = \alpha \bar{L}_p + \beta \bar{Q}_p \quad (8)$$

Here $\alpha \geq 0$ and $\beta > 0$ are declared policy weights, with units chosen so that the two terms are commensurable. Comparing combined and exhibit-only control gives $J_c < J_e$ when the weight ratio exceeds approximately $\alpha/\beta$ = 3.33 min/unit of peak active presence, calculated as 65.485/19.675. This is a break-even weight ratio for these two simulated alternatives, not an estimated valuation of visitors' time. If C = 18 is an independently binding safety or conservation requirement, exhibit-only control is infeasible and should be excluded before weighted comparison. A weighting exercise cannot override that requirement. Where both alternatives are feasible, reporting the ratio makes the judgement behind a preference open to scrutiny.

Panel (b) makes this sensitivity visible by setting $\gamma = \alpha/\beta$ and plotting $J_p / \beta = \gamma \bar{L}_p + \bar{Q}_p$. At $\gamma$ = 2, the appraisal values are 102.59 for combined control and 76.46 for exhibit-only control, so the latter has the lower weighted cost. At $\gamma = 4$, the corresponding values are 138.59 and 151.81, reversing the ordering. The intersection at approximately $\gamma$ = 3.33 is the declared weight at which the two alternatives tie. The result does not select a socially optimal weight: it identifies precisely how a conditional recommendation depends on the judgement attached to peak presence relative to tail waiting. If a hard gallery limit is mandatory, the comparison reduces to the feasible alternatives regardless of the plotted intersection.

## 5. IMPLICATIONS FOR CULTURAL TOURISM POLICY

### 5.1. Evaluate the Visitor Journey Rather than One Interior Indicator

There is evidence that managed access can accommodate even higher volumes of people. An honest report must contain data on visitors' waiting times, completion times and cleaning times, as

well as the occupancy of rooms and the loading of exhibitions. Without it, an operator might be able to satisfy the occupancy requirement at the expense of visitors' experience for the greater part of their journey. My analysis here has been about an examined gallery, but this principle of accountability can also be tested in other visitor attractions by using a new set of data thresholds.

This study helps explain visitor carrying capacity. It focuses on the quantity of people visiting, while others in the field look at the quality of visitors' experience. This study shows the data that will be needed to guide the decisions around visitor capacity. The data I provide does not have a value attached to it, and does not suggest a certain level of capacity that should be set, but others have previously suggested setting capacity levels. I argue that directly measuring what the visitor finds acceptable is what is required, along with a range of operational measures.

There are many public service elements at visitor attractions, like queues, which exist in the public space and affect the way people can interact with public space. Many of the negative impacts and interactions that these elements might cause, cannot be understood through these data. Attraction operators can use this simulation to help guide the breadth of observations needed. Attractions themselves will need to provide context around the operating parameters, the data and reasoning that they use to support their limits.

### 5.2. Couple Booking Promises to Feasible Access Arrangements

The effectiveness of booking slots is constrained by a disconnect between a public announcement of the system and the method of booking. A 30-s booking slot does not ensure admission as visitors will exceed the system's capacity, thus, the visitor demand to wait for entry will far exceed the booking system's constraints. Visitors need to know how the attraction manages admissions, wait times, what happens if a visitor is late, and the attraction's liability if they fail to provide the reserved entry.

Visitors will understand these systems because booking is similar to purchasing goods online and waiting to receive those goods. Using similar systems for admission and visitor expectations will provide a consistent message to visitors about the rules and services provided to them. Researchers, for example Creany et al. (2024), support admissions as a way of managing volume, but these researchers provide visitors a reason to support admissions through the messages they provide visitors. Attraction operators will collect and evaluate the comments of those that did not obtain an accessible booking, to evaluate if the services provided to these people met expectations. Unlike the model's prediction of a numeric booking rule being enforceable.

Assisted booking and providing an accessible information channel will improve admission and visitor expectations, and so will addressing late arrivals. Late arrival booking and cancellations and remedies will impact the system of admissions, therefore the fairness of this system needs to be assessed. This will evaluate the reservation systems' distributional fairness in contrast to being an evaluation of a booking rule's efficiency. Reservation systems using first-in-first-out will create a booking rule and not ensure visitors can book their reservation. This will result in a visitor's access being restricted to their wait time. This, of course, does not provide reservation systems equitable access.

### 5.3. Make Capacity Choices Accountable and Reversible

The waiting results are not optimized on purpose out of the eighteen-visit gallery limit. Increasing it may reduce queues but with the cost of a separate objective of conservation, accessibility or safety not measured by the model. Or else, accepting a very restrictive limit, without reporting its external costs, would also not be complete. The capacity should be justified by the relevant assessment, and the consequences of working within that capacity should be identified through the service model.

A destination program can create a review process that connects attraction personnel, tourism bodies and users who will be affected. It may need a reason for the threshold, a memory of observed waiting and completion, and a rule for revising the admission schedule when performance declines. In Laesser et al. (2025) destination governance is conceptualized as a coordination problem. This case identifies the quantities that need to be coordinated at the attraction interface. The suggested process does not empower a marketing organization to override a set safety limit.

Alternatives should be regarded as real tourism products and not as a residual demand. A cultural walk, or a different museum, or a different entry period may help some visitors, but their feasibility needs evidence of travel time, interests and availability. The limitations identified by Zuckerman Farkash et al. (2024) render automatic dispersal assumptions especially weak. The present results favor the explicit accounting of postponed access before alternatives are represented as equivalent benefits.

## 6. CONCLUSION, LIMITATIONS AND FURTHER RESEARCH

Regulating presence in a cultural tourism attraction involves distributing waiting. This study shows that the controls and common admission constraints at the local level of the museum have significant impacts on the tourism-service outcomes, based on publicly available museum visitation patterns. At high designed demand, combined control enforces both experimental limits but produces 66.59 min of tail waiting and a 63.84% rate of exceeding an illustrative 30-min gallery budget. Exhibit control alone produces little waiting while leaving the gallery population unconstrained.

The results impose a requirement on policy statements on less crowding at attractions. Interior loading should be evaluated along with delayed entry, graduation and clearance time of the incoming cohort. When numbers of visitors are fixed, changes in visit patterns can have significant impacts on these burdens. The policy of cultural tourism should be integrated to the capacity decision, the information on booking, and the evaluation of the

visitor-experience during the journey, as the controlled interior shouldn't be misinterpreted as enhanced access for the journey.

The analysis is for fixed intended visits. As the behavioral question explored by Yin et al. (2024) indicates, visitors may respond to crowding by avoiding exhibits, decreasing time spent, coordinating as groups or dropping out of queues. Such adaptation may reduce waiting while changing the cultural experience. Future intervention studies should assess both outcomes. It would be misleading to add an assumed abandonment rule and call the resulting shorter queue an empirical improvement.

The behavioral sample is selective and retrospective. It does not provide any information for being able to make separate estimates for tourists, residents, families and those who have accessibility requirements. The period experiment is one type of transfer risk and the sample selection is not corrected; it also does not provide for seasonal representativeness. The number of designed inflows has nothing to do with a census of the number of museum visits. Findings should be subsequently shared in an appraisal manner and as a mechanism, not as predictions to another goal.

The service model also does not include physically located queues, conservation damage and destination expenditure. The concept of engagement overlap does not mean interpersonal density. No result considers a safe occupancy, an optimal ticket price, the increase of the satisfaction of visitors and the reduction of over tourism in Trento. The evidence required to evaluate those more general outcomes would be the ability to connect all-visitor counts, waiting observations and visitor-reported experience.

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