Article

Predictive Analysis of Airport Safety Performance: Case Study of Split Airport

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Abstract: A predictive safety management methodology implies steps and tools of predictive safety management in aviation, i.e., use of predictive (forecasting) and causal modeling methods to identify potential and possible hazards in the future, as well as their causal factors which can help define timely and efficient mitigation measures to prevent or restrain emerging hazards turning into adverse events. The focus of this paper is to show how predictive analysis of an organization's safety performance can be conducted, on the sample airport. A case study regarding implementation of predictive analysis of an organization's safety performance, was performed at Split Airport. The predictive analysis of an airport's safety performance was conducted through the analysis of Split Airport safety database, causal modeling of Split Airport organizational and safety performance indicators, outlier root cause analysis of Split Airport safety performance indicators, predictive analysis of safety performance (forecasting of Split Airport organizational and safety performance indicators), and scenario cases that simulate future behavior of Split Airport safety performance indicators. Based on detected future hazards, and their causal factors, the appropriate mitigation measures are proposed for the purpose of improving and maintaining an acceptable level of safety at the airport.

Keywords: predictive; analysis; airport; safety performance; case study

1. Introduction

A Safety Management System (SMS) is a crucial mechanism to maintain and continuously improve safety levels in aviation organizations. The International Civil Aviation Organization (ICAO) developed a framework of efficient aviation safety management which is nowadays a regulatory obligation of every aviation organization [1,2]. ICAO SMS framework includes four main components, i.e., safety policy and objectives, safety risk management, safety assurance, and safety promotion [1–4]. Those components include twelve elements that form an efficient SMS: management commitment, safety accountability and responsibilities, appointment of key safety personnel, coordination of emergency response planning, SMS documentation, hazard identification, safety risk assessment and mitigation, safety performance monitoring and measurement, management of change, continuous improvement of the SMS, training and education, and safety communication. SMS is a management system that must be fully integrated into the everyday operations of every aviation organization [2,5,6].

Hazard identification represents one of the most important elements of any properly functional SMS, as it identifies hazards in the organization. Hazard identification uses sources and tools to successfully identify hazards. Tools to collect data and information in order to identify hazards are called safety management methodologies [2]. ICAO defines two types of safety management methodologies, i.e., reactive, and proactive. The third safety management methodology is called "predictive", but it exists only conceptually, i.e., it is not yet well established. However, a proactive methodology has been developed in this segment of aviation safety management, and it uses safety reporting systems,

safety oversight and safety performance indicators/targets to gather safety information continuously, to detect and mitigate the potential threats that may consequently trigger the occurrence of an accident or an incident. A proactive methodology introduces system defenses, to address potential safety issues through regulations, technology, and training, respectively. Recent studies have observed that a predictive methodology acts as an upgrade to a proactive methodology.

Previous research, with the focus on developing a predictive safety management methodology, via reactive and proactive approaches, has revealed new insights and possibilities [3,4,7–22]. A detailed chronological overview of the literature is presented in Section 2.

A predictive methodology in the current form uses real-time analytics softwares to analyze large amounts of flight data to detect emerging hazards, but it does not include predictive (forecasting) methods in the process. On the other hand, predictive (forecasting) methods are used in the aviation industry, mostly for planning purposes for future capacity or traffic demand but not in the segment of aviation safety management.

The authors of [21,22], developed a conceptual model of predictive safety management methodology, and defined the steps and tools of predictive safety management, i.e., use of predictive (forecasting) [18] and causal modeling methods [20] to identify potential and possible hazards in the future, as well as their causal factors which can help define timely and efficient mitigation measures to prevent or restrain emerging hazards turning into adverse events.

The scientific contribution of this research is reflected in the development of a predictive safety management methodology, and implementation of the same methodology to conduct a predictive analysis of airport safety performance on the sample airport, i.e., Split Airport. The methodology described in the paper can be adopted in any airport, i.e., it can be adopted in any organization. The forecasts of future events and the temporal causal model presented in the paper, are generated for the specific set of indicators monitored and recorded at Split Airport, but it can be generated for any other airport, using their own set of indicators.

2. Literature Overview

This part gives the chronological literature overview of research regarding prediction and causation, relevant to the predictive safety management.

Granger causality and its variations are among the most popular approaches to causal time series analysis [23]. It infers that X influences Y whenever the past values of X help in predicting Y from its own past [24,25].

In 1990, Apostolakis introduced a concept of probability in safety assessments of technological systems and stated how safety assessments of technological systems require the investigation of the occurrence and consequences of rare events [26].

Wu and others [27] explained the theory of evidence and the theory of possibility as possible alternatives to probability theory in the safety analyses of engineering systems.

Senders and Moray examine the nature of human error, i.e., its causes and origins, its classifications, and the extent to which it is possible to predict and prevent errors and their impact [28].

Pisanich and Corker [7] described a model for predicting pilot performance in interaction with varied levels of automation inflight management operations.

Spirtes and others [29] addressed questions of what assumptions and methods allow observations to be turned into causal knowledge, and how even incomplete causal knowledge can be used in planning and prediction to influence and control the environment. According to [29], causation is considered to be a relation between particular events; something happens and causes something else to happen. Each cause is a particular event, and each effect is a particular event.

In 2001, Sarasvathy stated that causation lies on a logic of prediction, effectuation on the logic of control and illustrated effectuation through business examples and realistic thought

experiments, with examination of its connections with existing theories and empirical evidence [30].

In 2002, NASA issued the Probabilistic Risk Assessment Procedures Guide for NASA Managers and Practitioners, after the Challenger accident in 1986, and once again became a strong proponent of Probabilistic Risk Assessment (PRA), strengthening its position as a powerful tool for the prediction of risk where a system or systems are highly variable [8].

In 2003, Ghobbar and Friend devised a new approach to forecasting evaluation, a model which compares and evaluates forecasting methods based on their factor levels when faced with intermittent demand [9].

In 2004, Cartwright stated that causation is not a single, monolithic concept, and that there are different kinds of causal relations embedded in different kinds of systems, described using thick causal concepts [31].

Sloman [32] described how people conceive of the relation between cause and effect, and action and outcome. The causal framework starts with the idea that the purpose of causal structure is to understand and predict the effects of intervention.

Longworth described counterfactual theories of causation and Hall's theory [33] that deals with cases of causation by omission, which have proved stubborn counterexamples to physical process theories of causation [34].

In 2006, Luxhøj and Coit presented an overview of a model that assessed the impact of new technology insertions or products designed to mitigate the likelihood or consequence of aviation accidents. The Aviation System Risk Model (ASRM), developed with joint support from the National Aeronautics and Space Administration (NASA) and the Federal Aviation Administration (FAA), was an example of a model devoted to classifying "low probability/high consequence" events [35].

Liou conducted [36] research to better understand the role that human factors play in major aviation accidents. A method for building an effective safety management system for airlines was developed that incorporated organization and management factors. It combined both fuzzy logic and the Decision-Making Trial and Evaluation Laboratory (DEMATEL). This method can map out the structural relations among diverse factors in a complex system and identify the key factors.

Roelen was one of the first authors who tried to explain how causal models could be used for controlling and managing aircraft accident risk and described the aviation system as a prime example of a complex multi-actor system. He stated how one of the main reasons to be interested in causation is because it allows for predicting system behavior if it is assumed that the past and present determine the future. Therefore, if observed in the past, certain causes have certain effects that can be assumed to be the same causes that would have the same effects in the future [37].

Shmueli [38] suggested that prediction is concerned with being able to know outcomes that have not yet been observed. Shmueli also explained how statistical modeling is a powerful tool for developing and testing theories by using causal explanation, prediction, and description.

In 2011, Du and Qin described a time-series extrapolation analysis model for short-term prediction of flight accidents in American general aviation [10] and Valdés and others [39] proposed risk models for runway overrun and landing undershoot, using a probabilistic approach. These models are supported with historical data on accidents in the area around the runway and will determine whether the risk level is acceptable or whether action must be taken to mitigate such risks at a given airport.

Buehner described temporal binding as a subjective shortening of elapsed time between actions and their resultant consequences. The research suggested that intentional action is not necessary for temporal binding and that it results from the causal relation linking actions with their consequences [40].

In 2013, Duanmu and others described theoretical methods of aviation accident forecasting, as well as early warning and prevention [11].

Button and Yuan examined the potential role that air freight transport can play in stimulating local and regional economic development. The focus was on causality, and not on simple correlation [41].

Van De Vijver and others explored the potential of Granger analysis in transport geography research by applying this method to a specific case of complex and potentially reciprocal linkages between the deployment of transport infrastructures and spatial economic development [42].

Roelen and others [12] conducted a study on an integrated approach to risk modeling in which the total aviation system, human factors and cultural aspects were considered in connection with technical and procedural aspects and with emphasis on representation of emerging and future risks.

In 2015, Di Gravio and others conducted research with the aim of building a statistical model of safety events in order to predict safety performance. They concluded that through the analysis of the possible scenarios, assessing their impact on equipment, procedures, and human factors, proposed model can address the interventions of the decision maker [13].

Peters and others [43] explained the difference between a prediction that is made with a causal model and a non-causal model. The predictions from a causal model will in general work as well under interventions as for observational data. In contrast, predictions from a non-causal model can potentially be very wrong if we actively intervene on variables.

To understand the importance of the key factors causing growth in air transport, Küçükönala and Sedefoğlu [44] used Granger causality analysis in order to see whether there is a causal relationship or not among air transport, tourism, economic growth and employment.

Pacheco and Fernandes explored the relations between international trade-related factors and international air passenger movement in Brazil, using the Granger causality methodology [45].

Peters and others in 2017, stated that probability theory and statistics are based on the model of a random experiment or probability space. Probability theory allows reasoning about the outcomes of random experiments, given the preceding mathematical structure. A causal structure entails a probability model, but it contains additional information not contained in a probability model, allowing the analysis of the effect of interventions or changes [46].

In 2018, Grant and others, stated that the prediction of accidents, or systems failure, should be driven by an appropriate accident causation model. Whilst various models exist, none is yet universally accepted, but there are elements of different models. They presented the findings from a review of the most frequently cited system-based accident causation models to extract a common set of systems-thinking tenets that could support the prediction of accidents [14].

Heinze-Deml and others stated that causal models can be viewed as a special class of graphical model that represent not only the distribution of the observed system but also the distributions under external interventions; hence enabling predictions under hypothetical interventions, which is important for decision making [47]. Heinze-Deml and others also emphasized how an important problem in many domains is to predict how a system will respond to interventions [48].

Rohrer discussed causal inference based on observational data, introducing graphical causal models that can provide a powerful tool for thinking more clearly about the interrelations between variables [49].

Singh and others analyzed the moderating effects of the multi-group in the relationship among safety management system (SMS), human factors (HF) and civil aviation safety (CAS) performance to highlight the impact of safety climate factors on the safety performance [50].

In 2019, Xu and others proposed a novel SARIMA-SVR model to forecast statistical indicators in the aviation industry that might be used for later capacity management and planning purpose. The results suggested that it achieved better accuracy than other

methods and proved that incorporating Gaussian White Noise increases forecasting accuracy [15].

Based on the highest density domain (HDR) analysis, Ben and others proposed a new algorithm to predict aviation safety in an uncertain framework [16].

Insua and others stated how, in most cases, organizations use unsophisticated methods based on risk matrices for the development of aviation safety management systems and presented models to forecast and assess the consequences of aviation safety occurrences as part of a framework for aviation safety risk management at state level [17].

Zheqi and others carried out forecasting of aviation safety probability based on the uncertainty of a neural network point forecasting value [51].

In summary, based on a thorough literature overview of previous research from the last decade, and analysis of basic methodologies in aviation safety management, it can be seen that various improvements have been made regarding aviation safety management. Various studies have been conducted regarding approaches to causal time series analysis, and they include: various accident causation models; theory of evidence; probability theory in safety analyses of engineering systems; examinations of human error and its causal impacts; various interpretations of causation and prediction and relations between them; development of various probabilistic risk assessment models; identification of factors impacting safety performance and establishment of safety performance indicators; theoretical methods of aviation accident forecasting; statistical models of safety events in order to predict safety performance, models of forecasting statistical indicators; forecasting of aviation safety probability, etc. The proposed research presented in this paper includes both predictive (forecasting) methods to predict adverse events in an organization, as well as causal modeling methods which complement forecasting methods, by detecting causal factors of predicted events, which in turn provides an addition information to senior management regarding necessary mitigation measures needed to be done in order to prevent predicted adverse events from happening.

3. Data and Methods

This paper presents how predictive and causal modeling methods, i.e., predictive analysis can be conducted to analyze an airport's safety performance. In order to conduct such an analysis, airport safety performance data are necessary. Safety performance data were collected from Split Airport, to perform predictive analysis of its safety performance.

3.1. Methods Used for Predictive Analysis of Split Airport Safety Performance

The aim of the research is to detect causal links among organizational and safety performance indicators from the sample airport. It is possible to improve safety management processes in aviation organizations, i.e., its safety performance, by identifying causal links and factors, and using predictive methods to forecast future events [22].

As explained in [22], the IBM SPSS Statistics 27 is a statistical and predictive analytics software that can be used to analyze all data in the observed datasets, to create optimal forecasting models and obtain forecasts, as well as to generate a causal model with causal links among all variables in the observed dataset. IBM SPSS Statistics 27 was used in this paper.

In [22], available examples of predicting methods used in various aviation sectors (air navigation services, airport operations, airline operations) were examined, and nine methods were tested as appropriate for aviation safety management: Holt's linear trend, Brown's linear trend, damped trend, simple exponential smoothing, simple seasonal exponential smoothing, Winter's additive method, Winter's multiplicative method, moving average method, and ARIMA modeling.

The predictive methods used in this study were chosen according to their applicability to the case in question, i.e., Split Airport, which has a strong seasonal component (it is busiest during the summer months, i.e., tourist season). The chosen methods are a simple seasonal exponential smoothing, a moving average method, and ARIMA modeling.

The mathematical representation of each predictive methods can be found in [52], which explains each formula. Each method is available in IBM SPSS Statistics 27 software, through functions called Forecasting–Expert Modeler, and Forecasting using Temporal Causal Model via a function called the Apply Temporal Causal Model.

A causal model can be generated once the dataset is prepared correctly, using the function called Create Temporal Causal Model. The Temporal Causal Model (TCM) detects causal links among all indicators (variables) in the observed dataset, in this case Split Airport, and presents them in a circular diagram or in impact diagrams.

3.2. Data Used for Predictive Analysis–Split Airport

The core business of Split Airport is to provide services for passengers, cargo, and aircraft handling for domestic and international air transport.

Split Airport is one of nine airports in Croatia. It is located in the Resnik area west of Kaštel Štafilić, 6 km from Trogir and 25 km from Split. The main elements of the airport infrastructure include maneuvering surfaces (runway (05/23), apron, etc.), passenger and cargo terminal, control tower, access roads, parking lots for buses and cars, and additional service and commercial facilities. Split Airport was opened on 15 November 1966. The number of passengers has grown year by year. This growth stopped in 1988 due to the economic crisis. In September 1991, the airport was closed due to the war, and in April 1992, it was reopened.

Recently, in 2020, the COVID-19 pandemic created a major setback for Split Airport traffic (Figure 1) due to the strict epidemiological measures [53].
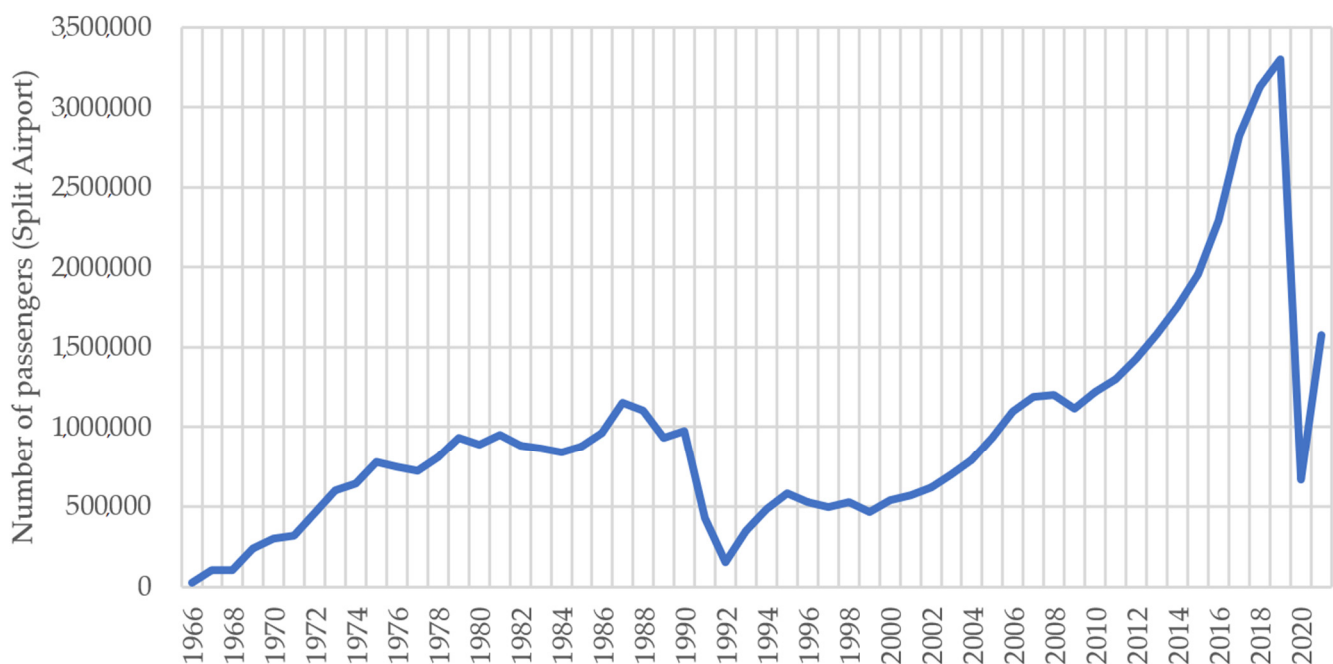
Figure 1. Passenger traffic and trendline at Split Airport in the period from 1966 to 2021. Adapted with permission from Ref. [53]. 2022, Split Airport.

The impact of COVID-19 on the aviation industry, from a global point of view, was major, resulting in ratings downgrades, liquidation and the bankruptcy of airlines and airports worldwide due to severe travel restrictions [54]. Even though the COVID-19 pandemic negatively impacted the aviation industry, the continuous growth of air traffic and the development of aviation systems is still anticipated in the near future.

Besides the impact of COVID-19, the war in Ukraine has also created a severe impacts on transport and trade, as it extends well beyond air travel to and from Ukraine; for example, airspace closures due to military activity and war-related sanctions have forced

airlines to seek alternative routes, which extends travel times, increases fuel consumption and costs, etc. [55]. A long war will increase the impact on international aviation and make its recovery from the COVID-19 pandemic even more difficult [55].

As per the International Air Transport Association (IATA) [56], the recovery in air travel continued in 2022, with an increase of 64.4% in total traffic. Globally, air traffic in 2022 was at 68.5% of pre-pandemic (2019) levels, which shows a fast recovery and increasing trend from 2020 onwards. Hence, a full recovery of air traffic is expected in 2024 or 2025. It is also important to emphasize that, according to the latest air crash statistics [57], air crash fatalities increased in 2020, in comparison to previous years, despite the COVID-19 pandemic's negative impact on the aviation industry and enormous decrease in the number of transported passengers during this period. Due to these observations, the existing safety management methodologies should be upgraded.

As per Split Airport, the traffic is recovering gradually (Figure 1), and in 2021 it reached 50% of the traffic accomplished 2019. In 2019, the airport was the second busiest in Croatia after Zagreb Airport, handling 3.3 million passengers. Split Airport was recorded as being the busiest airport in Croatia in 2021, handling 1.57 million passengers, and surpassing Zagreb Airport for the first time [53].

Due to the significant increase in passenger traffic, especially during the summer months, an expansion project was completed in summer of 2019, adding more than three times the floor space to the original terminal building, and increasing the capacity to five million passengers per year. The original terminal has been refurbished and is still being used for some international departures, while check in and all domestic departures as well as both international and domestic arrivals including baggage claim is located in the new areas. As a part of the expansion project, an enclosed bridge was built over the state road D409, taking passengers to the newly built parking lot, bus terminal and rental car facilities [53].

Split Airport holds high standards when it comes to safety and continuously seeks to improve its safety management. Applied safety management methodologies at Split Airport, in terms of gathering and processing safety data, are reactive and proactive. Split Airport uses sophisticated software to manage safety, i.e., Galiot Aero SMS 2.5.5. Galiot Aero SMS 2.5.5 provides strong and reliable proactive safety management at the airport.

A dataset of actual organizational and safety performance indicators at the airport, was used in this research. The dataset represents the safety data of Split Airport [53]. As a part of the Safety Assurance component, Split Airport has established a set of safety performance indicators (SPIs) and set-up accompanying safety performance targets (SPTs). SPIs are monitored on a monthly basis. The list of organizational indicators (OIs), safety performance indicators (SPIs) and safety performance targets (SPTs) for Split Airport SMS are presented in the following Table 1 [53].

A dataset is composed of monthly entries for two organizational indicators (OIs) and 25 safety performance indicators (SPIs). The values of achieved safety performance targets (SPTs) are also presented for each safety performance indicator. The observed period is from January 2014 until December 2021. The dataset contains 96 entries. All details can be found in the Appendix A.

It can be observed that all SPIs are the number of occurrences (adverse events) in different segments of airport operations. Figure 2 shows which areas are most critical in the observed time period from January 2014 until December 2021, i.e., SPI15—Number of occurrences related to passenger handling at the gate (which even reached 16 occurrences per month in 2016); SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving (which reached eight occurrences per month in 2018) and; SPI24:Number of occurrences related to wildlife (which even reached 13 occurrences per month in 2019).

Table 1. List of organizational and safety performance indicators in observed dataset at Split Airport. Adapted with permission from Ref. [53]. 2022, Split Airport.

Mark	Name of Organizational/Safety Performance Indicator	Targets [1] (For SPIs)
OI1	Number of aircraft operations	/
OI2	Number of passengers	/
SPI1	Number of occurrences related to LIRF and loadsheet crosscheck	≤1/10,000
SPI2	Number of occurrences related to wrong figures for loadsheet	≤1/10,000
SPI3	Number of dangerous goods incidents	≤1/10,000
SPI4	Number of aircraft damage occurrences	≤1/100
SPI5	Number of personnel or passenger injuries	≤1/1000
SPI6	Number of runway incursions/excursions	≤1/10,000
SPI7	Number of training deficiencies	≤1/1000
SPI8	Number of apron maintenance incidents	≤1/1000
SPI9	Number of vehicle maintenance incidents	≤1/1000
SPI10	Number of occurrences related to maneuvering area maintenance	≤1/1000
SPI11	Number of occurrences related to communication	≤1/10,000
SPI12	Number of incidents related to taxiing to/from apron	≤1/1000
SPI13	Number of aircraft marshalling occurrences	≤1/1000
SPI14	Number of occurrences related to FOD presence	≤1/1000
SPI15	Number of occurrences related to passenger handling at the gate	≤1/1000
SPI16	Number of occurrences related to passenger handling—disembarking/embarking	≤1/1000
SPI17	Number of occurrences related to personal protective equipment	≤1/1000
SPI18	Number of aircraft chocking incidents	≤1/1000
SPI19	Number of aircraft conning incidents	≤1/1000
SPI20	Number of occurrences related to baggage loading/unloading	≤1/1000
SPI21	Number of occurrences related to ground traffic (GSE) and vehicle driving	≤1/1000
SPI22	Number of anti-collision occurrences	≤1/1000
SPI23	Number of engine start-up incidents	≤1/1000
SPI24	Number of occurrences related to wildlife	≤1/1000
SPI25	Number of occurrences related to fuel handling	≤1/1000

[1] Safety Performance Targets (SPTs): Number of occurrences versus number of aircraft operations.
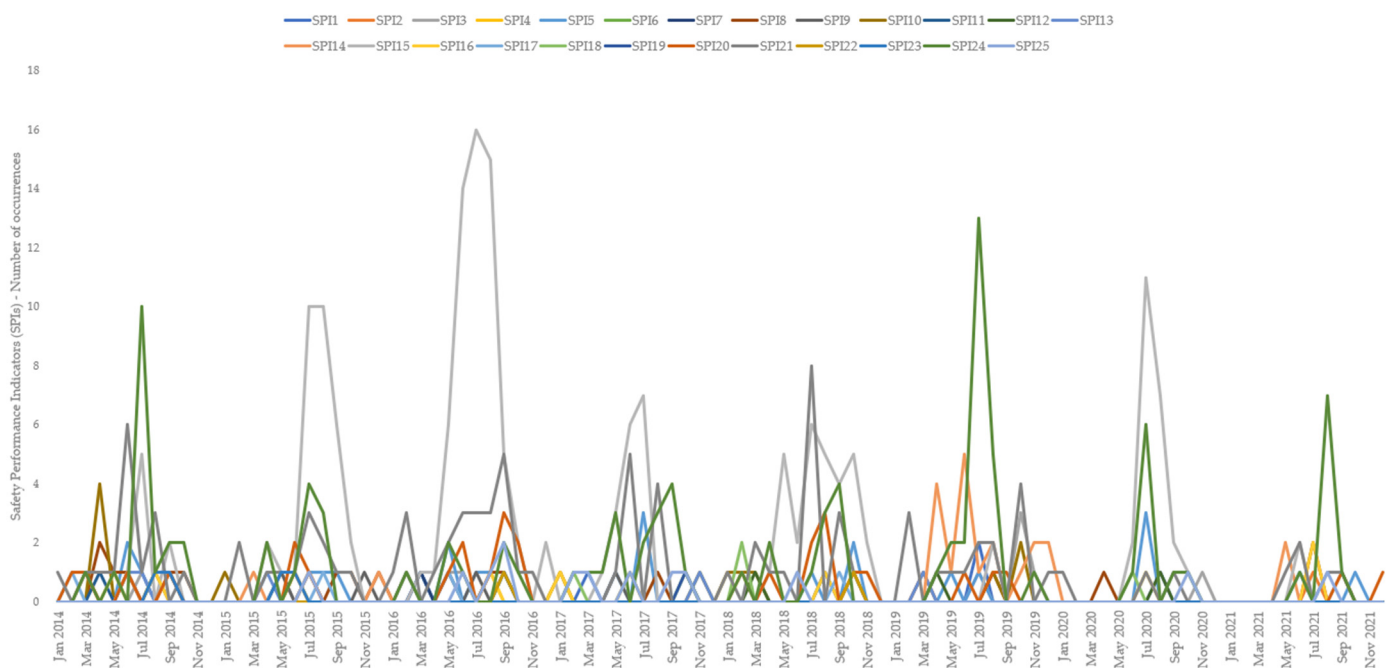
Figure 2. Split Airport safety performance indicators from 2014 to 2021. Adapted with permission from Ref. [53]. 2022, Split Airport.

Predictive methods used to conduct the predictive analysis of the airport safety performance for Split Airport, include time series decomposition methods, i.e., a simple exponential smoothing method with a seasonal component, moving average method, and auto regression model that integrates the moving average (ARIMA).

Causal modeling methods were used to establish causal relations among organizational and safety performance indicators at Split Airport, using IBM SPSS Statistics 27 software and its Temporal Causal Modeling function. Temporal Causal Modeling was also used to predict the future behavior of safety performance indicators at Split Airport due to its causal links, i.e., to generate case scenarios.

Finally, based on predictive analysis of airport safety performance, mitigation measures were proposed in order to improve safety performance at Split Airport.

4. Results

This part presents the results of a predictive analysis Split Airport safety performance, including causal modeling of Split Airport organizational and safety performance indicators, outlier root cause analysis of Split Airport safety performance indicators, predictive analysis of safety performance, i.e., forecasting of Split Airport organizational and safety performance indicators, predictive analysis and causal modeling, i.e., scenario cases for Split Airport, and proposal of mitigation measures based on predictive analysis of airport's safety performance.

4.1. Causal Model of Split Airport Organizational and Safety Performance Indicators

In this part, the aim is to establish a predictive causal model of defined organizational and safety performance indicators (SPIs) in order to present relations between organizational and safety performance indicators in an organization—in this case, the airport operator—Split Airport. Detecting relations between indicators indicates impacts (causes or effects) of indicators to one another, which in turn gives a possibility of improving the planning of future actions with enhanced forecasting (prediction) techniques that can improve safety performance at the airport.

To obtain impact relations between organizational and safety performance indicators, IBM SPSS function Temporal Causal Modeling was used. The set-up was made in such a way that independent variables are organizational indicators (OIs), i.e., OIs are set to be "inputs" in the temporal causal model, and safety performance indicators (SPIs) are dependent and independent variables, i.e., SPIs are set to be "both inputs and targets". SPI6 model was excluded since the values were constant, i.e., equal to 0. Attachment B shows fit statistical details for the top causal models generated for each of Split Airport's 24 safety performance indicators.

Figure 3 shows the causal model of all causal links among organizational indicators (OIs) and safety performance indicators (SPIs) for Split Airport.

Figure 4 shows the direct impact of organizational indicators (OIs) on safety performance indicators (SPIs) at Split Airport, i.e., OI1—Number of aircraft operations, and OI2—Number of passengers.

Figure 5 shows two examples of causal relations for individual organizational indicators (OIs) and safety performance indicators (SPIs) at Split Airport, for safety performance indicators SPI7—Number of training deficiencies, and SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving. Appendix B shows all causal relations for individual organizational indicators (OIs) and safety performance indicators (SPIs) at Split Airport.

The next step, after the causal model was made, was to examine the relations between indicators, and find which impacts the ones in question; hence, the causal model shows which of the OIs and SPIs impacts safety performance indicators (SPIs). Figure 6 shows an example of an impact diagram of one safety performance indicator (SPI14—Number of occurrences related to FOD presence). Appendix B shows an impact diagram for all indicators in the observed dataset.
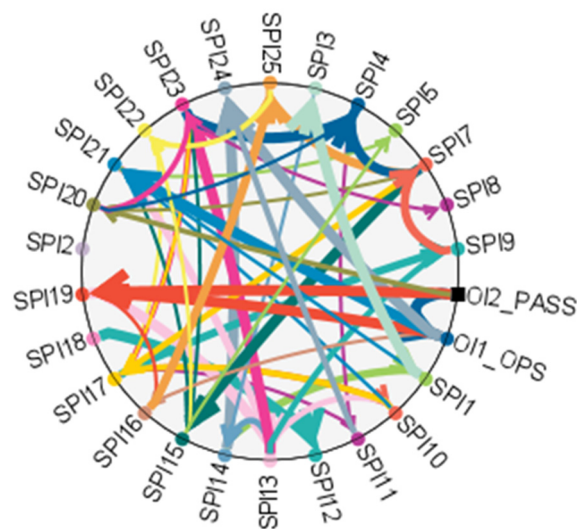
Figure 3. Causal model of Split Airport organizational and safety performance indicators.
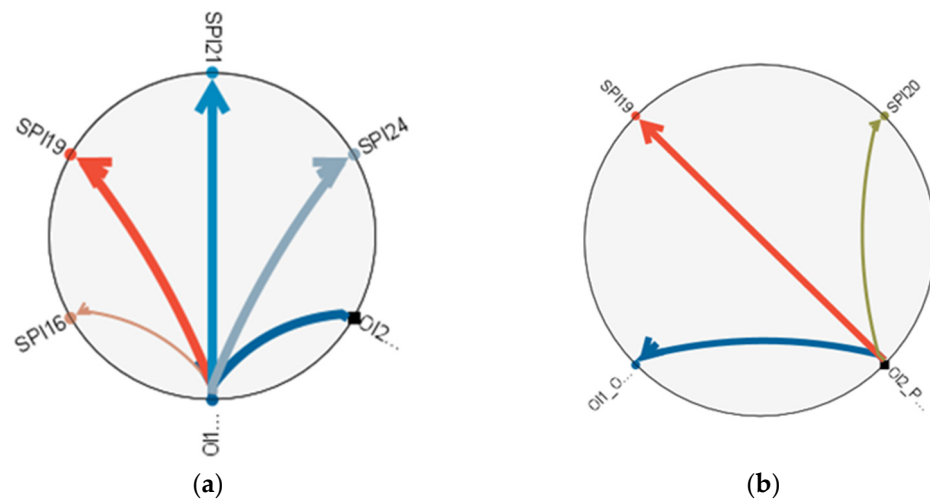
Figure 4. Direct impact of individual organizational indicators on safety performance indicators: (**a**) OI1—Number of aircraft operations; (**b**) OI2—Number of passengers.
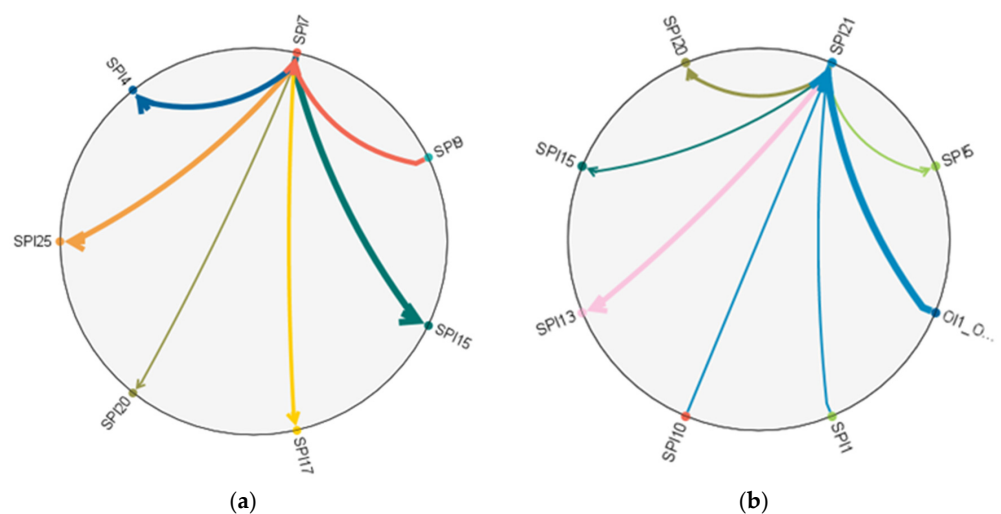
Figure 5. Examples of impacts of individual safety performance indicators: (**a**) SPI7—Number of training deficiencies; (**b**) SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving.
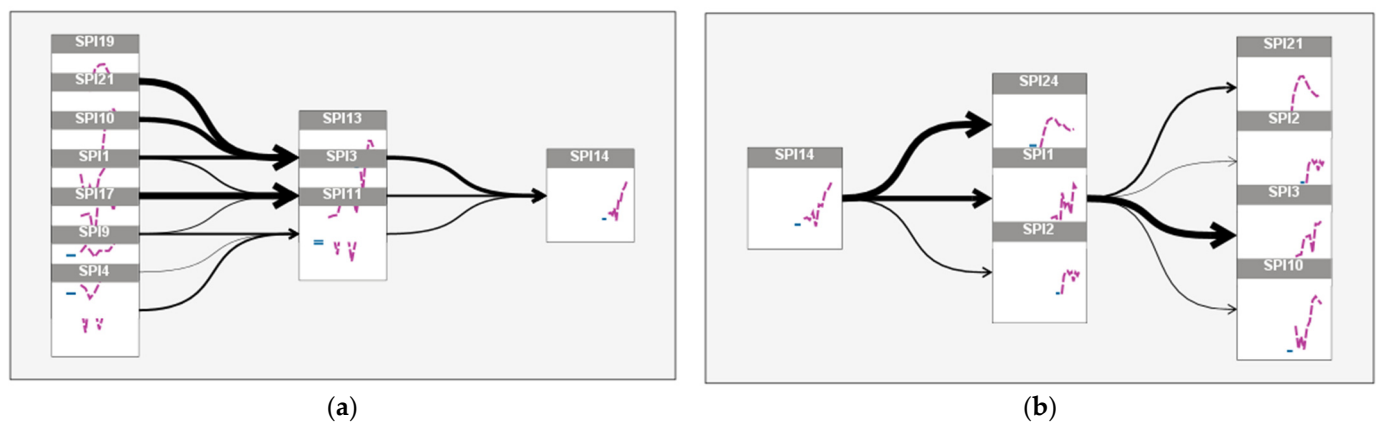
Figure 6. Impact diagrams of causes and effects of safety performance indicator (SPI14—Number of occurrences related to FOD presence): (**a**) Causes of SPI14; (**b**) Effects of SPI14.

4.2. Outlier Root Cause Analysis of Split Airport Safety Performance Indicators

As it can be observed that all SPIs occur in different segments of airport operations at Split Airport, it has been concluded that extreme numbers of occurrences are in fact outliers of each safety performance indicator dataset, which are in fact of most interest to any operator because those extreme values (outliers) are exactly the ones that are of most concern to an operator and exactly the ones any operator wishes to mitigate. Outliers can be very low or very high values that do not fit the pattern in the set of values that some dataset contains.

In this case, the upper (higher) values of outliers will be considered because they represent unwanted occurrences in an organization, i.e., every organization tends to reduce these events to 0 or to the minimum acceptable level (preferably below safety performance targets—SPTs). Hence, applying root cause analysis of outliers (hazardous events or occurrences in the organization) can be very useful to determine which indicators caused these extreme values in order to mitigate or prevent them in the future. Finding causes enables organization to react before hazardous events occur.

Table 2 shows outlier root cause analysis for one example of a safety performance indicator (SPI3—Number of dangerous goods incidents), conducted using IBM SPSS Statistics 27, function "Outlier Root Cause Analysis". Five outliers were detected in May 2015, July 2015, May 2016, July 2019, and October 2019. It can be observed that SPI3 was detected to be higher in May 2015 because of SPI16—Number of occurrences related to passenger handling—disembarking/embarking, in July 2015 because of SPI23—Number of engine start-up incidents, in May 2016 because of SPI17—Number of occurrences related to personal protective equipment, in July 2019 because of SPI1—Number of occurrences related to LIRF and loadsheet crosscheck, and in October 2019 because of SPI13—Number of aircraft marshalling occurrences.

Table 2. Outlier root cause analysis for indicator SPI3.

Time Point	Observed Value	Predicted Value	Outlier Probability	Root Causes
June 2017	0.00	1.06	1.00	SPI5
October 2019	3.00	2.01	1.00	SPI13
July 2015	1.00	0.02	1.00	SPI23
July 2019	1.00	0.03	1.00	SPI1
May 2015	1.00	0.03	1.00	SPI16
May 2016	1.00	0.15	1.00	SPI17
October 2015	0.00	0.65	0.97	SPI20

Figure 7 shows graphically which indicators caused SPI3, and points out the strongest cause among them, which is SPI17—Number of occurrences related to personal protective equipment.
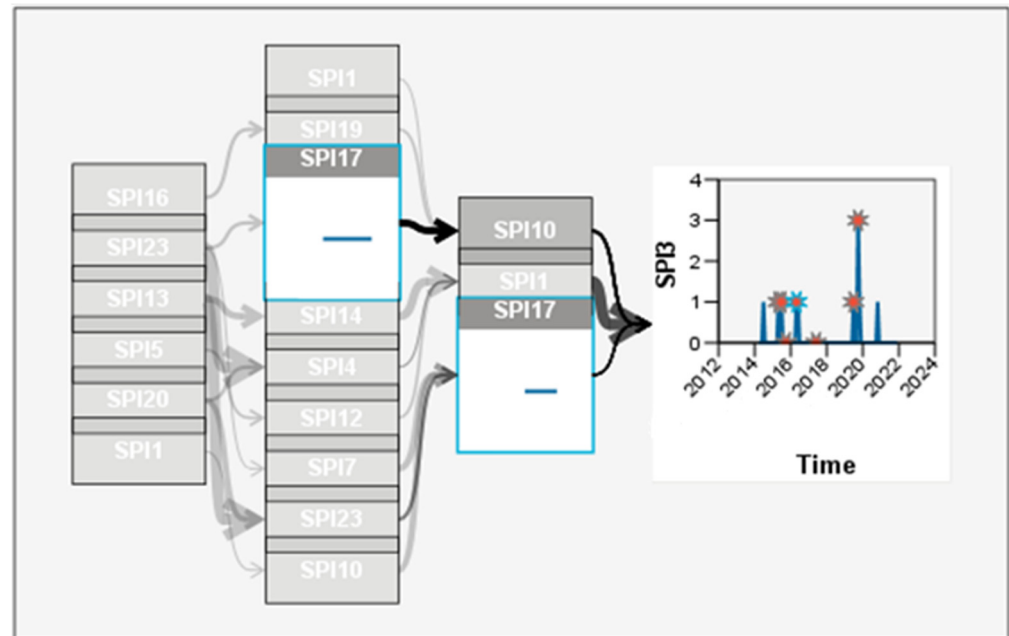
Figure 7. Outliers and root causes of indicator SPI3.

Details on every outlier root cause analysis for each safety performance indicator can be found in the Appendix C.

It is important to emphasize that some disruptive events (outliers), such as COVID-19 or war, as previously mentioned, can impact the organizational safety performance by causing discontinuities in the operating environment. Root cause analysis can help map out some causal factors impacting safety performance, but not all of them. However, any additional information about the causal relations can help improve safety performance in some respects. This can be applied to organizations with a rather stable set-up of their processes and operations, as presented in the following examples from Split Airport.

Figure 8 shows graphically the events which occurred over the observed time period from January 2014 to December 2021. The Figure shows all events (outliers) and their causes (the events that influenced them). It can be observed how previous events that occurred impacted the following, hence the connections that can be made between occurrences.

Figure 9 shows graphically the events which occurred over the observed time period from January 2014 to December 2021, caused by safety performance indicator SPI10—Number of occurrences related to maneuvering area maintenance, i.e., using events (incidents) related to maneuvering area maintenance. It can be observed that events related to maneuvering area maintenance (SPI10) affected events related to LIRF and loadsheet crosscheck (SPI1), events related to aircraft damage (SPI4), events related to vehicle maintenance (SPI9), events related to engine start-up (SPI23), and events related to fuel handling (SPI25), etc.

Hence, due to this analysis it can be concluded that introducing mitigating measures related to maneuvering area maintenance will positively reduce probability of adverse events in LIRF and loadsheet crosscheck procedures, in vehicle maintenance, reduce probability of aircraft damage or events related to engine start-up and fuel handling.
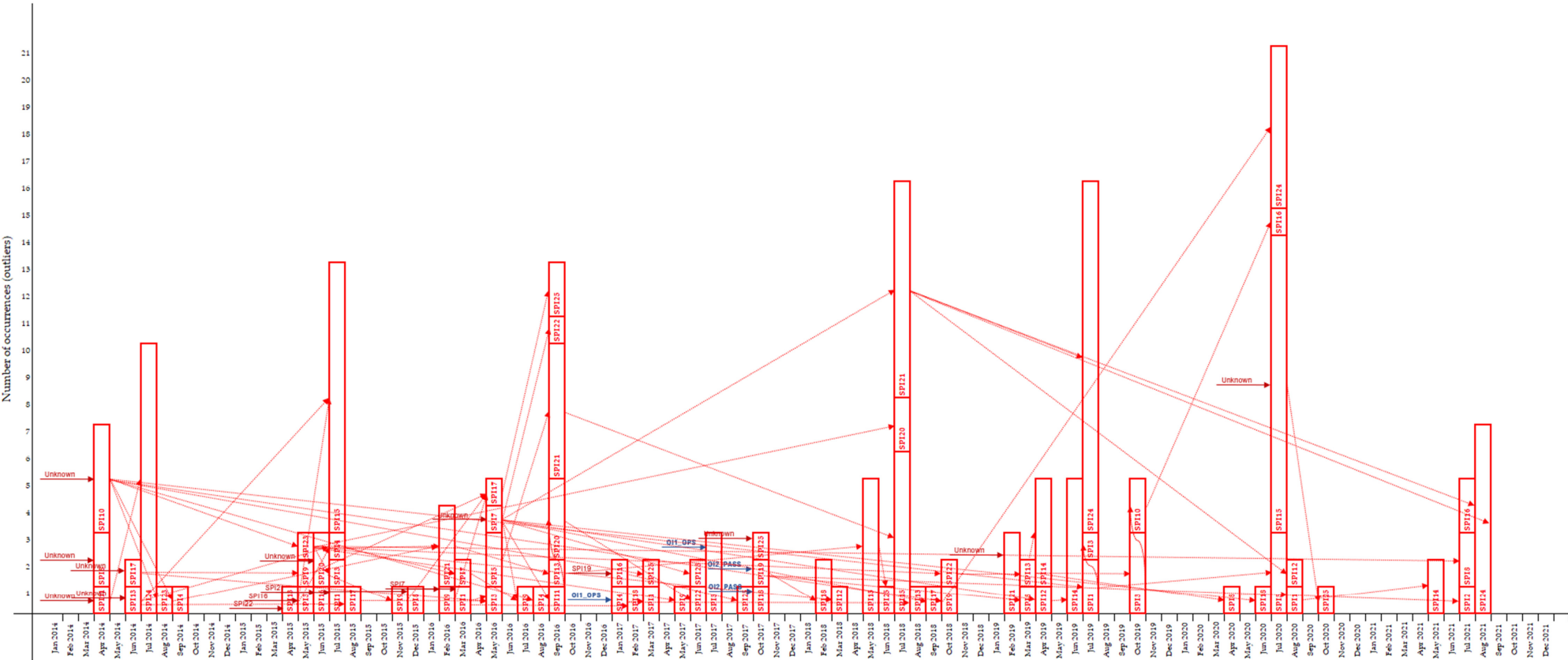
Figure 8. Outliers and root causes in observed period of time from 2014 to 2021.
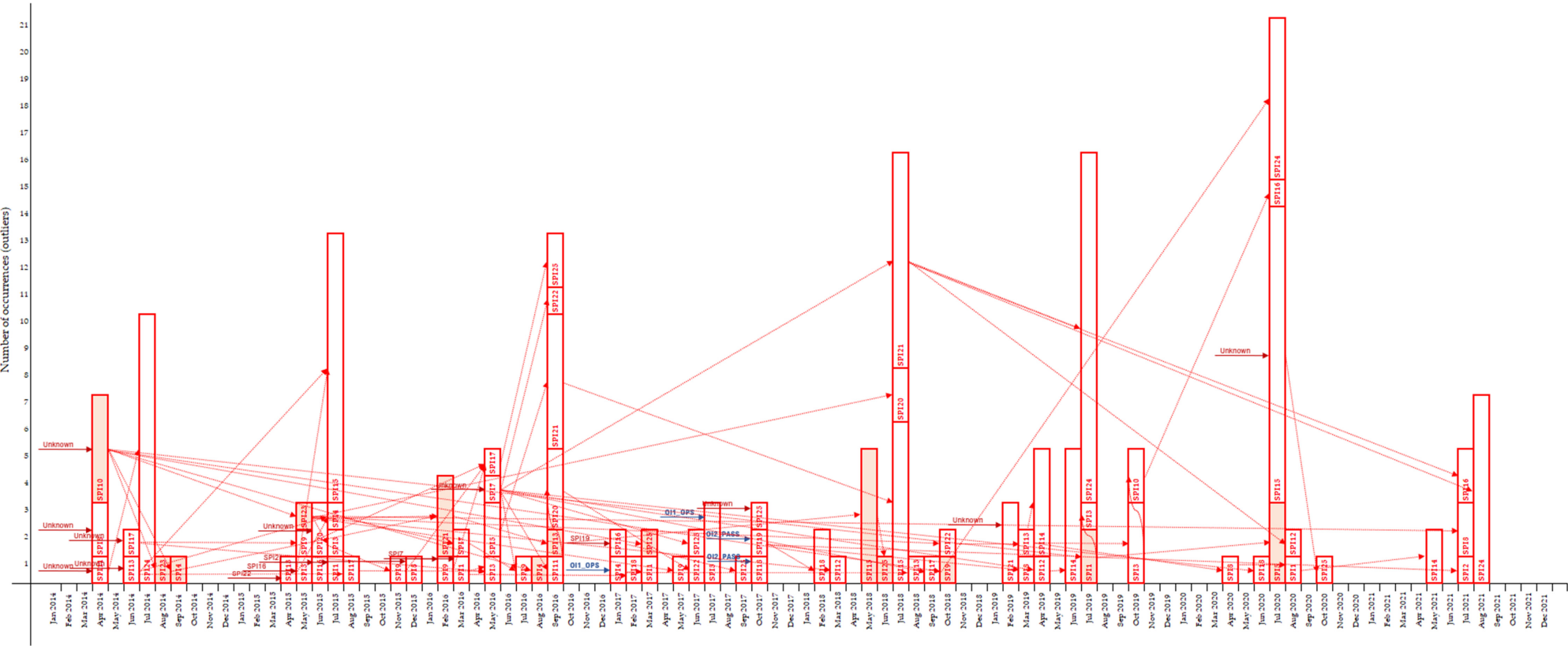
Figure 9. Outliers and root causes in observed period of time from 2014 to 2021—impact of SPI10.

4.3. Forecasting of Split Airport Organizational and Safety Performance Indicators

In this part of the research, forecasts for each safety performance indicator are made, using the IBM SPSS Statistics 27 software. Forecasting of indicators is conducted using function Expert Modeler and Forecasting using Temporal Causal Model.

Figure 10 shows forecasted values for organizational indicators in an observed dataset from Split Airport, i.e., OI1—Number of aircraft operations and OI2—Number of passengers, using IBM SPSS simple exponential forecasting method with seasonal component. Details on forecasted values of organizational indicators can be found in the Appendix D.
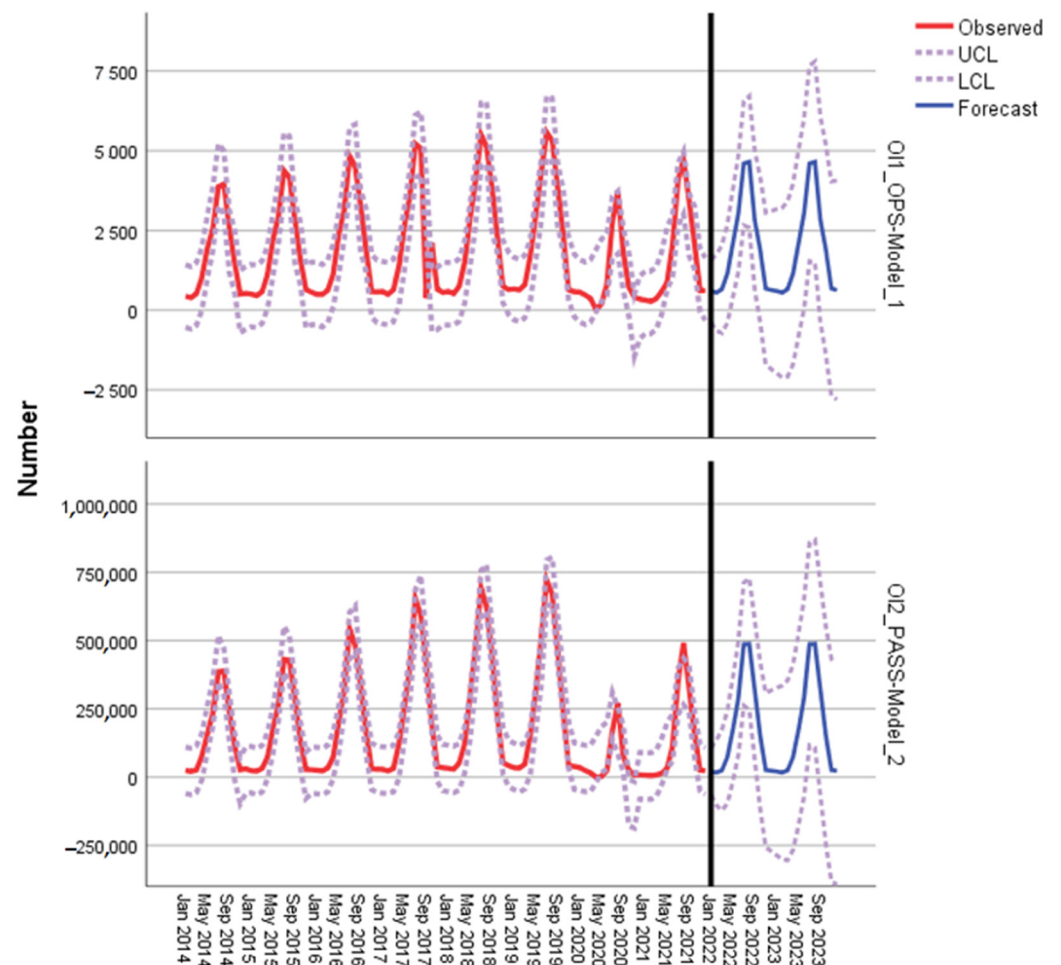
Figure 10. Forecasts of organizational indicators of Split Airport.

Figure 11 show examples of first initial forecast of Split Airport safety performance indicators using IBM SPSS function Forecasting using Temporal Causal Model. Details on first initial forecast of Split Airport safety performance indicators can be found in the Appendix D.

Figure 12 shows examples of a second set of initial forecasts from Split Airport safety performance indicators using IBM SPSS function Expert Modeler Forecasting. The first set uses ARIMA and exponential smoothing methods, while the second set uses exponential smoothing methods only. The set using smoothing methods could not build a model for safety performance indicator SPI6 because all of the values of the series are the same. The forecast period was set up to 24 months. Details on the second set of initial forecasts for Split Airport safety performance indicators with associated safety performance targets can be found in the Appendix D.
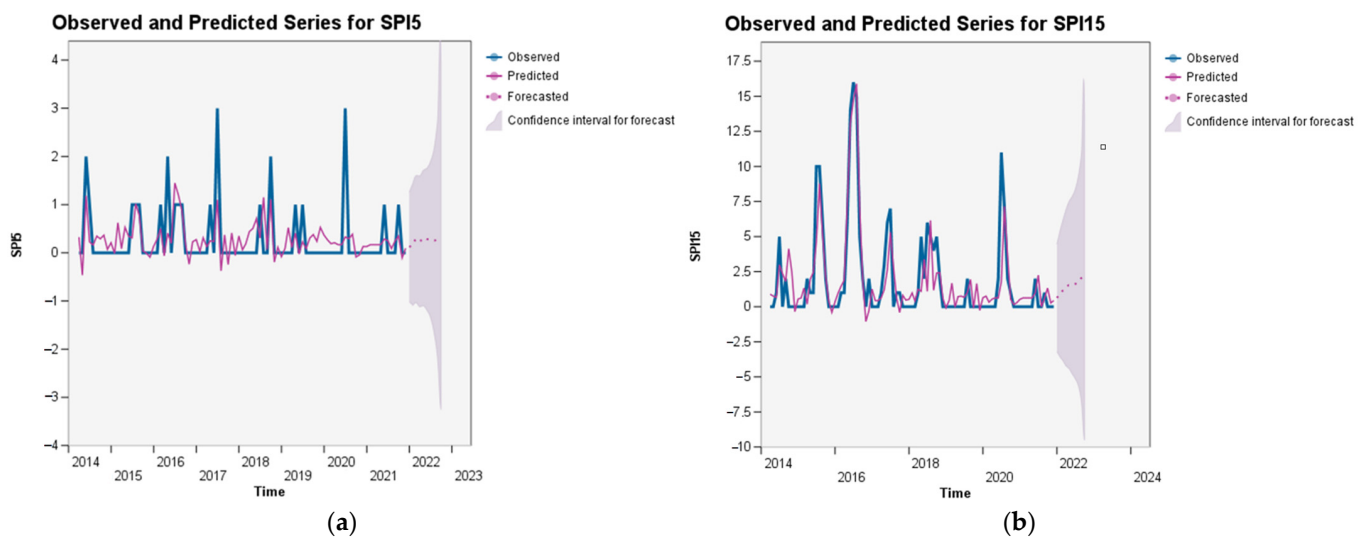
Figure 11. Forecasts of Split Airport safety performance indicators (forecasting using temporal causal model): (**a**) SPI5—Number of personnel or passenger injuries; (**b**) SPI15—Number of occurrences related to passenger handling at the gate.
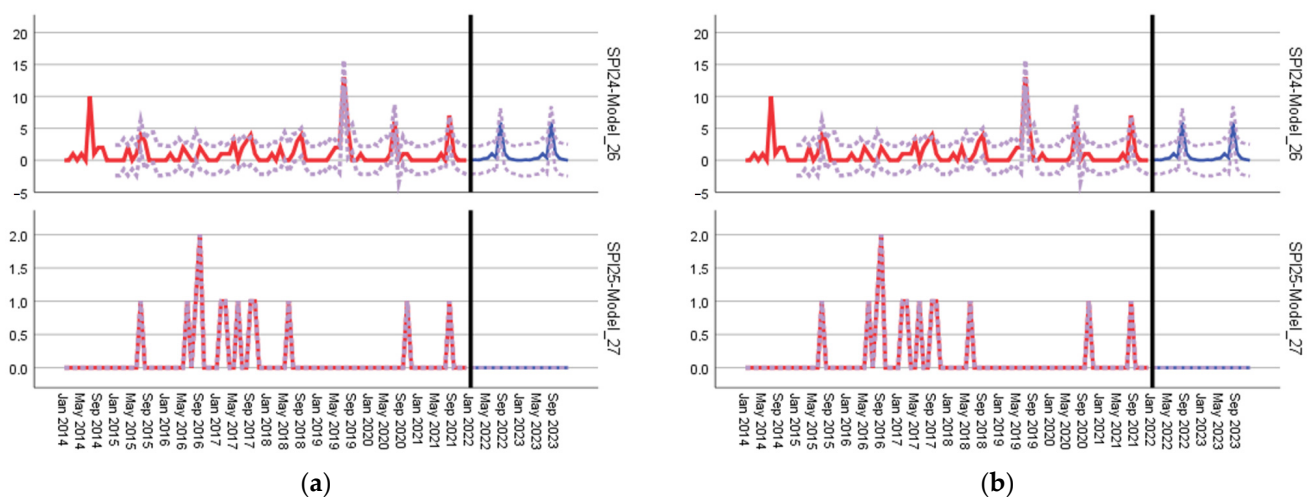
Figure 12. Forecasts of Split Airport safety performance indicators: (**a**) ARIMA and smoothing methods (SPI24); (**b**) Smoothing methods only (SPI24).

As per the results of the conducted research, i.e., from the predicted values of the safety performance indicators, it is evident that a higher number of potential occurrences (hazards) is anticipated in the near future, specifically for SPI15—Number of occurrences related to passenger handling at the gate, SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving, and SPI24—Number of occurrences related to wildlife. This can be explained by the fact that all of these indicators highlight higher values in summer months, due to a larger number of aircraft operations and a larger number of passenger, i.e., the seasonality component is strongly present at Split Airport. It also explains a larger number of wildlife occurrences, because in summer months wildlife activity is also higher.

4.4. Case Scenarios of Split Airport Safety Performance Indicators' Behavior

Using the causal model presented in Section 3.1. (Figure 3), it can be learned which indicators (variables) should be modified in order to obtain the desired level in each safety performance indicator.

This part shows how values of organizational indicators (in this case two available organizational indicators OI1:Number of aircraft operations and OI2—Number of passengers) affect future behavior of safety performance indicators, i.e., how they can influence or trigger adverse events in airport operations.

Four case scenarios are built to show how different values of organizational indicators (lower of the higher than original values), due to established causal relations, impact future adverse occurrences at Split Airport.

4.4.1. Scenario 1—Impact on Safety Performance Indicators Due to Increase of Aircraft Operations

The first scenario shows an example of increasing the organizational indicator OI1—Number of aircraft operations and its impact on safety performance indicator, and SPI3—Number of dangerous goods incidents (Figure 13). Figure 13a shows original values of OI1 and increased values of OI1 by 30% and Figure 13b shows how changes in OI1 impacts the behavior of safety performance indicator SPI3. Details of how an increase in OI1 impacts the behavior of every safety performance indicator can be found in Appendix E.
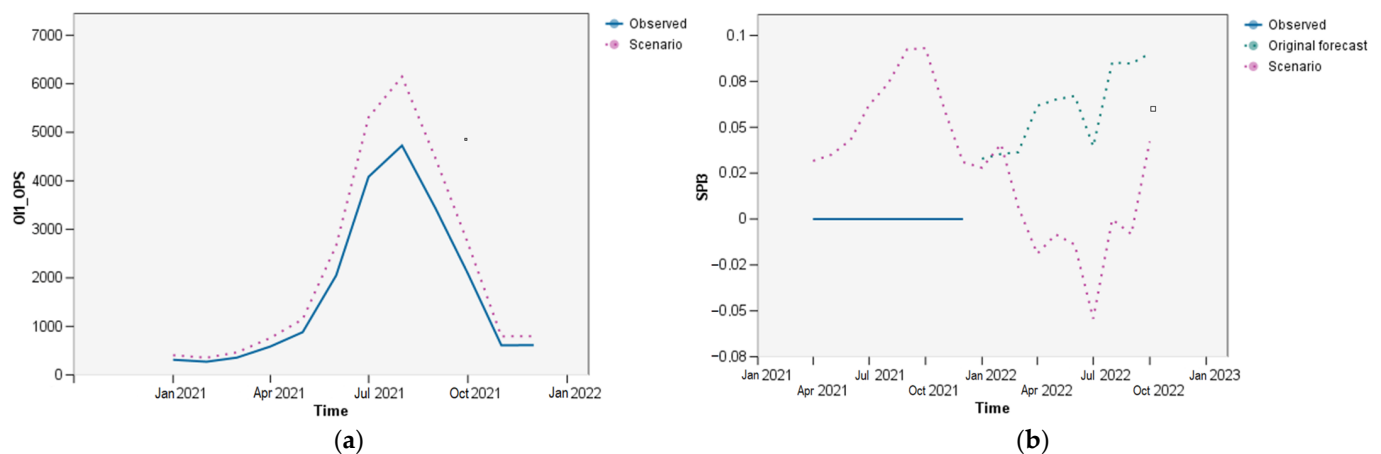
Figure 13. Example of increasing organizational indicator OI1 in the observed dataset by 30% and its impact on behavior of safety performance indicator SPI3: (**a**) Increase of OI1; (**b**) impact of increased OI1 on SPI3 (scenario case).

4.4.2. Scenario 2—Impact on Safety Performance Indicators Due to Decrease of Aircraft Operations

The second scenario shows an example of decreasing the organizational indicator OI1—Number of aircraft operations and its impact on safety performance indicator SPI7—Number of training deficiencies (Figure 14). Figure 14a shows the original values of OI1 and the decreased values of OI1 by 30% and Figure 14b shows how a change in OI1 impacts the behavior of the safety performance indicator SPI7. Details of how a decrease in OI1 impacts the behavior of every safety performance indicator can be found in Appendix E.
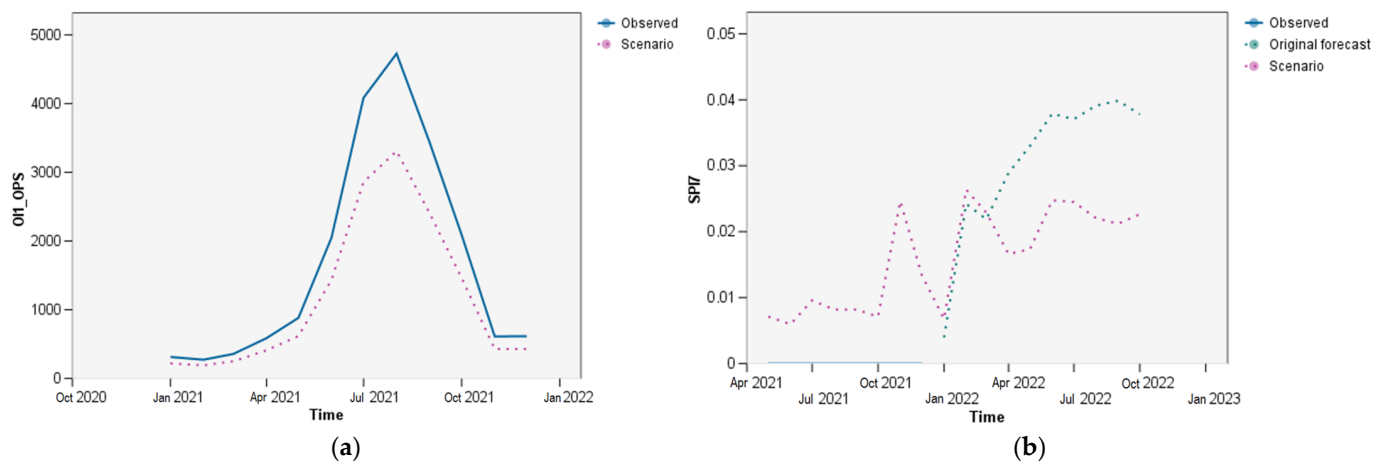
Figure 14. Example of decreasing organizational indicator OI1 in the observed dataset by 30% and its impact on behavior of safety performance indicator SPI7: (**a**) Decrease of OI1; (**b**) Impact of decreased OI1 on SPI7 (scenario case).

4.4.3. Scenario 3—Impact on Safety Performance Indicators Due to Increase of Number of Passengers

The third scenario shows an example of increasing the organizational indicator OI2—Number of passengers and its impact on safety performance indicator SPI11—Number of occurrences related to communication (Figure 15). Figure 15a shows the original values of OI2 and increased values of OI2 by 30% and Figure 15b shows how a change in OI2 impacts the behavior of the safety performance indicator SPI11. Details of how an increase in OI2 impacts the behavior of every safety performance indicator can be found in Appendix E.
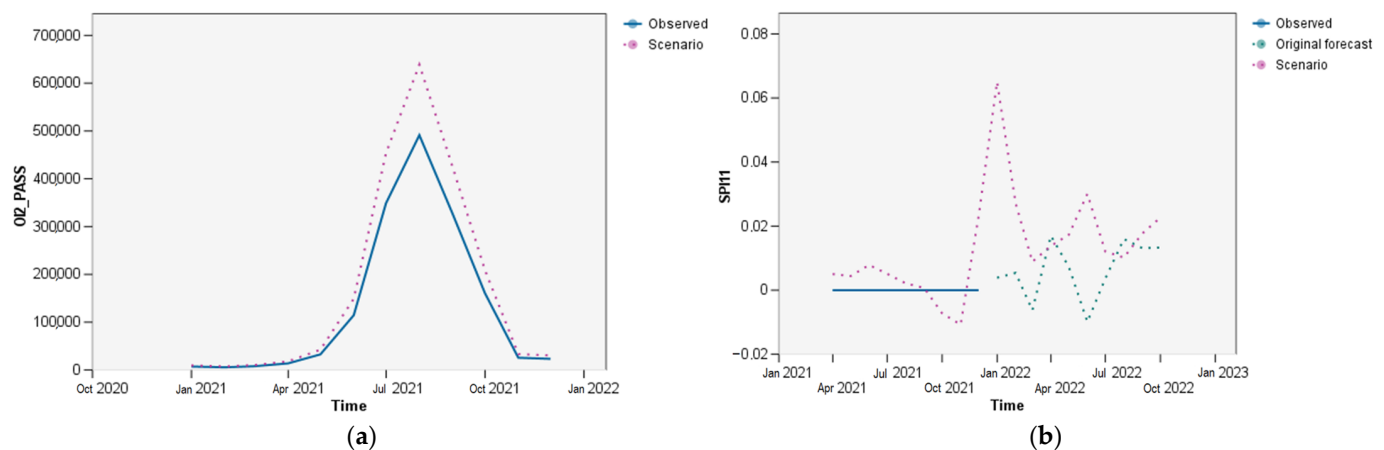
Figure 15. Example of increasing organizational indicator OI2 in the observed dataset by 30% and its impact on behavior of safety performance indicator SPI11: (**a**) Increase of OI2; (**b**) impact of increased OI2 on SPI11 (scenario case).

4.4.4. Scenario 4—Impact on Safety Performance Indicators Due to Decrease of Number of Passengers

The fourth scenario shows a decrease of the organizational indicator OI2—Number of passengers and its impact on safety performance indicators. Figure 16 shows an example of such impact on SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving. It shows original values of OI2 and decreased values of OI2 by 30% (Figure 16a) and Figure 16b shows how a change in OI2 impacts the behavior of the safety performance indicator SPI21. Details on every safety performance indicator can be found in Appendix E.
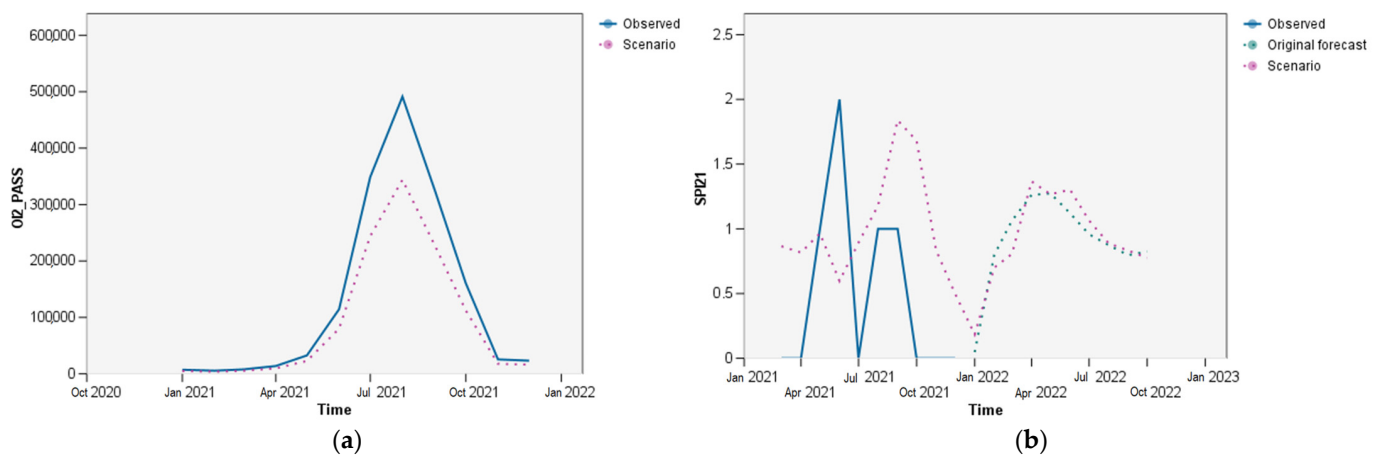
Figure 16. Example of decreasing organizational indicator OI2 in the observed dataset by 30% and its impact on behavior of safety performance indicator SPI21: (**a**) Decrease of OI2; (**b**) Impact of decreased OI2 on SPI21 (scenario case).

The fourth scenario shows an example of decreasing organizational indicator OI2—Number of passengers and its impact on safety performance indicator SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving (Figure 16). Figure 16a shows original values of OI2 and decreased values of OI2 by 30% and Figure 16b shows how a change in OI2 impacts the behavior of the safety performance indicator SPI21. Details of how decrease in OI2 impacts the behavior of every safety performance indicator can be found in Attachment E.

4.5. Summary of Results Based on Predictive Analysis of Airport Safety Performance

Figure 17 shows graphically all adverse events occurring over the observed time period from January 2014 to December 2021 and predicted time period from January 2022 to December 2023, at Split Airport, obtained by using the predictive safety management methodology in aviation. The Figure shows all events (past and future) and most probable causes of predicted events. Details can be found in Appendix F.
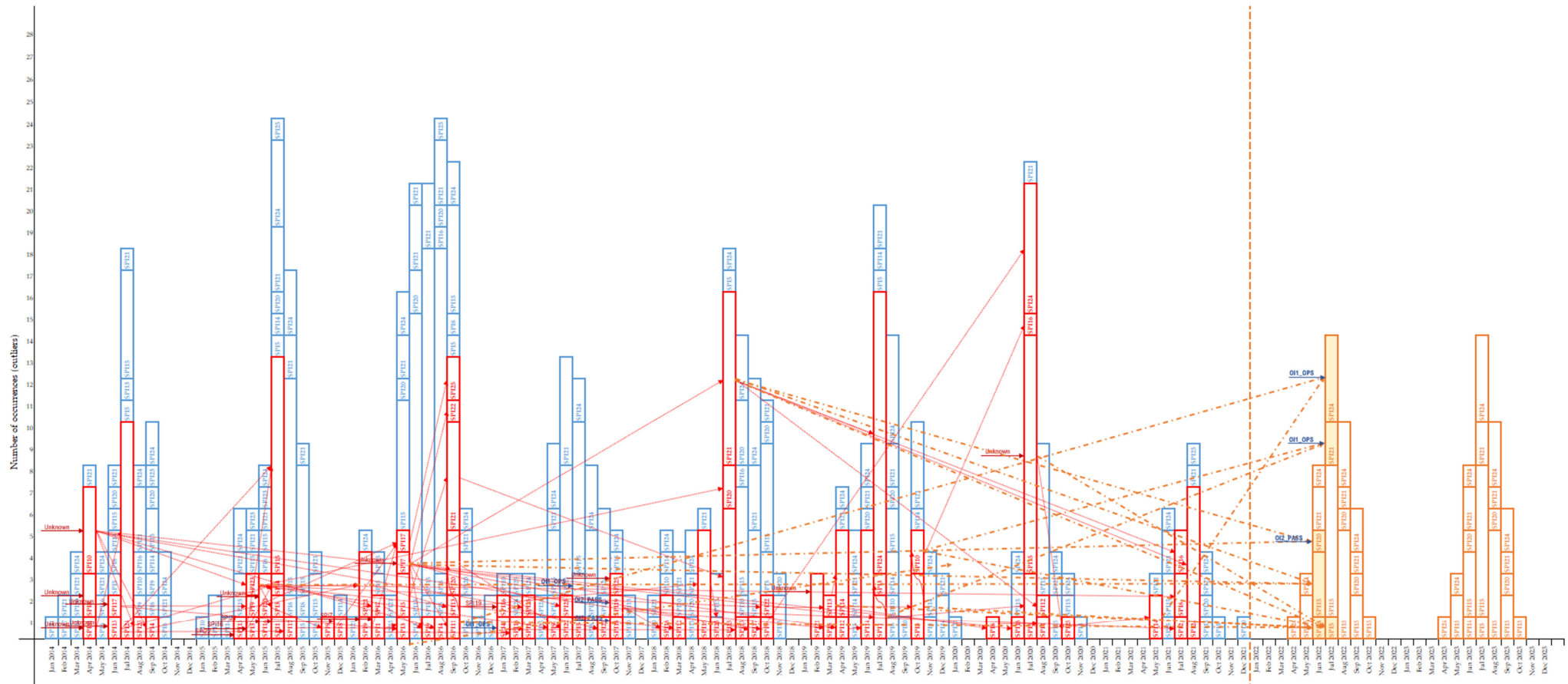
Figure 17. Observed and predicted safety performance indicators (hazards/events) over observed and future time period, at Split Airport.

4.6. Proposal of Mitigation Measures Based on Predictive Analysis of Airport Safety Performance

Based on predictive analysis of airport safety performance conducted for Split Airport, and presented in this paper, a proposal for mitigation measures was generated, to improve the safety performance at Split Airport.

The layout of the proposed mitigation measures is based on a predictive analysis of airport safety performance, on the sample from Split Airport operations. The layout includes importance level, anticipated time of occurrence, tolerance interval of anticipated time of occurrence, detected SPI (area of occurrence), name of the detected SPI, area of concern, anticipated number of occurrences, proposed mitigation measures/actions (direct), causal factors (OIs and SPIs), area of causal impact and additional proposed mitigation measures/actions.

Figure 18 shows an example of the proposed mitigation measures for adverse occurrences predicted to happen in May 2022, in the area of passenger handling at the gate, obtained by using predictive analysis of airport safety performance, at Split Airport. The importance level for this predicted event was "red" because it was anticipated to happen very soon, from the perspective of when the time point predictive analysis took place. Direct proposed mitigation measures/actions included an conducting inspection related to passenger handling at the gate; checking whether the procedures were carried out in accordance with the regulations; checking whether the personnel who carry out procedures of passenger handling at the gate were qualified to perform the tasks, and whether all refreshers had been carried out on time; checking whether all employees have undergone training in the field of safety and human factors, and whether they were familiar with all safety problems in their field of work; checking how passenger security check was conducted at the gate; whether it was carried out efficiently, and in accordance with the regulations; checking the technical fitness of equipment and systems used to handle passengers at the gate, etc. Additional proposed mitigation measures/actions were generated in relation to secondary causal factors, i.e., in the area of training deficiencies (SPI7), ground traffic (GSE), vehicle driving (SPI21) and engine start-up (SPI23).

Figure 19 shows an example of proposed mitigation measures for adverse occurrences predicted to happen in August 2022, in the area of concern–wildlife–obtained by using predictive analysis of airport safety performance, at Split Airport. The importance level for this predicted event was "orange" because it was not anticipated to happen so soon, from the perspective of when the time point predictive analysis took place. Direct proposed mitigation measures/actions included adjusting flight schedules where possible, to minimize the chance of a strike with wildlife species that have a predictable pattern of movement; temporarily closing a runway with unusually high bird activity or a large mammal incursion until wildlife control personnel disperse the animals, reduce, eliminate, or exclude one or more elements that attract wildlife, such as food, cover or standing water; minimize exposed areas which birds can use for perching and nesting; build a fence or net (if there is none) to prevent wildlife encroaching into the airport area; using repellent and harassment techniques to make the wildlife uncomfortable or fearful; conducting regular patrols of airside areas to disperse birds and other hazardous wildlife, etc. Additional proposed mitigation measures/actions were generated in relation to secondary causal factors, i.e., in the area of communications (SPI11), and FOD presence (SPI14).

Importance level	Anticipated time of occurrence	Tolerance interval of anticipated time of occurrence	Detected SPI	Name of detected SPI	Area of concern	Anticipated number of occurrences	Proposed mitigation measure/action (direct)	Causal factors (OIs & SPIs)	Area of causal impact	Proposed mitigation measure/action (additional)
⚠	May 2022	1-3 months	SPI15	Number of occurrences related to passenger handling at the gate	Passenger handling at the gate	2	1. Conduct inspection related to passenger handling at the gate; check whether the procedures are carried out in accordance with the regulations; established findings can reveal omissions and help define specific mitigation measures. 2. Check whether the personnel who carry out procedures of passenger handling at the gate is qualified to perform the tasks, and whether all refreshers are carried out on time. 3. Check in particular whether all employees have undergone training in the field of safety and human factors, and whether they are familiar with all safety problems in their field of work. 4. Check how passenger security check is conducted at the gate; whether it is carried out efficiently, and in accordance with the regulations. 5. Check the technical fitness of equipment and systems used to handle passengers at the gate.	SPI7	Training deficiencies	1. Conduct inspection of the personnel training procedures; check whether the procedures are carried out in accordance with the regulations; established findings can reveal omissions and help define specific mitigation measures. 2. Check whether the personnel who carry out training is qualified, and whether training materials are up to date and carried out on time. 3. Check in particular whether all employees have undergone training in the field of safety and human factors, and whether they are familiar with all safety problems related to training deficiencies.
								SPI21	Ground traffic (GSE) and vehicle driving	1. Conduct inspection in the area of ground traffic (GSE) and vehicle driving; check whether the procedures in this area are carried out in accordance with the regulations; established findings can reveal omissions and help define specific mitigation measures. 2. Check whether the personnel who carry out tasks in the area of ground traffic (GSE) and vehicle driving is qualified to perform the tasks, and whether all refreshers are carried out on time. 3. Check in particular whether all employees have undergone training in the field of safety and human factors, and whether they are familiar with all safety problems in their field of work. 4. Check if the procedures are implemented in correct way, and whether means of transport and equipment are used in correct way. 5. Check whether employees comply with the rules on the maximum permitted driving speed on the operating surface. 6. Check whether there are unnecessary detentions of vehicles and other means and equipment on the service road or at the apron. 7. Check the technical fitness and equipment of all vehicles and other means.
								SPI23	Engine start-up	1. Conduct inspection related to engine start-up procedures; check whether the procedures are carried out in accordance with the regulations; established findings can reveal omissions and help define specific mitigation measures. 2. Check whether the personnel who carry out procedures is qualified/trained to perform the tasks, and all refreshers are carried out on time. 3. Check in particular whether all employees have undergone training in the field of safety and human factors, and whether they are familiar with all safety problems in their field of work. 4. Check whether before engine start-up, an inspection of the aircraft was carried out in order to detect any defects or damage.

Figure 18. Sample of proposed mitigation measures for anticipated occurrences (two in May 2022) related to passenger handling at the gate.

Importance level	Anticipated time of occurrence	Tolerance interval of anticipated time of occurrence	Detected SPI	Name of detected SPI	Area of concern	Anticipated number of occurrences	Proposed mitigation measure/action (direct)	Causal factors (OIs & SPIs)	Area of causal impact	Proposed mitigation measure/action (additional)
⚠	August 2022	4-6 months	SPI24	Number of occurrences related to wildlife	Wildlife	3	1. Adjust flight schedules where possible, to minimize the chance of a strike with wildlife species that have predictable pattern of movement. 2. Temporarily close a runway with unusually high bird activity or a large mammal incursion until wildlife control personnel can disperse the animals. 3. Reduces, eliminate, or exclude one or more of elements that attract wildlife, such as food, cover or standing water. 4. Minimize exposed areas that birds can use for perching and nesting. 5. Build a fence or net to prevent wildlife into the airport area. 6. Use repellent and harassment techniques to make the wildlife uncomfortable or fearful. 7. Conduct regular patrols of airside areas to disperse birds and other hazardous wildlife.	SPI11	Communication	1. Conduct inspection in the communication-related equipment, personnel, and procedures; check whether the procedures are carried out in accordance with the regulations; established findings can reveal omissions and help define specific mitigation measures. 2. Check whether the personnel who carry out procedures is qualified to perform the tasks, and whether all refreshers are carried out on time. 3. Check in particular whether all employees have undergone training in the field of safety and human factors, and whether they are familiar with all safety problems in their field of work. 4. Inspect the technical fitness of communication equipment and systems. 5. Check whether communication equipment and systems (frequencies) somehow affect or attract wildlife to the airport.
								SPI14	FOD presence	1. Conduct inspection in the area related to FOD presence; check whether the procedures in the area are carried out in accordance with the regulations; established findings can reveal omissions and help define specific mitigation measures. 2. Check whether the personnel who carry out procedures in the area related to FOD presence is qualified to perform the tasks, and whether all refreshers are carried out on time. 3. Check in particular whether all employees have undergone training in the field of safety and human factors, and whether they are familiar with all safety problems in their field of work. 4. Inspect the stand and manoeuvring surfaces to detect FOD presence (FOD check). 5. Inspect if there are larger amounts FOD anywhere at the airport or in the vicinity of the airport, that attracts or might potentially attract wildlife (FOD check).
								OI1	Aircarft operation	ORGANIZATIONAL INDICATOR

Figure 19. Sample of proposed mitigation measures for anticipated occurrences (three in August 2022) related to wildlife.

5. Discussion/Conclusions

This paper has presented how predictive safety management can be implemented and used, on the sample airport, i.e., Split Airport. A predictive analysis of the airport's safety performance was conducted through the analysis of Split Airport safety database, causal modeling of Split Airport organizational and safety performance indicators, outlier root cause analysis of Split Airport safety performance indicators, predictive analysis of safety performance (forecasting of Split Airport organizational and safety performance indicators), and predictive analysis and causal modeling to generate scenario cases for future behavior of Split Airport safety performance indicators.

In the first step, the analysis showed which areas were most critical in the observed time period from January 2014 until December 2021, i.e., SPI15—Number of occurrences related to passenger handling at the gate (which even reached 16 occurrences per month in 2016), SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving (which reached eight occurrences per month in 2018), and SPI24—Number of occurrences related to wildlife (which reached 13 occurrences per month in 2019).

In the second step, a causal modeling of organizational and safety performance indicators was performed, using IBM SPSS Statistics 27 and a function called the Temporal Causal Model. With this model, causal relations were detected among each set of organizational and safety performance indicators at Split Airport. Causal relations of individual organizational indicators (OIs) and safety performance indicators (SPIs) at Split Airport, revealed which indicator influenced the others the most, i.e., SPI7—Number of training deficiencies, SPI13—Number of aircraft marshalling occurrences, SPI17—Number of occurrences related to personal protective equipment, SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving, and SPI23—Number of engine start-up incidents. Each of these SPIs impacted six or more other indicators. This suggests that certain mitigation measures should be implemented in these areas of airport operations, to generally prevent adverse effects. It can also be observed that all of these areas are related to the human factor element, hence measures such as additional training and more frequent inspections could be a good start in mitigating deficiencies in detected areas.

In the third step, outlier root cause analysis was performed, to analyze outliers more closely, which in fact represent extreme values of indicators, and which are, in fact, of most interest to any aviation operator because those extreme values (outliers) are exactly the ones that are of most concern to an operator and exactly the ones any operator wishes to mitigate. Applying root cause analysis of outliers can be very useful to determine which indicators caused these extreme values, and thereby mitigate or prevent them in the future. Outlier root cause analysis also revealed which indicators influence the others the most and helped to map out the path of each occurrence over the observed period of time, i.e., SPI7—Number of training deficiencies, SPI10—Number of occurrences related to maneuvering area maintenance, SPI13—Number of aircraft marshalling occurrences, SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving, and SPI23—Number of engine start-up incidents.

The next step was to perform forecasting (prediction) of each organizational and safety performance indicator, using the IBM SPSS Statistics 27 software. Forecasting of indicators was conducted using function Expert Modeler and Forecasting using the Temporal Causal Model. Three sets of forecasts were made, and the best fit was obtained by using exponential smoothing methods with a seasonal component. The significant events (ones that also showed they might cross safety performance target levels) were predicted to occur in July 2022 and July 2023, in the area SPI15—Number of occurrences related to passenger handling at the gate, and in September 2022 and September 2023, in the area SPI24—Number of occurrences related to wildlife. Other events were predicted to happen in areas SPI5—Number of personnel or passenger injuries, SPI14—Number of occurrences related to FOD presence, SPI20—Number of occurrences related to baggage loading/unloading, and SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving. All of these were anticipated to occur in summer months when the airport was the busiest, so more attention and additional mitigation measures should be implemented in those areas.

To mitigate or prevent anticipated occurrences, it was useful to use detected obtained causes that were known to have an impact on future events. Hence, per generated causal model, SPI5—Number of personnel or passenger injuries was impacted by SPI10—Number of occurrences related to maneuvering area maintenance, SPI15—Number of occurrences related to passenger handling at the gate and SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving. SPI14—Number of occurrences related to FOD presence was impacted by SPI3—Number of dangerous goods incidents, SPI11—Number of occurrences related to communication and SPI13—Number of aircraft marshalling occurrences. SPI15—Number of occurrences related to passenger handling at the gate was impacted by SPI7—Number of training deficiencies, SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving and SPI23—Number of engine start-up incidents. SPI20—Number of occurrences related to baggage loading/unloading was impacted by SPI7—Number of training deficiencies, SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving and OI2—Number of passengers. SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving was impacted by SPI1—Number of occurrences related to LIRF and loadsheet crosscheck, SPI10—Number of occurrences related to maneuvering area maintenance and OI1—Number of aircraft operations. SPI24—Number of occurrences related to wildlife was impacted by SPI11—Number of occurrences related to communication, SPI14—Number of occurrences related to FOD presence and OI1—Number of aircraft operations.

After conducting forecasting of each indicator at Split Airport, predictive analysis with causal impacts was performed, i.e., four scenario analyses were conducted to show how different values of organizational indicators (the lower of higher than original values), due to established causal relations, would impact future occurrences (SPIs) at Split Airport. Two organizational indicators were available for analysis, i.e., OI1—Number of aircraft operations and OI2—Number of passengers. Two scenarios were made for each organizational indicator (increase and decrease by 30%) to see how they would impact safety performance indicators. Since forecasts of OI1 and OI2 both anticipated an increase, scenarios showing how an increase in OI1 and OI2 impacted SPIs can be useful. Due to an increase in OI1—Number of aircraft operations, it can be observed that SPI1, SPI3, SPI4, SPI8, SPI9, SPI10, SPI11, SPI12, SPI13, SPI14, SPI17, SPI18, SPI23, SPI24 would decrease, SPI2, SPI5, SPI16, SPI19, SPI20, SPI21, SPI22, SPI25 would approximately remain the same, and only SPI7 and SPI15 would increase. Additional attention should be paid to these anticipated areas of increased occurrences. Due to an increase in OI2—Number of passengers, it can be observed that SPI1, SPI3, SPI4, SPI5, SPI9, SPI10, SPI11, SPI12, SPI14, SPI15, SPI17, SPI18, SPI19, SPI21, SPI23, SPI24 increased, SPI2, SPI8, SPI13, SPI16, SPI20, SPI22, SPI25 remained approximately the same, and only SPI7 decreased. Additional attention should be paid to these anticipated areas of increased occurrences. These two organizational indicators have opposite effects on safety performance indicators, hence in summary, attention should be paid to SPI5—Number of personnel or passenger injuries, SPI8—Number of apron maintenance incidents, and SPI15—Number of occurrences related to passenger handling at the gate. As a recommendation, conducting an analysis of additional organizational indicators could show what happens with safety performance indicators. This paper has shown how improved safety management, i.e., predictive safety management with use of predictive (forecasting) and causal modeling methods can identify potential and possible hazards in the future, as well as their causal factors, which can help define timely and efficient mitigation measures to prevent or restrain emerging hazards turning into adverse events. Based on detected future hazards, and their causal factors, the appropriate mitigation measures were generated for the purpose of improving and maintaining an acceptable level of safety at the airport.

Predictive analysis of airport safety performance was conducted on Split Airport, with a limited number of organizational and safety performance indicators, due to time and resource limitations, with the intention of verifying the quality and relevance of results that could be obtained with the implementation of proposed predictive safety

management methodology. In future research, the focus will be to define improved cause-sequenced breakdown of hazard/occurrence categories (SPIs) in order to obtain specific safety performance indicators related to each specific organizational area of activity. These categories could help define an extensive set of organizational and safety performance indicators that can be monitored, analyzed and predicted to mitigate or prevent future emerging hazards in the organization. Improving safety data input process, in general, could make the predictive safety management methodology even more efficient and useful. Future research will be focused on implementing predictive and causal modelling methods in a total management system, at the organizational level as well. The intention is to capillary integrate safety management system within a total management system of the organization. This could allow an organization to consider a large set of interactions (causal relationships) throughout the whole organizational system, that impacts directly or indirectly the organization's safety performance.

Appendix A

Table A1 shows a dataset of monthly organizational indicators (OIs) and safety performance indicators (SPIs) of Split Airport, in the period from January 2014 to December 2021 [53]. There are 27 indicators in total: OI1—Number of aircraft operations, OI2—Number of passengers, SPI1—Number of occurrences related to LIRF and loadsheet crosscheck, SPI2—Number of occurrences related to wrong figures for loadsheet, SPI3—Number of dangerous goods incidents, SPI4—Number of aircraft damage occurrences, SPI5—Number of personnel or passenger injuries, SPI6—Number of runway incursions/excursions, SPI7—Number of training deficiencies, SPI8—Number of apron maintenance incidents, SPI9—Number of vehicle maintenance incidents, SPI10—Number of occurrences related to maneuvering area maintenance, SPI11—Number of occurrences related to communication, SPI12—Number of incidents related to taxiing to/from apron, SPI13—Number of aircraft marshalling occurrences, SPI14—Number of occurrences related to FOD presence, SPI15—Number of occurrences related to passenger handling at the gate, SPI16—Number of occurrences related to passenger handling—disembarking/embarking, SPI17—Number of occurrences related to personal protective equipment, SPI18—Number of aircraft chocking incidents, SPI19—Number of aircraft conning incidents, SPI20—Number of occurrences related to baggage loading/unloading, SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving, SPI22—Number of anti-collision occurrences, SPI23—Number of engine start-up incidents, SPI24—Number of occurrences related to wildlife, and SPI25—Number of occurrences related to fuel handling.

Table A2 shows achieved safety performance targets (SPTs) in the period from January 2014 to December 2021 [53]. All deviations (breaches) from defined (desired) targets are marked in red.

Table A1. Dataset of organizational indicators (OIs) and safety performance indicators (SPIs) at Split Airport, in the observed time period. Adapted with permission from Ref. [53]. 2022, Split Airport.

Month	OI1	OI2	SPI1	SPI2	SPI3	SPI4	SPI5	SPI6	SPI7	SPI8	SPI9	SPI10	SPI11	SPI12	SPI13	SPI14	SPI15	SPI16	SPI17	SPI18	SPI19	SPI20	SPI21	SPI22	SPI23	SPI24	SPI25
January 2014	438	24,900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
February 2014	392	20,825	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
March 2014	514	26,410	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	1	0
April 2014	1032	77,575	0	0	0	0	0	0	0	2	0	4	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
May 2014	1942	157,070	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0
June 2014	2554	234,139	0	0	0	0	2	0	0	1	0	0	0	0	1	1	1	0	1	0	0	1	6	0	0	0	0
July 2014	3872	386,039	0	0	1	0	1	0	0	0	0	0	0	0	1	0	5	0	0	0	0	0	1	0	0	10	0
August 2014	3954	389,032	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	3	0	1	1	0
September 2014	2592	240,991	0	0	0	1	0	0	0	1	1	0	0	0	0	1	2	0	0	0	0	1	0	0	1	2	0
October 2014	1470	114,161	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0
November 2014	504	27,359	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December 2014	528	30,811	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
January 2015	504	23,513	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February 2015	454	22,234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
March 2015	576	31,941	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
April 2015	1132	73,149	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	1	0	0	2	0
May 2015	2232	179,794	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0
June 2015	2942	267,755	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	2	1	0	1	1	0
July 2015	4374	431,014	1	0	1	1	1	0	0	0	0	0	0	0	0	1	10	0	0	0	0	1	3	0	0	4	1
August 2015	4162	427,830	0	0	0	0	1	0	0	0	0	0	0	0	0	0	10	0	1	0	0	0	2	0	0	3	0
September 2015	2826	285,446	0	0	0	0	1	0	0	1	0	0	0	0	0	0	6	0	0	0	0	0	1	0	0	0	0
October 2015	1582	133,129	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0
November 2015	640	27,938	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December 2015	564	27,137	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
January 2016	492	25,028	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
February 2016	494	22,782	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0
March 2016	624	33,477	1	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
April 2016	1142	73,764	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
May 2016	2390	201,906	0	0	1	0	2	0	1	0	0	0	0	0	0	0	6	0	1	0	0	1	2	0	0	2	0
June 2016	3148	319,135	0	0	1	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	2	3	0	0	1	1
July 2016	4824	540,778	0	0	0	0	1	0	0	0	1	0	0	0	0	0	16	0	0	0	0	0	3	0	0	0	0
August 2016	4518	483,215	0	0	0	1	1	0	0	1	0	0	0	0	0	0	15	1	0	0	0	1	3	0	0	0	1
September 2016	3280	337,967	0	0	0	0	1	0	0	1	0	0	1	0	1	0	5	0	0	0	0	3	5	1	0	2	2
October 2016	1876	165,299	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	1	0	0	1	0
November 2016	582	30,676	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
December 2016	570	28,779	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
January 2017	586	28,994	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
February 2017	496	22,646	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1

Table A1. *Cont.*

Month	OI1	OI2	SPI1	SPI2	SPI3	SPI4	SPI5	SPI6	SPI7	SPI8	SPI9	SPI10	SPI11	SPI12	SPI13	SPI14	SPI15	SPI16	SPI17	SPI18	SPI19	SPI20	SPI21	SPI22	SPI23	SPI24	SPI25
March 2017	640	31,878	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
April 2017	1378	120,980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
May 2017	2644	254,265	0	0	0	0	1	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	1	0	0	3	0
June 2017	3594	401,347	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	5	1	0	0	1
July 2017	5216	653,743	0	0	0	0	3	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	2	0
August 2017	5078	590,830	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	3	0
September 2017	378	418,836	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4	1
October 2017	2116	195,837	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	1
November 2017	654	37,343	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
December 2017	554	34,626	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
January 2018	590	32,006	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
February 2018	520	29,109	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	2	0	0	0	0	1	0
March 2018	748	51,331	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0
April 2018	1486	121,372	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	2	0
May 2018	2878	301,377	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	0
June 2018	4052	471,962	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1
July 2018	5504	691,810	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	2	8	0	0	1
August 2018	5136	625,209	0	0	0	0	0	0	0	0	0	1	0	0	1	0	5	1	0	0	0	0	3	0	0	0	3
September 2018	3842	452,964	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	0	0	0	3	0	0	4	0
October 2018	2272	223,092	0	0	0	0	2	0	0	0	1	0	0	0	0	0	5	0	0	0	0	1	1	1	0	0	0
November 2018	750	52,942	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0
December 2018	646	42,434	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
January 2019	664	34,694	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February 2019	634	33,087	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
March 2019	800	48,095	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
April 2019	1698	153,474	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0	0	0	0	0	1	0	0	1	0
May 2019	2992	308,447	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	2	0
June 2019	4318	510,438	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	1	0	0	2	0
July 2019	5576	719,796	2	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	13	0
August 2019	5320	669,403	0	0	0	0	0	0	0	1	0	1	0	0	0	2	2	0	0	0	0	1	2	0	0	5	0
September 2019	3848	467,544	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
October 2019	2372	244,259	0	0	3	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	4	0	0	0	0
November 2019	634	42,859	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0
December 2019	574	38,949	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0
January 2020	567	35,282	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
February 2020	474	24,606	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
March 2020	370	16,117	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 2020	16	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A1. *Cont.*

Month	OI1	OI2	SPI1	SPI2	SPI3	SPI4	SPI5	SPI6	SPI7	SPI8	SPI9	SPI10	SPI11	SPI12	SPI13	SPI14	SPI15	SPI16	SPI17	SPI18	SPI19	SPI20	SPI21	SPI22	SPI23	SPI24	SPI25
May 2020	194	2319	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June 2020	818	24,929	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	1	0
July 2020	2757	169,229	0	0	0	0	3	0	0	0	0	0	0	0	0	0	11	1	0	0	0	0	1	0	0	6	0
August 2020	3676	271,362	1	0	0	0	0	0	0	0	0	0	0	1	0	0	7	0	0	0	0	0	0	0	0	0	0
September 2020	1807	74,653	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	1	0
October 2020	720	25,050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1
November 2020	410	7658	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December 2020	341	8145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
January 2021	314	7415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February 2021	274	5706	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
March 2021	358	8031	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 2021	587	13,964	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May 2021	883	32,754	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0
June 2021	2051	114,687	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	1	0
July 2021	4084	349,042	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
August 2021	4728	491,358	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7	1
September 2021	3435	326,347	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0
October 2021	2090	160,720	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
November 2021	613	25,726	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December 2021	615	23,428	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0

Table A2. Dataset of achieved safety performance targets (SPTs) at Split Airport, in the observed time period. Adapted with permission from Ref. [53]. 2022, Split Airport.

Month	SPI1	SPI2	SPI3	SPI4	SPI5	SPI6	SPI7	SPI8	SPI9	SPI10	SPI11	SPI12	SPI13	SPI14	SPI15	SPI16	SPI17	SPI18	SPI19	SPI20	SPI21	SPI22	SPI23	SPI24	SPI25
January 2014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0023[1]	0.0000	0.0000	0.0000	0.0000
February 2014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0026	0.0000	0.0000	0.0026	0.0000	0.0000	0.0000	0.0000	0.0000
March 2014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0019	0.0000	0.0000	0.0019	0.0000	0.0000
April 2014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0000	0.0039	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0000	0.0000	0.0000
May 2014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0005	0.0000
June 2014	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0004	0.0004	0.0004	0.0000	0.0004	0.0000	0.0000	0.0004	0.0023	0.0000	0.0000	0.0000	0.0000
July 2014	0.0000	0.0000	0.0003	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0026	0.0000
August 2014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000	0.0003	0.0003	0.0000
September 2014	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0004	0.0004	0.0000	0.0000	0.0000	0.0000	0.0004	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0004	0.0008
October 2014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0014	0.0000
November 2014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
December 2014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
January 2015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
February 2015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0044	0.0000	0.0000	0.0000	0.0000
March 2015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
April 2015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0000	0.0018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0000	0.0000	0.0018	0.0000
May 2015	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0004	0.0004	0.0000
June 2015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0003	0.0000	0.0000	0.0000	0.0007	0.0003	0.0000	0.0003	0.0003	0.0000
July 2015	0.0002	0.0000	0.0002	0.0002	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0023	0.0000	0.0000	0.0000	0.0000	0.0002	0.0007	0.0000	0.0000	0.0009	0.0002

Table A2. *Cont.*

Month	SPI1	SPI2	SPI3	SPI4	SPI5	SPI6	SPI7	SPI8	SPI9	SPI10	SPI11	SPI12	SPI13	SPI14	SPI15	SPI16	SPI17	SPI18	SPI19	SPI20	SPI21	SPI22	SPI23	SPI24	SPI25
August 2015	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0024	0.0000	0.0002	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0007	0.0000
September 2015	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000
October 2015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000
November 2015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
December 2015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
January 2016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0000	0.0000	0.0000
February 2016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0061	0.0000	0.0000	0.0020
March 2016	0.0016	0.0000	0.0000	0.0000	0.0016	0.0000	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
April 2016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000	0.0000
May 2016	0.0000	0.0000	0.0004	0.0000	0.0008	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0025	0.0000	0.0004	0.0000	0.0000	0.0000	0.0004	0.0008	0.0000	0.0000	0.0008
June 2016	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0044	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0010	0.0000	0.0003	0.0003
July 2016	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0033	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	0.0000
August 2016	0.0000	0.0000	0.0000	0.0002	0.0002	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0033	0.0002	0.0000	0.0000	0.0000	0.0000	0.0002	0.0007	0.0000	0.0000	0.0002
September 2016	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0003	0.0000	0.0000	0.0003	0.0000	0.0003	0.0000	0.0015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0015	0.0003	0.0006	0.0006
October 2016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000	0.0000	0.0000	0.0000	0.0011	0.0005	0.0000	0.0000	0.0005	0.0000
November 2016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000	0.0000
December 2016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0035	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
January 2017	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
February 2017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0020
March 2017	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016
April 2017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0000
May 2017	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0011
June 2017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0014	0.0003	0.0000	0.0000	0.0003
July 2017	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000
August 2017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0006
September 2017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0026	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0106	0.0026
October 2017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000	0.0005	0.0005	0.0000	0.0000	0.0000	0.0000	0.0005
November 2017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0015	0.0000	0.0000	0.0015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
December 2017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
January 2018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000
February 2018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0000	0.0000	0.0000	0.0019	0.0000	0.0000	0.0000	0.0038	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0000
March 2018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0013	0.0000	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0027	0.0000	0.0000	0.0000	0.0000
April 2018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0007	0.0000	0.0000	0.0013	0.0000
May 2018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000
June 2018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
July 2018	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0015	0.0000	0.0002	0.0002
August 2018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0002	0.0010	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0006	0.0000
September 2018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0008	0.0000	0.0010	0.0000
October 2018	0.0000	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0004	0.0004	0.0000	0.0000
November 2018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0027	0.0000	0.0000	0.0000	0.0000	0.0000	0.0013	0.0000	0.0000	0.0000	0.0000
December 2018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
January 2019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
February 2019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0047	0.0000	0.0000	0.0000
March 2019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0013	0.0000	0.0000	0.0000	0.0000	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
April 2019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0024	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	0.0006
May 2019	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0007
June 2019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002	0.0000	0.0000	0.0005
July 2019	0.0004	0.0000	0.0002	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0023
August 2019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0002	0.0000	0.0000	0.0000	0.0004	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0004	0.0000	0.0009	0.0000
September 2019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000
October 2019	0.0000	0.0000	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000
November 2019	0.0000	0.0000	0.0016	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0032	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016	0.0000	0.0000	0.0000
December 2019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0035	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000
January 2020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018	0.0000	0.0000	0.0000
February 2020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table A2. *Cont.*

Month	SPI1	SPI2	SPI3	SPI4	SPI5	SPI6	SPI7	SPI8	SPI9	SPI10	SPI11	SPI12	SPI13	SPI14	SPI15	SPI16	SPI17	SPI18	SPI19	SPI20	SPI21	SPI22	SPI23	SPI24	SPI25
March 2020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
April 2020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0625	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
May 2020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
June 2020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0024	0.0000	0.0000	0.0012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	0.0000
July 2020	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0022	0.0000
August 2020	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
September 2020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	0.0006	0.0000
October 2020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0014	0.0014
November 2020	0.0000	0.0000	0.0024	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
December 2020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
January 2021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
February 2021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
March 2021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
April 2021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
May 2021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000	0.0000	0.0000	0.0000
June 2021	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0000	0.0000	0.0005	0.0000
July 2021	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000
August 2021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0015	0.0002
September 2021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0003	0.0003	0.0000	0.0000	0.0003	0.0000
October 2021	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
November 2021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
December 2021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000

[1] All deviations (breaches) from defined (desired) targets are marked in red.

Appendix B

Figure A1 shows causal relationships of all individual organizational indicators (OIs) and safety performance indicators (SPIs) at Split Airport.
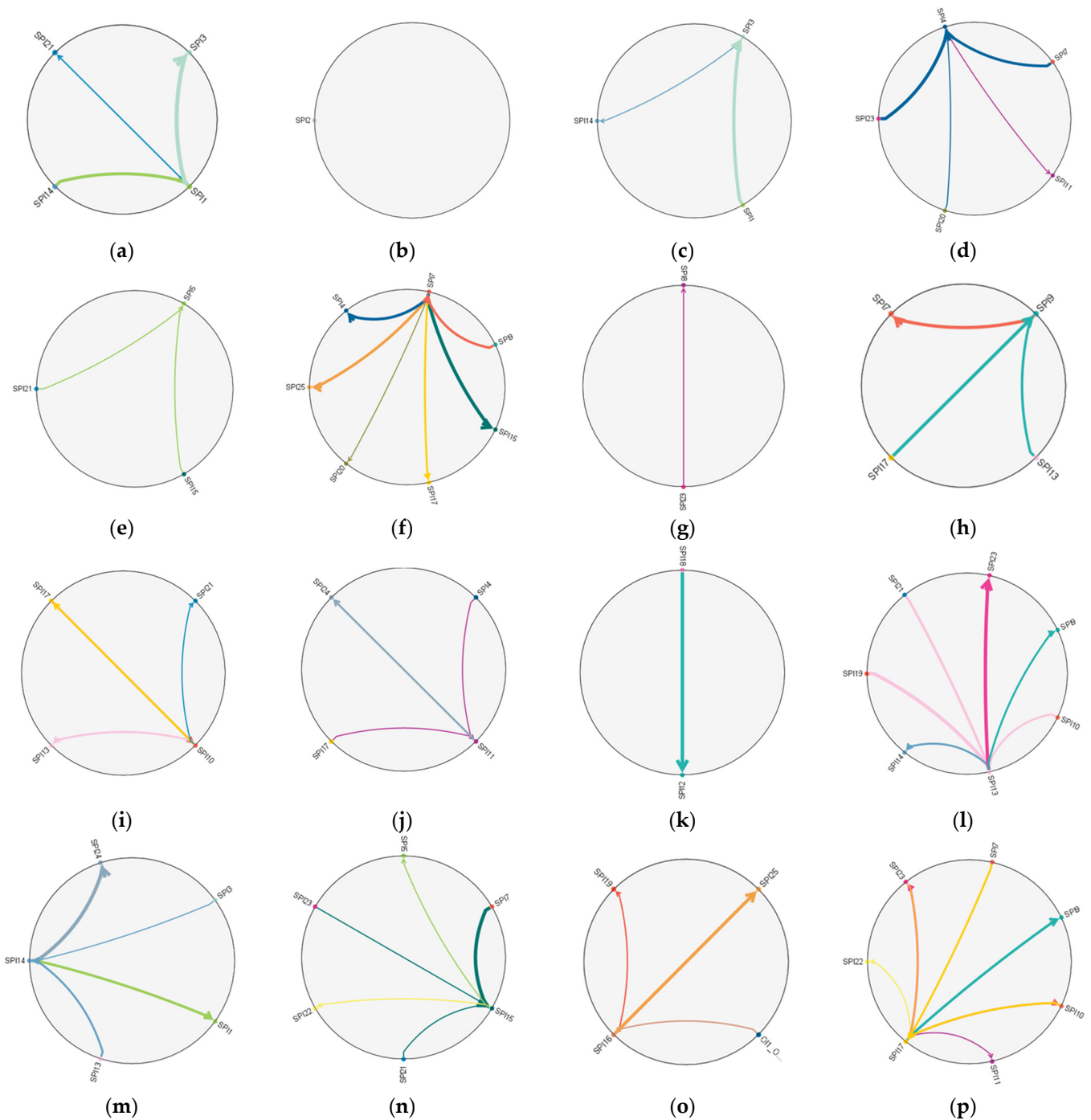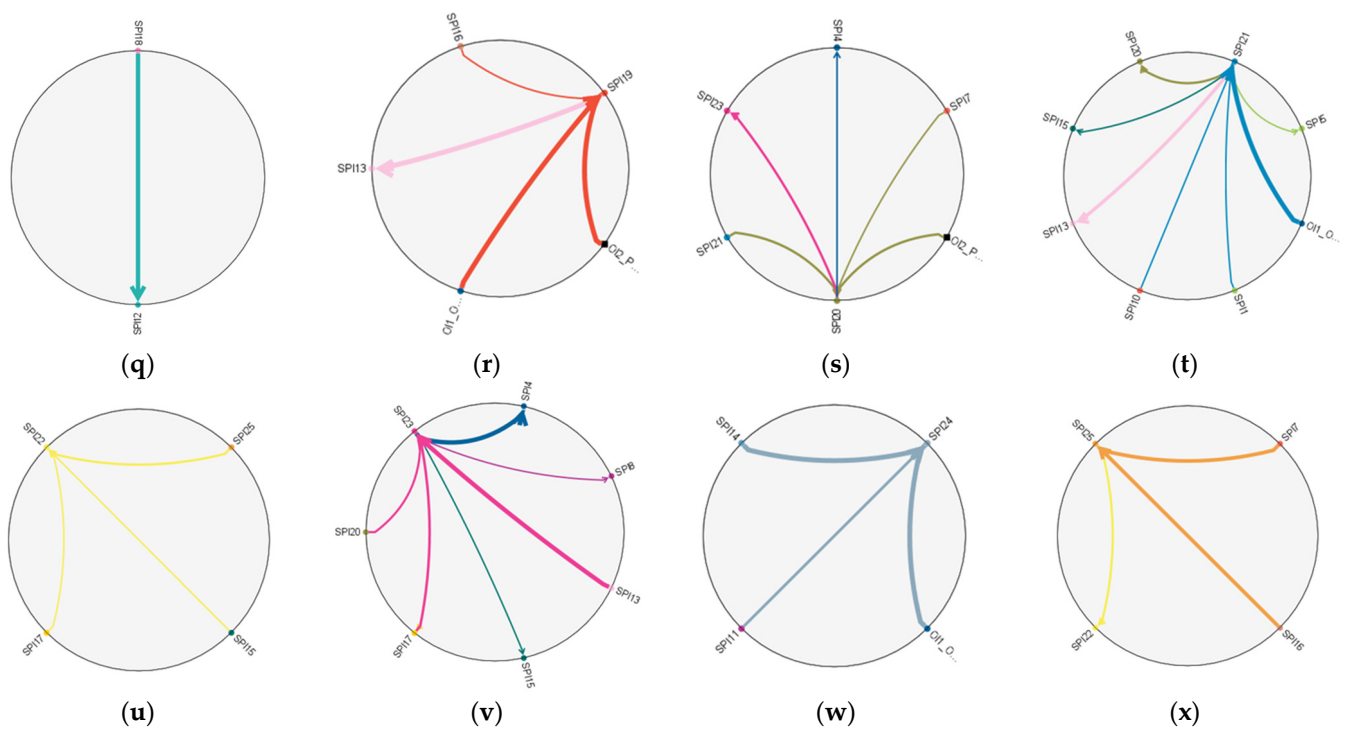

Figure A1. *Cont.*

Figure A1. Impacts of individual safety performance indicators: (**a**) SPI1—Number of occurrences related to LIRF and loadsheet crosscheck; (**b**) SPI2—Number of occurrences related to wrong figures for loadsheet; (**c**) SPI3—Number of dangerous goods incidents; (**d**) SPI4—Number of aircraft damage occurrences; (**e**) SPI5—Number of personnel or passenger injuries; (**f**) SPI7—Number of training deficiencies; (**g**) SPI8—Number of apron maintenance incidents; (**h**) SPI9—Number of vehicle maintenance incidents; (**i**) SPI10—Number of occurrences related to maneuvering area maintenance; (**j**) SPI11—Number of occurrences related to communication; (**k**) SPI12—Number of incidents related to taxiing to/from apron; (**l**) SPI13—Number of aircraft marshalling occurrences; (**m**) SPI14—Number of occurrences related to FOD presence; (**n**) SPI15—Number of occurrences related to passenger handling at the gate; (**o**) SPI16—Number of occurrences related to passenger handling—disembarking/embarking; (**p**) SPI17—Number of occurrences related to personal protective equipment; (**q**) SPI18—Number of aircraft chocking incidents; (**r**) SPI19—Number of aircraft conning incidents; (**s**) SPI20—Number of occurrences related to baggage loading/unloading; (**t**) SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving; (**u**) SPI22—Number of anti-collision occurrences; (**v**) SPI23—Number of engine start-up incidents; (**w**) SPI24—Number of occurrences related to wildlife; (**x**) SPI25—Number of occurrences related to fuel handling.

Figure A2 shows all impact diagrams of causes and effects of each organizational indicators (OIs) and safety performance indicators (SPIs) in the observed dataset, at Split Airport.
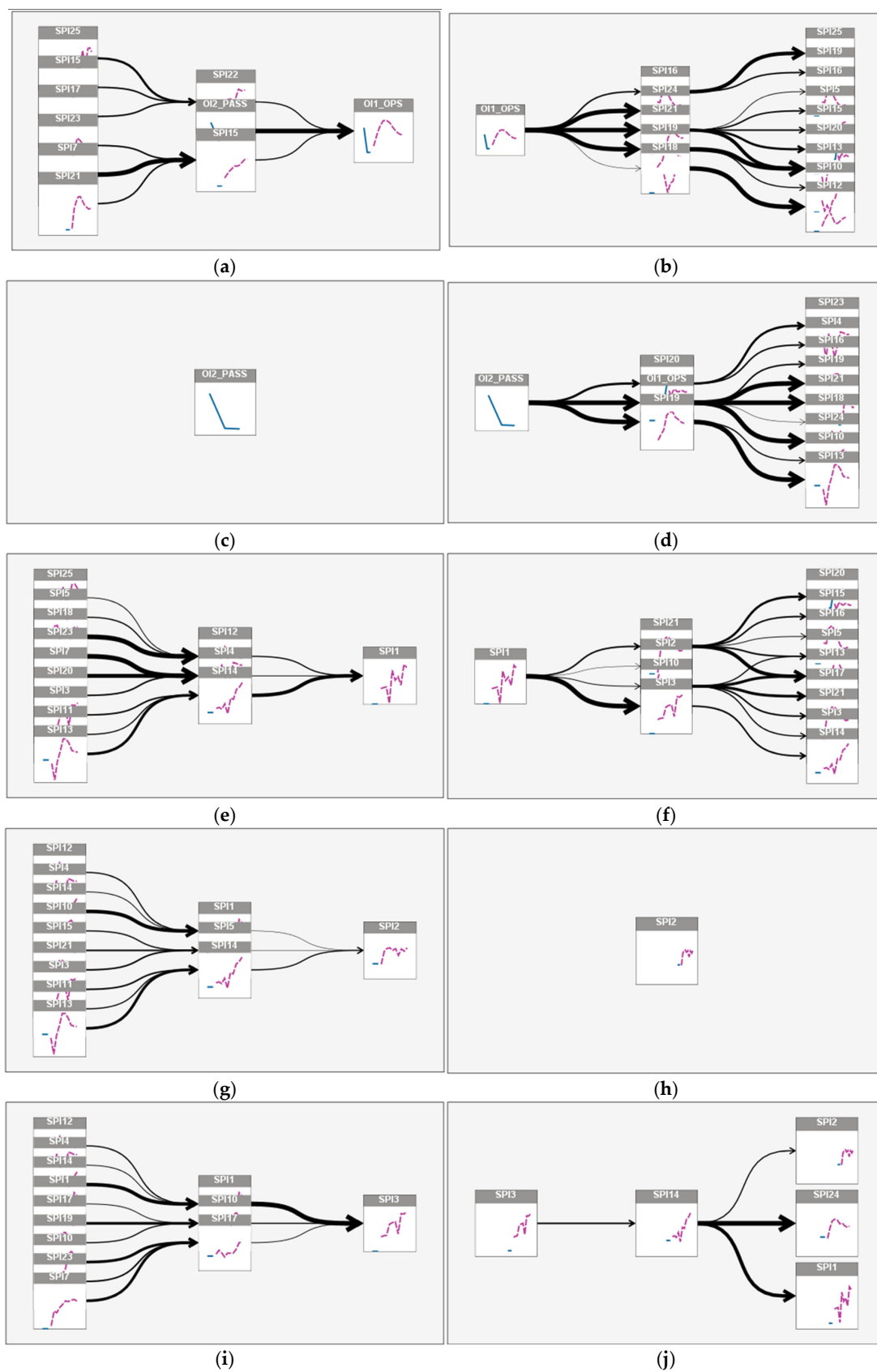
(**a**)

(**b**)
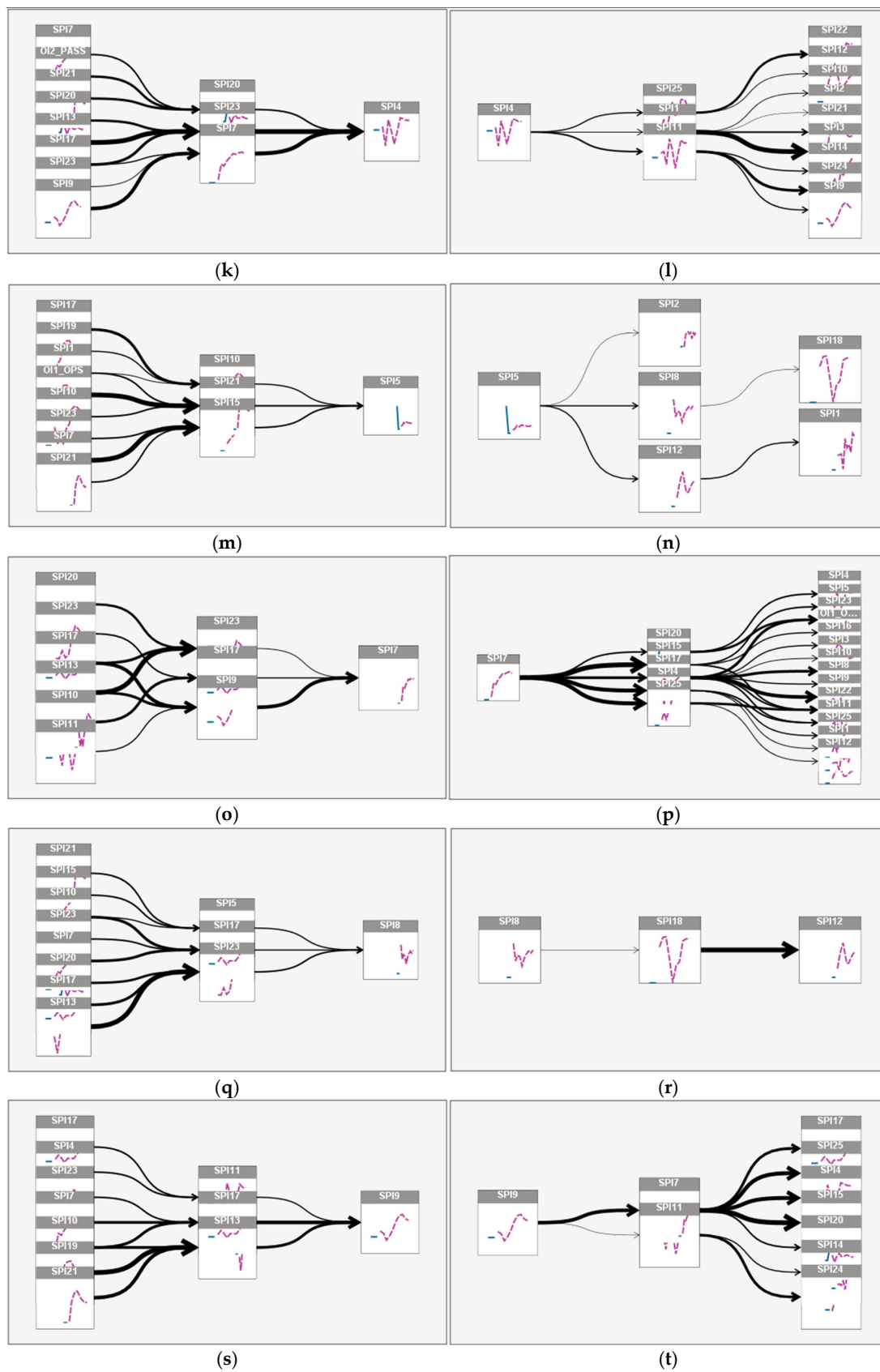
(**c**)

(**d**)
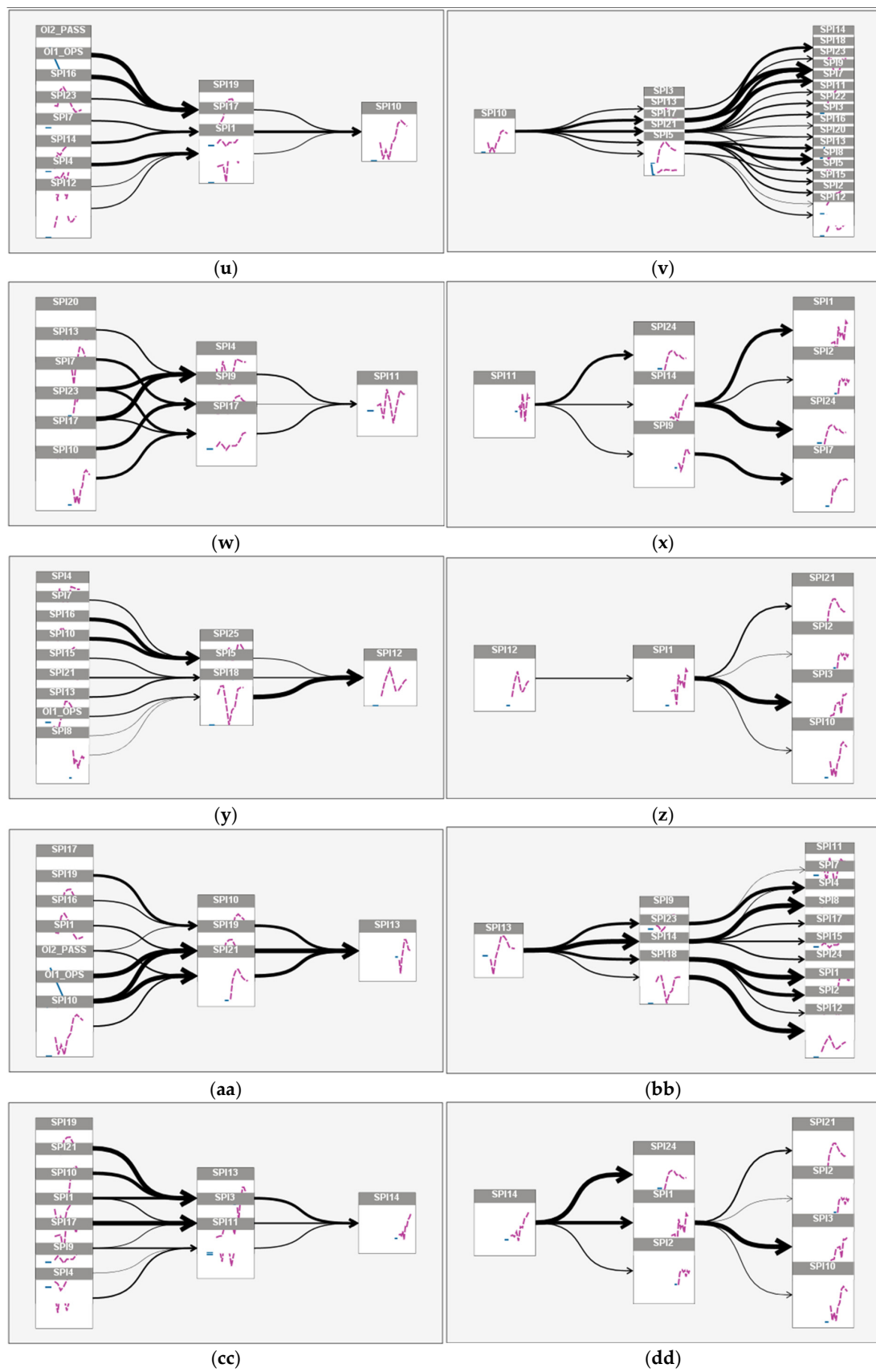
(**e**)

(**f**)

(**g**)

(**h**)

(**i**)

(**j**)

Figure A2. *Cont*.

Figure A2. *Cont.*

(**u**)

(**v**)

(**w**)

(**x**)

(**y**)

(**z**)

(**aa**)

(**bb**)

(**cc**)

(**dd**)

Figure A2. *Cont.*

(**ee**)

(**ff**)

(**gg**)

(**hh**)

(**ii**)

(**jj**)

(**kk**)

(**ll**)

(**mm**)

(**nn**)

Figure A2. *Cont.*

(**oo**)

(**pp**)

(**qq**)

(**rr**)

(**ss**)

(**tt**)

(**uu**)

(**vv**)

(**ww**)

(**xx**)

Figure A2. *Cont.*

(**yy**) (**zz**)

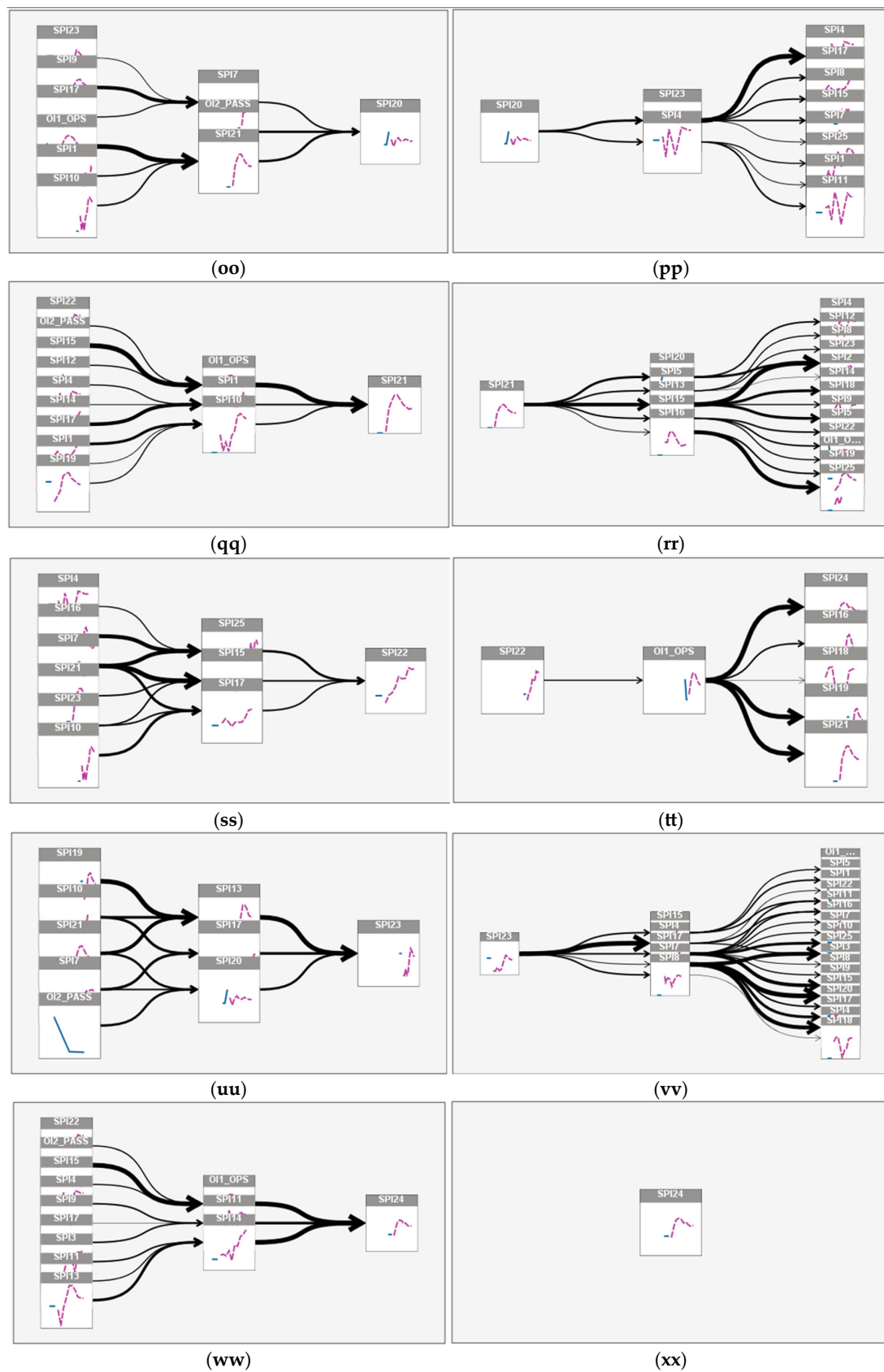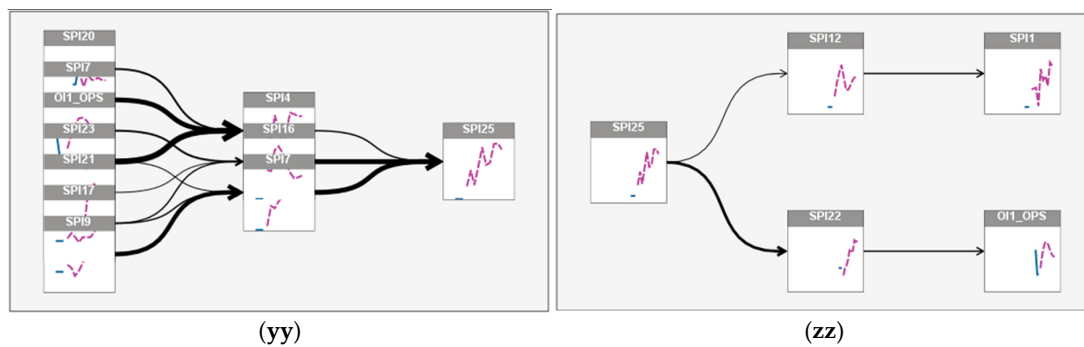**Figure A2.** Impact diagrams of causes and effects of all indicators in the observed dataset: (**a**) causes of OI1; (**b**) effects of OI1; (**c**) causes of OI2; (**d**) effects of OI2; (**e**) causes of SPI1; (**f**) effects of SPI1; (**g**) causes of SPI2; (**h**) effects of SPI2; (**i**) causes of SPI3; (**j**) effects of SPI3; (**k**) causes of SPI4; (**l**) effects of SPI4; (**m**) causes of SPI5; (**n**) effects of SPI5; (**o**) causes of SPI7; (**p**) effects of SPI7; (**q**) causes of SPI8; (**r**) effects of SPI8; (**s**) causes of SPI9; (**t**) effects of SPI9; (**u**) causes of SPI10; (**v**) effects of SPI10; (**w**) causes of SPI11; (**x**) effects of SPI11; (**y**) causes of SPI12; (**z**) effects of SPI12; (**aa**) causes of SPI13; (**bb**) effects of SPI13; (**cc**) causes of SPI14; (**dd**) effects of SPI14; (**ee**) causes of SPI15; (**ff**) effects of SPI15; (**gg**) causes of SPI16; (**hh**) effects of SPI16; (**ii**) causes of SPI17; (**jj**) effects of SPI17; (**kk**) causes of SPI18; (**ll**) effects of SPI18; (**mm**) causes of SPI19; (**nn**) effects of SPI19; (**oo**) causes of SPI20; (**pp**) effects of SPI20; (**qq**) causes of SPI21; (**rr**) effects of SPI21; (**ss**) causes of SPI22; (**tt**) effects of SPI22; (**uu**) causes of SPI23; (**vv**) effects of SPI23; (**ww**) causes of SPI24; (**xx**) effects of SPI24; (**yy**) causes of SPI25; (**zz**) effects of SPI25.

Appendix C

Figure A3 shows outlier root cause analyses conducted for each indicator (where causal links were found) in the observed dataset from January 2014 to December 2021.

(**a**) (**b**)

(**c**) (**d**)
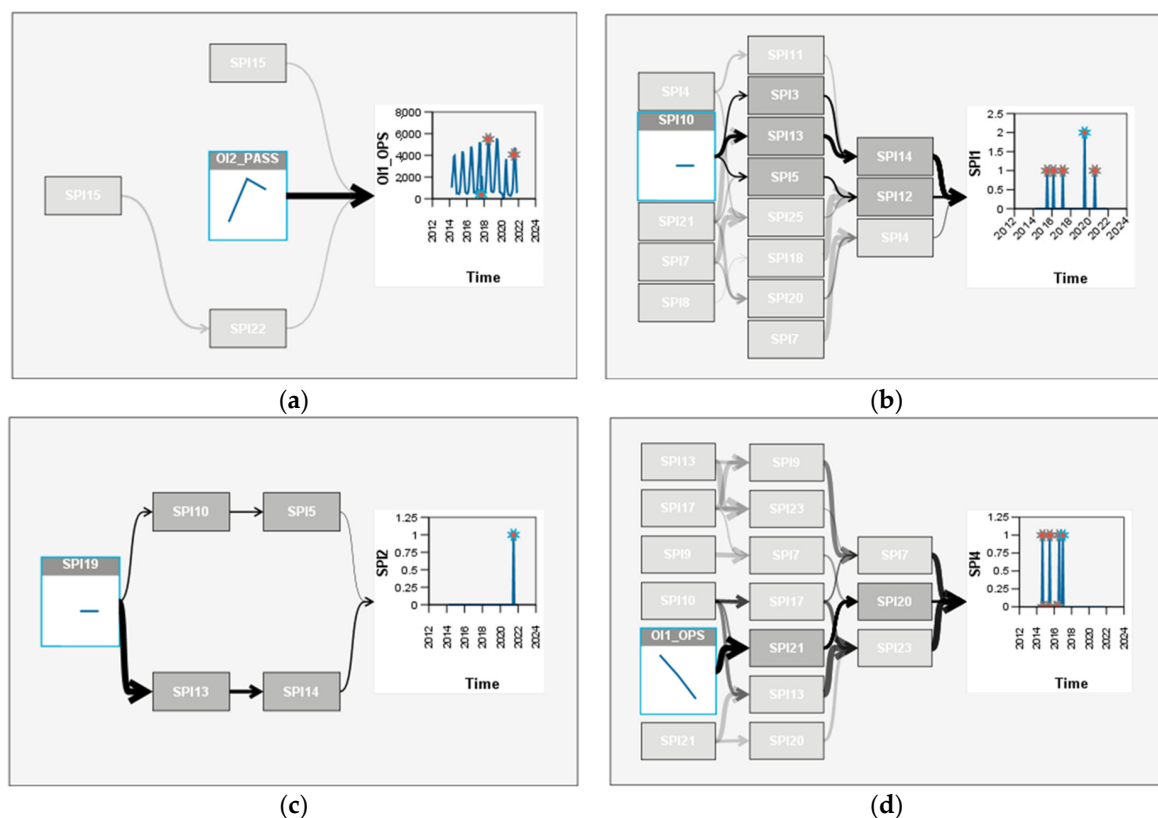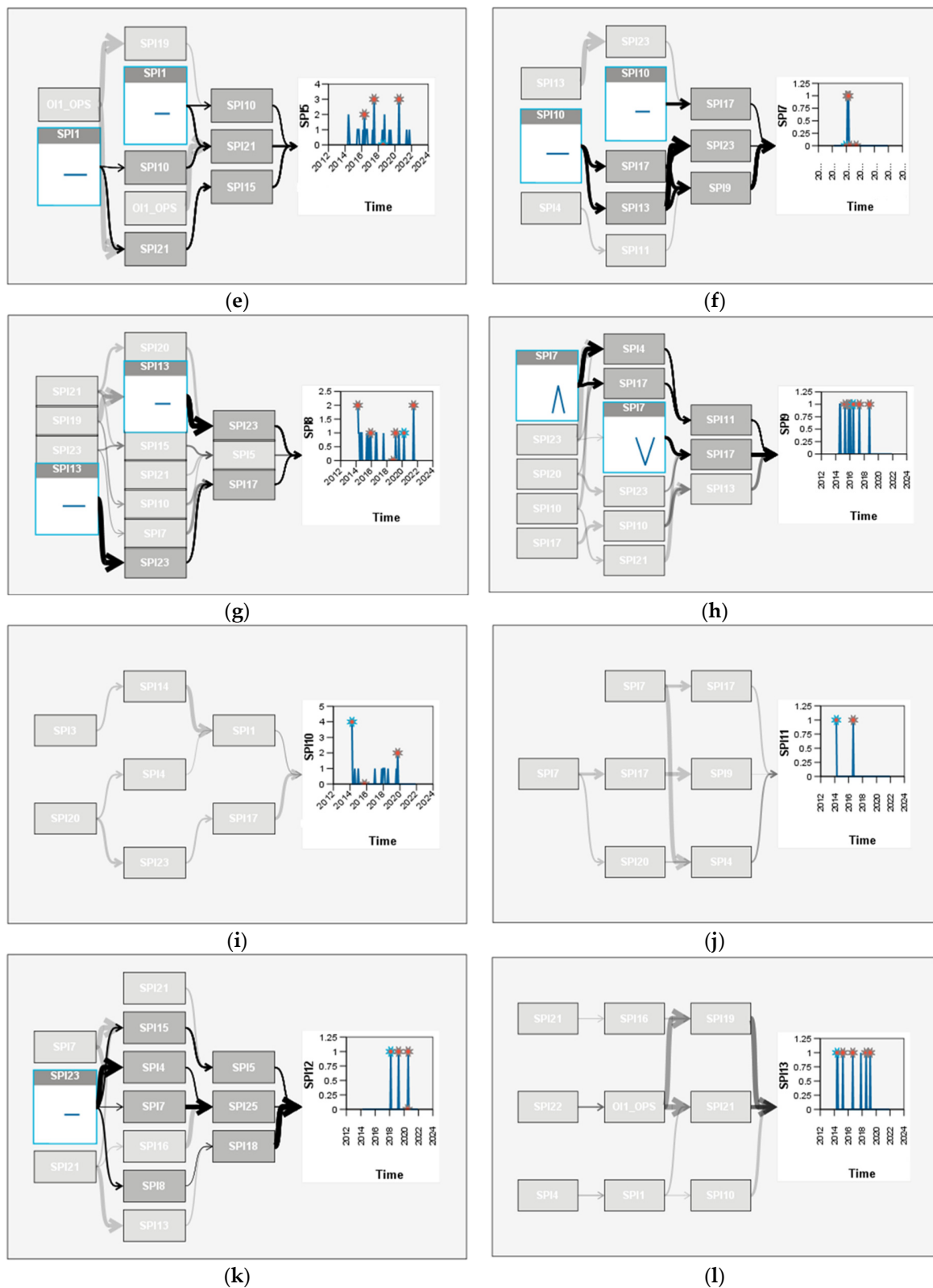
Figure A3. *Cont*.

Figure A3. *Cont.*

Figure A3. *Cont.*

(u)

(v)

(w)

(x)
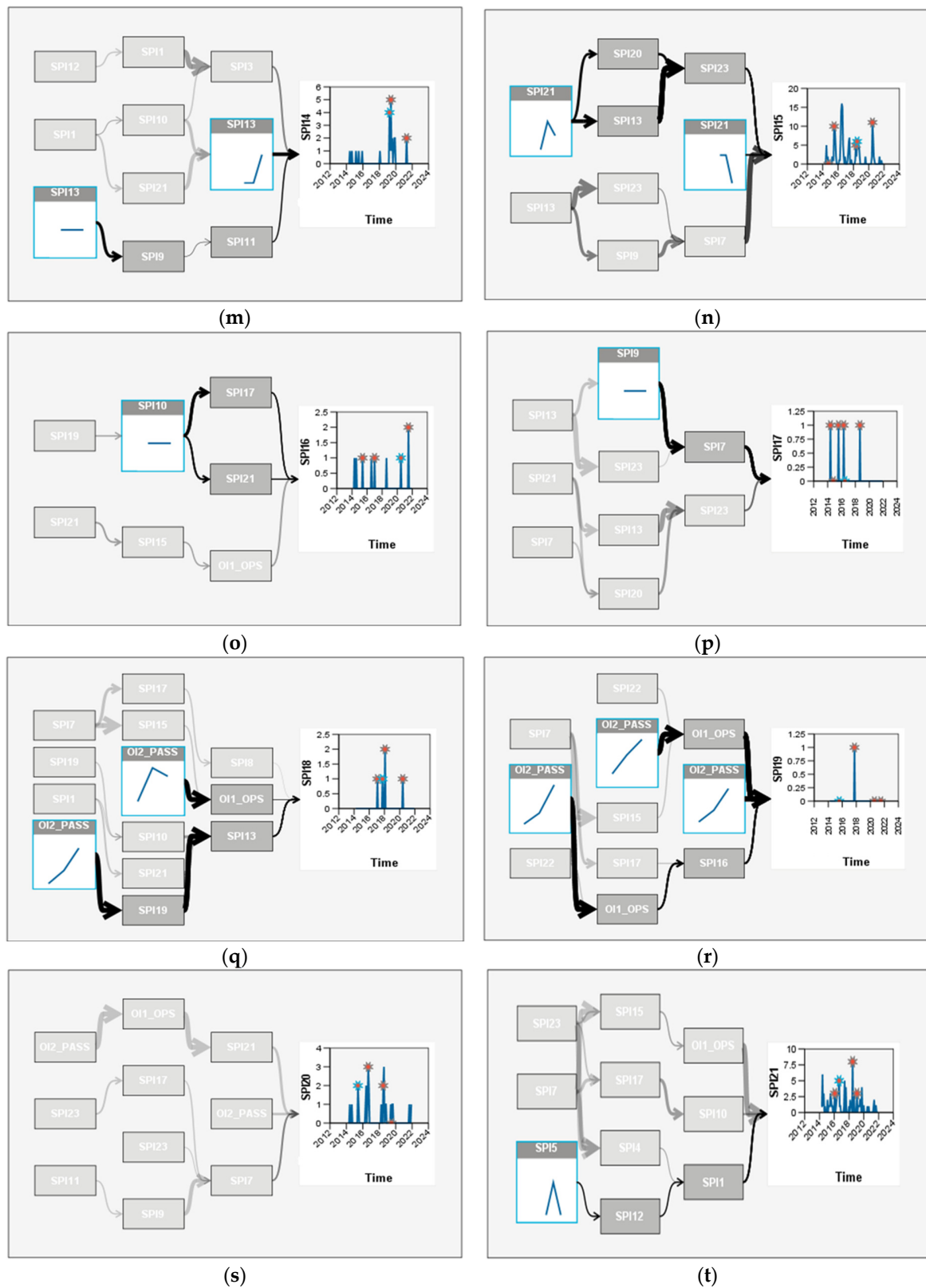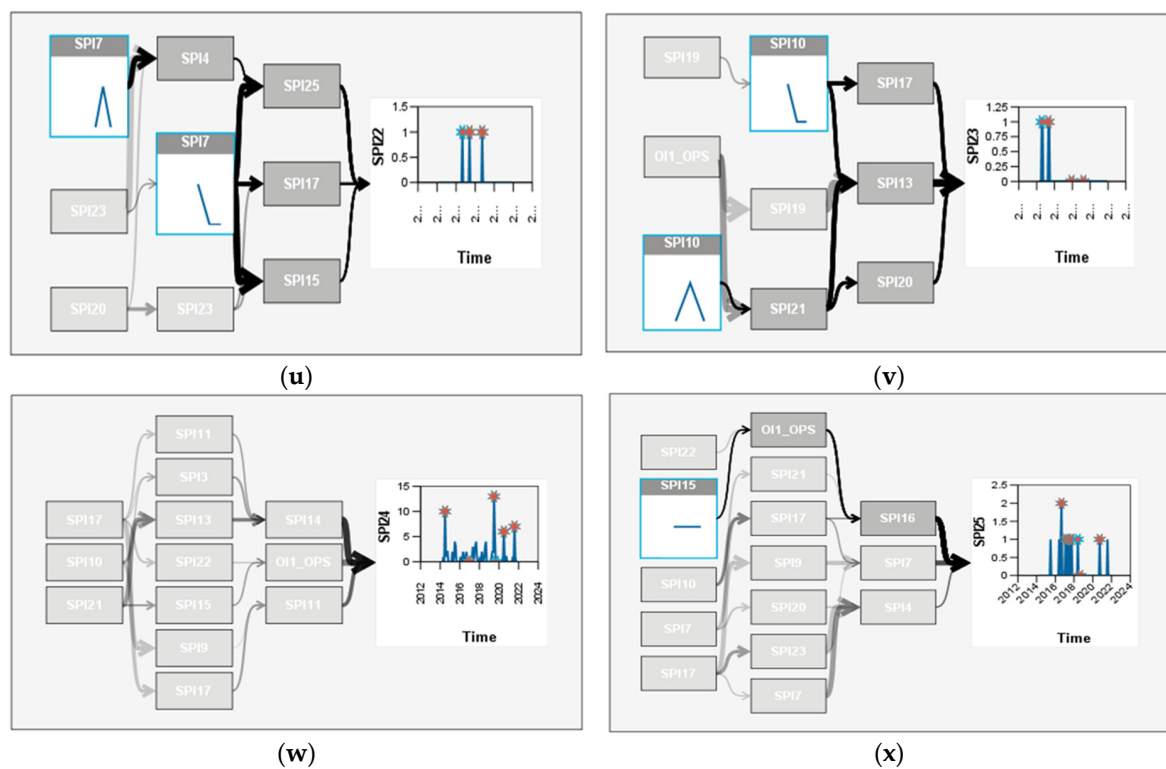
Figure A3. Outlier root cause analyses of all indicators in the observed dataset: (**a**) OI1; (**b**) SPI1; (**c**) SPI2; (**d**) SPI4; (**e**) SPI5; (**f**) SPI7; (**g**) SPI8; (**h**) SPI9; (**i**) SPI10; (**j**) SPI11; (**k**) SPI12; (**l**) SPI13; (**m**) SPI14; (**n**) SPI15; (**o**) SPI16; (**p**) SPI17; (**q**) SPI18; (**r**) SPI19; (**s**) SPI20; (**t**) SPI21; (**u**) SPI22; (**v**) SPI23; (**w**) SPI24; (**x**) SPI25.

Table A3 shows all outliers occurring at Split Airport over the observed time period, from January 2014 to December 2021.

Table A3. Outliers and their root causes for Split Airport safety performance indicators over observed time period.

Time Point	SPIs	Outliers	Root Causes	Time Point	SPIs	Outliers	Root Causes	Time Point	SPIs	Outliers	Root Causes
April 2014	SPI8	2	Unknown	July 2016	SPI9	1	SPI7	September 2018	SPI17	1	SPI7
April 2014	SPI10	4	Unknown	August 2016	SPI4	1	SPI10	October 2018	SPI9	1	SPI10
April 2014	SPI11	1	Unknown	September 2016	SPI11	1	SPI7	October 2018	SPI22	1	SPI23
June 2014	SPI13	1	Unknown	September 2016	SPI13	1	SPI21	February 2019	SPI21	3	Unknown
June 2014	SPI17	1	Unknown	September 2016	SPI20	3	SPI11	March 2019	SPI8	1	SPI19
July 2014	SPI24	10	SPI11	September 2016	SPI21	5	SPI5	March 2019	SPI13	1	SPI22
August 2014	SPI23	1	SPI10	September 2016	SPI22	1	SPI7	April 2019	SPI12	1	SPI7
September 2014	SPI4	1	SPI10	September 2016	SPI25	2	SPI17	April 2019	SPI14	4	SPI13
April 2015	SPI13	1	SPI22	January 2017	SPI4	1	OI1_OPS	June 2019	SPI14	5	SPI12
May 2015	SPI3	1	SPI16	January 2017	SPI16	1	SPI19	July 2019	SPI1	2	SPI10
May 2015	SPI9	1	SPI17	February 2017	SPI18	1	SPI1	July 2019	SPI3	1	SPI1
May 2015	SPI23	1	SPI10	March 2017	SPI1	1	SPI4	July 2019	SPI24	13	SPI21
June 2015	SPI16	1	SPI21	March 2017	SPI25	1	SPI10	October 2019	SPI3	3	SPI13
June 2015	SPI20	2	Unknown	May 2017	SPI9	1	SPI23	October 2019	SPI10	2	SPI3
July 2015	SPI1	1	SPI21	June 2017	SPI22	1	SPI20	April 2020	SPI8	1	SPI13
July 2015	SPI3	1	SPI23	June 2017	SPI25	1	SPI7	June 2020	SPI18	1	SPI7
July 2015	SPI4	1	SPI13	July 2017	SPI5	3	OI1_OPS	July 2020	SPI5	3	SPI1
July 2015	SPI15	10	SPI13	September 2017	SPI25	1	SPI16	July 2020	SPI15	11	Unknown
August 2015	SPI17	1	SPI13	October 2017	SPI18	1	OI2_PASS	July 2020	SPI16	1	SPI10
November 2015	SPI9	1	SPI20	October 2017	SPI19	1	OI2_PASS	July 2020	SPI24	6	SPI17
December 2015	SPI8	1	SPI21	October 2017	SPI25	1	Unknown	August 2020	SPI1	1	SPI8
February 2016	SPI9	1	SPI7	February 2018	SPI18	2	SPI19	August 2020	SPI12	1	SPI21
February 2016	SPI21	3	SPI23	March 2018	SPI12	1	SPI23	October 2020	SPI25	1	SPI15
March 2016	SPI1	1	SPI7	May 2018	SPI15	5	SPI13	May 2021	SPI14	2	SPI1
March 2016	SPI7	1	SPI4	June 2018	SPI25	1	SPI15	July 2021	SPI2	1	SPI19
May 2016	SPI3	1	SPI17	July 2018	SPI15	6	SPI21	July 2021	SPI8	2	SPI23
May 2016	SPI5	2	SPI1	July 2018	SPI20	2	SPI23	July 2021	SPI16	2	SPI21
May 2016	SPI7	1	Unknown	July 2018	SPI21	8	SPI7	August 2021	SPI24	7	SPI21
May 2016	SPI17	1	SPI9	August 2018	SPI13	1	SPI4				

Appendix D

Table A4 shows the obtained forecasted values of organizational indicators in an observed dataset from Split Airport, i.e., OI1—Number of aircraft operations and OI2—Number of passengers using IBM SPSS simple exponential forecasting method with seasonal component.

Table A4. Forecasts of organizational indicators of Split Airport.

Time Point	OI1_Model_1	OI2_Model_2
January 2022	599	20,618
February 2022	546	16,764
March 2022	658	25,049
April 2022	1138	73,424
May 2022	2099	173,881
June 2022	3014	287,188
July 2022	4605	486,821
August 2022	4651	487,669
September 2022	2830	319,733
October 2022	1891	151,833
November 2022	678	25,702
December 2022	628	23,428
January 2023	599	20,618
February 2023	546	16,764
March 2023	658	25,049
April 2023	1138	73,424
May 2023	2099	173,881
June 2023	3014	287,188
July 2023	4605	486,821
August 2023	4651	487,669
September 2023	2830	319,733
October 2023	1891	151,833
November 2023	678	25,702
December 2023	628	23,428

Table A5 shows the obtained forecasted values of organizational indicator (OI1) in an observed dataset from Split Airport, i.e., Number of aircraft operations, using IBM SPSS function Forecasting using the Temporal Causal Model.

Table A5. Initial forecast of organizational indicator OI1 Number of aircraft operations.

Time Point	OI1_TCM_Model_1	Graph
January 2022	993	
February 2022	1687	
March 2022	2184	
April 2022	2519	
May 2022	2544	
June 2022	2399	
July 2022	2116	
August 2022	1869	
September 2022	1715	
October 2022	1666	

Table A6 and Figure A4 show complete first initial forecast of all Split Airport safety performance indicators using IBM SPSS function Forecasting using Temporal Causal Model.

Figure A4. *Cont.*

(**i**)

(**j**)

(**k**)

(**l**)

(**m**)

(**n**)

(**o**)

(**p**)

Figure A4. *Cont.*

Observed and Predicted Series for SPI18

(**q**)

Observed and Predicted Series for SPI19

(**r**)

Observed and Predicted Series for SPI20

(**s**)

Observed and Predicted Series for SPI21

(**t**)

Observed and Predicted Series for SPI22

(**u**)

Observed and Predicted Series for SPI23

(**v**)

Figure A4. *Cont.*

(w)

(x)
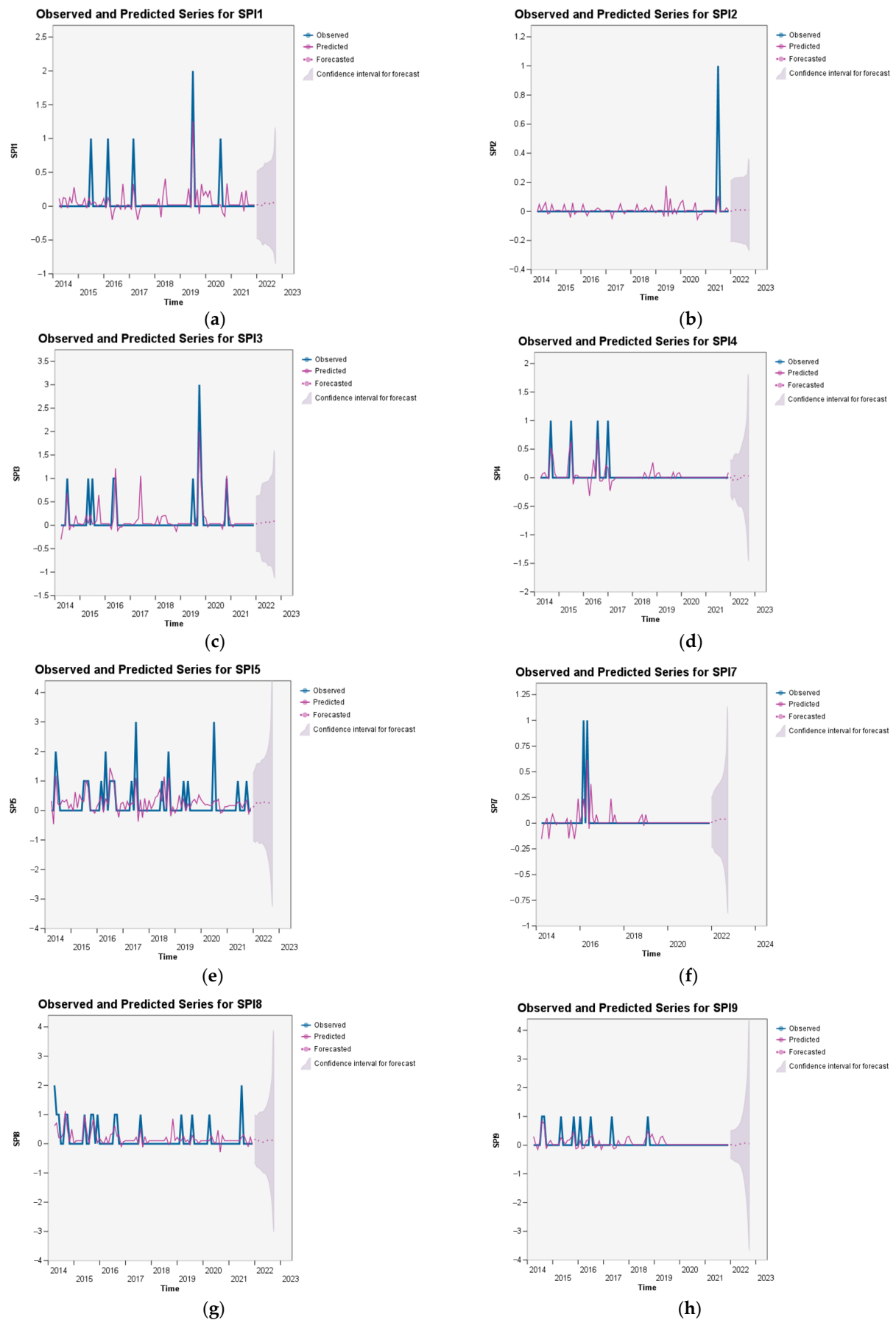
Figure A4. Forecasts of Split Airport safety performance indicators (forecasting using temporal causal model): (**a**) SPI1—Number of occurrences related to LIRF and loadsheet crosscheck; (**b**) SPI2—Number of occurrences related to wrong figures for loadsheet; (**c**) SPI3—Number of dangerous goods incidents; (**d**) SPI4—Number of aircraft damage occurrences; (**e**) SPI5—Number of personnel or passenger injuries; (**f**) SPI7—Number of training deficiencies; (**g**) SPI8—Number of apron maintenance incidents; (**h**) SPI9—Number of vehicle maintenance incidents; (**i**) SPI10—Number of occurrences related to maneuvering area maintenance; (**j**) SPI11—Number of occurrences related to communication; (**k**) SPI12—Number of incidents related to taxiing to/from apron; (**l**) SPI13—Number of aircraft marshalling occurrences; (**m**) SPI14—Number of occurrences related to FOD presence; (**n**) SPI15—Number of occurrences related to passenger handling at the gate; (**o**) SPI16—Number of occurrences related to passenger handling—disembarking/embarking; (**p**) SPI17—Number of occurrences related to personal protective equipment; (**q**) SPI18—Number of aircraft chocking incidents; (**r**) SPI19—Number of aircraft conning incidents; (**s**) SPI20—Number of occurrences related to baggage loading/unloading; (**t**) SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving; (**u**) SPI22—Number of anti-collision occurrences; (**v**) SPI23—Number of engine start-up incidents; (**w**) SPI24—Number of occurrences related to wildlife; (**x**) SPI25—Number of occurrences related to fuel handling.

Tables A7–A10 and Figure A5 show a second set of initial forecasts for Split Airport safety performance indicators (SPIs) with associated safety performance targets (SPTs) using IBM SPSS function Expert Modeler Forecasting. The first set uses ARIMA and exponential smoothing methods, while the second set uses exponential smoothing methods only. A model for safety performance indicator SPI6 could not be built because all of the values of the series are the same (constant). The forecast period is set up to 24 months.

Table A6. First initial forecast of Split Airport safety performance indicators (forecasting using temporal causal model).
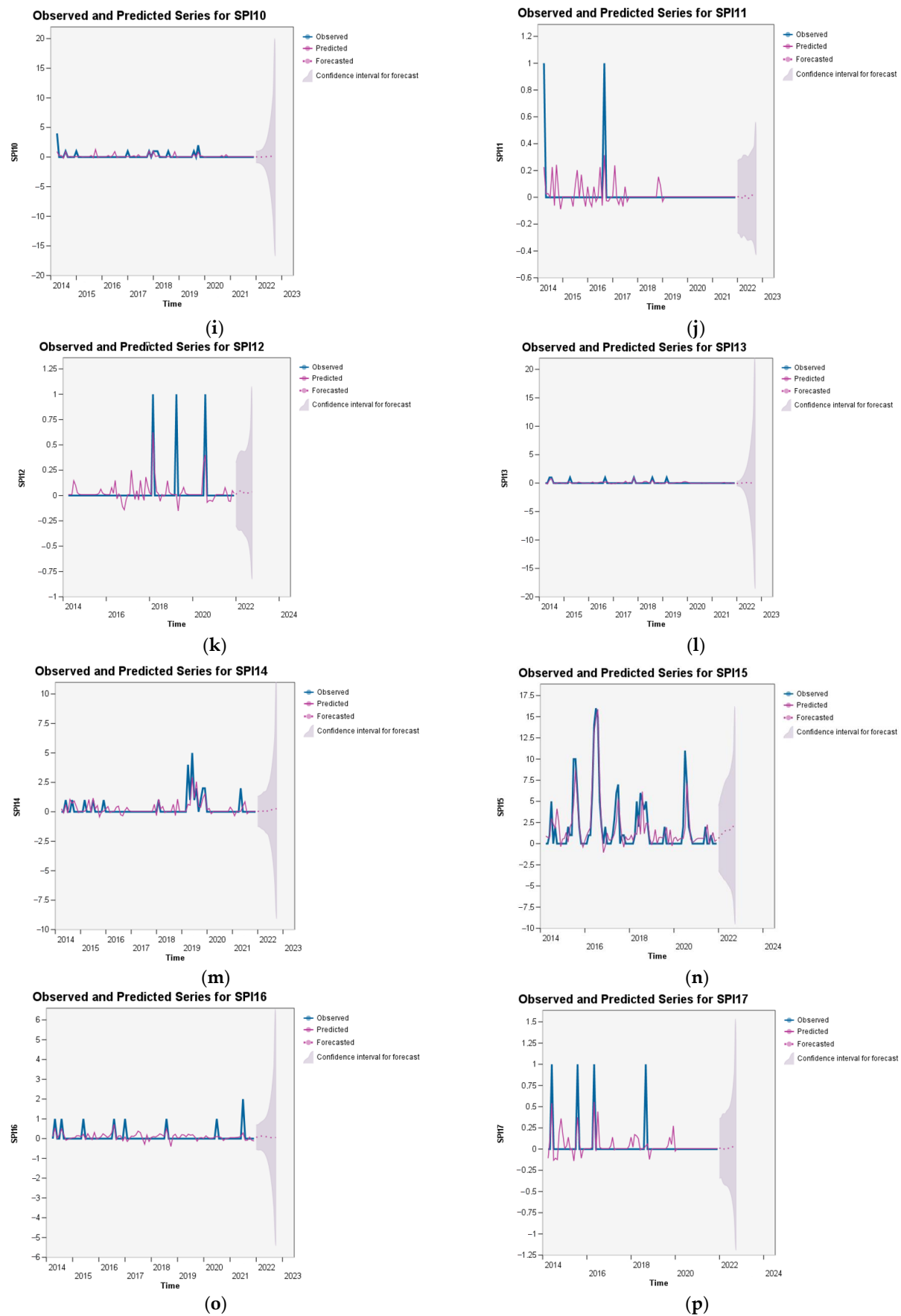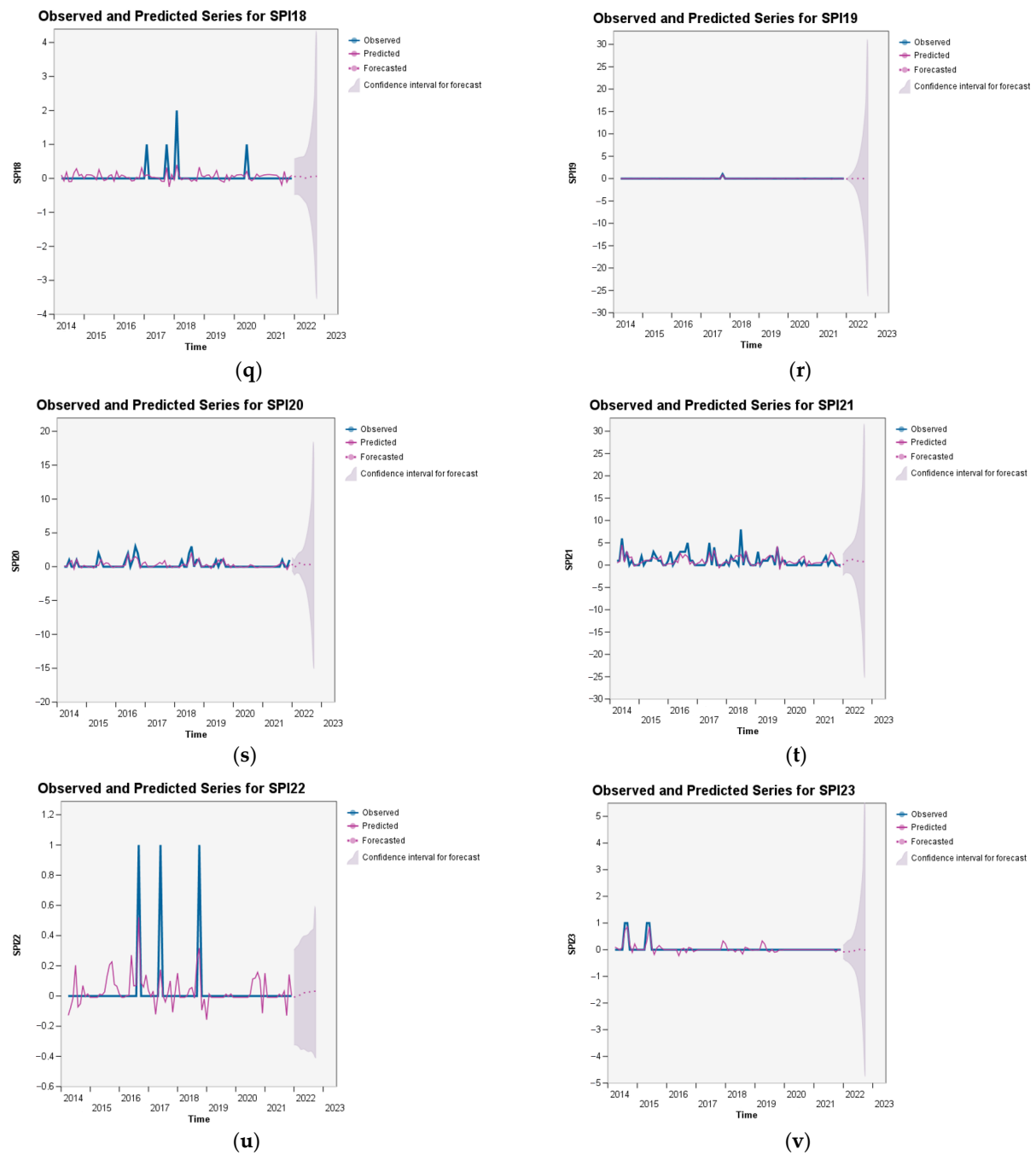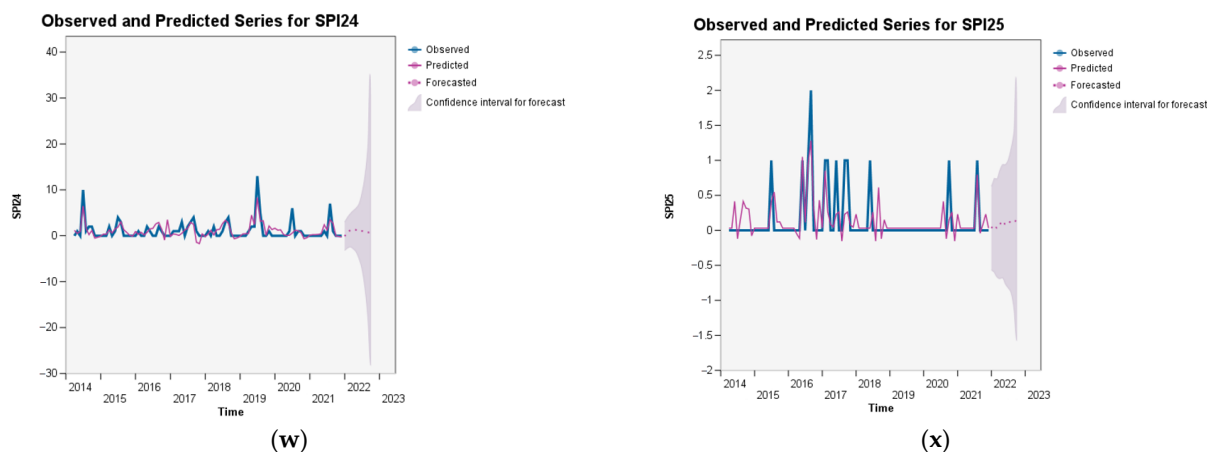
Month	SPI1	SPI2	SPI3	SPI4	SPI5	SPI7	SPI8	SPI9	SPI10	SPI11	SPI12	SPI13	SPI14	SPI15	SPI16	SPI17	SPI18	SPI19	SPI20	SPI21	SPI22	SPI23	SPI24	SPI25
January 2022	0.02	0.00	0.03	0.01	0.12	0.00	0.17	0.02	0.06	0.00	0.01	−0.02	0.04	0.63	0.07	0.01	0.05	−0.07	0.40	0.05	−0.01	−0.08	−0.10	0.03
February 2022	0.02	0.01	0.04	−0.05[1]	0.18	0.02	0.08	0.01	0.01	0.01	0.03	−0.09	0.05	0.92	0.07	0.02	0.07	−0.05	−0.14	0.80	0.00	−0.08	0.70	0.07
March 2022	0.02	0.01	0.04	0.03	0.29	0.02	0.11	−0.01	0.04	−0.01	0.04	−0.01	0.03	**1.16[2]**	0.12	0.01	0.07	−0.03	0.35	**1.06**	0.00	−0.06	**1.19**	0.04
April 2022	0.00	0.01	0.06	0.00	0.24	0.03	0.10	0.00	0.00	0.02	0.05	0.04	0.08	**1.36**	0.13	0.00	0.04	0.02	0.53	**1.26**	0.01	−0.08	**1.31**	0.08
May 2022	0.05	0.01	0.07	−0.05	0.31	0.03	0.06	0.02	0.06	0.01	0.04	0.09	−0.01	**1.55**	0.12	0.01	0.00	0.03	0.30	**1.27**	0.02	−0.07	**1.26**	0.13
June 2022	0.03	0.01	0.07	0.00	0.28	0.04	0.09	0.05	0.07	−0.01	0.02	0.09	0.13	**1.54**	0.09	0.01	0.03	0.03	0.29	**1.12**	0.02	−0.02	0.97	0.09
July 2022	0.04	0.01	0.04	0.04	0.28	0.04	0.11	0.07	0.12	0.00	0.02	0.07	0.12	**1.62**	0.07	0.01	0.03	0.01	0.42	0.96	0.02	0.02	**1.04**	0.09
August 2022	0.03	0.01	0.09	0.04	0.25	0.04	0.13	0.07	0.13	0.02	0.03	0.04	0.21	**1.84**	0.05	0.02	0.06	0.00	0.36	0.87	0.03	0.01	0.82	0.14
September 2022	0.05	0.01	0.08	0.03	0.28	0.04	0.12	0.06	0.12	0.01	0.03	0.04	0.23	**2.05**	0.05	0.05	0.06	−0.01	0.26	0.80	0.03	−0.01	0.73	0.14
October 2022	0.05	0.01	0.09	0.03	0.27	0.04	0.13	0.05	0.11	0.00	0.04	0.03	0.27	**2.10**	0.06	0.05	0.06	−0.01	0.27	0.83	0.03	−0.01	0.79	0.12

[1] Negative values are perceived as 0. [2] Bold and colored values present predicted adverse events.

Table A7. Second initial forecast of Split Airport safety performance indicators (ARIMA and smoothing methods).

Month	SPI1	SPI2	SPI3	SPI4	SPI5	SPI7	SPI8	SPI9	SPI10	SPI11	SPI12	SPI13	SPI14	SPI15	SPI16	SPI17	SPI18	SPI19	SPI20	SPI21	SPI22	SPI23	SPI24	SPI25
Method	Simple Seasonal	Simple Seasonal	ARIMA (0,0,2)(1,0,0)	ARIMA (0,1,1)(0,0,0)	ARIMA (0,0,0)(0,1,0)	Simple Seasonal	ARIMA (0,0,0)(1,0,0)	Winters' Additive	ARIMA (0,0,0)(0,0,0)	Simple Seasonal	Simple Seasonal	Winters' Additive	Simple Seasonal	ARIMA (1,0,0)(1,0,0)	ARIMA (0,1,1)(0,0,0)	ARIMA (0,1,1)(0,0,0)	ARIMA (0,0,0)(0,0,1)	ARIMA (0,1,0)(0,0,0)	ARIMA (0,3)(0,0,0)	ARIMA (0,0,0)(0,0,0)	Simple Seasonal	ARIMA (0,0,0)(0,0,0)	ARIMA (0,0,0)(0,1,1)	ARIMA (0,0,0)(0,0,0)
January 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	3	−1[1]	0	0	0	0	1	0	0	0	0
February 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	1	0	0	0	0
March 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	1	0	0	0	0
April 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	1	0	0	0	0
May 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	1	0	0	0	0
June 2022	0	0	0	0	1[2]	0	0	0	0	0	0	0	1	0	−1	0	0	0	0	1	0	0	1	0
July 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	1	0	0	0	0
August 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	1	0	0	6	0
September 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	1	0	0	1	0
October 2022	0	0	0	0	1	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	1	0	0	0	0
November 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	1	0	0	0	0
December 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
January 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	3	−1	0	0	0	0	1	0	0	0	0
February 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	1	0	0	0	0
March 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	1	0	0	0	0
April 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	1	0	0	0	0
May 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	1	0	0	0	0
June 2023	0	0	0	0	1	0	0	0	0	0	0	0	1	0	−1	0	0	0	0	1	0	0	1	0
July 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	1	0	0	0	0

Table A7. *Cont.*

Month	SPI1	SPI2	SPI3	SPI4	SPI5	SPI7	SPI8	SPI9	SPI10	SPI11	SPI12	SPI13	SPI14	SPI15	SPI16	SPI17	SPI18	SPI19	SPI20	SPI21	SPI22	SPI23	SPI24	SPI25
Method	Simple Seasonal	Simple Seasonal	ARIMA (0,0,2)(1,0,0)	ARIMA (0,1,1)(0,0,0)	ARIMA (0,0,0)(0,1,0)	Simple Seasonal	ARIMA (0,0,0)(1,0,0)	Winters' Additive	ARIMA (0,0,0)(0,0,0)	Simple Seasonal	Simple Seasonal	Winters' Additive	Simple Seasonal	ARIMA (1,0,0)(1,0,0)	ARIMA (0,1,1)(0,0,0)	ARIMA (0,1,1)(0,0,0)	ARIMA (0,0,0)(0,0,1)	ARIMA (0,1,0)(0,0,0)	ARIMA (0,0,3)(0,0,0)	ARIMA (0,0,0)(0,0,0)	Simple Seasonal	ARIMA (0,0,0)(0,0,0)	ARIMA (0,0,0)(0,1,1)	ARIMA (0,0,0)(0,0,0)
August 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	**1**	0	0	**6**	0
September 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	**1**	0	0	**1**	0
October 2023	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	**1**	0	0	0	0
November 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0	**1**	0	0	0	0
December 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0

[1] Negative values are perceived as 0. [2] Bold and colored values present predicted adverse events.

Table A8. Associated forecast of Split Airport safety performance targets (ARIMA and smoothing methods).

Month	SPI1	SPI2	SPI3	SPI4	SPI5	SPI7	SPI8	SPI9	SPI10	SPI11	SPI12	SPI13	SPI14	SPI15	SPI16	SPI17	SPI18	SPI19	SPI20	SPI21	SPI22	SPI23	SPI24	SPI25
Method	ARIMA (0,0,0)(0,0,0)	Simple Seasonal	ARIMA (0,0,0)(0,0,1)	ARIMA (0,0,1)(0,0,2)	ARIMA (0,0,0)(0,0,0)	ARIMA (0,0,0)(0,0,0)	Simple Seasonal	Simple Seasonal	ARIMA (0,0,0)(1,0,0)	ARIMA (0,1,1)(0,0,0)	Simple Seasonal	Simple Seasonal	ARIMA (0,0,3)(0,0,0)	ARIMA (1,0,0)(0,0,0)	Simple Seasonal	Simple Seasonal	ARIMA (0,0,0)(0,0,0)	Simple Seasonal	ARIMA (0,0,0)(0,0,0)	ARIMA (0,0,0)(0,0,0)	Simple Seasonal	Simple Seasonal	ARIMA (0,0,0)(0,0,0)	ARIMA (0,0,0)(0,0,0)
January 2022	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	−0.0006[1]	−0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0002**	0.0000	0.0000	0.0000	**0.0003**	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
February 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0006	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0003**	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
March 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0005	−0.0001	0.0000	0.0000	**0.0001**	**0.0001**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
April 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0074[2]**	−0.0001	0.0000	0.0000	**0.0001**	**0.0001**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
May 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
June 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0005	−0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
July 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
August 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
September 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
October 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
November 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0006	0.0001	0.0000	0.0000	0.0000	**0.0002**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
December 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0004	−0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
January 2023	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	−0.0006	−0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0002**	0.0000	0.0000	0.0000	**0.0003**	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
February 2023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0006	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0003**	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
March 2023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0005	−0.0001	0.0000	0.0000	**0.0001**	**0.0001**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
April 2023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0074**	−0.0001	0.0000	0.0000	**0.0001**	**0.0001**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
May 2023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
June 2023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0005	−0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
July 2023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
August 2023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
September 2023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
October 2023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
November 2023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0006	0.0001	0.0000	0.0000	0.0000	**0.0002**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000
December 2023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0004	−0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0005**	0.0000	0.0000	**0.0004**	0.0000

[1] Negative values are perceived as 0. [2] Bold and colored values present predicted breaches of safety performance targets.

Table A9. Second initial forecast of Split Airport safety performance indicators (smoothing methods only).

Month	SPI1	SPI2	SPI3	SPI4	SPI5	SPI7	SPI8	SPI9	SPI10	SPI11	SPI12	SPI13	SPI14	SPI15	SPI16	SPI17	SPI18	SPI19	SPI20	SPI21	SPI22	SPI23	SPI24	SPI25
Method	Simple Seasonal	Simple Seasonal	Simple Seasonal	Winters' Additive	Winters' Additive	Simple Seasonal	Winters' Additive	Winters' Additive	Winters' Additive	Simple Seasonal	Simple Seasonal	Winters' Additive	Simple Seasonal	Simple Seasonal	Simple Seasonal	Winters' Additive	Simple Seasonal	Simple Seasonal	Simple Seasonal	Simple Seasonal	Simple Seasonal	Simple Seasonal	Simple Seasonal	Simple Seasonal
January 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
March 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
May 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0
June 2022	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	1	2	0	0	1	0
July 2022	0	0	0	0	1[1]	0	0	0	0	0	0	0	0	7	0	0	0	0	0	2	0	0	4	0
August 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	1	0	0	3	0
September 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	1	0	0	2	0
October 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
November 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December 2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
January 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
March 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
May 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0
June 2023	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	1	2	0	0	1	0
July 2023	0	0	0	0	1	0	0	0	0	0	0	0	0	7	0	0	0	0	0	2	0	0	4	0
August 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	1	0	0	3	0
September 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	1	0	0	2	0
October 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
November 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December 2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[1] Bold and colored values present predicted adverse events.

Table A10. Associated forecast of Split Airport safety performance targets (smoothing methods only).

Month / Method	SPI1 Simple Seasonal	SPI2 Simple Seasonal	SPI3 Simple Seasonal	SPI4 Simple Seasonal	SPI5 Winters' Additive	SPI7 Simple Seasonal	SPI8 Simple Seasonal	SPI9 Simple Seasonal	SPI10 Winters' Additive	SPI11 Simple Seasonal	SPI12 Simple Seasonal	SPI13 Simple Seasonal	SPI14 Simple Seasonal	SPI15 Simple Seasonal	SPI16 Simple Seasonal	SPI17 Simple Seasonal	SPI18 Simple Seasonal	SPI19 Simple Seasonal	SPI20 Simple Seasonal	SPI21 Winters' Additive	SPI22 Simple Seasonal	SPI23 Simple Seasonal	SPI24 Simple Seasonal	SPI25 Simple Seasonal
January 2022	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	−0.0006	−0.0001	0.0005	0.0000	0.0000	0.0000	−0.0001	−0.0006	0.0002	0.0000	−0.0001	0.0000	0.0003	0.0005	0.0000	0.0000	−0.0003	−0.0001
February 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0006	0.0002	0.0001	0.0000	0.0000	0.0000	0.0002	−0.0006	0.0000	0.0003	0.0007	0.0000	0.0007	**0.0015**	0.0000	0.0000	0.0005	0.0002
March 2022	**0.0004**[2]	0.0000	0.0000	0.0000	0.0002	0.0002	−0.0005	−0.0001	0.0000	0.0000	0.0001	0.0001	0.0004	−0.0004	0.0000	0.0000	−0.0001	0.0000	0.0006	0.0002	0.0000	0.0000	0.0002	0.0001
April 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0074**	−0.0001	0.0003	**0.0001**	0.0001	0.0001	0.0002	−0.0001	0.0000	0.0000	−0.0001	0.0000	0.0004	0.0001	0.0000	0.0000	0.0003	−0.0001
May 2022	0.0000	0.0000	**0.0001**	0.0000	0.0001	0.0000	−0.0005	0.0000	−0.0002	0.0000	0.0000	0.0000	0.0003	0.0001	0.0000	0.0000	−0.0001	0.0000	0.0004	0.0001	0.0000	0.0000	0.0001	−0.0001
June 2022	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	−0.0005	−0.0001	−0.0002	0.0000	0.0000	0.0000	0.0001	0.0007	0.0000	0.0000	0.0001	0.0000	0.0006	0.0004	0.0000	0.0000	0.0001	0.0000
July 2022	0.0000	0.0000	**0.0001**	0.0000	0.0003	0.0000	−0.0006	0.0000	−0.0002	0.0000	0.0000	0.0000	0.0000	**0.0010**	0.0001	0.0000	−0.0001	0.0000	0.0004	0.0000	0.0000	0.0000	0.0008	0.0000
August 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0005	0.0000	−0.0001	0.0000	0.0000	0.0000	0.0000	0.0005	0.0001	0.0000	−0.0001	0.0000	0.0005	0.0000	0.0000	0.0000	0.0003	0.0000
September 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0005	0.0000	−0.0002	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	−0.0001	0.0000	0.0006	0.0000	0.0000	0.0000	**0.0015**	0.0003
October 2022	0.0000	0.0000	**0.0001**	0.0000	0.0001	0.0000	−0.0004	0.0000	−0.0001	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0005	0.0001	0.0000	0.0000	0.0002	0.0002
November 2022	0.0000	0.0000	**0.0005**	0.0000	0.0000	0.0000	−0.0006	0.0001	0.0000	0.0000	0.0000	0.0002	0.0003	−0.0003	0.0000	0.0000	−0.0001	0.0000	0.0005	−0.0002	0.0000	0.0000	−0.0001	−0.0001
December 2022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0004	−0.0001	−0.0002	0.0000	0.0000	0.0000	0.0006	−0.0002	0.0000	0.0000	−0.0001	0.0000	0.0005	−0.0002	0.0000	0.0000	−0.0003	−0.0001
January 2023	0.0000	0.0000	0.0000	0.0002	−0.0001[1]	0.0000	−0.0006	−0.0001	0.0005	0.0000	0.0000	0.0000	−0.0001	−0.0006	0.0002	0.0000	−0.0001	0.0000	0.0003	0.0005	0.0000	0.0000	−0.0003	−0.0001
February 2023	0.0000	0.0000	0.0000	0.0000	−0.0001	0.0000	−0.0006	0.0002	0.0000	0.0000	0.0000	0.0000	0.0002	−0.0006	0.0000	0.0003	0.0007	0.0000	0.0007	**0.0014**	0.0000	0.0000	0.0005	0.0002
March 2023	**0.0004**	0.0000	0.0000	0.0000	0.0001	0.0002	−0.0005	−0.0001	0.0000	0.0000	0.0001	0.0001	0.0004	−0.0004	0.0000	0.0000	−0.0001	0.0000	0.0006	0.0001	0.0000	0.0000	0.0002	0.0001
April 2023	0.0000	0.0000	0.0000	0.0000	−0.0001	0.0000	**0.0074**	−0.0001	0.0003	**0.0001**	0.0001	0.0001	0.0002	−0.0001	0.0000	0.0000	−0.0001	0.0000	0.0004	0.0000	0.0000	0.0000	0.0003	−0.0001
May 2023	0.0000	0.0000	**0.0001**	0.0000	0.0001	0.0000	−0.0005	0.0000	−0.0002	0.0000	0.0000	0.0000	0.0003	0.0001	0.0000	0.0000	−0.0001	0.0000	0.0004	0.0000	0.0000	0.0000	0.0001	−0.0001
June 2023	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	−0.0005	−0.0001	−0.0002	0.0000	0.0000	0.0000	0.0001	0.0007	0.0000	0.0000	0.0001	0.0000	0.0006	0.0003	0.0000	0.0000	0.0001	0.0000
July 2023	0.0000	0.0000	**0.0001**	0.0000	0.0003	0.0000	−0.0006	0.0000	−0.0002	0.0000	0.0000	0.0000	0.0000	**0.0010**	0.0001	0.0000	−0.0001	0.0000	0.0004	0.0000	0.0000	0.0000	0.0008	0.0000
August 2023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0005	0.0000	−0.0001	0.0000	0.0000	0.0000	0.0000	0.0005	0.0001	0.0000	−0.0001	0.0000	0.0005	−0.0001	0.0000	0.0000	0.0003	0.0000
September 2023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0005	0.0000	−0.0002	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	−0.0001	0.0000	0.0006	−0.0001	0.0000	0.0000	**0.0015**	0.0003
October 2023	0.0000	0.0000	**0.0001**	0.0000	0.0001	0.0000	−0.0004	0.0000	−0.0001	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0005	0.0000	0.0000	0.0000	0.0002	0.0002
November 2023	0.0000	0.0000	**0.0005**	0.0000	−0.0001	0.0000	−0.0006	0.0001	0.0000	0.0000	0.0000	0.0002	0.0003	−0.0003	0.0000	0.0000	−0.0001	0.0000	0.0005	−0.0003	0.0000	0.0000	−0.0001	−0.0001
December 2023	0.0000	0.0000	0.0000	0.0000	−0.0001	0.0000	−0.0004	−0.0001	−0.0002	0.0000	0.0000	0.0000	0.0006	−0.0002	0.0000	0.0000	−0.0001	0.0000	0.0005	−0.0003	0.0000	0.0000	−0.0003	−0.0001

[1] Negative values are perceived as 0. [2] Bold and colored values present predicted breaches of safety performance targets.

Figure A5. *Cont.*

(a) (b) (c) (d)

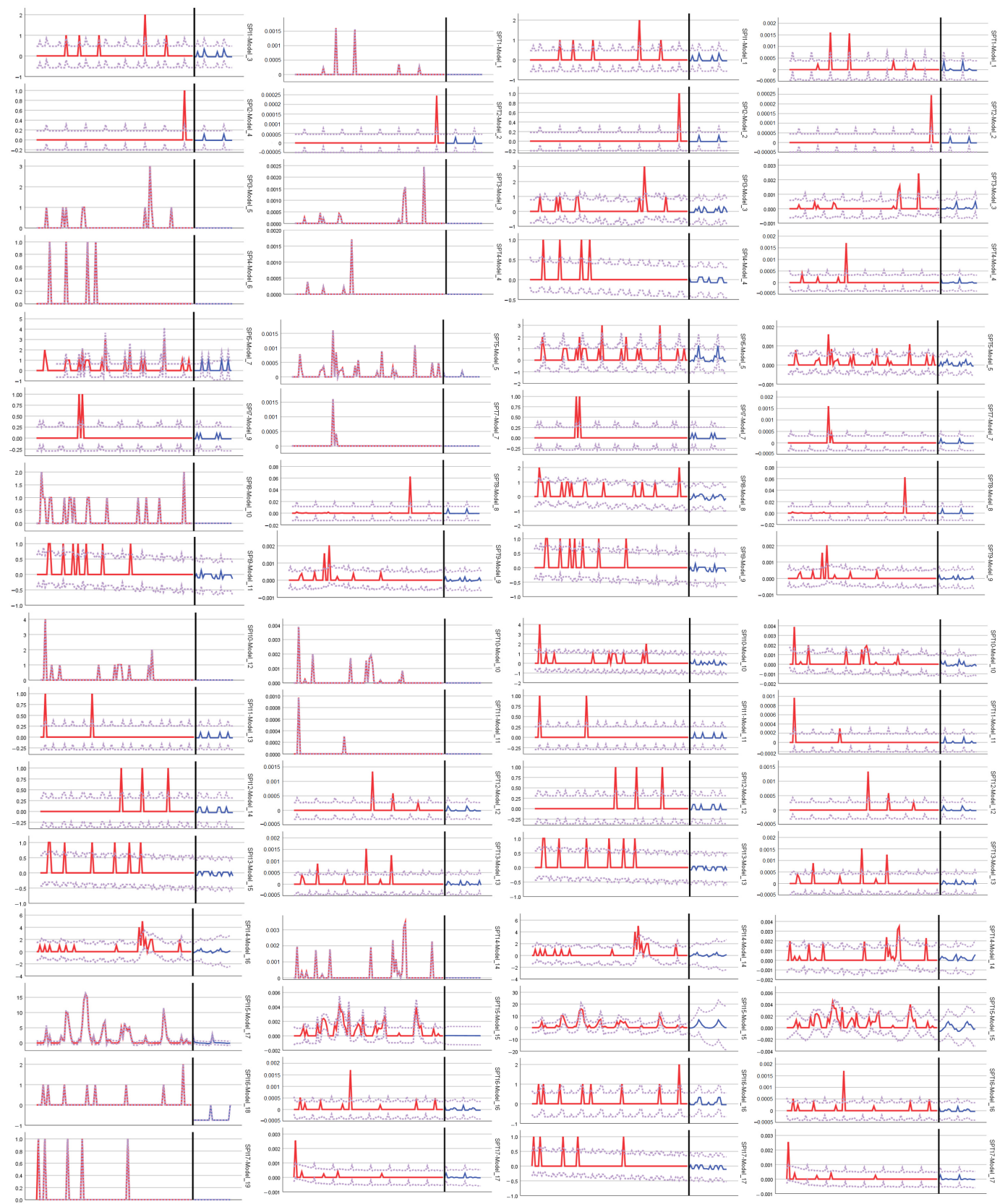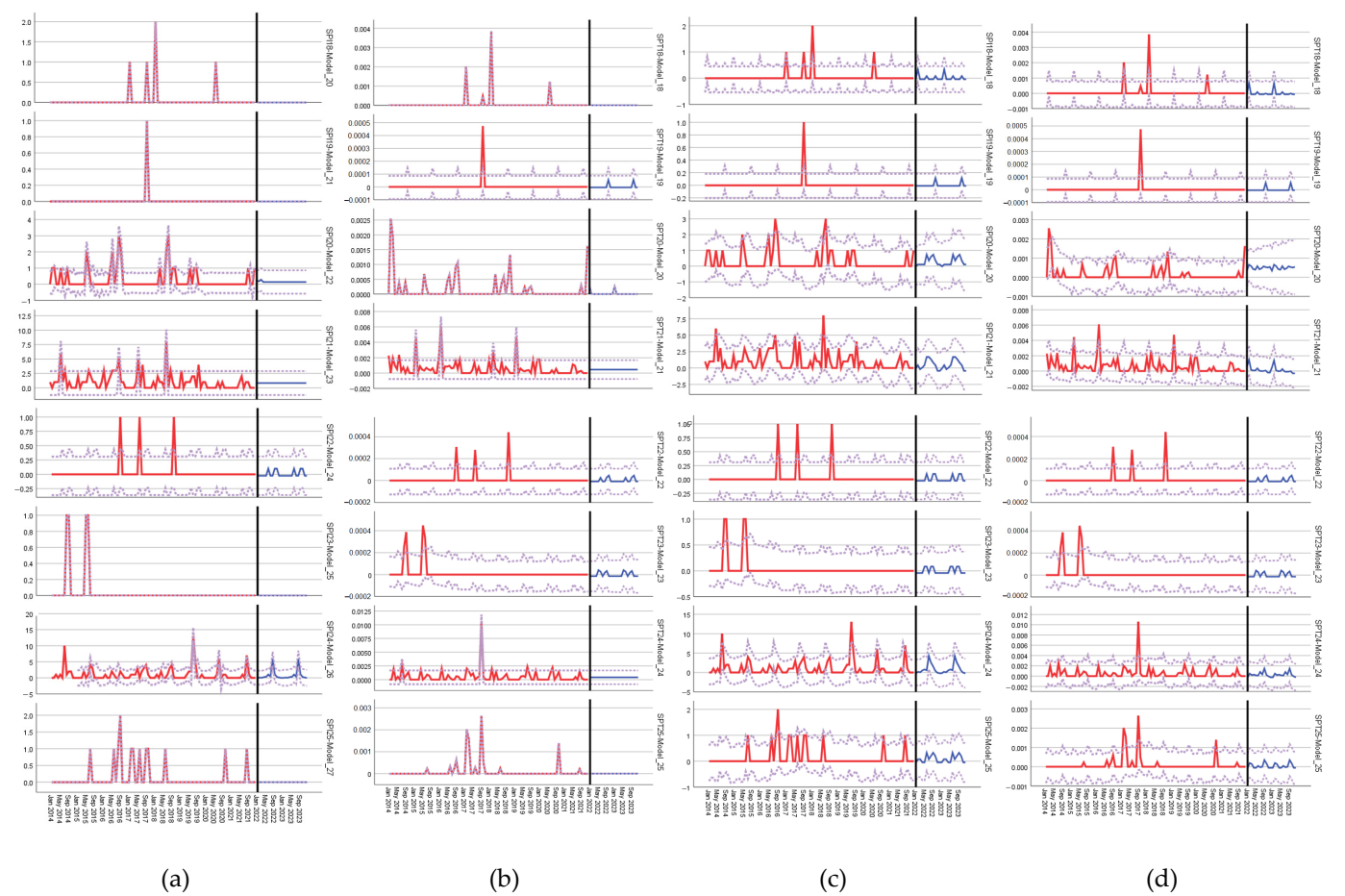**Figure A5.** Forecasts of Split Airport safety performance indicators and associated targets (ARIMA and smoothing methods/smoothing methods only): (**a**) SPIs—ARIMA and smoothing methods; (**b**) SPTs—ARIMA and smoothing methods; (**c**) SPIs—smoothing methods only; (**d**) SPTs—smoothing methods only.

Appendix E

Scenario 1

Table A11 shows original values of OI1 and increased values of OI1 for 30%, as well the graph.

Table A11. Increase of organizational indicator OI1—Number of aircraft operations.

Time Point	OI1_OPS Initial	OI1_OPS Increased for 30%	Graph
January 2022	314	408	
February 2022	274	356	
March 2022	358	465	
April 2022	587	763	
May 2022	883	1148	
June 2022	2051	2666	
July 2022	4084	5309	
August 2022	4728	6146	
September 2022	3435	4466	
October 2022	2090	2717	
November 2022	613	797	
December 2022	615	800	

Figure A6 shows an impact diagram of increased organizational indicator OI1 on other safety performance indicators.
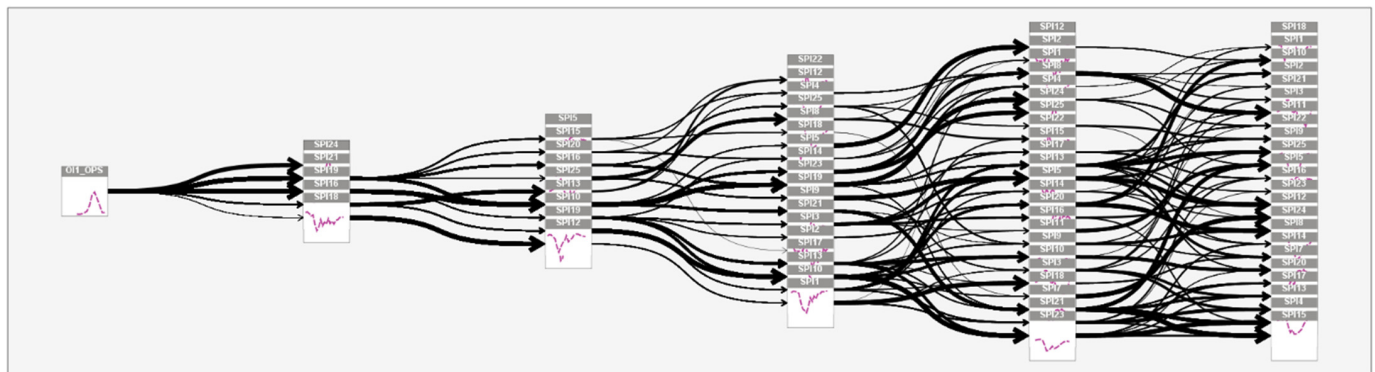

Figure A6. Impact diagram of increased organizational indicator OI1 on safety performance indicators.

Figure A7 shows a complete set of all cases in Scenario 1 set-up, showing how increased organizational indicator OI1 influences other safety performance indicators in the observed dataset, i.e., changing their behavior (increase, decrease, no impact), using IBM SPSS function Forecasting using Temporal Causal Model—Run Scenarios. All graphs show three curves. The blue curve shows observed values of (each) safety performance indicator in the dataset. The green curve shows original forecasted values of (each) safety performance indicator. The pink curve shows scenario forecasted values of (each) safety performance indicator due to the influence of a change in organizational indicator. Comparison of green and pink curves shows direct influences between indicators and can be very useful in planning and decision-making processes.
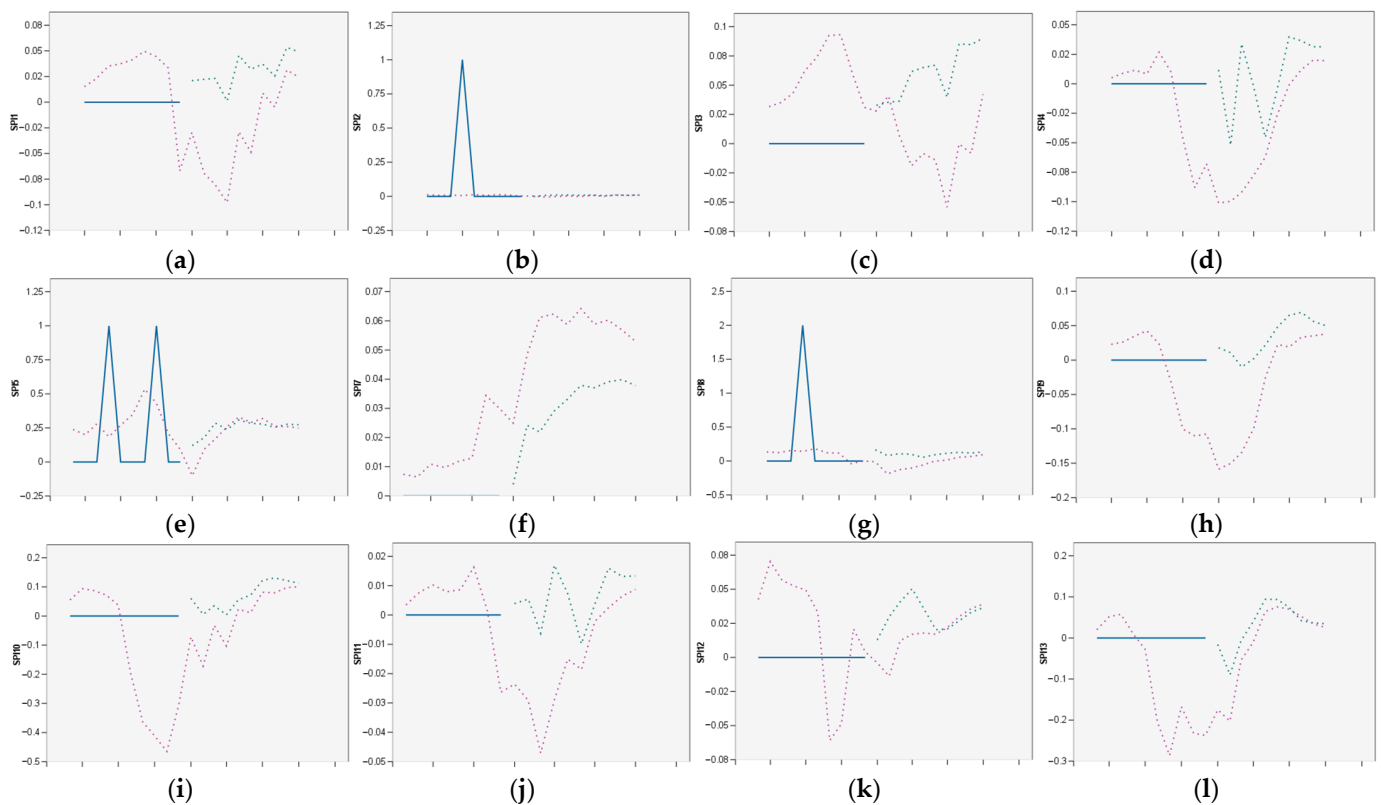

Figure A7. *Cont.*
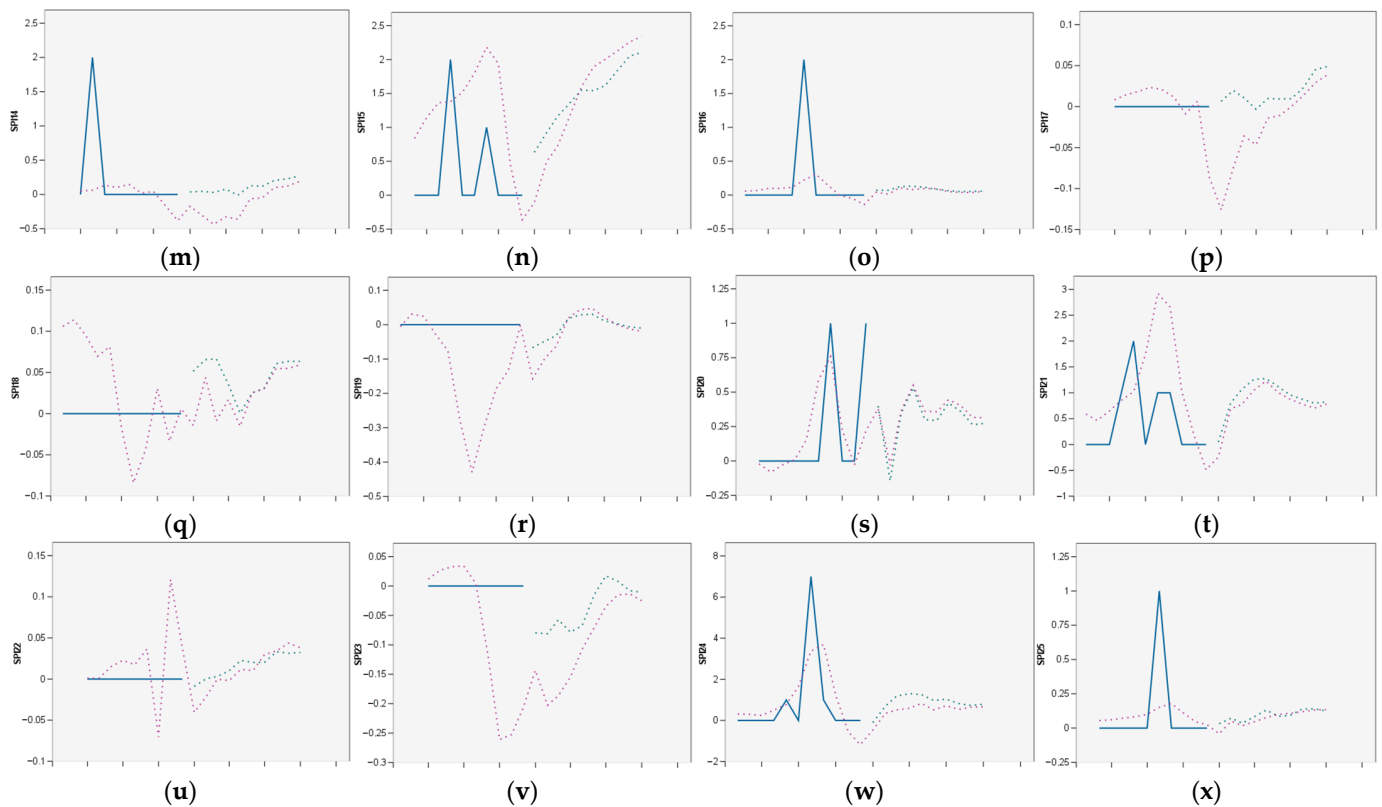
Figure A7. Predicted safety performance indicators due to increased organizational indicator OI1: (**a**) SPI1—Number of occurrences related to LIRF and loadsheet crosscheck; (**b**) SPI2—Number of occurrences related to wrong figures for loadsheet; (**c**) SPI3—Number of dangerous goods incidents; (**d**) SPI4—Number of aircraft damage occurrences; (**e**) SPI5—Number of personnel or passenger injuries; (**f**) SPI7—Number of training deficiencies; (**g**) SPI8—Number of apron maintenance incidents; (**h**) SPI9—Number of vehicle maintenance incidents; (**i**) SPI10—Number of occurrences related to maneuvering area maintenance; (**j**) SPI11—Number of occurrences related to communication; (**k**) SPI12—Number of incidents related to taxiing to/from apron; (**l**) SPI13—Number of aircraft marshalling occurrences; (**m**) SPI14—Number of occurrences related to FOD presence; (**n**) SPI15—Number of occurrences related to passenger handling at the gate; (**o**) SPI16—Number of occurrences related to passenger handling—disembarking/embarking; (**p**) SPI17—Number of occurrences related to personal protective equipment; (**q**) SPI18—Number of aircraft chocking incidents; (**r**) SPI19—Number of aircraft conning incidents; (**s**) SPI20—Number of occurrences related to baggage loading/unloading; (**t**) SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving; (**u**) SPI22—Number of anti-collision occurrences; (**v**) SPI23—Number of engine start-up incidents; (**w**) SPI24—Number of occurrences related to wildlife; (**x**) SPI25—Number of occurrences related to fuel handling.

Scenario 2

Table A12 shows original values of OI1 and decreased values of OI1 for 30%, as well the graph.

Table A12. Decrease of organizational indicator OI1—Number of aircraft operations.

Time Point	OI1_OPS Initial	OI1_OPS Decreased for 30%	Graph
January 2022	314	220	
February 2022	274	192	
March 2022	358	251	
April 2022	587	411	
May 2022	883	618	
June 2022	2051	1436	
July 2022	4084	2859	
August 2022	4728	3310	
September 2022	3435	2405	
October 2022	2090	1463	
November 2022	613	429	
December 2022	615	431	

Figure A8 shows impact diagram of decreased organizational indicator OI1 on other safety performance indicators.
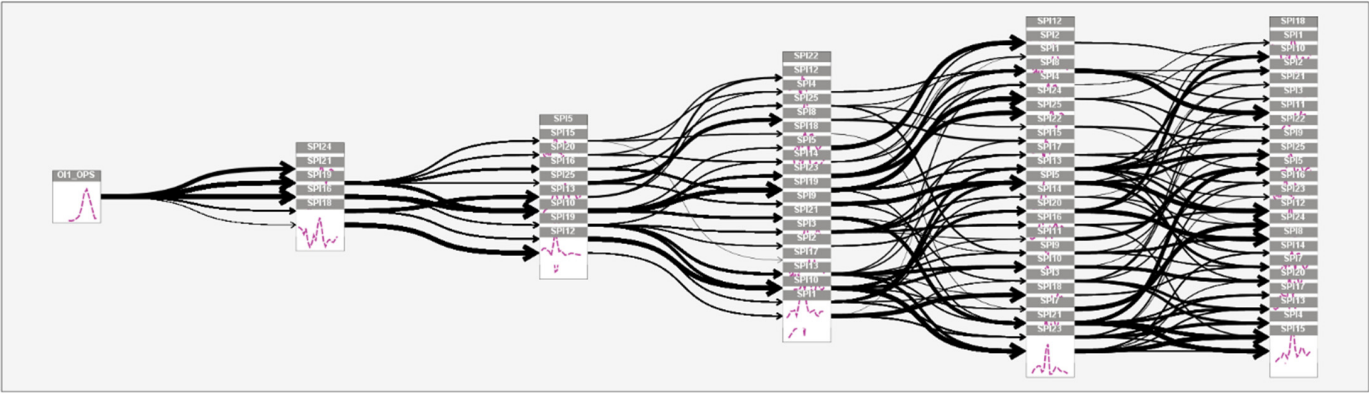

Figure A8. Impact diagram of decreased organizational indicator OI1 on safety performance indicators.

Figure A9 shows a complete set of all cases in Scenario 2 set-up, showing how the decreased organizational indicator OI1 influences other safety performance indicators in the observed dataset, i.e., changing their behavior (increase, decrease, no impact), using IBM SPSS function Forecasting using Temporal Causal Model–Run Scenarios. All graphs show three curves. The blue curve shows observed values of (each) safety performance indicator in the dataset. The green curve shows original forecasted values of (each) safety performance indicator. The pink curve shows scenario forecasted values of (each) safety performance indicator due to the influence of a change in organizational indicator.

(**a**)   (**b**)   (**c**)   (**d**)

Figure A9. *Cont.*

Figure A9. Predicted safety performance indicators due to decreased organizational indicator OI1: (**a**) SPI1—Number of occurrences related to LIRF and loadsheet crosscheck; (**b**) SPI2—Number of occurrences related to wrong figures for loadsheet; (**c**) SPI3—Number of dangerous goods incidents; (**d**) SPI4—Number of aircraft damage occurrences; (**e**) SPI5—Number of personnel or passenger injuries; (**f**) SPI7—Number of training deficiencies; (**g**) SPI8—Number of apron maintenance incidents; (**h**) SPI9—Number of vehicle maintenance incidents; (**i**) SPI10—Number of occurrences related to maneuvering area maintenance; (**j**) SPI11—Number of occurrences related to communication; (**k**) SPI12—Number of incidents related to taxiing to/from apron; (**l**) SPI13—Number of aircraft

marshalling occurrences; (**m**) SPI14—Number of occurrences related to FOD presence; (**n**) SPI15—Number of occurrences related to passenger handling at the gate; (**o**) SPI16—Number of occurrences related to passenger handling—disembarking/embarking; (**p**) SPI17—Number of occurrences related to personal protective equipment; (**q**) SPI18—Number of aircraft chocking incidents; (**r**) SPI19—Number of aircraft conning incidents; (**s**) SPI20—Number of occurrences related to baggage loading/unloading; (**t**) SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving; (**u**) SPI22—Number of anti-collision occurrences; (**v**) SPI23—Number of engine start-up incidents; (**w**) SPI24—Number of occurrences related to wildlife; (**x**) SPI25—Number of occurrences related to fuel handling.

Scenario 3

Table A13 shows original values of OI2 and increased values of OI2 for 30%, as well the graph.

Table A13. Increase of organizational indicator OI2—Number of passengers.

Time Point	OI2_PASS Initial	OI2_PASS Increased for 30%	Graph
January 2022	7415	9640	
February 2022	5706	7418	
March 2022	8031	10,440	
April 2022	13,964	18,153	
May 2022	32,754	42,580	
June 2022	114,687	149,093	
July 2022	349,042	453,755	
August 2022	491,358	638,765	
September 2022	326,347	424,251	
October 2022	160,720	208,936	
November 2022	25,726	33,444	
December 2022	23,428	30,456	

Figure A10 shows an impact diagram for increased organizational indicator OI2 on other safety performance indicators.

Figure A10. Impact diagram of increased organizational indicator OI2 on safety performance indicators.

Figure A11 shows complete set of all cases in Scenario 3 set-up, showing how increased organizational indicator OI2 influences other safety performance indicators in the observed dataset, i.e., changing their behavior (increase, decrease, no impact), using IBM SPSS function Forecasting using Temporal Causal Model–Run Scenarios. All graphs show three curves. The blue curve shows observed values of (each) safety performance indicator in the dataset. The green curve shows original forecasted values of (each) safety performance

indicator. The pink curve shows scenario forecasted values of (each) safety performance indicator due to the influence of a change in organizational indicator.
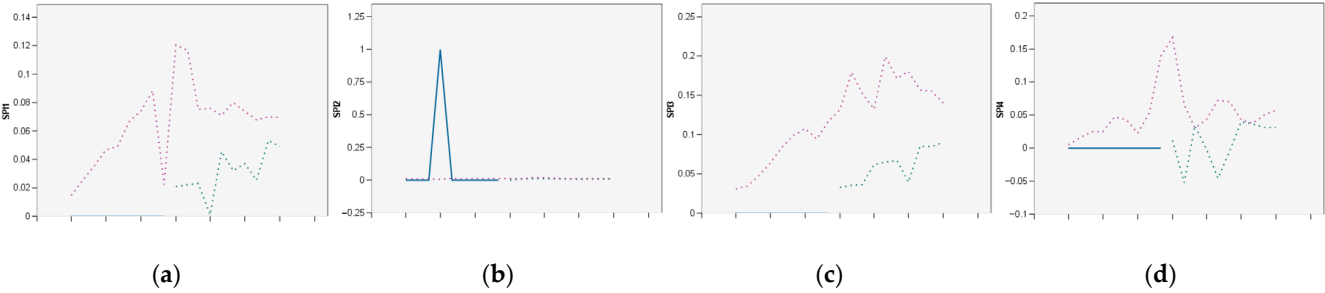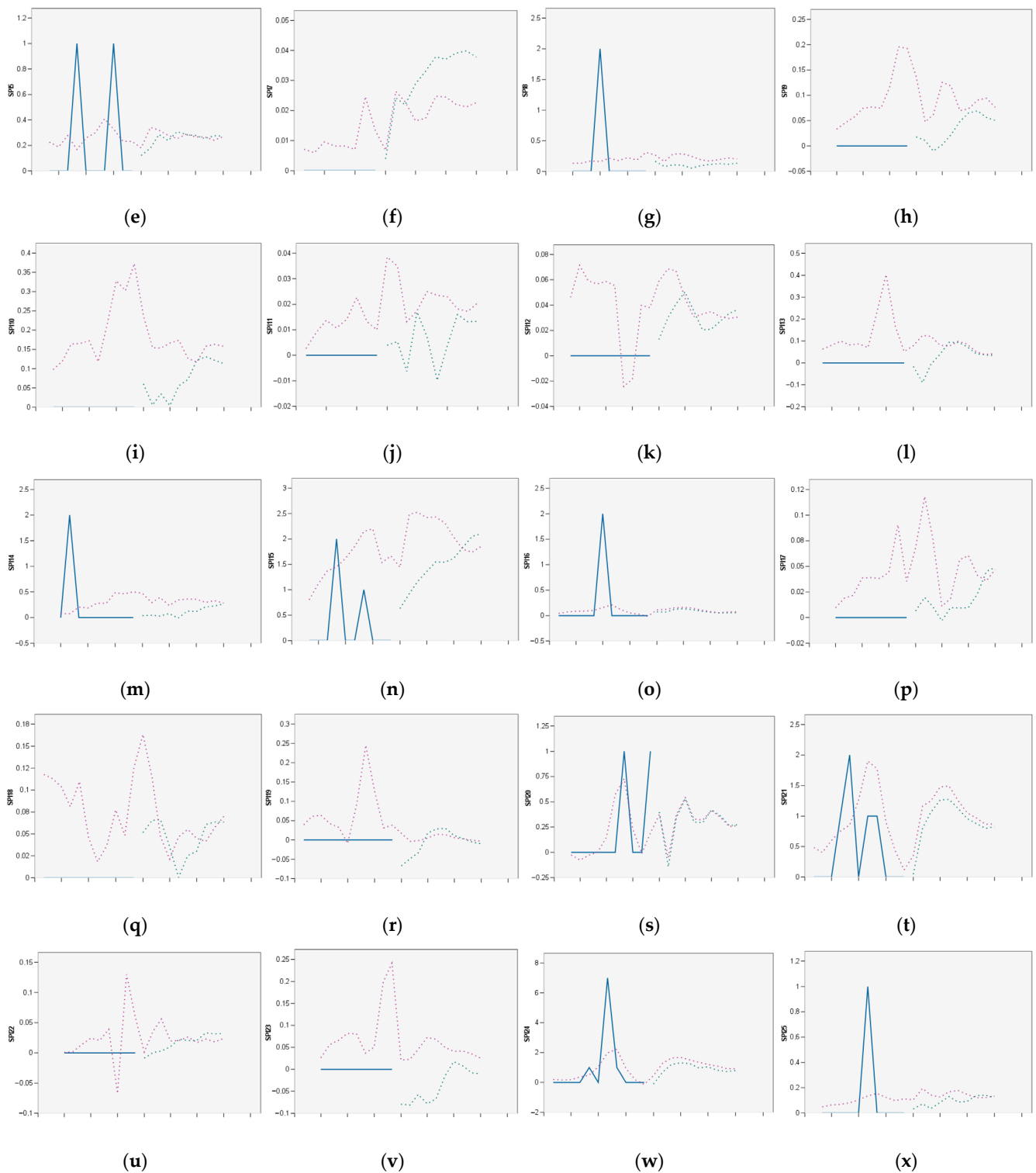

Figure A11. *Cont.*

(**u**)   (**v**)   (**w**)   (**x**)

Figure A11. Predicted safety performance indicators due to increased organizational indicator OI2:
(**a**) SPI1—Number of occurrences related to LIRF and loadsheet crosscheck; (**b**) SPI2—Number of
occurrences related to wrong figures for loadsheet; (**c**) SPI3—Number of dangerous goods incidents;
(**d**) SPI4—Number of aircraft damage occurrences; (**e**) SPI5—Number of personnel or passenger
injuries; (**f**) SPI7—Number of training deficiencies; (**g**) SPI8—Number of apron maintenance in-
cidents; (**h**) SPI9—Number of vehicle maintenance incidents; (**i**) SPI10—Number of occurrences
related to maneuvering area maintenance; (**j**) SPI11—Number of occurrences related to commu-
nication; (**k**) SPI12—Number of incidents related to taxiing to/from apron; (**l**) SPI13—Number
of aircraft marshalling occurrences; (**m**) SPI14—Number of occurrences related to FOD presence;
(**n**) SPI15—Number of occurrences related to passenger handling at the gate; (**o**) SPI16—Number
of occurrences related to passenger handling—disembarking/embarking; (**p**) SPI17—Number of
occurrences related to personal protective equipment; (**q**) SPI18—Number of aircraft chocking inci-
dents; (**r**) SPI19—Number of aircraft conning incidents; (**s**) SPI20—Number of occurrences related
to baggage loading/unloading; (**t**) SPI21—Number of occurrences related to ground traffic (GSE)
and vehicle driving; (**u**) SPI22—Number of anti-collision occurrences; (**v**) SPI23—Number of engine
start-up incidents; (**w**) SPI24—Number of occurrences related to wildlife; (**x**) SPI25—Number of
occurrences related to fuel handling.

Scenario 4

Table A14 shows original values of OI2 and decreased values of OI2 for 30%, as well
the graph.

Table A14. Decrease of organizational indicator OI2—Number of passengers.

Time Point	OI2_PASS Initial	OI2_PASS Decreased for 30%	Graph
January 2022	7415	5191	
February 2022	5706	3994	
March 2022	8031	5622	
April 2022	13,964	9775	
May 2022	32,754	22,928	
June 2022	114,687	80,281	
July 2022	349,042	244,329	
August 2022	491,358	343,951	
September 2022	326,347	228,443	
October 2022	160,720	112,504	
November 2022	25,726	18,008	
December 2022	23,428	16,400	

Figure A12 shows impact diagram of decreased organizational indicator OI2 on other
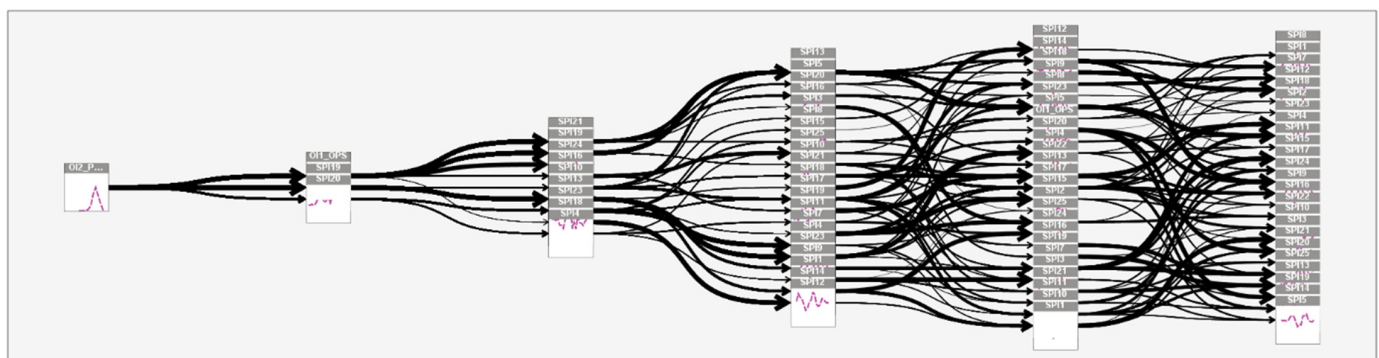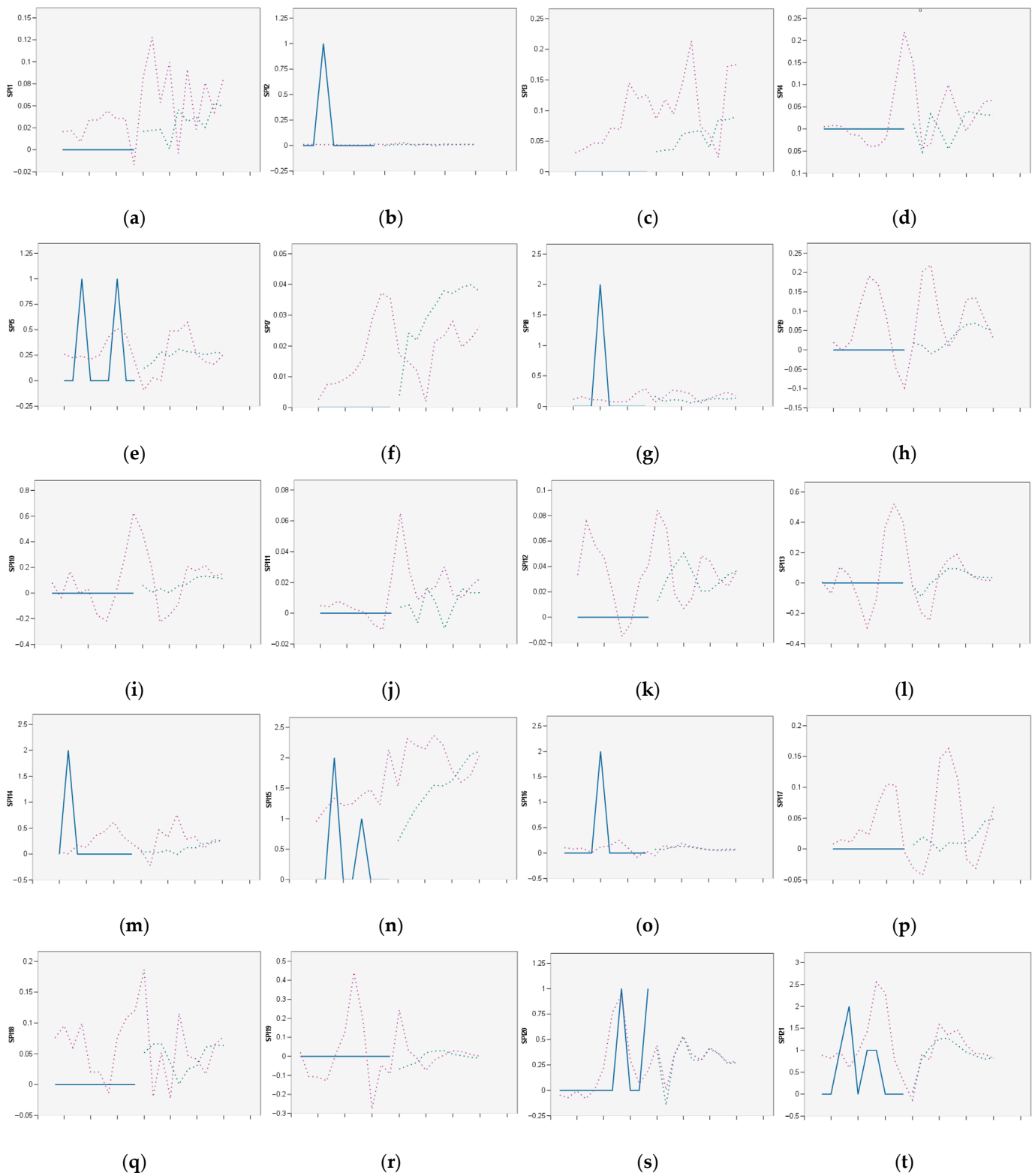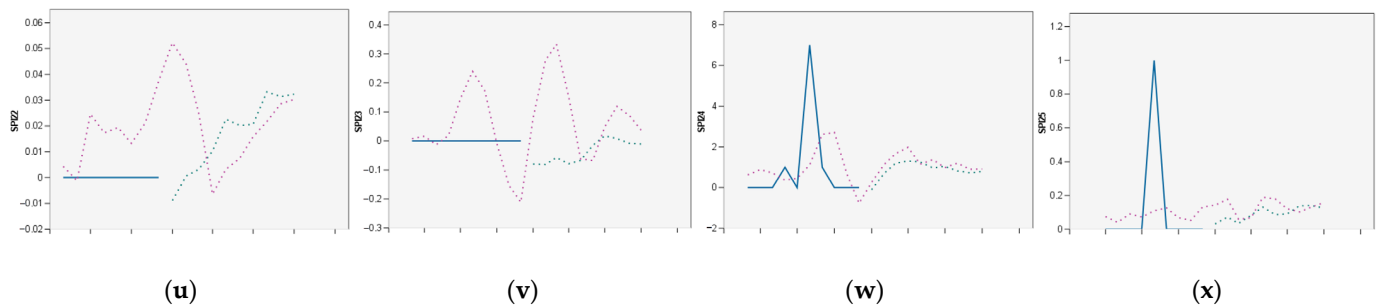safety performance indicators.
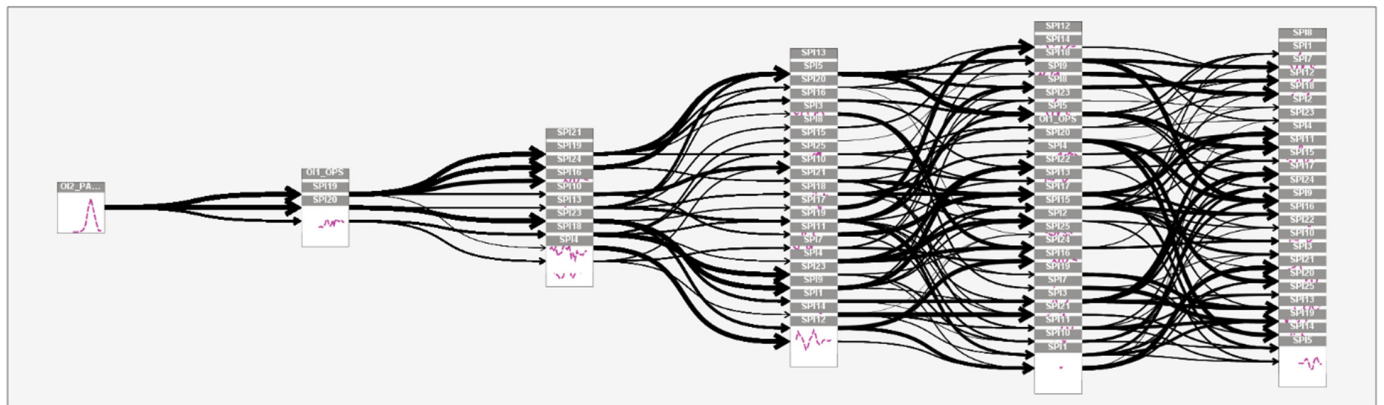
Figure A12. Impact diagram of decreased organizational indicator OI2 on safety performance indicators.

Figure A13 shows a complete set of all cases in Scenario 4 set-up, showing how a decreased organizational indicator OI2 influences other safety performance indicators in the observed dataset, i.e., changing their behavior (increase, decrease, no impact), using IBM SPSS function Forecasting using Temporal Causal Model–Run Scenarios. All graphs show three curves. The blue curve shows observed values of (each) safety performance indicator in the dataset. The green curve shows original forecasted values of (each) safety performance indicator. The pink curve shows scenario forecasted values of (each) safety performance indicator due to the influence of a change in organizational indicator.
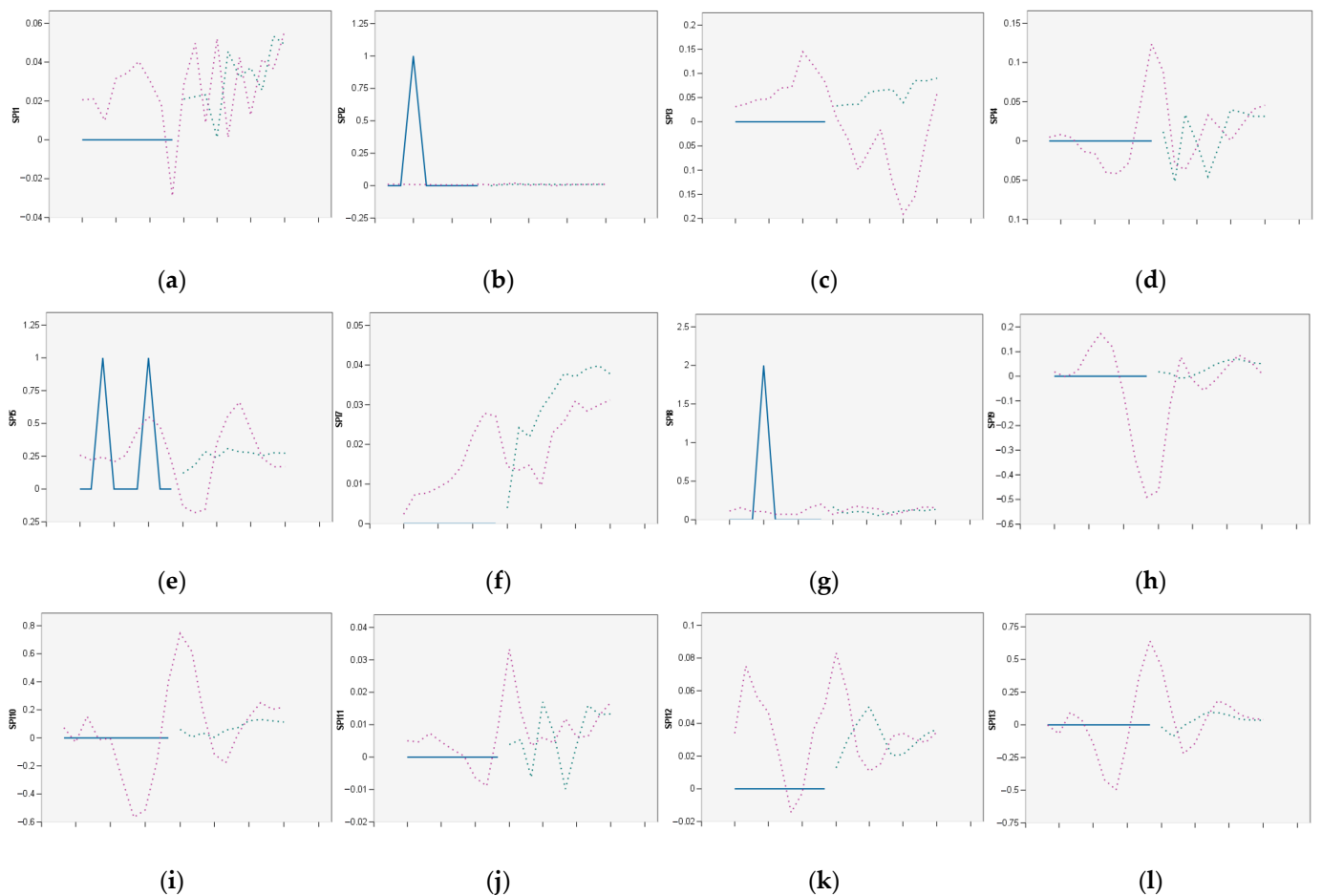
Figure A13. *Cont.*
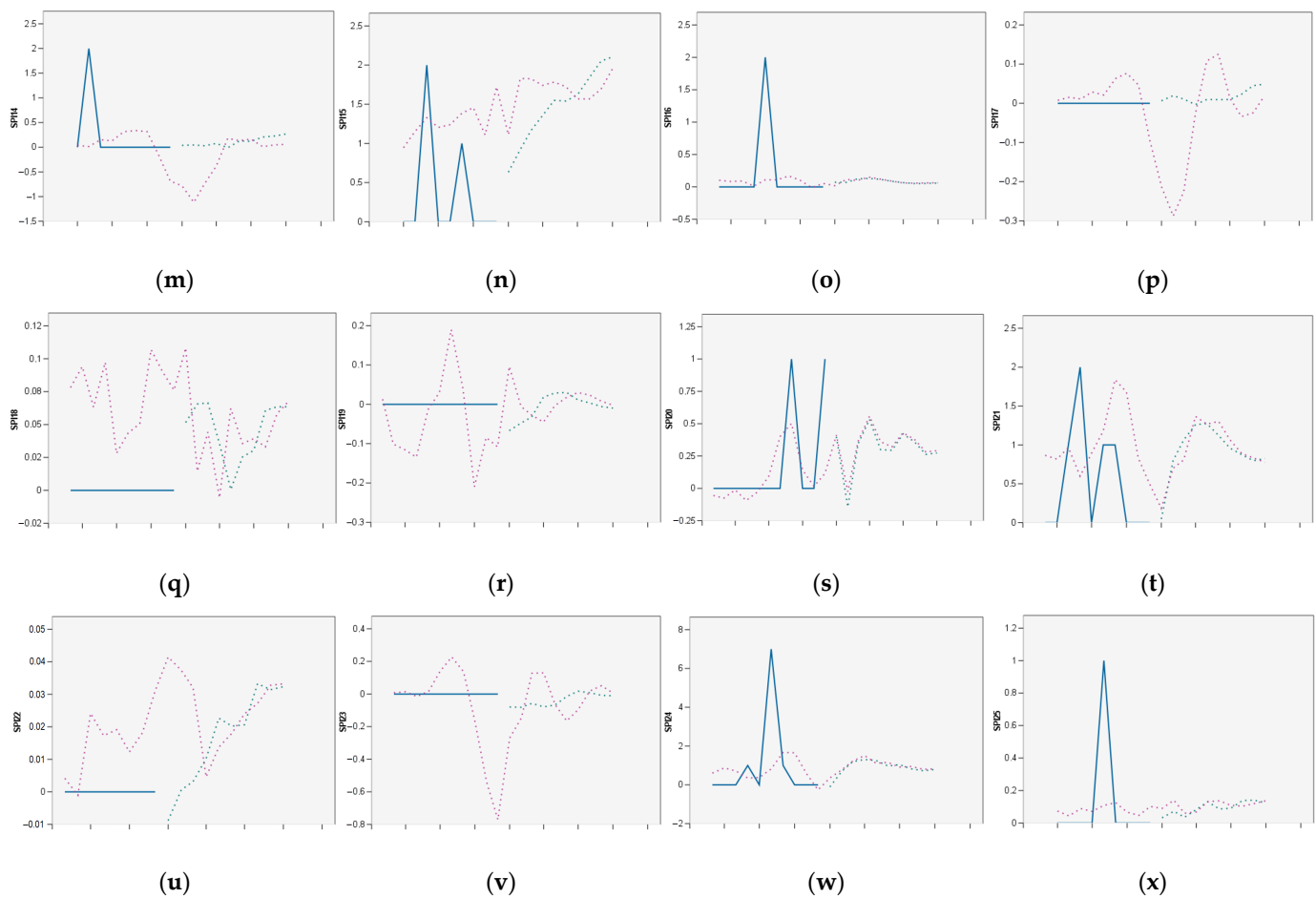
Figure A13. Predicted safety performance indicators due to decreased organizational indicator OI2: (**a**) SPI1—Number of occurrences related to LIRF and loadsheet crosscheck; (**b**) SPI2—Number of occurrences related to wrong figures for loadsheet; (**c**) SPI3—Number of dangerous goods incidents; (**d**) SPI4—Number of aircraft damage occurrences; (**e**) SPI5—Number of personnel or passenger injuries; (**f**) SPI7—Number of training deficiencies; (**g**) SPI8—Number of apron maintenance incidents; (**h**) SPI9—Number of vehicle maintenance incidents; (**i**) SPI10—Number of occurrences related to maneuvering area maintenance; (**j**) SPI11—Number of occurrences related to communication; (**k**) SPI12—Number of incidents related to taxiing to/from apron; (**l**) SPI13—Number of aircraft marshalling occurrences; (**m**) SPI14—Number of occurrences related to FOD presence; (**n**) SPI15—Number of occurrences related to passenger handling at the gate; (**o**) SPI16—Number of occurrences related to passenger handling—disembarking/embarking; (**p**) SPI17—Number of occurrences related to personal protective equipment; (**q**) SPI18—Number of aircraft chocking incidents; (**r**) SPI19—Number of aircraft conning incidents; (**s**) SPI20—Number of occurrences related to baggage loading/unloading; (**t**) SPI21—Number of occurrences related to ground traffic (GSE) and vehicle driving; (**u**) SPI22—Number of anti-collision occurrences; (**v**) SPI23—Number of engine start-up incidents; (**w**) SPI24—Number of occurrences related to wildlife; (**x**) SPI25—Number of occurrences related to fuel handling.

Appendix F

Table A15 shows a dataset of all observed (black) and predicted (colored) values of organizational and safety performance indicators at Split Airport, obtained by using predictive safety management methodology in aviation, i.e., predictive analysis of airport safety performance.

Table A15. Dataset of observed and predicted organizational and safety performance indicators at Split Airport.

Month	OI1	OI2	SPI1	SPI2	SPI3	SPI4	SPI5	SPI6	SPI7	SPI8	SPI9	SPI10	SPI11	SPI12	SPI13	SPI14	SPI15	SPI16	SPI17	SPI18	SPI19	SPI20	SPI21	SPI22	SPI23	SPI24	SPI25
January 2014	438	24,900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
February 2014	392	20,825	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
March 2014	514	26,410	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	1	0
April 2014	1032	77,575	0	0	0	0	0	0	0	2	0	4	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
May 2014	1942	157,070	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0
June 2014	2554	234,139	0	0	0	0	2	0	0	1	0	0	0	0	1	1	1	0	1	0	0	0	1	6	0	0	0
July 2014	3872	386,039	0	0	1	0	1	0	0	0	0	0	0	0	1	0	5	0	0	0	0	0	1	0	0	10	0
August 2014	3954	389,032	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	3	1	1	0
September 2014	2592	240,991	0	0	0	1	0	0	0	1	1	0	0	0	0	1	2	0	0	0	0	0	1	0	1	2	0
October 2014	1470	114,161	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0
November 2014	504	27,359	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December 2014	528	30,811	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
January 2015	504	23,513	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February 2015	454	22,234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
March 2015	576	31,941	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
April 2015	1132	73,149	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	1	0	0	2	0
May 2015	2232	179,794	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0
June 2015	2942	267,755	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	2	1	0	1	1	0
July 2015	4374	431,014	1	0	1	1	1	0	0	0	0	0	0	0	0	1	10	0	0	0	0	1	0	3	0	4	1
August 2015	4162	427,830	0	0	0	0	1	0	0	0	0	0	0	0	0	0	10	0	1	0	0	0	0	2	0	3	0
September 2015	2826	285,446	0	0	0	0	1	0	0	1	0	0	0	0	0	0	6	0	0	0	0	0	1	0	0	0	0
October 2015	1582	133,129	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0
November 2015	640	27,938	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December 2015	564	27,137	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
January 2016	492	25,028	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
February 2016	494	22,782	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0
March 2016	624	33,477	1	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
April 2016	1142	73,764	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
May 2016	2390	201,906	0	0	1	0	2	0	1	0	0	0	0	0	0	0	6	0	1	0	0	1	0	2	0	2	0
June 2016	3148	319,135	0	0	1	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	2	0	3	0	1	1
July 2016	4824	540,778	0	0	0	0	1	0	0	0	1	0	0	0	0	0	16	0	0	0	0	0	0	3	0	0	0
August 2016	4518	483,215	0	0	0	1	1	0	0	1	0	0	0	0	0	0	15	1	0	0	0	1	0	3	0	0	1
September 2016	3280	337,967	0	0	0	0	1	0	0	1	0	0	1	0	1	0	5	0	0	0	0	3	0	5	1	2	2
October 2016	1876	165,299	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	1	0	0	1	0
November 2016	582	30,676	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
December 2016	570	28,779	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0

Table A15. *Cont.*

Month	OI1	OI2	SPI1	SPI2	SPI3	SPI4	SPI5	SPI6	SPI7	SPI8	SPI9	SPI10	SPI11	SPI12	SPI13	SPI14	SPI15	SPI16	SPI17	SPI18	SPI19	SPI20	SPI21	SPI22	SPI23	SPI24	SPI25
January 2017	586	28,994	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
February 2017	496	22,646	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
March 2017	640	31,878	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
April 2017	1378	120,980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
May 2017	2644	254,265	0	0	0	0	1	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	1	0	0	3	0
June 2017	3594	401,347	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	5	1	0	0	1
July 2017	5216	653,743	0	0	0	0	3	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	2	0
August 2017	5078	590,830	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	3	0
September 2017	378	418,836	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4	1
October 2017	2116	195,837	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	1	1
November 2017	654	37,343	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
December 2017	554	34,626	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
January 2018	590	32,006	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
February 2018	520	29,109	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	0	0	0	0	0	1	0
March 2018	748	51,331	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0
April 2018	1486	121,372	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	2	0
May 2018	2878	301,377	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	0
June 2018	4052	471,962	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1
July 2018	5504	691,810	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	2	8	0	1	0
August 2018	5136	625,209	0	0	0	0	0	0	0	0	0	1	0	0	0	1	5	1	0	0	0	0	3	0	0	3	0
September 2018	3842	452,964	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	0	0	0	3	0	0	4	0
October 2018	2272	223,092	0	0	0	0	2	0	0	0	1	0	0	0	0	0	5	0	0	0	0	0	1	1	1	0	0
November 2018	750	52,942	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0
December 2018	646	42,434	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
January 2019	664	34,694	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February 2019	634	33,087	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
March 2019	800	48,095	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
April 2019	1698	153,474	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	0	0	0	0	0	1	0	0	1	0
May 2019	2992	308,447	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	2	0
June 2019	4318	510,438	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	1	0	2	0
July 2019	5576	719,796	2	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	13	0
August 2019	5320	669,403	0	0	0	0	0	0	0	1	0	1	0	0	0	0	2	2	0	0	0	0	1	2	0	5	0
September 2019	3848	467,544	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
October 2019	2372	244,259	0	0	3	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	4	0	0
November 2019	634	42,859	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0
December 2019	574	38,949	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0

Table A15. *Cont.*

Month	OI1	OI2	SPI1	SPI2	SPI3	SPI4	SPI5	SPI6	SPI7	SPI8	SPI9	SPI10	SPI11	SPI12	SPI13	SPI14	SPI15	SPI16	SPI17	SPI18	SPI19	SPI20	SPI21	SPI22	SPI23	SPI24	SPI25
January 2020	567	35,282	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
February 2020	474	24,606	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
March 2020	370	16,117	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 2020	16	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May 2020	194	2319	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June 2020	818	24,929	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	1	0
July 2020	2757	169,229	0	0	0	0	3	0	0	0	0	0	0	0	0	0	11	1	0	0	0	0	1	0	0	6	0
August 2020	3676	271,362	1	0	0	0	0	0	0	0	0	0	0	1	0	0	7	0	0	0	0	0	0	0	0	0	0
September 2020	1807	74,653	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	1	0
October 2020	720	25,050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1
November 2020	410	7658	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December 2020	341	8145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
January 2021	314	7415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February 2021	274	5706	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
March 2021	358	8031	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 2021	587	13,964	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May 2021	883	32,754	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0
June 2021	2051	114,687	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	1	0
July 2021	4084	349,042	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
August 2021	4728	491,358	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	7	1
September 2021	3435	326,347	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0
October 2021	2090	160,720	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
November 2021	613	25,726	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December 2021	615	23,428	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
January 2022	599[1]	20,618	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February 2022	546	16,764	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
March 2022	658	25,049	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 2022	1138	73,424	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
May 2022	2099	173,881	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2[2]	0	0	0	0	0	0	0	0	1	0
June 2022	3014	287,188	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	1	2	0	1	0
July 2022	4605	486,821	0	0	0	0	1	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	2	0	4	0
August 2022	4651	487,669	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	1	0	3	0
September 2022	2830	319,733	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1	0	2	0
October 2022	1891	151,833	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
November 2022	678	25,702	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December 2022	628	23,428	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A15. *Cont.*

Month	OI1	OI2	SPI1	SPI2	SPI3	SPI4	SPI5	SPI6	SPI7	SPI8	SPI9	SPI10	SPI11	SPI12	SPI13	SPI14	SPI15	SPI16	SPI17	SPI18	SPI19	SPI20	SPI21	SPI22	SPI23	SPI24	SPI25
January 2023	599	20,618	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February 2023	546	16,764	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
March 2023	658	25,049	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 2023	1138	73,424	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0
May 2023	2099	173,881	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**	0	0	0	0	0	0	0	0	**1**	0
June 2023	3014	287,188	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**3**	0	0	0	0	**1**	**2**	0	0	**1**	0
July 2023	4605	486,821	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	**7**	0	0	0	0	0	**2**	0	0	**4**	0
August 2023	4651	487,669	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**5**	0	0	0	0	**1**	**1**	0	0	**3**	0
September 2023	2830	319,733	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**	0	0	0	0	**1**	**1**	0	0	**2**	0
October 2023	1891	151,833	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0
November 2023	678	25,702	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December 2023	628	23,428	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[1] Red-colored area respresents the future period. [2] Bold and colored values present predicted adverse events.

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