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Costs for passengers and airlines due to the significant delays and other irregularities at European airports in the 2022 summer season

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Abstract

In the 2022 summer season, severe flight delays, lost luggage and other irregularities were recorded at a number of European airports. Staff cuts during the COVID-19 pandemic, a fairly strong recovery in the aviation sector in 2022 and resulting staff shortages were identified as the main causes. However, some airports (e.g. in Southern Germany) appear to have managed these problems better than others. Such severe delays and other irregularities in air transport cause economic damage for different stakeholders, especially for airport operators, airlines, the (federal) police, ANSPs (air navigation service providers), ground-handling and security service companies, as well as for the travelers themselves. In this paper we evaluate the key causes for, and economic effects of the recorded irregularities for the passengers and airlines. As a first step, literature on the economic impact of delays in air transport is analyzed. In a second step, available data is used to quantify the delay situation in the summer period of 2022 for selected flight routes and airports. After this, the value of time damage is estimated for flight passengers based on the selected flights. This is complemented by a delay cost estimation for the airlines serving the affected airports. The paper closes with recommendations for improvement.

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Keywords: Airport stakeholder management; transport economics; flight delay; passenger value of time

1. Background

In the summer of 2022, massive delays, cancellations and other irregularities occurred at various European airports. For example, passengers at Cologne-Bonn and Düsseldorf airports had to spend many hours in queues on some days,

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and there were more than 2,100 flight cancellations in the German state North Rhine-Westphalia alone in the period from mid-May to mid-July (Parliament Nordrhein-Westfalen, 2022). This was not a purely German problem; for example, London Heathrow and Amsterdam Schiphol airports were equally affected. Among the causes cited were staff shortages as a result of job cuts during the COVID 19 crisis. Despite these reasons, which appear to apply throughout Europe, these problems were apparently better managed at some aviation locations than elsewhere, such as airports in southern Germany.

Such a situation is not just annoying for passengers, airlines and airports, but also causes economic damage due to the severe delays, missed flights, lost baggage and flight cancellations. Such damages are incurred by various stakeholders:

a) Passengers as a result of lost vacation time (private travelers) and missed business appointments (business travelers). Here, the Value of Travel Time (VTT) or Value of Travel Time Savings (VTTS) must be assessed differently depending on the passenger segment. If applicable, costs for unused flights and hotel nights, if not reimbursed, as well as costs for lost or delayed baggage should be added to the time costs.

b) Airport operators as a result of the additional costs of providing information and supplies to passengers during waiting times, as well as lost airport charges due to flight cancellations. In addition, there are image losses, which are difficult to quantify, and thus a possible partly loss of passenger demand.

c) Airlines firstly through possible obligations to pay compensation or ticket price refunds to passengers affected by the significant flight delays and cancellations. If flights are missed by passengers because they are still in queues or similar at the time of departure, the legal situation is unclear, as the government, not the airport, is responsible for the controls. Secondly, and easier to quantify, there are also additional operational costs for the airlines due to the delays in their planned flight schedules. In addition, airlines may also experience image losses due to the delays at airports. However, the effects of these image losses are difficult to estimate quantitively.

d) Federal police, security service providers at the airport as well as ANSPs (air navigation service providers) as costs for additional personnel that may be required or overtime for existing personnel may occur.

These additional costs (a - d) are offset by any additional revenue generated by the operators of airport stores and parking facilities. These additional so-called 'non-aeronautical revenues' may be derived by passengers staying longer at the airport.

The problem of severe irregularities in the summer 2022 period is of overarching importance, as it leads to overall economic damage. Moreover, the complexity of the investigated issue is not only in the terms of stakeholders affected, but also in causes of delays and processes in air transportation.

Against this background, in the second section we analyze the publicly available literature on delays and delay management. In section 3 we provide an overview of which stakeholders interact at an airport and the reasons why delays and other irregularities can occur. Section 4 is dedicated to the quantitative approach to the delay situation in summer 2022 and its causes. In section 5 we estimate the economic damages of significant delays and flight cancellations in the summer of 2022 both for the affected travelers and airlines. Finally, in section 6 we develop recommendations for improvement.

2. Literature review

In literature, the economic impact of passenger waiting times and delays at airports has been studied in a variety of contexts, but - at least to our knowledge - not for the summer of 2022 irregularities.

Ishutkina et al. (2008) examined the interactions between air travel and overall economic activities. The authors found that in developed air transportation systems such as the U.S., the cost of delays adversely affects economic development, particularly at the regional level.

Zou and Hansen (2014) studied the impact of flight delays on airfares and flight frequencies. Their results indicated that airlines tend to pass on delay costs to passengers through higher fares, and that delays can lead to an increase in flight frequencies. Chen et al. (2018) published an empirical study on the impact of flight delays on China's economy. The results showed, among other things, that the total economic effects of air traffic delays on the Chinese economy were approximately US$3.6 billion (350.71 billion yen) in 2013. In comparison, the effects of flight delays in the United States were estimated to be between US$4 billion and US$9.6 billion in 2007.

Graham (2005) introduced KPIs (key performance indicators) for airport benchmarking. These include airport operational performance in terms of delays (percentage of delayed departures), availability of passenger and baggage handling equipment (elevators, people movers, and trolleys), check-in waiting time and queue length, security checks and border control, and baggage handling (baggage delivery time). Empirical delay data for such benchmarking is published by organizations such as the International Air Transport Association (IATA), the UK Civil Aviation Authority (CAA), and the Association of European Airlines (AEA). Benchmarking can help to improve regulatory frameworks, such as those related to service quality. Cohen and Coughlin (2003) analyzed airport congestion and the economics of airport expansion. In particular, they developed a cost-benefit analysis for the proposed expansion of the Lambert-St. Louis International Airport in light of expected passenger delays. As a result, the airport expansion lead to net savings from avoided delays. Britto et al. (2012) estimated the impact of flight delays on social welfare based on econometric modelling. They concluded that flight delays in the U.S. impose significant costs on passengers and U.S. airlines, and that airline delay costs are three times higher than passenger costs.

Prager et al. (2015) focused on the macroeconomic impact of waiting times at four international U.S. airports, specifically examining the effects of reduced waiting times at passport control under two scenarios. In the first scenario, an additional Customs and Border Protection officer is added to each of the 14 checkpoints, while in the second scenario, waiting times at the checkpoints are reduced by a flat-rate of 50%. Using a general equilibrium model for the U.S. economy, they found that hiring an additional 14 officers at the four airports would increase the U.S. GDP by $4.5 million to $11.7 million, which equates to an additional 36 to 93 jobs across the economy. Similarly, a 50% reduction in waiting times would increase the U.S. GDP by $81.5 million to $260.7 million, equivalent to creating 651 to 2,152 new jobs for the U.S. economy.

3. Stakeholder at an airport

Passengers and the public often believe that an airport is a single company responsible for all ground-based processes related to air traffic. However, this is not the case. Kemppainen et al. (2007) provide an overview of basic processes, stakeholders and their cooperation possibilities at an airport (Fig. 1).

In the airport terminal, the most important control points include passenger check-in with the respective airline, baggage check-in, and security checks for passengers and baggage. Catering, stores, e.g. duty-free stores, cafés and restaurants generate additional revenue from passenger sales in the terminal. Furthermore, there are the processes directly related to the aircraft, such as boarding passengers at the gate, loading baggage and catering onto the aircraft, and other operational processes that have to take place until departure.

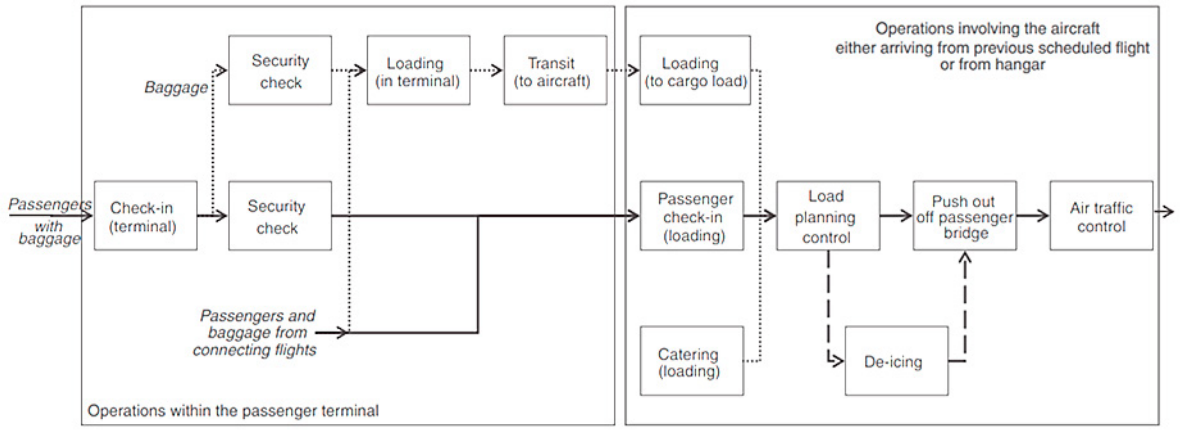

Fig. 1. Key airport stakeholders and ground-handling processes. Source: Kemppainen et al. (2007).

The airport operator, for example Royal Schiphol Group for Amsterdam, Rotterdam and Lelystad airports, is responsible for capacity and operational planning to ensure smooth and safe airport operations as well as compliance with all airport regulations. In this context, it is the responsibility of the airport management, partly in compliance with EU legal requirements, to approve external and internal service providers as well as personnel for operational processes on the airport premises. Agreed service contracts with external partners are generally defined by service level agreements (SLAs). By contrast, border control, for example, is a sovereign task of the Federal Ministry of the Interior and is therefore the responsibility of the Federal Police as the supreme aviation security authority on site. The same applies to aviation security checks on passengers and hand baggage. The Federal Ministry of the Interior lays down specific requirements for the type of screening measures and the equipment used. The personnel of the contracted security companies carry out the checks on behalf of the Federal Police. Therefore, smooth cooperation between the various stakeholders is particularly important to minimize the occurrence of passenger delays during the various processes prior to departure.

4. Overview on the delay situation in summer 2022 and its causes

The severe irregularities at a number of European airports in the summer season of 2022 have been intensively discussed in the daily press. Since empirical data on this topic is not publicly available at the level of individual airports, the authors of this paper planned to conduct expert interviews with selected airport and airline representatives in Germany. However, only a few company or association representatives were willing to share their data and experiences with the authors. In the meantime, reliable data on the overall delay situation in Europe has been published by EUROCONTROL (2022) which, of course, does not provide data at the individual airports level.

The Central Office for Delay Analysis (EUROCONTROL, 2022) estimates that average air traffic delays in Europe have increased from about 9 minutes per departure in March 2022 to 24 minutes per flight in June 2022 (see Figure 2). This corresponds to a 170% increase in average flight delays. The so-called long departure delays ('long departure delays' = between 60 minutes and 120 minutes) increased from about 2.5% in March 2022 to more than 10% in June 2022 (Figure 3). In the previous year, these 'long departure delays' accounted for just under 2% in the same period. In 2019 (i.e., before COVID-19), the average departure delay for the full year 2019 was 13.1 minutes per flight. Operational cancellation rates for flights were between 1% and 2.5% in 2019.

According to the interviews, the main causes of delays in Germany were staff recruitment problems following severe pandemic-related staff cuts and a shortage of skilled staff compared to 2019, high pandemic-related sickness rates, and deviations from standard processes and turnaround times, including in the security area. A combination of these factors in conjunction with unexpectedly high passenger demand in the summer of 2022 then led to significant subsequent delays and further irregularities.

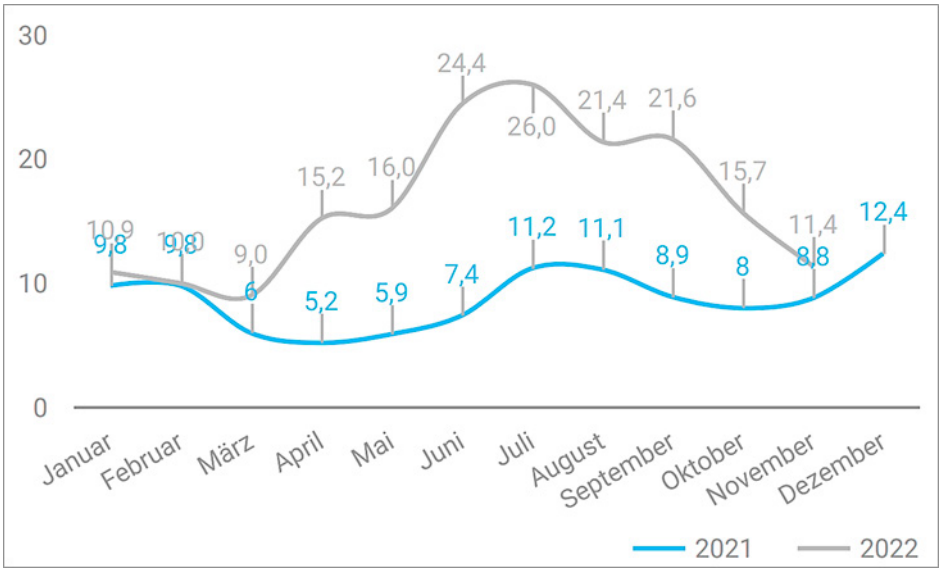

Fig. 2. Average delay on departure (min) for European airports. Source: EUROCONTROL (2022).

It must be taken into account here that overall air traffic volumes in Germany in 2022 were still well below the level of 2019 due to significantly fewer business travelers, lower flight frequencies and a slump in domestic demand. If air traffic demand had fully recovered in 2022, the delays and other irregularities would therefore have been much greater. In addition, the data situation does not permit quantification of waiting times before security or additional buffer times voluntarily scheduled by travelers. The same applies to baggage delivery. Since many passengers had to wait many hours there, the economic damage is likely to be much larger.

5. Estimation of the economic damage to air travelers and airlines based on three sample routes

As data on the delay situation on airport level is not publicly available, we estimated the flight delays for selected airports and airlines based on Flightradar24 (2022) data. These estimations serve as a basis for the monetization and quantification of the economic damages to passengers and the costs for airlines from flight delays and other irregularities in the summer of 2022. For this analysis, we chose three example flight routes to Mallorca. Tables 1-3 provide an overview of the selected example flights. The routes to Mallorca (PMI) were selected as Mallorca is a popular European destination for German and European tourists, especially during the summer season. Airlines operating between Germany and Mallorca in summer 2022 include Eurowings (incl. Eurowings Europe), Condor, Ryanair (incl. Malta Air and Laudamotion), TUIfly, easyJet and Lufthansa. For each route, a typical airline with a high market share was selected, which is not mentioned by name here, however, because only the flights of a specific flight number were evaluated for each route (e.g., the daily 6 a.m. flight of airline A). Düsseldorf (DUS), Munich (MUC) and Cologne-Bonn (CGN) were chosen as departure airports.

Our analysis shows that all sample flights in 2022 were significantly delayed compared to the identical flights in 2021. An evaluation of additional flights yielded similar results. In total we evaluated more than 1,200 flights.

For the sample flights, the average delay in summer 2022 was between 38 and 99 minutes per flight. By comparison, in summer 2021, the average delay for the same flights was 12 to 31 minutes per flight. However, some airlines and airports were more affected by delays than others.

In our sample, Airline C (Table 3) shows the worst performance in terms of flights delayed more than 60 minutes, with about 50-67% of all sample flights of this airline delayed in summer 2022. During the same period, almost every flight (about 93-97%) had a delay of more than 15 minutes. Flights of the other two airlines (Tables 1 and 2) were also severely delayed, with about 20-30% of flights delayed more than 60 minutes and 80-96% of flights delayed more

than 15 minutes. The sample shows that the overall flight punctuality at airports and airlines was very low in the summer of 2022, and that the punctuality also varied by airline significantly.

Table 1. Selected flights from Duesseldorf to Palma de Mallorca in summer 2022/2021. Source: Own modelling results.

Airline A DUS - PMI	No. of Flights under considered flight number	Total departure delay (min) over all flights under considered flight number	Average delay (min) per flight	% flights with departure delay > 15min	% flights with departure delay > 60min
Jun 21	25	490	20	48.0 %	0.0 %
Jul 21	28	836	30	82.1 %	7.1 %
Aug 21	15	355	24	73.3 %	6.7 %
Jun 22	15	713	48	80.0 %	20.0 %
Jul 22	32	1684	53	93.8 %	25.0 %
Aug 22	32	1222	38	90.6 %	18.8 %

Table 2. Selected flights from Munich to Palma de Mallorca in summer 2022/2021. Source: Own modelling results.

Airline B MUC - PMI	No. of Flights under considered flight number	Total departure delay (min) over all flights under considered flight number	Average delay (min) per flight	% flights with departure delay > 15min	% flights with departure delay > 60min
Jun 21	23	352	15	43.5 %	0.0 %
Jul 21	26	492	19	53.8 %	0.0 %
Aug 21	21	646	31	66.7 %	14.3 %
Jun 22	28	1172	42	96.4 %	17.9 %
Jul 22	30	1497	50	80.0 %	20.0 %
Aug 22	31	1799	58	93.5 %	29.0 %

Table 3. Selected flights from Cologne/Bonn to Palma de Mallorca in summer 2022/2021. Source: Own modelling results.

Airline C CGN - PMI	No. of Flights under considered flight number	Total departure delay (min) over all flights under considered flight number	Average delay (min) per flight	% flights with departure delay > 15min	% flights with departure delay > 60min
Jun 21	30	357	12	30.0 %	3.3 %
Jul 21	31	666	21	32.3 %	9.7 %
Aug 21	32	613	19	50.0 %	3.1 %
Jun 22	28	2629	94	96.4 %	60.7 %
Jul 22	30	2964	99	93.3 %	66.7 %
Aug 22	31	2037	66	96.8 %	51.6 %

How can the damage caused by flight delays to the affected travelers be estimated and monetized? This is not a trivial question since every delay situation is different and the harm in terms of a "loss of benefit" can only be assessed individually. In literature, the potential individual harm (in terms of lost benefits) from passenger waiting and/or delay times has been examined in a number of studies, e.g., National Academies of Sciences, Engineering, and Medicine (2015), Czerny and Zhang (2011), U.S. DOT (2016), Ehreke et al. (2015), and EUROCONTROL (2018). The so-called 'Value of Time (VoT)' or the 'Value of Travel Time (VTT)' or the 'Value of Travel Time Savings (VTTS)' is often used as an indicator.

Since the sample flights selected for this paper were operated in Europe and Palma de Mallorca is a popular European destination, the VoT value proposed by EUROCONTROL (2018) for tourists and leisure travelers (see

Table 4) was used for our value of time damage estimations. EUROCONTROL compares 'Value of Time' estimates for air travel determined in different studies. However, it must be pointed out that VoT estimations are often subject to uncertainties and should therefore rather be considered as rough estimates.

Table 4. Value of Time (VoT) estimations for air travel segmented by travel purpose. Source: Own compilation.

VoT per person and hour	Personal private travel	Holiday travel	Business travel
U.S. DOT (2015 Euro)	€ 27.9 - € 41.9	-	€ 45.6 - € 68.3
EUROCONTROL (2018; in 2016 Euro)	€ 13.6 - € 20.9	€ 50.3	€ 70.3
Ehreke et al. (2015)	€ 25.5	-	€ 38.8

By multiplying the delay minutes per flight and the number of delayed passengers by the VoT value given above (€50.3 per hour for leisure travelers), the damage per sample flight can be roughly quantified for all passengers on this flight. It should be noted that the estimations in Table 5 are average damages per passenger based on the average flight delay of the sample. However, in the summer of 2022, a significant proportion of travelers experienced delays of more than 60 minutes (see Tables 1-3), while other passengers experienced shorter delays. For comparison, a delay of 60-90 minutes corresponds to a 'Value of Time' loss of €50.3 to €75.5 per passenger. In contrast, a 30-minute flight delay results in a loss of €25.2.

Finally, it has to be noted that Table 5 only shows the additional damage of each passenger on one of the sample flights analyzed compared to summer 2021. For example, a passenger choosing a flight from Cologne/Bonn to Mallorca with Airline C in July 2022 had to bear a VoT loss of €64.9 on average compared to the previous year 2021 with the same airline and flight. This VoT damage is solely caused by the additional waiting times for departure at the departure airport. Additional waiting times at the passenger-specific level, such as in queues, are also not considered here.

Table 5. Cost estimations for passengers caused by flight delays at departure airports. Source: Own modelling results. In 2016 Euro.

Flight route	DUS - PMI	MUC - PMI	CGN - PMI
Additional VoT damage for each passenger compared to 2021 based on the average departure delay per flight	(Airline A)	(Airline B)	(Airline C)
June 22 compared to June 21	€ 23.4	€ 22.3	€ 68.8
July 22 compared to July 21	€ 19.1	€ 26.0	€ 64.9
August 22 compared to August 21	€ 12.2	€ 22.9	€ 39.0

Table 6 shows the average 'Value of Time' damage incurred for all passengers per flight, using the sample flights for the calculation. The respective load factor per flight was assumed based on real market data. Table 6 reveals that the average load factor per flight on the three routes increased significantly in summer 2022 compared to the previous year. Concerning the VoT calculations it must be taken into account that a linear progression of the VoT function was assumed here; this may well be different in reality, for example lower VoT values in the first hour and higher VoT values after the first hour of waiting time. However, due to unavailable data, only a linear progression could be assumed.

The total VoT damage per flight, i.e. the average VoT loss for all passengers on this flight together due to the delays, is between €20,000 to €40,000 according to this estimation. Compared to a "reference delay situation", e.g. in the summer of 2021, the additional damage for all passengers per flight together amounts to between €11,000 and €33,500, with the example route from Cologne/Bonn to Palma de Mallorca being the most severely affected. The largest delays occurred on this route, as shown in Table 3 (93-97% of all flights evaluated were delayed by more than 15 minutes). However, there may also be a reinforcing effect here, as this route also has the highest load factor, with 185 passengers per flight. As a result, the average total VoT damage on the Cologne/Bonn - Palma de Mallorca route adds up to a good €40,000 per flight and clearly stands out from the other two routes. This effect cannot only be

explained by the relatively high total demand, because as Table 7 shows, demand in the summer of 2022 on the Düsseldorf to Palma route is significantly higher in absolute terms with a good 100,000 passengers than on the Cologne/Bonn - Palma de Mallorca route with just under 70,000 passengers. Compared to the previous year, the passenger volume in Düsseldorf was significantly higher than in Cologne/Bonn.

Extrapolated to the total number of passengers served by the respective airline on the respective route in the period from June to August 2022, this results in an additional VoT damage of just under €9 million for all passengers on the three sample routes in total, as shown in Table 7. Again, Cologne is the most affected, but differs less from Düsseldorf, which handled by far the most passengers in absolute terms. Munich shows the lowest number of passengers due to market conditions, has fewer delays and performs best overall in terms of total damage. It is reasonable to assume that the results shown here only represent a lower limit of VoT damages, as many passengers were rebooked, also to other airlines, or did not travel at all, in part due to cancellations and delays.

Table 6. Value of Time (VoT) damage for all passengers per selected flight. Source: Own modelling results. In 2016 Euro.

Flight route	DUS - PMI	MUC - PMI	CGN - PMI
VoT damage per flight based on average departure delay. (Assumed VoT: € 50,3/h)	(Airline A)	(Airline B)	(Airline C)
Average load factor per flight (Jun-Aug 2021)	163 Pax	128 Pax	150 Pax
Average load factor per flight (Jun-Aug 2022)	180 Pax	154 Pax	185 Pax
'Value of Time' per flight (Jun-Aug 2022)	€ 20,876	€ 19,338	€ 40,076
Delta 'Value of Time' (Jun-Aug 2022 vs. 2021)	€ 10,884	€ 12,365	€ 33,469

Table 7. Value of Time (VoT) damage calculated for all passengers per airline on the selected route. Source: Own modelling results. In 2016 Euro values.

Flight route	DUS - PMI	MUC - PMI	CGN - PMI
VoT damage for all passengers per airline on the selected route based on average departure delay of selected flights. (Assumed VoT: €50,3/h)	(Airline A)	(Airline B)	(Airline C)
Passengers served by airline (Jun-Aug 2021)	40,854 Pax	25,958 Pax	45,734 Pax
Passengers served by airline (Jun-Aug 2022)	101,915 Pax	50,664 Pax	69,710 Pax
'Value of Time' for all passengers served (Jun-Aug 2022)	€ 3,941,308	€ 2,143,766	€ 4,979,787
Delta 'Value of Time' (Jun-Aug 2022 vs. 2021)	€ 3,047,540	€ 1,676,307	€ 4,261,246

The airline-specific costs due to the delays are shown in Table 8. Here, the direct flight operating costs were analyzed, i.e., the airline's direct cost per minute of delay per flight, as determined by EUROCONTROL (2015). Opportunity costs for passengers are not included here because they are based on VoT costs for passengers and these VoT costs have already been considered (see Table 5). Economically, these costs would otherwise be counted twice. European reference values were used to calculate the airline costs. Accordingly, the average cost per flight for airlines is €49.5 per minute of delay. These costs already include network effects and reactionary costs due to subsequent delays (EUROCONTROL, 2015).

The highest additional costs were calculated for Airline C on the route Cologne/Bonn - Palma de Mallorca with an estimated €10,190 for all delayed flights in summer 2022 on this route. The total costs from the perspective of the airlines on the other two analyzed routes are significantly lower at around €3,200 for Düsseldorf - Palma de Mallorca and €4,200 for Munich - Palma de Mallorca. An additional analysis, based on the tactical delay cost benchmarks provided by Cook and Tanner (2015) to determine flight costs (including passenger opportunity costs), indicated that the selected airlines faced significantly higher costs in 2022. Here, the additional costs for airlines A and B were approximately in the same range, but the costs for airline C were significantly higher, more than three times as high as for airlines A and B.

An analysis of EUROCONTROL CODA data for the period June to August 2022 based on all European flights operated and their average delay resulted in total costs of all airlines together of €3.37 billion, according to our estimation. Again, delay costs, i.e., the direct cost of an airline of €49.5 per minute per flight were assumed. The number of flights operated during the period was just under 2.8 million, with the month of July showing the highest average delay of 26 minutes. The average delay for the previous year, i.e. June to August 2021, was only between 7 and 11 minutes.

Table 8. Additional direct cost of the airline per flight caused by departure delays. Source: Own modelling results. Airline delay cost factors provided by EUROCONTROL refer to 2014 Euro values.

Flight route	DUS - PMI	MUC - PMI	CGN - PMI
Additional costs per airline compared to 2021 based on average departure delay	(Airline A)	(Airline B)	(Airline C)
June 22 compared to June 21	€ 1,383	€ 1,314	€ 4,059
July 22 compared to July 21	€ 1,127	€ 1,533	€ 3,827
August 22 compared to 21	€ 719	€ 1,350	€ 2,304

6. Conclusions and possible solutions

In the summer of 2022, many passengers at European airports faced significant flight delays, waiting times and other irregularities. In some cases, for example at Amsterdam Airport, airport operators decided to limit the total number of passengers. However, some airports seem to have managed these multiple and pan-European problems better than others.

The results of our analysis show that all sample flights from Düsseldorf, Cologne/Bonn and Munich airports to Palma de Mallorca in the summer of 2022 were significantly delayed compared to identical flights in 2021. Thus, the average delay of the analyzed flights from June to August 2022 was between 38 and 99 minutes per flight. In contrast, the results for the summer of 2021 season showed delays of only between 12 and 31 minutes per flight for the same flights. These delays were caused in part by the unexpected increase in passenger numbers following the COVID-19 pandemic and limited ground handling capacity at airports due to staff shortages. From a macroeconomic perspective, these delays during the summer season can negatively impact the market for vacation travel and the overall economy. The damages for passengers and airlines in the summer of 2022 were considerable: The 'Value of Time'-loss or damage due to the delays for all passengers only on the three analyzed routes could be estimated at a total of almost €9 million. The additional, delay-related costs for the airlines on these routes were calculated at an average of €3,200 to €10,190 per flight.

How can such delays and other irregularities in air traffic be better avoided in the future? In principle, a number of opportunities for improvement exist:

- Negotiating improved service contracts between stakeholders at the airport would be an important option for improvement. This is basically in the responsibility of all stakeholders at the airport except for the travelers.
- An early and better communication between all affected parties would also prevent or improve delay situations. This mainly refers to all companies at airports.
- Simplified security review processes mandated by government for hiring new employees in security-related positions could also improve potential delay situations. In particular, the service contract design (e.g., incentives for remuneration based on the number of passengers handled per hour) should be better aligned with the requirements at the airport and the procurement of equipment, e.g., security scanners, should be less bureaucratic. Here, the federal police has the responsibility for improvements at many airports. Another starting point for avoiding delays would be to agree on delay-minimizing service level agreements with service providers, for example in the areas of security and ground handling. These possible solutions are in the responsibility of the federal police, the airport and the ground handling companies, respectively.

Some German airports have now started to implement improvement measures. At Berlin-Brandenburg Airport, for example, it is possible to book online a guaranteed access time to security checks in advance. Similar models have been introduced by other airports. Frankfurt Airport took over the organization of security checks from the German Federal Police in January 2023. Fraport expects this to result in higher efficiency and flexibility in the security controls, which will continue to be carried out by external service providers in the future (Airliners.de, 2023). In particular, the contract design will be better aligned with the requirements at the airport. The Federal Ministry of the Interior and thus the Federal Police remain responsible for all aviation security-related issues in Frankfurt as the supreme aviation security authority (Airliners.de, 2023). Further, the Federal Police has started to use CT scanners for hand luggage checks. By using this technology, it is expected that hand luggage checks can be carried out in half the time previously required. Another starting point for avoiding delays would be to agree delay-minimizing service-level agreements with security service providers. Due to the limited number of security personnel available, the use of new technologies should also be considered in the long term, such as image recognition using artificial intelligence for the screening of carry-on and checked baggage.

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