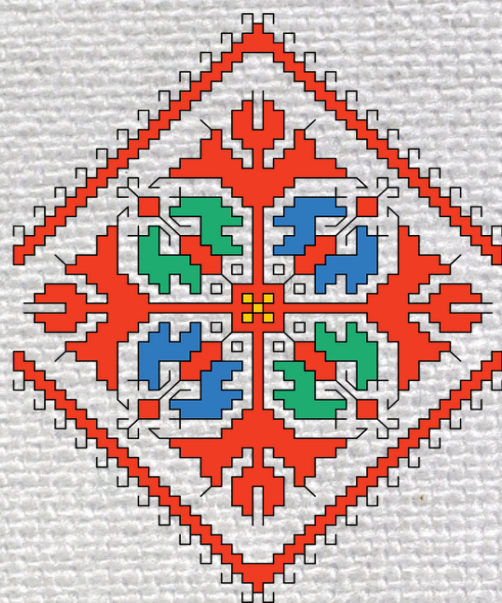


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ОБЩЕСТВЕНИ КОМУНИКАЦИИ И ИНФОРМАЦИОННИ НАУКИ **PUBLIC COMMUNICATIONS AND INFORMATION SCIENCES**

RELEVANCE OF CAR FINANCING IN GERMANY FOR PRIVATE CUSTOMERS

Patrick Schiebel

University of Library Studies and Information Technologies

Abstract: *Automotive car finance is an option in car sales, enabling automotive customers to finance their purchase, giving them exclusive access to a vehicle until repayment of the credit or when they return the car. Customers can either purchase a car via an (electronic) cash transfer or via a means of car financing. Car financing products are classified into car loans, with different loan variations, and leasing, where customers return the vehicle at the end of the lease. The economics of the financing products are similar and based on the contract duration, interest rate, and expected residual value, which is derived from the driven mileage and time. This paper discusses the dynamics of car financing, which has been recently influenced with an increase of refinancing costs of Euribor, the specific products offered in the German market, which are KM-leasing and a multi-option credit and its relevance for the German private new car sales, as well as related stakeholders like OEMs, car retailers and banks offering the products.*

Keywords: *Car Financing, Retail Car Sales, Germany, Credit, Leasing*

INTRODUCTION

As one of Germany's most relevant industry sectors, the automotive industry is responsible for 4.7% of the national GDP in 2016 (DESTATIS 2019), with an ambition to become emission-free in the long term with the introduction of BEVs. BEVs are considered more expensive than traditional combustion engines, which require a higher purchasing power from consumers for the outright purchase. However, there might be benefits of lower operating costs when customers overcome the higher entry barrier of increased price (Moll and Link 2021).

Car sales in Germany have drastically reduced starting with the Covid-19 crisis in 2020, falling from 3.6m in 2019 to 2.9m vehicles in 2020, with the lowest point in 2021 (2.62m), the vehicle sales are now continuously recovering to 2.65m in 2022 and 2.84m in 2023, of which 32.8% are registered on behalf of private consumers (~930k), the focus group of this paper. Important to note is that in this context, the mix of vehicles has drastically changed; at the end of 2019, more than 85% of vehicles which have been sold were equipped with combustion engines, whereas in 2023, the combustion engines reached a market share of around 50% (KBA 2023c, 2023b, 2023a, 2024). This has implications for the transaction price of new cars, which has already increased around 5000€ in 2022 (Büttner 2023).

Banks and leasing companies (LeaseCos) offer different financing solutions to make vehicle purchases affordable. OEM-owned banks, also known as Captives, have a long tradition in Germany and reaches back to the 1930s, when Ford introduced the first Captive in 1926, followed by Opel and Fiat in 1929 and further OEMs after World War II (Berger 2007, 182). Volkswagen

Leasing introduced leasing in 1966, a product initially targeted at corporate customers for accounting and tax benefits, but now widely accepted by private customers (Stenner 2010, 2). Dominant in Germany is currently leasing or financing to purchase new cars for private customers. Statistics show that 62% of all privately purchased vehicles were financed, and 22% were leased in Germany in 2020. This concludes a total market penetration of 84% for car financing in Germany within the retail and private customers sector (DAT 2021, 4).

RESEARCH METHODOLOGY

The research of this publication is based on literature review, where a specific focus is set on understanding the role of car financing within Germany, as well as existing studies on impact of car financing on the retail car sales landscape in Germany. The research should allow to conclude on to what extent car financing is required to sell new cars towards private customers in Germany and how car financing can influence further goals of industry stakeholders, like OEMs, retailers. The literature review includes published books, journals, research papers, and online articles, as well as websites, which are used to consider more recent evolvments. In a first step the dynamics of car financing is explored, to understand what drives the attractiveness of car financing offers for private customers. Secondly the car financing products are explored to understand how car financing is marketed to customers. In the final section, research results on car financing influencing car sales are explored.

DRIVERS OF MONTHLY RATES FOR CAR FINANCING

Car financing products are provided by independent banks, Captives, or LeaseCos, which allow the vehicle to be repaid via monthly rates instead of an outright electronic cash purchase. Financing players calculate the monthly rates using the interest rate, the contract duration, and, depending on the product, a residual value.

The interest rate the customer is required to pay is calculated based on the refinancing rate the bank must pay to acquire the funds and the margin spread it adds on top. The margin spread needs to cover the OPEX, probability of default, eventual commission to partners, and a profit margin. A lower refinancing rate, which can be measured via the 3-month EURIBOR, has been beneficial for car loans and cheap monthly rates. The figure below shows the evolution of the EURIBOR 3M from 1999 to 2023, highlighting the current challenge in refinancing costs. (Figure 1; Deutsche Bundesbank 2024)

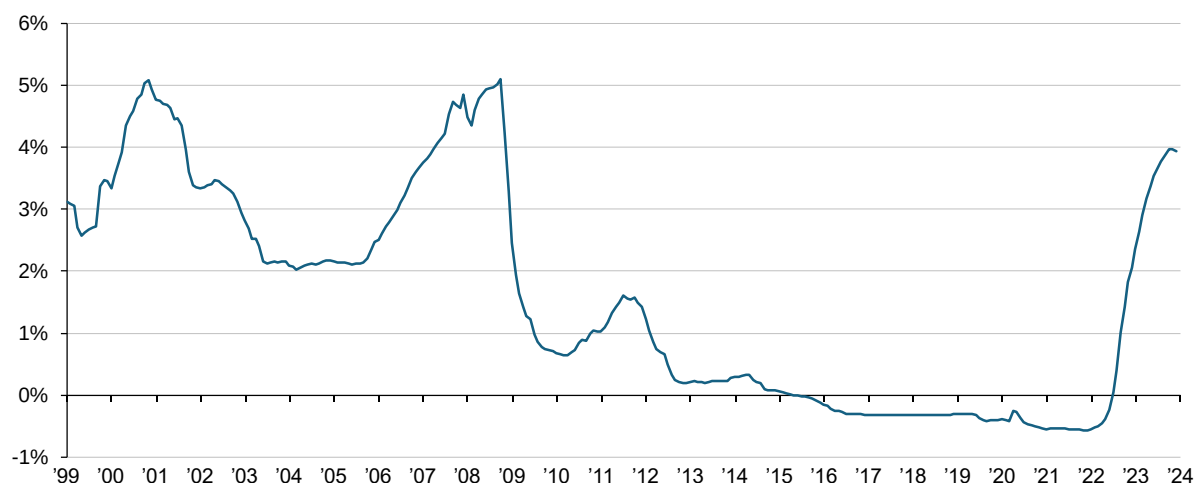


Fig. 1. Evolvement of EURIBOR 3M from 1999 to 2023

Whereas the car financing market has been benefiting from low refinancing costs and resulting monthly rates, this has drastically changed in the past two years, when interest rates have increased. This overall decreases the affordability of car financing products as the monthly installments become higher.

If customers choose a product where it is not intended to repay the credit product within the contract duration, financial services players need to set a residual value in the contract. This can be the case in a balloon credit, where the customer is obliged to repay the last installment, or in a lease, where the lessor takes the RV risk, and the customer hands back the vehicle at the end of the lease. The RV is driven by the expected transaction price the vehicle is assumed to achieve at a given point in the future when the vehicle is remarketed within the Used Car market. Attractiveness is mostly driven by the brand and model, but detailed factors like color and vehicle configuration might also increase or decrease valuation. Furthermore, most notably, the vehicle age and the mileage driven decide on the used car's value. It is important to note that the yearly depreciation decreases every year; hence, the vehicle loses a large share of its value within the first years. In addition to that, business decisions and the risk appetite of players play a critical role in setting the RV. In traditional loan products, where the customers take the RV risk, banks are more likely to set a more conservative RV estimate to avoid the risk of a customer not being able to repay the loan, as their used car can't be sold for the RV. Meanwhile, in leasing, the market competition might lead players to set a more competitive RV to increase the volumes and balance sheet size, which is critical for economies of scale in operational costs. Also, LeaseCos might integrate remarketing within the value chain to be more successful and achieve higher prices in the used car market when retailing the leasing returns. (Diekmann 2009, 8; Stefan Lessmann et al. 2010, 2–5)

PRODUCT OPTIONS OF CAR FINANCING

Car financing products have evolved over time, whereas the historical starting point was with only credits, where customers had the option to make a down payment and monthly amortize the loan with installments, which also included the interest rates (annuity loan). This product is still offered today, where banks require a down payment if the borrower's financial situation doesn't allow them to borrow the full amount. Given the nature of full repayment, these loans typically tend to last longer to stretch the amortization over the monthly installments. With the introduction of leasing in the market, banks have reacted and offered the balloon loan, which is characterized by a last large installment (the balloon). Similar to a lease, the balloon is based on the residual value of the vehicle and is set in a way to not financially stress the lender, hence typically below the actual residual value the lender would achieve when selling the vehicle. Leasing, hence, has had a competitive edge in the market, with a lower monthly rate, as LeaseCos can be more competitive on the RV, hence need to amortize less within the contract period. Customers have not been keen on taking the residual value risk in a balloon credit, and so VW invented the “Auto-Credit” in the 1990s, a product known across markets as a multi-option credit/loan and in Germany as three-way-financing (“3-Wege-Finanzierung”). Customers here have the option to choose from three options at the end of the credit: either return the car (same as in a lease), refinance the remaining amount, or fully repay the credit. The residual value here is calculated based on the agreed maximum mileage (with extra costs for extra mileage), no damages on the vehicle, and age-appropriate use. (ADAC 2022; Wallner 2023).

Leasing can be viewed as a natural evolution of financing customers, as customers tend to seek lower rates, where customers trade off the right to own the vehicle at the end of the contract and still get exclusive access to the vehicle for the agreed time. This has been proven in data samples, which show that customers choose leasing to upgrade their vehicle while paying the same monthly rate, or to reduce the monthly financial burden (Mannering, Winston, and Starkey 2002, 155, 161).

In Germany, two forms of leasing exist: residual value leasing (RV-Leasing), where customers can participate in the up-and-downside of the RV at the end of the contract, and Kilometer leasing (KM-Leasing), where customers agree on a set number of kilometers per year linked to the lease duration and the Dealer or OEM takes the vehicle buy-back. This creates a suboptimal situation, which incentivizes dealers to promote RV-Leasing with very low monthly rates, where customers could face a substantial RV risk at the end of the contract, to achieve the sale of the vehicle. Various consumer-oriented portals and organizations do not recommend this contract type, leading to a situation where the KM-Leasing is the dominant lease product, and RV-Leasing is only considered to be marginal (Joho 2017; Verbraucherzentrale Bayern e.V. 2021; Bauer 2022; ADAC 2023b).

The following table summarizes the options a customer can choose from, indicating the discussed parameters of down payment, contract duration, end of contract, and the residual value risk. (Table 1; Stenner 2012, 72)

Table 1. Comparison of different car financing options

	Car loan	Balloon loan	Multi-Options loan	Residual Value (RV) leasing	Kilometer (KM) Leasing
Down-payment	<i>Often required to lower the monthly installments</i>	<i>Optional</i>	<i>Optional</i>	<i>Optional</i>	<i>Not typical</i>
Contract Duration	<i>4-6 years</i>	<i>3-5 years</i>	<i>3-4 years</i>	<i>3-4 years</i>	<i>2-4 years</i>
End of Contract	-	<i>Large last installment (balloon)</i>	<i>3 Options: return vehicle, refinance, repay loan</i>	<i>Return of vehicle</i>	<i>Return of vehicle</i>
Residual Value Risk	-	<i>Customer</i>	<i>OEM/ Dealer</i>	<i>Customer</i>	<i>OEM/ Dealer</i>

CAR FINANCING INFLUENCING CAR SALES

OEMs invented car financing for vehicles in the 1920s with the main intention of promoting sales and making vehicles more affordable for their customers (Berger 2007, 182). With the high financing shares of today, the car financing industry has become a significant portion of many financial services companies' portfolios, next to other lending classes like houses or consumer credits (Diekmann 2009, 1). In addition to that, also Captives have become a key income source for OEM groups, where OEMs might be deficient in some years without their captives (Diekmann 2009, 3).

Industry experts assume that the impact of leasing and car loans/credit can be assumed as substantial and that it is likely that around 20% of vehicles wouldn't be sold if there wasn't an offer from Auto-Banks (Diez 2010, 20). This can also be explained by the structural benefit for auto retailers, as they are already at the point in time when they sell the car when the customers are likely to search for a new car (at the end of the contract) and have set up dedicated communication to follow-up for a new car cycle. This allowed dealers to increase customer loyalty, where it has been measured that customers who buy cars in cash tend to drive them longer, and the retention rate

increases by 20 percentage points in financing contracts (Schürmann 2010, 92–94). This becomes even more critical in the context of the switch towards BEVs, where customers show low brand loyalty by default, with only 18% (Köllner 2023).

Past research has also argued that leasing does not necessarily create higher affordability, as the leasing share is not the highest for the specific model with the highest price. Still, leasing higher-priced vehicles could be even more attractive, as they hold their value particularly well (high RV), which leads to comparably low monthly rates in relation to their vehicle price (Desai and Purohit 1999, 42). Empirical studies have also shown that customers tend to select more extra options (with a paid premium) when they purchase vehicles in a lease contract, as well as accept lower rebates (Lorenz 2001, 88).

CONCLUSION

Car financing is not only relevant for selling new cars by dealers and OEMs but also has grown over the years towards a substantial industry, which saved OEM groups in some years when they had challenges with their profit margins. With high shares of above 80% in the German retail market, car financing is enabling private customers to purchase vehicles substantially and allowing dealers to manage customer loyalty with pre-set interactions. The relevance is expected to increase with the introduction of BEVs, where customers are generally more skeptical of the new technology and linked improvements over the next years, hence less keen on taking the residual value risk. This risk avoidance can already be measured in some customer surveys, which show a higher share of leasing for EVs (ADAC 2023a).

Concluding on the financial product, it can be argued that credit/loan-based products are expected to decrease to the benefit of leasing, or the multi-option loans, if it can be made competitive enough in terms of the monthly rate. This is important to understand for financial services players, as the products might require different licenses to offer a financial lease than an operating lease (BaFin 2021).

Several studies have shown that customers think in monthly rates, which changes the general perception of extras, as they become marginal (“a few Euros per month”). In addition to that, customers start to optimize their monthly rates, which provides relevant insights for offer-makers (Dealers, OEMs, Captives, Banks) to either provide attractive up-sell options or become cheaper for the same vehicle, which could be done via a lower cost-to-income ratio (lower OPEX) and maximally digital operations.

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ЗНАЧЕНИЕ НА ФИНАНСИРАНЕТО НА АВТОМОБИЛИ В ГЕРМАНИЯ ЗА ЧАСТНИ КЛИЕНТИ

Резюме: Финансирането на автомобили е опция при продажбата им, която позволява на клиентите да финансират покупката си, като им дава изключителен достъп до автомобила, до изплащането на кредита или до връщането на автомобила. Клиентите могат да закупят автомобил чрез (електронен) паричен превод или чрез средство за финансиране. Продуктите за финансиране на автомобили се класифицират на заеми за автомобили с различни варианти и лизинг, при който клиентите връщат автомобила в края на лизинговия договор. Икономическите показатели на финансовите продукти са сходни и се основават на продължителността на договора, лихвения процент и очакваната остатъчна стойност, която се определя от изминатия пробег и времето. В настоящата статия се разглежда динамиката на финансирането на нови автомобили при продажба на дребно и значението ѝ за германския пазар.

Ключови думи: финансиране на автомобили, продажби на автомобили, Германия, търговия на дребно, кредит, лизинг, абонамент, продажба в брой

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ОБЩЕСТВЕНИ КОМУНИКАЦИИ И ИНФОРМАЦИОННИ НАУКИ **PUBLIC COMMUNICATIONS AND INFORMATION SCIENCES**

THE ROLE OF EMOTIONS WITHIN THE CONCEPT OF CUSTOMER DELIGHT

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Abstract: *Within the Western European culture especially, emotions and emotional approaches seem to be banned from business life. This results in an analytical and fact driven focus of decision making and customer approaching processes. Increasing research on the human behavior and the reasons why one offer is preferred over the other is highlighting the importance of emotions. For the customer delight concept, in which the individual should be surprised, and a long-term, unique relationship is targeted, the emotional aspect is a key factor. This influences the set-up of the direct customer interaction, the leadership style and requires constant organizational learning.*

Keywords: *Customer delight, change management, emotions, leadership, organizational learning*

INTRODUCTION

Before further exploring the role of emotions within the concept of customer delight, it is important to briefly introduce the concept itself. Since the time that the supply became greater than the demand the companies had to fight for every customer to ensure their long-term business success. To support these activities, the marketing departments became more important and constantly gained more influence on business decisions. In consumer goods markets, market saturation, product interchangeability and consumers' information overload are constantly increasing. Marketing strategies therefore strive to achieve psychological market differentiation, e.g., by using experiential strategies. The customer approach becomes more personal and the communication is influenced by emotions (Kroeber-Riel and Weinberg 1996, 358). Driven by the ongoing digitalization and faster market and product developments the previous approach of customer satisfaction is constantly evolving towards a concept of customer delight. Here there is the need for more individual customer service and product features. Bösener describes customer delight as an emotional mix of surprise, joy and excitement (Bösener 2015, 36). Stepping back from an objective product performance focus there is now the need to ensure agility to fulfill subjective, changing, and individual requirements that are emotionally driven. This is something that must be learned before the companies can start implementing it within their organizations. To achieve this change, so stated Arnold in 2005, there is the need for recognizing and questioning the emotionality of our own worldviews because learning culture change requires a reflective approach to oneself (Arnold 2005, 11). The goal of customer delight creates a need for change in dealing with emotional demands and the professional learning within companies.

“The two primary emotions are love and hate” (Stanley-Jones 1970, 25). Emotions “play a central role in the significant events in our lives” (Lazarus 1991, 3). For this they have three main

functions: evaluation, behavioral preparation and communication (Sokolowski 2002, 376). As emotions are everywhere there is the need to incorporate them into future oriented, customer centric organizations, especially when those plan to achieve customer delight. That the rational perspective regarding the behavior of humans has a disadvantage was already stated by Stanley-Jones in 1970: “When the emotions and the intellect are in competition for control of the will, it is usually the emotions that win” (Stanley-Jones 1970, 31). Despite this there is a significant cultural impact on how emotions are treated and rated. Especially in Western culture emotions are considered as something wrong (Oatley and Jenkins 1996, 38). Based on Ulich is emotionality in Western industrial societies often viewed as a weakness, as immaturity or as a luxury that can only be enjoyed in special designated private spaces (Ulich 1985, 12). At this point it is important to state that similar situations may cause different emotions, based on the individual culture background of the respective person (Merten 2003, 120). “From a humanistic perspective, service experiences are socially constructed. The individual consumer’s unique values, actions, beliefs, motives, traditions, possessions, and aspirations shape their response to the service experience. Hence, a small detail that effectively creates a favorable experience for one consumer will not necessarily be effective for another consumer” (Bolton et al. 2014, 260).

Within the context of this reflection, the Western European culture will be considered. Regardless of this focus, there is always a link between the concept of customer delight and the emotional influence on the people and organizations involved. Based on this perspective the role of emotions, embedded in the customer delight approach, will be reviewed. The peculiarities of dealing with emotions are worked out and new requirements based on this will be pointed out. Beyond that potential needs for the future will be described.

RESEARCH METHODOLOGY

A comprehensive literature review forms the basis for this publication. This was carried out in order to further understand the role of emotions within the concept of customer delight. Emotion research can look back on a long tradition, while there is still relatively little knowledge on the subject of customer delight compared with this. Regardless, connections between these two areas of research are being sought. The literature examined goes beyond the economic perspective in order to be able to work out the emotional characteristics in particular.

RESULTS

Before elaborating the role of emotions, it is necessary to understand the general specifics of the customer delight concept. Once this is described the emotional impact and the resulting consequences will be highlighted.

Customer delight is the next step in innovation that started with customer orientation and later developed to customer satisfaction. “Customer delight is the reaction of customers when they receive a service or product that not only satisfies, but provides unexpected value or unanticipated satisfaction” (Chandler 1989, 30). Finn specified this in 2005 and conceptualized customer delight “as an emotional response, which results from surprising and positive levels of performance” (Finn 2005, 104). Customer delight can be understood to be a positive emotional state that is perceived far more intensely than pure satisfaction and leads to a strongly emotional attitude among customers (Gouthier et al. 2012, 212). Or, as stated by Becker, customer delight is an intensely felt, positive emotion of the customer, triggered by a particularly convincing service (Becker 2015, 28). This goes beyond the actual product benefit or a simple execution of a service request. Therefore, it is important to emphasize the demarcation between a satisfying or expected product or service and a delighting experience. “Delight is a bonus that ‘buys’ greater depth in the relationship and increased loyalty from customers” (Schneider and Bowen 1999, 42). In this context, it is important

to understand, that many delight factors have their origin not only in what is done, but above all in how something is done (Schüller 2006, 8). Reviewing the way how a service, which ideally ends with a delighted customer, is executed forms the transition towards the consideration of emotions in this context. Especially in this case, where a shift from objective evaluations to subjective evaluation standards, that vary from customer to customer. Additionally, customers might react differently in recurring situations based on their emotional state. This is the basis for the importance of taking emotional influences into account in the customer decision-making process. “Among the components of the consumption experience, emotional responses may occupy a unique position” (Oliver and Westbrook 1993, 12). For many goods, the additional emotional stimuli provided even become the primary reason for consumption or for choosing a particular brand (Kroeber-Riel and Weinberg 1996, 115). Or, as stated by Popli, who also reviewed the connections between delight and emotions: “High satisfaction or delight creates an emotional bond with the brand, not just a rational preference” (Popli 2005, 19). Emotional approaches play an integral role in influencing customer decisions (White and Yu 2005, 417). This is not only relevant for researchers and marketing managers. It will be more and more incorporated within the daily work of frontline employees, their managers, the executive leaders and within various professional learning program that should support this change process. According to a survey of 197 customer managers, emotional customer loyalty is the most important goal of customer delight management (buw Unternehmensgruppe/Center of Service Excellence CSE 2013). The goal is to create an emotional bond between the customer and the company (Gouthier 2013, 5). In summary it can be stated that “emotions are regarded as a powerful driving force in consumer decision making. Customers derive a great amount of pleasure when they are emotionally touched” (Bagdare 2015, 9). The concept of customer delight is the tool that connects the business needs with the emotional responds.

EMOTIONS

How the emotional responds are influencing the human interaction, how they can be influenced and why this is so important to ensure long-term business success will be described now. As emotions are human feelings, we are surrounded by them constantly. Despite that, emotions are difficult to define. “Everyone knows what an emotion is, until asked to give a definition. Then, it seems, no one knows” (Fehr and Russell 1984, 464). From Arnold's perspective emotions are “affective states that can arouse an impulse to action together with physiological changes” (Arnold 1960, 228). This impulse to act needs to be triggered if, e. g. you intend to delight the customer you are dealing with at this moment. Kleinginna and Kleinginna propose this working definition which shows the various aspects that have to be considered: “Emotion is a complex set of interactions among subjective and objective factors, mediated by neural/hormonal systems, which can (a) give rise to affective experiences such as feelings of arousal, pleasure/displeasure; (b) generate cognitive processes such as emotionally relevant perceptual effects, appraisals, labeling processes; (c) activate widespread physiological adjustments to the arousing conditions; and (d) lead to behavior that is often, but not always, expressive, goal directed, and adaptive” (Kleinginna and Kleinginna 1981, 355). This working definition expresses the complexity of scientific subjects which have a connection to emotional topics. Willingness to act is seen as the core of the emotion. If an emotion is generated, the associated willingness to act is also given higher priority (Merten 2003, 15). “Emotions are strong feelings that demand attention and are likely to affect cognitive processes and behavior. Some examples of emotions include anger, fear, sadness, happiness, disgust, shame, surprise, and love” (Yukl 2006, 201). Confirmation or disconfirmation as a customer response to a business exchange are highly emotionally influenced, even if the decision or reaction is expected to be purely rationally driven. According to Appelmann, emotions touch a person in a very deep, profound and not always comprehensible way (Appelmann 2011, 51).

To understand the complex ways emotions are influencing human behavior is key to be successful with the concept of customer delight. The focus of this concept is set on subjective ratings and therefore highly dependent on emotionally driven impressions and decisions. Staying with Arnold people learn and act in the context of their emotionality (Arnold 2005, 11). And by doing so, “we may not even be aware that we are reacting emotionally because we have misinterpreted our reaction or the conditions bringing it about” (Lazarus 1991, 18). This mostly unconscious emotional processes should improve our adaptation to the requirements of our living environment, they should inform us whether environmental events are important to us and enable us to react quickly to them (Merten 2003, 137). Plutchik sees emotions as non-linear (Plutchik 2001, 347). While the review of Oatley and Jenkins leads to the conclusion to describe them as initiated, processed and then expressed (Oatley and Jenkins 1996, 98). Simonov stated already in 1970 that “positive emotions also serve as a means of overcoming the deficiency of information experienced by the individual. In a sense, emotions are opposed to rational experience because logic alone is insufficient for the success of adaptive actions in a changing environment” (Simonov 1970, 149). By doing this, he highlighted the importance and influence of positive feelings in connection with a decision to be taken. In this context it is further important to understand the specifics of decision-making processes. “Decision processes are likely to be characterized more by confusion, disorder, and emotionality than by rationality” (Yukl 2006, 26). Referring to the initially mentioned Western European culture it shows the dilemma caused by this process which can be designated as uncontrolled, disordered, individually, and potentially unpredictable. Regardless of this it will become more and more important to understand the functionality of emotions and to make use of them while creating individual and delightful customer experiences. This requires also to accept that, compared to other psychological phenomena, the expression and understanding of emotions takes place primarily via non-verbal communication channels (Ulich 1985, 36). While understanding the need for mood-congruent processes in the sense that emotionally colored information that matches one's own mood is processed preferentially, i.e. more attention tends to be paid to such information (Steckelberg 2016, 164). This also underlines the need for a mental shift towards a more individual and less hard fact-oriented business approach, especially within the process design of direct customer interaction.

As emotion “is not produced by the brain” (Arnold 1970, 179) customer delight requires a different approach to achieve the desired effect. This is a collective task within an organization and requires a clear understanding of the requirements to achieve the desired future organizational state where agility and flexibility will become more important. Of course and in addition to the emotional aspect, the customer has to be inspired by the product or service itself (Pfaff 2006, 25). “The emotion system is reactive to immediate events and the current physiological state of the person. Thus a person's emotions fluctuate over time” (Diener and Lucas 2000, 333). As there is always an emotional coloration, every decision is ultimately an emotional decision (Schüller 2006, 6). Transferring this insight into the business environment where international competition and the overstimulation of the customer are increasing, the unpredictability of customer behavior will be the consequence – emotional criteria are increasingly determining consumer behavior (Becker and Schnee 2005, 29). The results of Schneider and Bowen “suggest that focusing on customer delight and outrage – emotions more intense than satisfaction or dissatisfaction – may lead to a better understanding of the dynamics of customer emotions and their effect on customer behavior and loyalty” (Schneider and Bowen 1999, 36). The power of emotions has been discovered by advertising and marketing specialists. Those are developing strategies to make use of the mentioned emotional influence within in the decision-making process. At some stages they try to use those findings to manipulate customers and their preferences (Merten 2003, 9). But this is not part of the customer delight concept. Customer delight is targeting to create real delightful customer

experiences, based on honest, individual, and flexible interactions that result in long-term, trustful relationships. That this achieves positive results in practice is expected from Lee et al.: “It is possible consumers would be much happier with choices based more on their emotional reaction. [...] Indeed, our results suggest that the heart can very well serve as a more reliable compass to greater long-term happiness than pure reason” (Lee et al. 2009, 185). In order to broaden the perspective, it should also be noted that internal organizational set-up and mind-set have to evolve in the same way. Customer delight requires a holistic organizational change approach, where also a specific focus is set on the responsible managers and their leadership behavior. “Until the 1980s, few conceptions of leadership recognized the importance of emotions as a basis for influence. In contrast, many recent conceptions of leadership emphasize the emotional aspects of influence much more than reason. According to this view, only the emotional, value-based aspects of leadership influence can account for the exceptional achievements of groups and organizations” (Yukl 2006, 5). The emotional influence and the potential impact of embracing this might offer new and unexpected opportunities.

CONCLUSION

The possibility to make delightful decisions within customer interactions need to be given to the frontline employees. While managers need to adapt to the new challenges and leadership requirements they need to become open-minded to change their leadership style. Related to those two key determinants and supported by an organization-wide focus on emotional aspects the concept of customer delight can be sufficiently supported in order to introduce it successfully. Besides necessary changes within the processes and leadership approach, an understanding for the importance of the emotional needs has to be developed.

The particularities of these challenges described in this publication must be analyzed individually and adapted to the company's specific situation. In combination with a prior assessment of the current situation, a plan, usually consisting of several stages, must be drawn up for the introduction of customer delight. In addition, special training courses for employees with customer contact and managers must be developed and implemented. In addition, intensive work must be done on the necessary understanding of the customer delight concept and the special role of emotions identified here. The diverse requirements associated with this multi-purpose approach require an organizational-wide commitment and an ongoing organizational exchange and learning at all hierarchical levels.

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РОЛЯТА НА ЕМОЦИИТЕ В КОНЦЕПЦИЯТА ЗА УДОВЛЕТВОРЕНОСТ НА КЛИЕНТА

Резюме: Особено в рамките на западноевропейската култура емоциите и емоционалните подходи изглеждат са отхвърлени в бизнес средите. Това води до аналитичен и ориентиран към фактите фокус на процеса на вземане на решения и подход към клиента. Увеличаващите се изследвания върху човешкото поведение и причините, поради които една оферта е предпочитана пред друга, подчертават важността на емоциите. При концепцията за удовлетвореност на клиента, в която индивидът трябва да бъде изненадан и се цели дългосрочна, уникална връзка, емоционалният аспект е ключов фактор. Това оказва влияние върху настройката на директното взаимодействие с клиентите, стила на лидерство и изисква постоянно организационно обучение.

Ключови думи: удовлетвореност на клиента, управление на промените, емоции, лидерство, организационно обучение

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ИНФОРМАТИКА И КОМПЮТЪРНИ НАУКИ INFORMATICS AND COMPUTER SCIENCES

ИЗПОЛЗВАНЕ НА ИЗКУСТВЕН ИНТЕЛЕКТ ЗА АНАЛИЗ И КАТЕГОРИЗАЦИЯ НА КИБЕРАТАКИ ЧРЕЗ РАЗПОЗНАВАНЕ НА ПОВЕДЕНЧЕСКИ МОДЕЛИ

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Резюме: Докладът представя детайлен анализ на текущото състояние на киберсигурността в България, като се фокусира върху оценката на риска от кибератаки, които засягат или се извършват върху български IP адреси. Изследването разглежда различни подходи и инструменти за събиране и анализ на данни, включително оперативен мониторинг в реално време, използването на honeypot системи, както и анализ чрез Jupyter Notebook и Python, които подпомагат изчерпателния анализ на информацията. Изследването се базира на подход, който включва обобщаване на метаданните, използвани в анализа, и методите за откриване на кибератаки, като подчертава важността на географското местоположение, методите на нападение и тяхната последователност във времето. Анализът подчертава интензивността и разпространението на кибернападенията в страната, както и значителното разнообразие и потенциалната нестабилност на тези атаки. Основната част от анализа представя ключови статистически данни относно кибератаките, които показват активността и широтата на киберзаплахите в страната, включително дескриптивен анализ и клъстерен анализ на нападенията. Разглеждат се корелационни анализи за изучаване на свързването между кибератаките и различни географски региони, както и времеви анализ за откриване на дългосрочни тенденции. Използвайки визуализационни инструменти като 3D бар графика и линейна графика, предоставя подробно представяне на корелациите и промените по време, докато boxplot и KS тест за пригодно сравняване се използват за оценка на разпределението и нормалността на данните. Докладът представя общ поглед за киберсигурността в България, като използва разнообразни методи и инструменти за събиране и анализ на данни с цел идентифициране на ключовите тенденции и потенциалните рискове от кибератаките. Изводите подчертават важността на непрекъснатото мониториране и анализ на кибератаките за откриването на тенденции и бързо реагиране. Важно е да се разработят цели и стратегии за киберзащита, като се вземат предвид регионални, икономически и технологични фактори, които могат да повлияят на киберсигурността. Докладът предлага препоръки за бъдещи изследвания, включително установяването на дългосрочни модели и разработването на прогнозни модели, които да предвидят изменения в тактиките на нападателите и да предложат ефективни превантивни стратегии.

Ключови думи: киберсигурност, кибератаки, тенденции, корелационен анализ, времеви серии

ВЪВЕДЕНИЕ

В настоящата епоха на глобализация и технологично развитие киберсигурността е от съществено значение за националната и корпоративната сигурност. Процесите на цифровизация и увеличаване на зависимостта от интернет технологиите променят начина, по който обществото функционира, като увеличават рисковете от кибератаки. Тези атаки не само представляват заплаха за личните данни на хората, но могат да имат дългосрочни икономически и социални последици, което подчертава необходимостта от по-ефективни мерки за киберсигурност. В този контекст държавите, включително България, стоят пред предизвикателството да изградят и приложат стратегии за защита срещу все по-сложните и често срещани кибератаки.

България е страна с активно развиваща се информационна и комуникационна инфраструктура (ИКТ) и това я изправя пред нуждата да засилва своите способности в областта на киберсигурността, за което е от решаващо значение да се проучи рискът от кибератаки, които засягат или се извършват върху български IP адреси.

1. МЕТОДОЛОГИЯ НА ИЗСЛЕДВАНЕТО

МЕТОДИ ЗА АГРЕГИРАНЕ НА МЕТАДАННИ

Извършването на оперативен мониторинг в реално време е от съществено значение за ефективното откриване на кибератаки, затова оперативният мониторинг играе ключова роля. Използването на honeypot системи е от съществено значение за засичането на всеки неоторизиран опит за достъп, което гарантира постоянно наблюдение на мрежовата активност. Следващата стъпка е ефективното агрегиране и централизация на събраните данни, които са необходими за аналитичен преглед и оценка. За да бъде осигурена неприкосновеността и надеждността на данните, важно е да бъдат въведени строги мерки за сигурност, които гарантират защита и поверителност на информационните потоци.

МЕТОДИ ЗА АНАЛИЗ И ИНСТРУМЕНТАРИУМ

Аналитичният процес в изследването е организиран чрез използване на езици и платформи, които са широко приложими в сферата на научните изследвания, като Jupyter Notebook и Python. Jupyter Notebook осигурява интерактивност и детайлен анализ на данните. В процеса на анализа се използват различни Python библиотеки: Pandas за ефективно манипулиране и анализ на данните, Matplotlib и Seaborn за интуитивна графична визуализация (Hunter 2007), както и Scikit-learn за прилагане на разширени статистически модели и алгоритми за машинно обучение (Pedregosa 2011).

ОПИСАНИЕ, ИЗТОЧНИЦИ И ПРЕДСТАВИТЕЛНОСТ НА МЕТАДАННИТЕ

В рамките на нашето научно изследване проведохме процедури за стандартизиране на метаданните и последваща валидация, с които да откриваме всякакви аномалии и изключения, които биха могли да окажат влияние върху достоверността на аналитичния процес. Нашият статистически анализ включва инструментариум от различни изчисления за

централната тенденция и разпръснатост – средни стойности, медиани, моди, стандартни отклонения и екстремални стойности. Тези метрики ни помагат да имаме по-пълна представа за разпределението на данните.

- **Мрежа от honeypot системи**

В контекста на настоящото изследване извлечената информация произтича от разширена мрежа от honeypot системи, стратегически разположени в множество урбанизирани агломерации. Тези системи са стратегически разположени в различни общини и институции и имитират различни уязвимости в мрежовата инфраструктура. Целта на тяхното приложение е да служат като средство за привличане и регистриране на неоторизиран достъп и злонамерени действия, предоставяйки данни за поведението и методите на нападателите.

- **Описание на методите за разпознаване на кибератаки**

Главните параметри при идентификацията на киберинциденти включват географското местоположение на нападателите (определено чрез IP адресите), последователността на атаките във времето, използваните методи и вектори на атака (включително сканиране на портове, експлоатация на известни уязвимости) и събраните метаданни, описващи всяко действие.

- **Представителност на данните – период, обем, локации**

Представителността на данните се основава на информация за дневния брой кибератаки и свързаните с тях уникални IP адреси, произлизащи от български източници. Анализът включва данни за едногодишен период, които са разделени на месечни интервали, за да бъде по-лесно обработване и визуализиране на тенденциите.

1. РЕЗУЛТАТИ И АНАЛИЗ НА КАРТИНАТА НА КИБЕРСИГУРНОСТТА В БЪЛГАРСКИЯ НАЦИОНАЛЕН ДОМЕЙН

2.1. Основни статистически данни

- **Дескриптивен анализ**

Анализът на статистическите данни за кибератаките, които са извършени от или на български IP адреси, предоставя важна информация за характера и обема на такива инциденти (вж. Таблица 1). Изследванията показват, че обемът на атаките средно на ден достига до около 162 454 извършени от 89 на брой уникални български IP адреси. Тези данни показват активността и разпространеността на кибератаките в страната. Стандартното отклонение от 108 135 подчертава значителната нестабилност и вариация на дневната активност. Това е сигнал за непостоянство в атаките или за периоди на по-агресивна активност, което е съществено за разбирането на динамиката на киберпрестъпленията и подчертава сериозността и мащаба на киберзаплахите, които засягат региона.

Таблица 1. Анализ на статистически данни на кибератаки със среден брой IP адреси

Изчисление	Стойност
Среден брой дневни атаки	162 454
Среден брой уникални IP адреси на ден	89
Общ брой атаки на ден	1 620 178

Също така средният брой на уникалните български IP адреси, които участват в атаките, е около 89 на ден, със стандартно отклонение от 32, което предполага наличието на известно разнообразие в броя на активните източници на атаки (вж. Таблица 2). Това ни дава представа за големината и за размера на мрежата на атакуващите в рамките на страната.

Стандартното отклонение на дневните атаки от 108 135 и броят на уникалните IP адреси на ден от 32, както и значителното стандартно отклонение от 1 130 543 на общия брой атаки показват високата вариативност и потенциалната нестабилност на страната. Тези колебания в данните за деня могат да сигнализират за различни модели на атаки, които могат да бъдат предизвикани от различни фактори, включително времеви периоди, технически уязвимости и човешки фактори.

Таблица 2. Анализ на статистически данни на кибератаки със стандартно отклонение

Изчисление	Стойност
Стандартно отклонение на дневни атаки	108 135
Стандартно отклонение на уникални IP адреси на ден	32
Стандартно отклонение на общ брой атаки на ден	1 130 543

В рамките на проведеното изследване броят на регистрираните кибератаки за определен ден възлиза приблизително на 1 620 178, с огромно стандартно отклонение от 1 130 543. Този висок индекс подсказва, че има голямо колебание и възможност за големи кибератаки. Откритото съотношение на атаките, които произхождат от IP адреси в България и които представляват около 10.03% от общия брой атаки за деня, подчертава значимата роля, която тези адреси играят в киберсигурността на държавата.

Тази статистика е изключително важна за научния анализ, като предоставя съществени данни относно броя и честотата на кибератаките, свързани с IP адресите в България, както и тяхната връзка с общия обем на международните кибератаки (вж. Таблица 3). Това ни дава

възможност да разберем по-добре локалните модели на кибернападения и тяхната роля в широкия спектър от киберзаплахи.

Анализът на данните разкрива важни характеристики на кибератаките, извършени от български IP адреси. Високото съотношение на атаките спрямо адресите, което достига средно до 1822.71 атаки за всеки адрес, подчертава тенденцията за концентрация на атаките в ръцете на ограничен брой нападатели. Това дава основание да се предположи, че има съществуващи активни кибератакуващи групи, които оперират в рамките на страната.

Таблица 3. Честота на кибератаки от български IP адреси

Показател	Стойност	Описание
Съотношение на българските атаки към българските IP адреси	1822.71	Средно за всеки български IP адрес са извършени около 1822 атаки
Средно съотношение на българските атаки към общия брой атаки	10.03	Средно българските атаки представляват около 10.03% от всички атаки на ден

Средното съотношение на българските атаки спрямо общия брой на атаките, което е около 10.03%, предоставя основа за изследване на влиянието на местните кибератаки в контекста на глобалните киберзаплахи. Този показател подкрепя заключението, че българските източници на атаки са значима част от общата киберактивност и въздействат не само на национално, но и на международно ниво.

Във връзка със споменатата концентрация и значителния обем на общите атаки е изключително важно да се проучат кибератаките от български IP адреси, за да се разработят целенасочени стратегии за киберзащита (Brown 2018). За да се справим ефективно с тези видове атаки, трябва подробно да разберем мотивите, методите и технологиите, които използват нападателите.

- **Клъстерен анализ на кибератаките**

Извършеният анализ предоставя детайлна статистика за три различни клъстера, които представляват групи от кибератаки, сортирани въз основа на различни характеристики, като честотата и източника на атаките. Анализът на тези данни предоставя ценна информация относно моделите, шаблоните и обхвата на кибератаките, фокусирайки се върху ролята на българските IP адреси в този процес (вж. Таблица 4).

Таблица 4. Клъстерен анализ на кибератаки

Показател	Клъстер 1	Клъстер 2	Клъстер 3
Среден брой атаки	1 087 073	6 140 481	2 075 983
Минимален брой атаки	0	4 222 992	1 060 602
Максимален брой атаки	2 310 624	7 559 298	5 701 032
Стандартно отклонение на атаки	468 478	1 281 068	781 073
Среден брой БГ IP	72.64	112.83	112.51
Минимален брой БГ IP	0	85	70
Максимален брой БГ IP	140	143	157
Стандартно отклонение на БГ IP	27.48	28.42	20.59

Клъстер 1 се характеризира с най-ниския среден брой атаки – 1 087 073, което предполага, че този клъстер включва по-малко агресивни или по-рядко срещани форми на кибератаки (Smith & Jones 2017). Наблюдението за минимален брой атаки, равен на нула, предполага периоди на намаляваща активност или пълна липса на такива, докато максималният регистриран обем от 2 310 624 и ниското стандартно отклонение от 468 478 подчертават стабилността в разпределението на атаките в този клъстер. Средният брой засечени IP адреси в България, участвали в атаките, е относително нисък – 72.64, с минималното стандартно отклонение от 27.48, което предполага стабилност и липса на резки пикове в активността.

Клъстер 2 се отличава със значително по-висок среден брой атаки – 6 140 481, което показва, че клъстерът включва много активни атаки или атаки с голям мащаб. Стандартното отклонение на атаките 1 281 068 е значително, което показва, че въпреки високия среден брой атаки, има съществени колебания в тяхната честота (Lee & Kim 2018). Това се свързва с периодични или сезонни кампании. Българските IP адреси също показват високо средно ниво 112.83 и най-голям максимален брой 143, което подчертава значимата роля на българските източници в този клъстер.

Клъстер 3 представлява средният диапазон между първите два клъстера по отношение

на средния брой атаки от 2 075 983. Показва най-голямо разнообразие в обема на атаките, което се отразява в максималния обем от 5 701 032 и стандартното отклонение от 781 073. В този клъстер се включват различни видове атаки или такива, които са повлияни от специфични външни събития. Средният брой на IP адресите в България е подобен на този в Клъстер 1 (112.51), но ниските стойности на стандартно отклонение от 20.59 показват постоянна активност във времето на атакуващите групи в България.

Изследването на големия брой кибератаки, извършени от български IP адреси в определени категории, подчертава необходимостта от по-детайлно познание за регионалните особености на такива инциденти. Важността на тази информация е подчертана в работата на Thompson и неговите колеги (Thompson 2019), които призовават за разширено научно изследване на влиянието на тези атаки върху глобалната киберсигурност. Това ни помага да идентифицираме ключовите аналитични елементи и модели, необходими за наблюдение и предотвратяване на потенциални заплахи, както разискват Rodriguez и Anderson (Rodriguez & Anderson 2020).

2.2. Корелационен анализ по време и събития

След изследване на връзките между кибератаките и различните географски региони, забелязваме силна свързаност в Бургас с корелация от 0.632924, което подсказва значително влияние на географията върху модела на атаките в този регион (вж. Таблица 5). Изглежда, че географското местоположение играе важна роля за киберзаплахите там. Варна и Пловдив, от друга страна, показват по-слаба свързаност с корелации от 0.132300 и 0.082618 съответно, което ни дава основание да предположим, че тези региони не са толкова засегнати от киберзаплахите, обусловени от географията. Интересно е да отбележим и силната корелация над 0.9 за Харманли, София и Велинград, което подсказва концентрираност на атаките или присъствие на специфични заплахи в тези райони.

Таблица 5. Корелационен анализ на събития

Град	Корелация	Сила на връзката
Бургас	0.632924	умерена до силна връзка
Варна	0.132300	слаба връзка
Пловдив	0.082618	много слаба връзка
Харманли	над 0.9	силна връзка
София	над 0.9	силна връзка
Велинград	над 0.9	силна връзка

При корелационен анализ по време става ясно, че има по-силни връзки при използването на седмични и месечни времеви интервали в сравнение с дневните (вж. Таблица 6). Това е индикация за по-ясно дефинирани модели на кибератаки в по-дългосрочен план. Например ДАЕУ показва висока свързаност в трите времеви интервала, което подсказва стабилност и

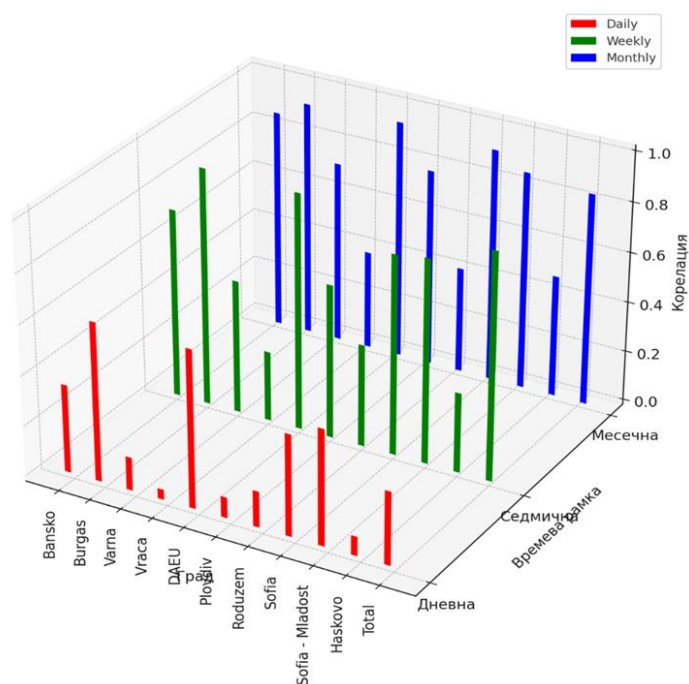
предвидимост в атаките. В същото време градовете Враца и Хасково имат по-ниски стойности на свързаност, особено при дневна база, което означава по-случайни или различни модели на кибератаки.

Таблица 6. Корелационен анализ по време

Град	Дневна корелация	Седмична корелация	Месечна корелация
Банско	0.3511	0.7515	0.8701
Бургас	0.6329	0.9457	0.9337
Варна	0.1323	0.5313	0.7232
Враца	0.0403	0.2786	0.3921
ДАЕУ	0.6295	0.9404	0.9483
Пловдив	0.0826	0.6133	0.7851
Рудозем	0.1432	0.4080	0.4215
София	0.4051	0.7968	0.9272
София – Младост	0.4621	0.8138	0.8684
Хасково	0.07696	0.3192	0.4858
Total (общо)	0.2921	0.9073	0.8454

2.3. Триизмерна бар графика (3d bar chart)

Този тип графика представлява аналитичен инструмент, използван за визуализиране на корелационните коефициенти между кибератаките и различни географски региони в рамките на различни времеви рамки – дневна, седмична, месечна (вж. фиг. 1). Тази графика осигурява детайлно представяне на вариативността и сравненията на корелациите във всяка времева перспектива и за всеки изследван град, което дава възможност за по-дълбоко разбиране на динамиката на кибератаките и тяхното разпределение в различните региони.



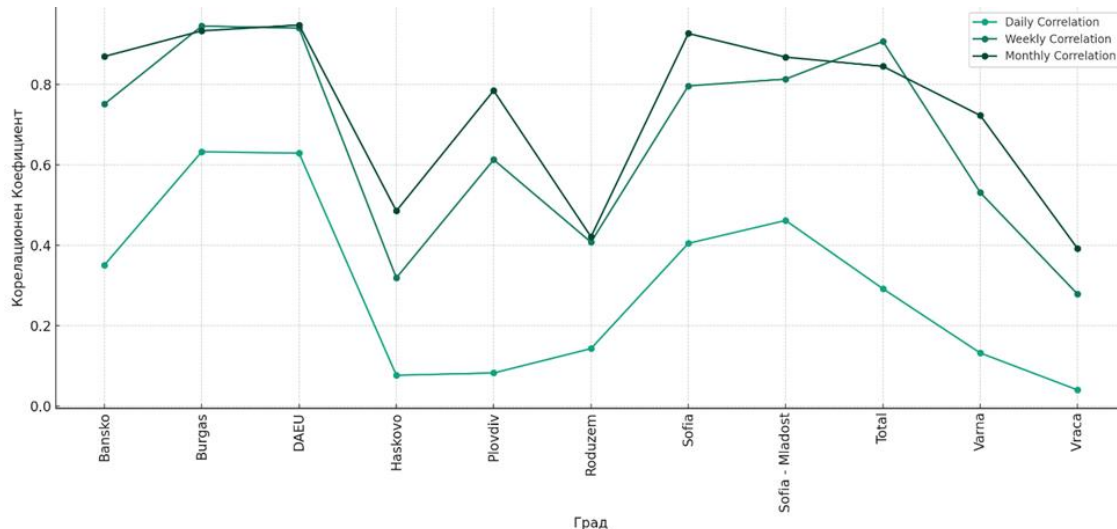
Фиг. 1. Триизмерна графика на корелациите между BG Attack и BG IP

Графиката показва корелационните коефициенти между броя на атаките, извършени от български IP адреси (BG Attack), и броя на уникалните български IP адреси (BG IP) за всяка времева рамка (дневна, седмична, месечна) по отношение на всеки град. Триизмерните барове позволяват визуализация на различията в корелациите през различните времеви периоди и градове, като се вижда, че в общия случай корелациите са по-високи за месечните данни в сравнение с дневните и седмичните. Това отразява по-стабилни дългосрочни взаимодействия между активностите на атаките и наличието на локални атакуващи източници.

2.4. Линейна графика (line chart)

Промените в корелационните коефициенти през времето за всеки град могат да се представят чрез времеви редове, които показват как връзката между кибератаките и географските региони се променя (вж. фиг. 2). Този анализ е полезен за откриване на дългосрочни тенденции и потенциални причини за вариации в киберсигурността, които могат да бъдат свързани с изменения в социално-икономическите условия, технологичното развитие или политическите стратегии за сигурност.

Графичното представяне като линейни графики позволява да видим корелационните коефициенти за всеки град отделно и да направим сравнение между различни градове. Това е особено полезно при откриването на необичайни или изключителни събития, които влияят на киберсигурността в определена област.



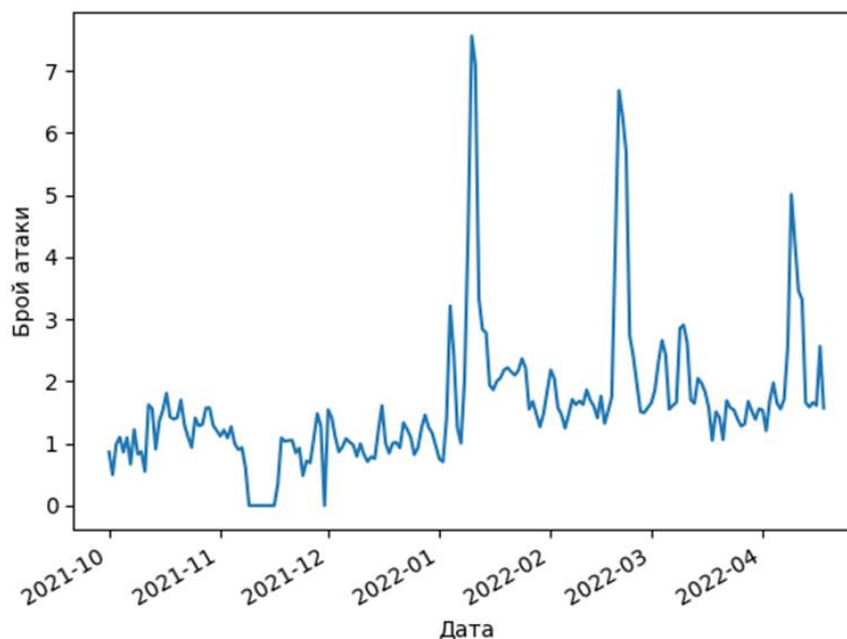
Фиг. 2. Промяна на корелационни коефициенти през времето по градове

Промяна на корелациите във времето: графиката показва, че за повечето градове има по-голяма свързаност в седмични и месечни периоди в сравнение с дневните. Това подсказва за стабилността на отношенията в по-дългосрочен план. Например в градове като Бургас и ДАЕУ високите корелации подчертават последователността на атаките, свързани с местни източници.

Сравнение между градовете: различията в корелациите между градовете могат да отразяват уникални локални условия, които оказват влияние върху киберсигурността. Столицата София и нейните райони като „Младост“ показват значителни корелационни стойности, което подкрепя идеята за интензивна киберактивност в тези райони.

Тенденции и модели: Откритите тенденции могат да бъдат използвани за идентифициране на потенциални рискови фактори или за разработване на адаптивни модели за реагиране на кибератаки. Аномалиите или необичайните събития могат да бъдат изследвани, като се отклоняват от общия модел.

- **Диаграма на динамиката на дневните атаки**



Фиг. 3. Динамика на дневните атаки

На представената графика е изобразена динамиката на дневните кибератаки за периода от ноември 2021 г. до април 2022 г. (вж. фиг. 3). Наблюдава се голяма промяна в количеството на нападенията, като се отбелязват няколко високи върха, които указват периоди на интензивност в кибератаките.

В началото на наблюдавания период броят на атаките остава относително стабилен и нисък, което сочи за период на нормална киберактивност или ефективно предотвратяване на атаките. Впоследствие се наблюдава серия от остри възходи в броя на атаките, които достигат своите върхни точки през месеците декември и февруари, последвани от април. Тези пикове могат да са резултат от специфични кампании на кибератаки, масирано разпространение на вредоносен софтуер или други координирани злонамерени действия.

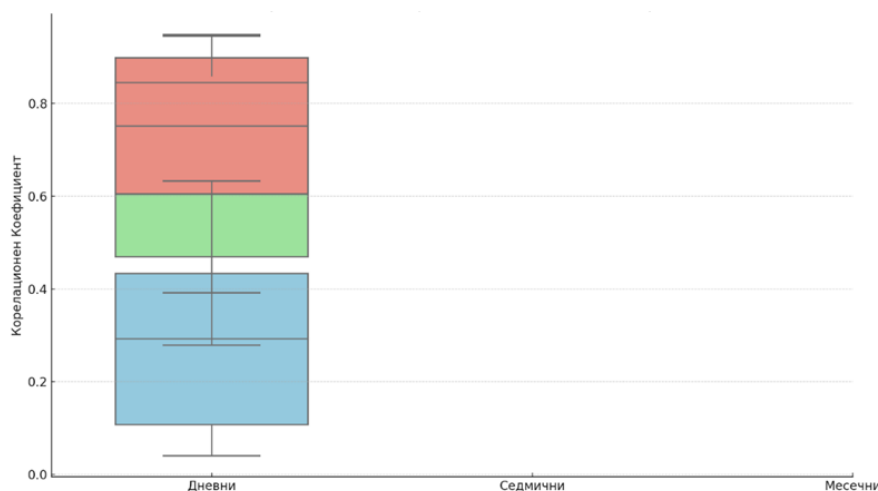
Значителните пикове в броя на атаките също могат да отразяват сезонни тенденции или събития с висока стойност на целите, като празнични периоди или големи търговски събития, по време на които се увеличава броят на онлайн транзакциите и потенциално – уязвимостите за кибератаки.

Общият анализ на графиката подчертава значението на непрекъснатия мониторинг и анализ на кибератаките за идентифицирането на потенциални модели и реагирането в реално време. Също така осигурява ценни данни за изследванията в областта на киберсигурността, които могат да допринесат за разработването на предвидими и превантивни мерки за справяне с бъдещи заплахи.

2.5. Boxplot диаграма

Представената графика е боксплот (boxplot) или кутийна диаграма, която илюстрира разпределението на уникалните IP адреси, участващи в кибератаките на дневна база (вж. фиг. 4). Графиката сама по себе си показва междуквартилния размах (между първия и третия кваartil), където се съдържа централната половина от данните, а линията в средата на кутията отразява медианата на разпределението.

От графиката се вижда, че медианата е около 89 уникални IP адреса на ден, но има и дни с много по-висока активност, което се показва от аутлайърите в диаграмата.



Фиг. 4. Boxplot диаграма на корелационни коефициенти за различните времеви рамки

Боксплотът на графиката илюстрира разпределението на корелационните коефициенти между броя на кибератаките от български IP адреси (BG Attack) и броя на уникалните български IP адреси (BG IP) за дневни, седмични и месечни времеви рамки. Този вид визуализация е изключително полезен за оценка на вариабилността на данните и идентифицирането на изключения (аутлайъри).

Дневни данни: Наблюдаваме по-широк спектър на корелационни стойности с медиана, която е по-ниска от тази на седмичните и месечните данни. Това показва, че дневните връзки между BG Attack и BG IP могат да бъдат по-променливи, което отразява дневните флуктуации в кибератаките.

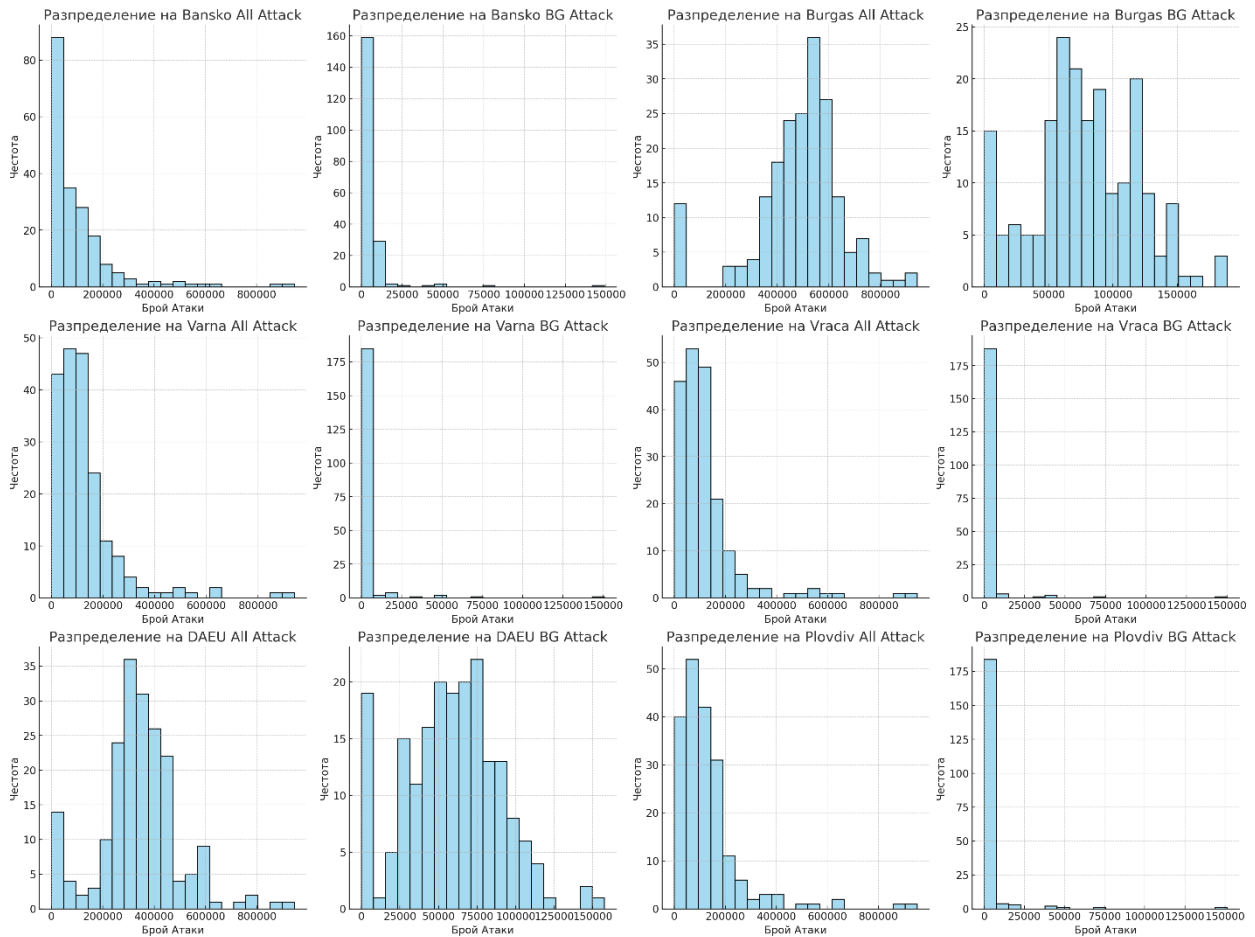
Седмични данни: Седмичните данни показват по-висока медиана и по-малка вариация в сравнение с дневните данни, което предполага, че седмичните връзки са по-стабилни и предвидими.

Месечни данни: Месечните данни се отличават с най-високата медиана и най-слабата вариация, подчертавайки значението на дългосрочната връзка между BG Attack и BG IP.

2.6. KS тест за пригодност

Kolmogorov–Smirnov test (K–S test или KS test) за пригодност е статистически тест, който

се използва за сравняване на емпирично разпределение на извадка с очакваното (референтно) разпределение (вж. фиг. 5). Създадените хистограми предоставят информация за разпределението на атаките за избраните колонии. В таблицата са показани KS статистиката и Р-стойностите за всяка колона, което ни помага да оценим нормалността на разпределението на данните за атаки.



Фиг. 5. KS тест за пригодност

Ненормално разпределение: за много от колоните (като **Bansko BG Attack**, **Varna BG Attack**, и **Vratsa BG Attack**) статистиката на KS е висока, а Р-стойността е много ниска (по-малка от 0.05), което показва, че разпределението на атаките значително се различава от нормалното разпределение.

Възможно нормално разпределение: за други колонии (като **Burgas BG Attack** и **DAEU BG Attack**) Р-стойността е по-висока (по-голяма от 0.05), което означава, че данните не се различават значително от нормално разпределение.

2.7. Описание на картината на киберсигурността

На националния домейн

Графиката представлява корелационна матрица, която илюстрира степента на взаимовръзка между различни видове кибератаки, регистрирани от определени географски точки (вж. фиг. 6). Корелационната матрица използва координати на цветовете, за да покаже силата и посоката на връзката между две променливи. Тук е използвана цвятова скала от червено до бяло, където:

- Тъмночервено представлява силна положителна корелация (близо до 1).
- Бяло представлява нулева корелация (близо до 0).
- Тъмносиньо представлява силна отрицателна корелация (близо до -1).

От корелационната матрица може да направим следните изводи:

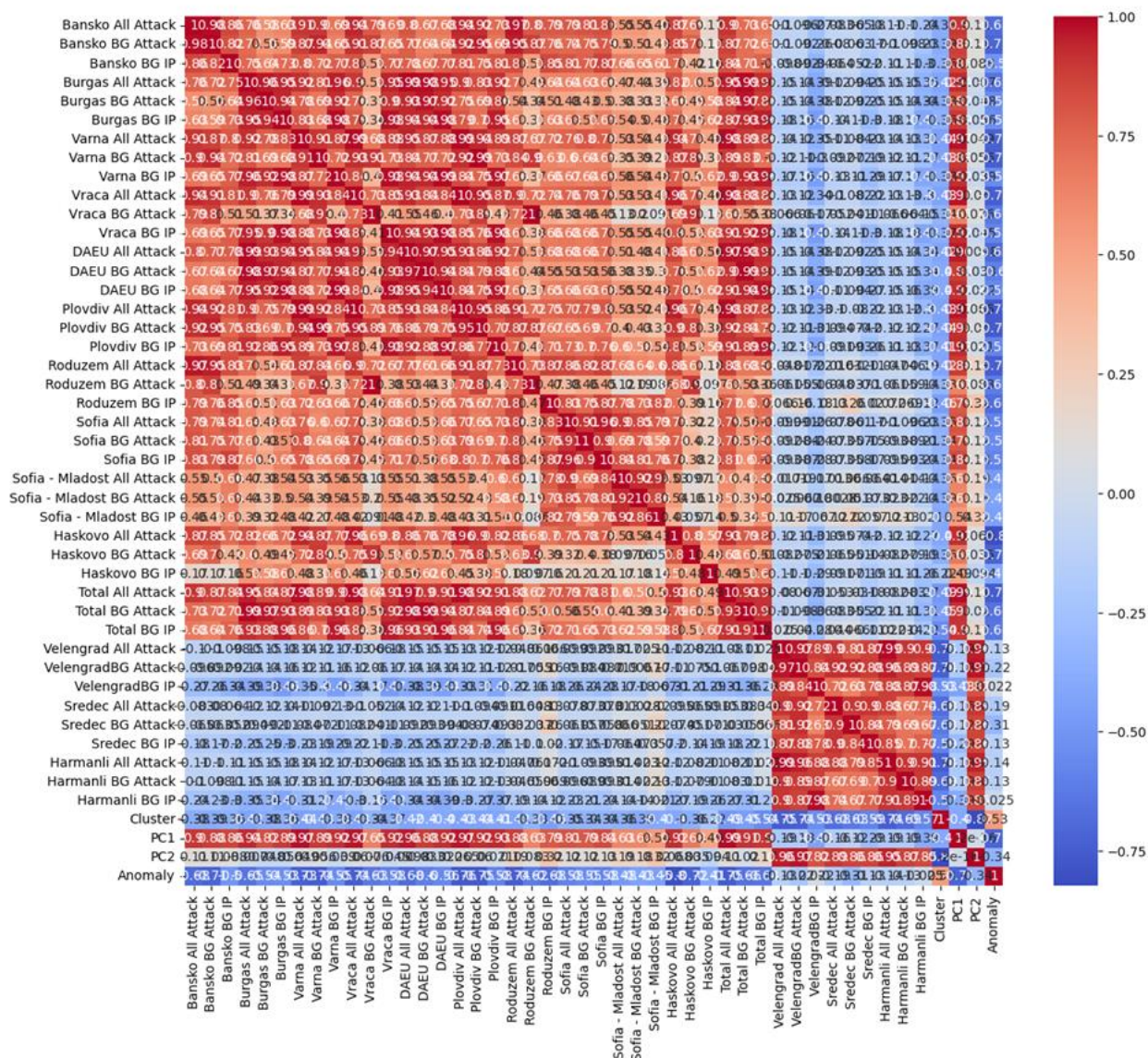
Силни положителни корелации: високи положителни стойности (тъмночервено) по диагонала показват, че всяка променлива е перфектно корелирана със себе си, което е очаквано. Освен това високите стойности между различни атаки и IP адреси в един и същи град или област показват, че колкото повече атаки се извършват, толкова повече уникални IP адреси се използват.

Умерени до високи корелации между градовете: някои видове атаки имат висока положителна корелация помежду си, което показва, че те се случват едновременно или че са резултат от сходни уязвимости или тактики на нападателите. Например високите положителни стойности в някои редове и колони могат да индикират, че определен тип атака се появява едновременно в множество географски региони, което би могло да покаже координирана атака или глобална киберзаплаха.

Различия в корелационните стойности: различията в корелационните стойности между различните градове и общия брой атаки могат да предполагат, че някои региони имат различно поведение при атаките. Например някои могат да имат по-синхронизирани атаки, докато други – по-независими или случайни модели на атаки.

Интерес представляват и включените компоненти за главни (PC1 и PC2), които предполагат, че има основни фактори или оси на вариация, които обясняват голяма част от наблюдаваните данни. Включването на метрика за аномалии в долната част на матрицата също е ключово, тъй като показва потенциалната способност на модела да идентифицира изходящи данни, които могат да представляват нестандартни или неочаквани атаки.

Корелационната матрица е мощен инструмент за визуализация, който помага да се идентифицират потенциални връзки между различни променливи и може да служи като основа за по-нататъшен анализ, като каузален анализ или разработване на модели за предвиждане на атаките.



Фиг. 6. Корелационна матрица на характеристиките

Анализът на динамиката на дневните атаки, както е показано на графиката, предоставя ценна информация за честотата и интензивността на кибератаките във времето. Според изследване на Sharma и Panigrahi вариациите в броя на атаките могат да бъдат обвързани със сезонни тенденции или глобални събития, които влияят на поведението на нападателите (Sharma & Panigrahi 2012). Допълнително значителните върхове, наблюдавани в графиката, могат да отразяват специфични кампании на кибератаки или разпространението на нови видове вредоносен софтуер, както е отбелязано от Alazab et al. (Alazab, Venkatraman & Watters 2013). Важно е да се отбележи, че такива анализи могат да помогнат на организациите да подобрят своите отбранителни стратегии и да разработят по-адаптивни мерки за реагиране на заплахи в реално време.

ИЗВОДИ

Научният анализ на хистограмите и други графични методи представлява фундаментален подход за изследване на динамиката и моделите на кибератаките, позволявайки детайлно разбиране и формиране на хипотези относно причините за разпределението на атаките. Такива методи са особено полезни за идентифицирането на повишена киберактивност по време на значими национални празници, както е наблюдавано в България, където се регистрира висока честота на атаки в деня на националния празник. Това подчертава важността на специализирани стратегии за превенция на кибератаките особено в периоди с предвидимо увеличение на киберактивността.

Анализът разкрива също така, че определени региони като Варна и Рудозем са „горещи точки“ за кибератаки, подчертавайки необходимостта от разработване на регионално адаптирани стратегии за киберсигурност. Наблюдаваните времеви вариации и сезонни модели изискват допълнителен анализ за оптимизиране на отбранителните стратегии, като се вземат предвид регионални и икономически фактори, които могат да влияят на честотата и интензивността на атаките.

По-тесните интерквартилни интервали (IQR) за седмичните и месечните данни подчертават стабилността на кибератаките във времето, изисквайки внимателен мониторинг и анализ за идентифициране на потенциални аномалии или специфични събития, които могат да предизвикат извънредни атаки.

Научното изследване, включващо данни от honeypot системите, подчертава многостранния характер на кибератаките и подкрепя необходимостта от прецизен анализ и интерпретация на събраните данни. Това включва разработването на динамични и адаптивни подходи, които интегрират реално времеви данни и машинно обучение за справяне с постоянно променящата се природа на киберзаплахите, както и създаването на регионално адаптирани стратегии за сигурност, базирани на корелационни анализи.

Бъдещите изследвания трябва да се фокусират върху установяването на дългосрочни модели и разработването на прогностични модели, които могат да предвиждат изменения в тактиките на атакуващите и да предложат превантивни стратегии. Важно е също така да се включат социално-икономически и психологически фактори за пълното разбиране на мотивите зад кибератаките, което ще спомогне за разработването на комплексни образователни и правни стратегии за справяне с киберзаплахите. Такъв холистичен подход ще допринесе за задълбочено разбиране на киберпространството и ще спомогне за разработването на интегрирани решения за сигурност, като по този начин се повиши защитата срещу кибератаките във всички аспекти на обществото.

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USING ARTIFICIAL INTELLIGENCE TO ANALYZE AND CATEGORIZE CYBER ATTACKS THROUGH BEHAVIORAL PATTERN RECOGNITION

Abstract: *The article presents a detailed analysis of the current state of cybersecurity in Bulgaria, focusing on assessing the risk of cyberattacks that affect or are carried out on Bulgarian IP addresses. Various approaches and tools are studied for data collection and analysis, including real-time operational monitoring, the use of honeypot systems, and analysis through Jupyter Notebook and Python, which support the comprehensive analysis of information. The research is based on an approach that includes summarizing the metadata used in the analysis and the methods for detecting cyberattacks, highlighting the importance of geographic location, methods of attack, and their sequence over time. The analysis emphasizes the intensity and spread of cyberattacks in the country, as well as significant diversity and potential instability of these attacks. The main part of the analysis presents key statistical data regarding cyberattacks, showing the activity and breadth of cyber threats in the country, including descriptive analysis and cluster analysis of the attacks. Correlation analyses are examined to study the connection between cyberattacks and different geographic regions, as well as time analysis for detecting long-term trends. Using visualization tools such as 3D bar charts and line charts provides a detailed representation of the correlations and changes over time, while boxplot and KS test for fitting comparison are used to assess the distribution and normality of the data. The article provides an overall view of cybersecurity in Bulgaria, using various methods and tools for data collection and analysis, with the aim of identifying key trends and potential risks from cyberattacks. The conclusions underline the importance of continuous monitoring and analysis of cyberattacks to detect trends and respond quickly. It is important to develop goals and strategies for cyber defense, taking into account regional, economic, and technological factors that can affect cybersecurity. The article offers*

recommendations for future research, including establishing long-term models and developing forecasting models that can predict changes in attackers' tactics and offer effective preventative strategies.

Keywords: cybersecurity, cyber attacks, trends, correlational analysis, time series

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ИНФОРМАТИКА И КОМПЮТЪРНИ НАУКИ INFORMATICS AND COMPUTER SCIENCES

TECHNOLOGICAL MODEL OF THE FIRST BULGARIAN NOTIFIED PRIVATE SCHEME FOR ELECTRONIC IDENTIFICATION THROUGH A MOBILE DEVICE

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Abstract: *This paper presents a comprehensive examination of the first Bulgarian notified private scheme for electronic identification (eID) via mobile devices. It delves into the technological framework and operational mechanisms that align with the European Union's eIDAS regulation. The focus is on the innovative approach adopted by Bulgaria in establishing a private eID scheme, highlighting its compatibility with EU standards for cross-border electronic transactions. By analyzing the legal framework, technological infrastructure, and the notification process under eIDAS, this study showcases the scheme's significance in enhancing digital security and facilitating seamless digital services across the EU. The Evrotrust eID scheme, as a pioneering model, illustrates the practical application of advanced technologies in user registration and real-time electronic identification, ensuring high levels of security and user convenience. The findings contribute to understanding the dynamics of deploying private eID schemes within the EU's digital single market, emphasizing the role of national regulatory bodies and independent conformity assessment. This study underscores the potential of private eID schemes in driving digital transformation and fostering a secure digital environment.*

Keywords: *Electronic Identification, eIDAS Regulation, Mobile Devices, Digital Security, private scheme*

ELECTRONIC IDENTIFICATION AND NOTIFICATION OF EID MEANS

The identification of subjects is utmost important element for the functioning of society. It is necessary both for the provision of commercial services – banking, telecommunications, leasing, insurance, etc., and for the provision of administrative services by the state. It is also the basis for the functioning of the entire judicial system.

One of the key principles of the cornerstone regulatory act in the European Union and directly applicable to Bulgaria is Regulation (EU) No. 910/2014 of the European Parliament and of the Council of July 23, 2014 on electronic identification and trust services in electronic transactions on the Internal Market and on repealing Directive 1999/93/EC (eIDAS). This regulation establishes the principle of mutual recognition in Art. 7. This comes to say that if means for electronic identification are recognized as compatible with eIDAS standards in one EU Member State, they must be recognized as valid in all other Member States. eIDAS is interested in and regulates the use of electronic identification only for online access to public services. It does not regulate

electronic identification in the private sector. There, each private entity is free to choose any method it wishes for the electronic identification of its customers and counterparties. Also, eIDAS does not establish a single means of electronic identification of European citizens and organizations. Each Member State has the freedom to choose which technology and which model of electronic identification it will prefer (Sharif et al. 2022).

The process of officially “recognizing” a national scheme at EU level to be usable cross-border is called “notification”. Each country decides for itself which schemes to notify. eIDAS allows the notification of public and private electronic identification schemes (eIDAS Regulation, Preamble (13). Bulgaria, as a member state of the EU, has allowed pluralism in the choice of national schemes for electronic identification.

Pursuant to Decision 634/27.08.2021 of the Council of Ministers of the Republic of Bulgaria, providers of qualified authentication services who have entered an electronic identification service in the National trust list of authentication services as services at the national level may request from the Minister of e-Government to be notified the electronic identification schemes built by them, if they meet the requirements of Art. 7–9 of eIDAS.

The supervisor of the private eID scheme providers is the Communications Regulation Commission. It oversees providers of electronic identification services, as a type of trust service, in accordance with eIDAS and the Electronic Document and Electronic Trust Services Act. The CRC grants or revokes qualified status to the trust service providers and to the trust services they provide, in accordance with Art. 20 and 21 eIDAS. CRC is also responsible for establishing, maintaining and publishing the National List of Trust Services, pursuant to Art. 22, paragraph 3 of eIDAS (eIDAS, Art. 32, para. 4).

The assessment of whether the electronic identification scheme and means of electronic identification meet the requirements of eIDAS and whether the scheme is suitable for notification is based on the verification and certification by an independent conformity assessment body. Regarding the notification obligation, the Minister of e-Government is subordinate and reports to the Council of Ministers.

The Minister of e-Government has published a special Methodology for the verification of electronic identification schemes. Based on this Methodology, any eID scheme provider willing to have its scheme notified as national, must submit an application which is assessed by an interagency committee.

Providers of private electronic identification schemes in Bulgaria must meet a number of technical and organizational requirements, as well as comply with certain procedures. The same are described in the internal rules of the electronic identification service providers.

Among the requirements that must be met, those for the security of the systems, for the protection of personal data (Dimitrov & Zahariev 2022, 239–256) and for risk management should be noted. Providers of private electronic identification schemes must also ensure that their systems are compatible with the technological requirements of public bodies that provide electronic services (Alonso et al. 2020, 770).

After successfully passing through the internal national evaluation procedure, the state, through the Minister of e-Government, notifies the European Commission according to the procedure provided for in eIDAS.

Currently, only one Bulgarian provider of an electronic identification scheme has successfully passed an inspection by the European Commission for compliance of the scheme with the requirements of eIDAS and has successfully completed the notification procedure – “Eurotrust Technologies” AD. It is listed in the EU Trust List of the Pre-notified and Notified National eID schemes (European Commission, n.d.).

MECHANISM OF OPERATION OF THE BULGARIAN NOTIFIED PRIVATE SCHEME FOR ELECTRONIC IDENTIFICATION EVROTRUST EID

The electronic identification scheme Evrotrust eID is a complex system for electronic identification of individuals and legal entities, which includes users, relying parties, infrastructure, hardware and software components, connectivity to registries and other components, providing secure electronic data verification in real time for the needs of providing electronic services. It is based on the requirements of eIDAS.

The scheme consists of two main processes:

- remote user registration;
- issuing a means of electronic identification in real time to a user (electronic identification service) and providing the means of electronic identification to a relying party.

Remote user registration

For the remote registration of a user, an identification method is used, which is certified by an accredited conformity assessment body for compliance with the requirements of Art. 24, para. 1, “d” of eIDAS, as a method giving a degree of assurance at to a physical presence. The method is nationally recognized by the national regulatory body at the place of establishment of “Eurotrust Technologies” AD – the CRC, and it was given a qualified status by the Decision of CRC with Ex. No. 12-01-1758 of 29.12.2020 (European Commission, n.d.).

In order to initiate the remote registration process, the user needs to install the Evrotrust application on their mobile phone as a stand-alone application or integrated via an SDK module into a mobile application of a relying party. For the purposes of registration, it is necessary for the person to capture a photo of his identity document with the camera of his mobile phone. The data obtained from the machine-readable area of the identity document and the image of the document are processed automatically, including being checked for security elements by specialized software. The scheme is developed using technology that automatically recognizes the data from the identity document and checks it against a trusted source (for example: population register, identity document register, etc.) through an encrypted real-time connection. When the person is a legal entity, the attributes of the legal entity and its status, together with the representative power, are verified by the relevant national register of legal entities (in Bulgaria – Commercial Register and the Register of Non-Profit Legal Entities maintained by the Registration Agency). When no direct connectivity is established and the ID document is digital and has an embedded RFID ICAO chip and the mobile device supports NFC technology, the data is extracted from the ID document by bringing it closer to the mobile device.

After the data is retrieved and verified, an electronic identification process begins to verify that the person providing the ID document is identical to the person identified by the validated ID document. The process is automated and includes automatic video identification, which prompts the person to video-capture their face with the front-facing camera of the mobile device, while performing an automated analysis of the facial image with the acquired and verified biometric data from the face photo from the ID document. The result is generated by high-tech software that performs biometric analysis of the shape and unique features of the face with a high degree of matching, and the process also includes a 3D verification of the presence of a live person in front of the camera through a specially integrated technology (Lee et al. 2008). This allows to avoid using someone else's photo, video or computer generated avatar of another person.

To establish the identity of a natural person who is a representative of a legal entity (managers, board members, procurators, etc.), when the representative power derives from law, an automated check is made against the relevant registers in the presence of such integration (for example:

Commercial register, Register of non-profit legal entities, etc.).

In case of unsuccessful automatic video identification (for example, due to possible changes to the face or the photo was not received from a reliable source), the process switches to video identification by an operator of “Eurotrust Technologies” JSC through an established video connection between the user's mobile device and the operator. The real-time video session operator visually identifies the person based on the copy of the ID document and the extracted photo, asking the person control questions to establish permanent knowledge of certain personal data, as well as prompting the person to turn the camera to capture the document for identity verification of security and other elements (Dimitrov, 2023).

Any identification, whether automated or done by an operator, is subject to an immediate follow-up second check by a supervisor.

After successful identification of the person, a profile is created and he can be issued a means of electronic identification and provided with qualified trust services (Eurotrust, 2023).

Electronic identification service

The electronic identification service is a complex service for attesting the electronic identity of a user registered under item 1, which is provided in real time. It consists of the following steps:

Request for identification

The user accesses a system of a trusted party (e.g. a public service) for which there is a need for electronic identification. After submitting an identifier (e.g. national identity number, registered mobile number or registered e-mail), the system of the relying party submits a request for user identification to the backend system of “Eurotrust Technologies” JSC. The request states the amount of personal data required from the user for identification purposes for the specific public service. The request is automated, in machine-readable form, and can be submitted via an API for automated connectivity or through a purpose-built portal from which a relying party representative can initiate the request via a web interface. A national uniform identification code is also provided for the identification of a legal entity.

User verification and authentication

The request for electronic identification is received by “Eurotrust Technologies” JSC, and after verifying the fact that there is a registered user with a corresponding ID of the person, an immediate (“instant”) message is sent in the mobile application. The user opens the request and is informed that identification is requested, while is also advised on who has requested the identification, as well as the purposes of the identification (which service it is meant for), including the volume of personal data that is required for the identification. If identification of a legal entity is requested, information on the required data of the legal entity is also provided. If the user agrees to enable the electronic identification service, he confirms the identification by authenticating with knowledge (PIN code) or biometrics (face, thumbprint, etc.) (Zahariev, 2018) accessible through the smart device.

Issuing a means of electronic identification

Upon informed confirmation of the desire for identification and activation of the electronic identification service, a means of electronic identification is issued subject to compliance with the following rules:

A. In the presence of established connectivity with primary registers (national registers for identity documents, population databases, commercial registers, etc.) a check is carried out for the actuality and validity of the data at the time of identification;

B. Based on the validated data, an electronic document is generated for the user – a statement for the provision of personal data. This document is in both human-readable (PDF) and machine-readable (XML) format, in which the user makes a statement that this is their personal data required by the relying party and that it is up-to-date. For legal entities, a second document is generated in the same formats, in which a statement is made about the data of the legal entity and the relationship between the individual and the legal entity.

C. A key pair is generated at the request of the user remotely in a hardware cryptographic module (HSM), for an advanced or for a qualified electronic signature;

D. An attribute qualified or advanced certificate is issued for the public key, which contains those personal data that are required under the Implementing Regulation (EU) 2015/1501. Thus, it is possible to verify the identity between data declared and authenticated in the attributive certificate and confidence in the authenticity of the declared data. Upon identification of a legal entity, a statement is generated in which data about it is entered, and an attributive qualified or advanced certificate is issued;

E. The private key of the key pair is used to remotely sign the privacy statement in the relevant standard in the hardware cryptographic module, with the attributive certificate accompanying the signed document. For the legal entity, the document containing the data on the legal entity is also signed remotely. “Eurotrust Technologies” JSC is certified by an independent conformity assessment body under eIDAS for the service of remote signing with an advanced or qualified electronic signature, according to the requirements of the European standards;

F. A qualified electronic time stamp will be then issued for the statement of disclosure of personal data so signed, which shall also be attached to the statement. Such is generated and attached to the statement of provision of data for the legal entity;

G. The electronic identification means is generated consisting of the personal data disclosure statement in PDF/XML format, signed with an advanced or qualified electronic signature, accompanied by an attributive qualified or advanced certificate and a qualified electronic time stamp. It is sent to the relying party through an automated interface (API) or through a portal operated by a representative of the relying party. For the legal entity, the means of electronic identification for the legal entity is also added in a package (Dimitrov, 2023).

The mechanism of action of the electronic identification scheme is depicted in the following diagram:

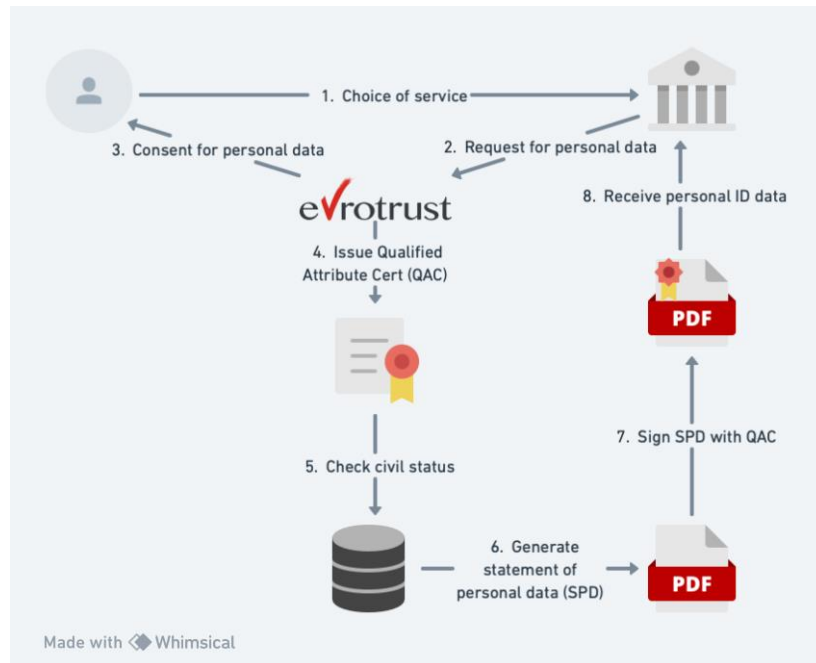


Fig. 1. Mechanism of the private notified electronic identification scheme Evrotrust eID

EVROTRUST EID ASSURANCE LEVELS

The electronic identification scheme of “Eurotrust Technologies” AD is built on a dynamic model for authentication of data that can be provided depending on the volume requested by the relying party.

The minimum set of data to be attested for a natural person are: surname (or names), first name (or names), date of birth, national unique identifier, if any, in accordance with the technical specifications for cross-border identification purposes, which will remain unchanged for as long as possible (for example, for Bulgarian citizens and foreigners residing in Bulgaria, the EGN, respectively LNC). The specified minimum data set is always verified with a significant or high level of confidence. Additional specific data that may be submitted are, for example: first name (or names) and surname (or names) at birth, place of birth, permanent address, gender, current address, as well as any other data that may be supplemented indefinitely and dynamically and be authenticated to the relying party (e.g. data related to owned identity document, professional identity, health status, medical status, educational status, geolocation, etc.).

For a legal entity, the minimum set of data to be authenticated is a name and a unique national identifier (in Bulgaria – EIC/BULSTAT). If necessary and upon request, additional and specific data can be certified, such as: VAT registration number, tax number, identification code according to Art. 3, par. 1 of Directive 2009/101/EC of the European Parliament and of the Council, the identification code of the legal entity (UEI) referred to in Commission Implementing Regulation (EU) No. 1247/2012; economic operator identification number (EORI number) specified in Commission Implementing Regulation (EU) No. 1352/2013; excise number provided for in Article 2, paragraph 12 of Council Regulation No. 389/2012, registered office, address of management, as well as any other data such as subject of activity, capital, representation, entry number in primary register, date of entry, management, method of representation, status (active, in liquidation, in bankruptcy), etc. (Dimitrov, 2023).

The additional specific data for both individuals and legal entities can be of different levels of assurance - high, substantial and low, depending on whether they have been checked by Eurotrust Technologies JSC against an authoritative source, they have been checked to a limited extent or are self-declared. The degree of security of any data can be entered into the means of electronic identification.

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ТЕХНОЛОГИЧЕН МОДЕЛ НА ПЪРВАТА БЪЛГАРСКА ЧАСТНА СХЕМА ЗА ЕЛЕКТРОННА ИДЕНТИФИКАЦИЯ ЧРЕЗ МОБИЛНО УСТРОЙСТВО

Резюме: Настоящата статия представя цялостно изследване на първата частна схема, нотифицирана за електронна идентификация (EID) чрез мобилни устройства. Статията задълбочава в технологичната рамка и оперативните механизми, които се привеждат в съответствие с регулацията на EIDAS на Европейския съюз. Фокусът е върху иновативния подход, възприет от България при създаването на частна схема на EID, като подчертава съвместимостта му със стандартите на ЕС за трансгранични електронни транзакции. Анализирайки правната рамка, технологичната инфраструктура и процеса на уведомяване по EIDAS, това проучване показва значението на схемата за повишаване на цифровата сигурност и улесняване на безпроблемните цифрови услуги в ЕС. Схемата на Eurotrust EID, като новаторски модел, илюстрира практическото приложение на модерни технологии в регистрацията на потребителите и електронната идентификация в реално време, като

гарантира високи нива на сигурност и удобство на потребителя. Констатациите допринасят за разбирането на динамиката на разгръщането на частни схеми на EID в рамките на дигиталния пазар на ЕС, подчертавайки ролята на националните регулаторни органи и независимата оценка на съответствието. Това проучване подчертава потенциала на частните схеми на EID при стимулиране на цифровата трансформация и насърчаване на сигурна цифрова среда.

Ключови думи: електронна идентификация, Регламент EIDAS, мобилни устройства, цифрова сигурност, частна схема

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ИНФОРМАТИКА И КОМПЮТЪРНИ НАУКИ **INFORMATICS AND COMPUTER SCIENCES**

FDI AND GDP: COMPARATIVE ANALYSIS FOR CHINA, INDIA AND EUROPE

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Abstract: *This work aims to examine the connection between FDI (foreign direct investment) and the Gross Domestic Product (GDP) of Europe, China, and India. A linear regression model was chosen using China, India, and Europe as examples, using GDP as the dependent variable and FDI as the independent variable. The best results with this model were achieved for China, where the highest correlation of both factors was found at 0.9929813. For India, the correlation between FDI and GDP was slightly lower (0.9548797), while for Europe, GDP and FDI appear to be relatively uncorrelated (correlation of 0.2576872).*

Keywords: *FDI, GDP, CAI, Linear Regression*

INTRODUCTION

With the background of the Comprehensive Agreement on Investment (CAI), established between China and Europe at the end of 2020, the connection between FDI and GDP in comparison to China, India and Europe will be investigated.

Foreign Direct Investment (FDI) is regarded as a crucial provider of technology and expertise in developing nations. In contrast to portfolio investments and development aid, they are characterised by the transfer of production know-how and management skills. While portfolio investments are limited and do not provide the advanced technologies needed, FDI promotes growth through job creation, meeting investment needs and knowledge sharing. The presence of foreign companies forces local companies to invest in education, and competition motivates innovation. FDI's generate positive productivity effects for the host economy (Agrawal & Khan 2011, 72–73).

In this work, the connection between FDI and GDP of Europe, China and India will be investigated. First, we must figure out if there are fundamental differences between these countries regarding this. Later, some statistical investigations to find out if the influence of FDI on the GDP is significant will be explored.

PREVIOUS RESEARCH

Foreign Direct Investment (FDI)

Normally, when one thinks of FDI, one thinks of setting up a production facility in another country. However, FDI includes a significantly larger number of cross-border activities (Neuhaus 2006, 42). FDI is a cross-border investment made by the investor, who is resident in another country or economy, with the aim of establishing a permanent and strategic, long-term stake in a company in the other economy build relationship. This is the case if the direct investor receives at least 10%

of the voting rights in the target company of the investment (the so-called 10%-rule). Direct investments are contrasted with so-called portfolio investments, in which the goal is generally not to have any influence on the part of the investor (OECD 2009, 17). If this definition is taken as a basis, setting up a production facility in another economy is definitely a method of FDI, but so is buying into an investment that already exists in another economy (Neuhaus 2006, 42). The above mentioned 10% rule just mentioned can also be deviated from if it is possible to exert influence with less than a 10% share in the company. This also applies in the other direction, for example, in the United Kingdom prior to 1999, influence involvement was only equivalent to 20% (Jones & Wren, 2006, p. 8).

Gross Domestic Product (GDP)

The GDP is the standard measure for the value of all products and services that are produced in a country or a region within a certain time period. The term “gross” implies that no deductions have been made in the depreciation of machinery, buildings and other capital goods used in production. “Domestic” refers to production coming from the institutional units located in the country. This includes end products, services, fixed assets, and exports (less imports). The GDP can be measured in three different ways (OECD 2010, 16):

- As value added: this includes production minus intermediate consumption, plus taxes on products (such as value-added-tax, VAT), but minus subsidies on products.
- As income from production: this corresponds to the sum of compensation of employees, the gross operating surplus of companies and the state, the gross self-employment income of unincorporated companies and the net taxes on production and imports (such as VAT, payroll tax, import duties, etc., less subsidies).
- As expenditure on final goods and services: this includes consumption expenditure, gross capital formation and exports, less imports.

Although GDP is seen as the most important indicator of the economic strength or economic activities of a country or region, it is not a measure of the well-being or standard of living of a society (OECD 2010, 16). The GDP only reflects an overall value; it does not provide any information about how wealth is distributed in current society.

Comprehensive Agreement on Investment (CAI)

On December 30, 2020, the European Union (EU) and China completed the fundamental negotiations on the CAI. This agreement gives EU investors improved access to the Chinese market. Under this agreement, China has committed to ensuring fairer treatment for EU companies so that they can operate on a level playing field in China. These obligations extend to state-owned companies, including transparency of subsidies and rules against forced technology transfer (European Commission, n. d.).

Egger (2021) investigated the China-European union CAI. Before the agreement, Chinese investors in the EU had significantly more liberal market access compared to European investors in China. This led to one-sided regulation of foreign investment to varying degrees between the EU and China. Looking at the provisions of the agreement, it is clear that the new advantages granted to EU investors in China are proportionally greater than vice versa. In addition, the agreement contains a comprehensive list of sustainable development goals as well as non-investment goals (Egger 2021, 191–192). The main benefit of the agreement for China is to create a clearer legal framework for growing Chinese investment in Europe. This is particularly significant in the context of trade protectionism emanating from the United States (US). For example, a Chinese company under scrutiny for national security reasons can appeal to the arbitral tribunal to examine whether the host

government's actions and measures comply with the principle of good faith as set out in the CAI (Wang & Li 2021, 5–6).

Literature Review

Until 1991, the Indian economy was highly regulated by numerous bureaucratic rules. Domestic and foreign companies could develop their activities only after prior approval by the government. High import duties and hesitant approval of foreign investments were intended to protect domestic industry (Matter 2000).

Sengupta and Puri (2018) examined the relationship between FDI and GDP in India and its neighboring countries Pakistan, Nepal, Bangladesh and Sri Lanka. It was discovered that a relationship between FDI and GDP existed in all the cases. FDI is instrumental in improving the economic situation as the countries under study grow. It was determined that the target country is most likely to benefit from FDI if it has a high level of technological progress, a high savings rate and an open trading system. India has had a steady GDP growth since 2000, with only a small dip in the GDP growth curve between 2008 and 2009. In addition, the FDI growth in India has been increasing since the liberalisation of the country (Sengupta & Puri 2018, 476–477). FDI acts as a source of financing and increases the competitiveness of the domestic economy. However, their importance varies from country to country. In India, the results of FDI are extremely positive as the country has repeatedly been considered an attractive destination for foreign investors on a global scale (Sengupta & Puri 2018, 484). In the research of Agrawal and Khan (2011), it was discovered that a 1% increase in FDI in China leads to an increase in GDP by 0.07% in China and in India by 0.02%. The impact of FDI on growth was stronger in China than in India, reflecting on the preference of most foreign investors for China. This is due to China's larger market, easier access to the export market, government incentives, developed infrastructure, cost efficiency and a positive macroeconomic climate. In contrast, India scores with a talented management system, rule of law, transparent labor system, cultural affinity and a favorable regulatory environment (Agrawal & Khan 2011, 76).

Regarding Europe, in 2021, the main players in EU foreign investment flows were the United States, the United Kingdom and Singapore. FDI can be subject to significant fluctuations related to global economic events, industry-specific developments or the individual situation of companies considering investing abroad. These fluctuations can also be due to periods of uncertainty among investors. Eurostat (2023) has examined fluctuations since 2013. There was a significant volatility between 2013 and 2016. The situation changed in 2017, when the value of EU FDI fell for the second year in a row, both in outflows and inflows. 2018 saw its third annual decline as flows turned negative. In 2019, EU FDI flows returned to positive, albeit comparatively low levels. In 2020, the direction of changes in flow values diverged for the first time in the period under consideration. Inflows increased again, although less sharply than in the previous year, while outflows decreased. In 2021, both flows fell again, with inflows falling more sharply and becoming negative, while outflows fell more moderately and remained positive (Eurostat 2023).

RESEARCH METHODOLOGY

Data

The United Nations Conference on Trade and Development (UNCTAD) offers its statistics in the freely accessible UNCTADstat database. These statistical data series are regularly updated and categorised according to various topics. Through the navigation browser, users can view tabular or graphical representations, easily select and reorganise data and use personalised functions. Several simple extraction options are also available (UNCTAD, n. d.). The data is downloaded from UNCTAD as a complete database for FDI and GDP that includes all countries. For China, the data

for the special administrative regions of Hong Kong and Macao as well as the province of Taiwan are also provided. However, only the data for China as a whole is covered. The data for each country will be extracted in R. Data from 1990 to 2022 will be used. Before 1990, Europe was separated, and therefore, it is expected that the data of 1989 and before are less consistent.

First, there has to be distinguished between inward and outward flows resp. inward and outward stocks. Inward flows and stocks describe the investments that are made by foreign investors in resident enterprises of the target country, while outward flows and stocks describe the investments made by the investors and enterprises in the target country countries (OECD, n.d. a; b). Regarding this, the inward flows and stocks are relevant for this investigation. More information about the collection methodologies can be found in UNCTAD (2009, 77).

Furthermore, a distinction must be made between flows and stocks. Flows describe the investments during a certain time, e.g., a year, while stocks describe the complete investments that are made until this particular time (OECD, n.d. a; b). In this regard, flows have to be observed for the investigation.

In Fig. 1 the FDI for China, India, and Europe since 1989 is shown. While FDI in China and India rose steadily, apart from a slight dip in 2009, FDI in Europe fluctuated greatly at times which coincide with the recent investigations mentioned above. In 2002, FDI in Europe even fell below zero. This can be interpreted as foreign investors withdrawing money from a country in total.

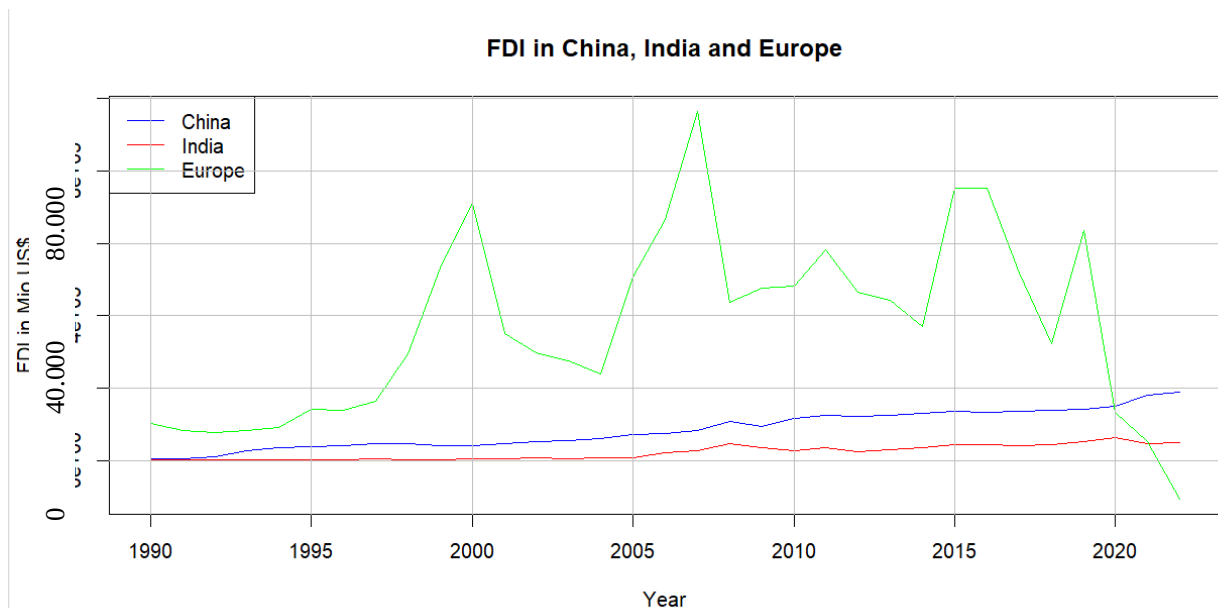


Fig. 1. FDI in China, India, and Europe. Source: own figure

Different measures are also available for GDP, first in prices and in prices per capita. The prices per capita takes the different populations of the target countries into account. But since it has to investigate the connection of the FDI that is given for the countries, the normal price should be considered, which is not normalised on the population. Furthermore, one can choose between the current price at the time of the country or constant prices, normalised to the prices of 2015. It was decided to consider the current prices, since the FDI is also given in current prices.

Fig. 2 shows the GDP in China, India, and Europe since 1990. India's GDP shows a constant increase, while China's GDP has risen faster than India's after 2010. Europe's GDP has seen greater fluctuations, rising from around 1 Mio. US\$ up to 2 Mio. US\$ after 2000, although it seems to have stabilised around this level.

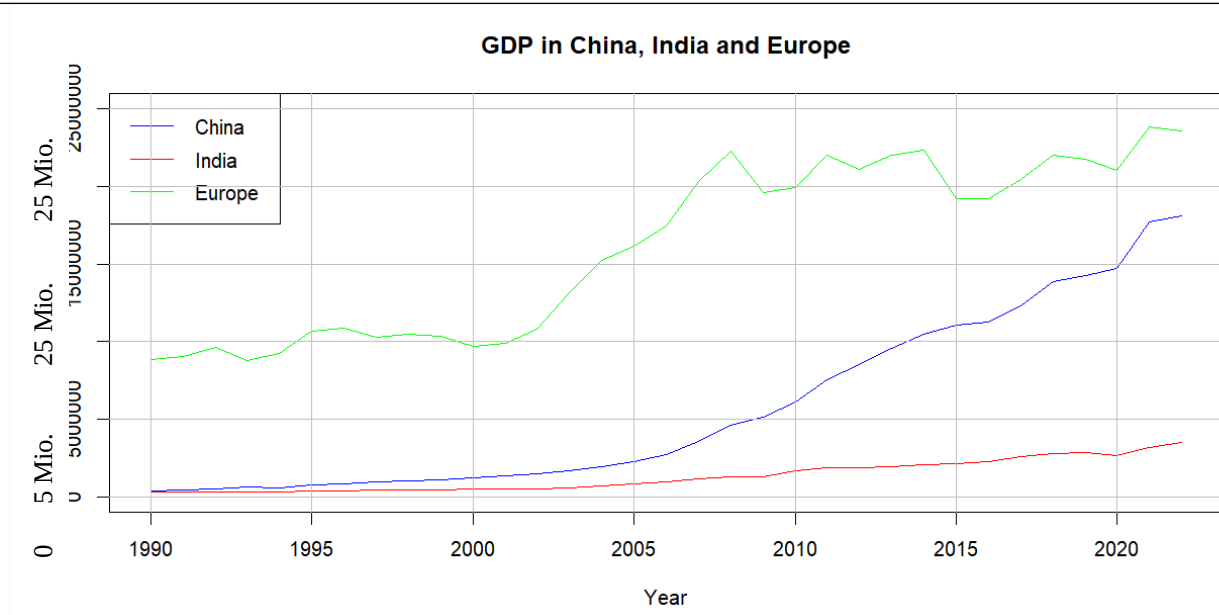


Fig. 2. GDP in China. India and Europe. Source: own figure

Correlation between FDI and GDP

In order to analyse the correlation between FDI and GDP, the Pearson correlation and the Spearman correlation were utilised. The Pearson correlation is the standard correlation and it measures the linear relationship between two continuous variables and it assumes that the data is normally distributed. The data should be checked for normal distribution using the Shapiro-Wilk test. The results are shown in Table 1. For the critical P value, 0.05 was set. It can be seen that many of the p-values determined are above this, so it cannot be concluded that the data is distributed normally. Therefore, the correlation should be determined using the Spearman correlation.

Table 2 shows the Spearman correlation coefficients for FDI and GDP for China, India, and Europe. FDI and GDP show a very high correlation for China and India, while these indicators only have a very low correlation for Europe. This appears logical, since the FDI in Europe fluctuated while the GDP increased continuously (see Fig. 1 and Fig. 2).

Table 1. Results of Shapiro-Wilk normality test of the FDI and GDP of China, India, and Europe

Results of Shapiro-Wilk test, p-value	FDI	GDP
China	0.07496	0.0001763
India	0.0006229	0.00101
Europe	0.4589	0.0002777

Table 2. Results of Spearman Correlation between the FDI and GDP of China, India, and Europe

	Spearman Correlation FDI-GDP
China	0.9929813
India	0.9548797
Europe	0.2576872

Linear regression between FDI and GDP

In this work, the connection between FDI and GDP for the three countries will be examined using a linear regression model, modelled in the statistics software R.

First, it should be checked whether the connection between FDI and GDP can be represented using a linear approach. For this purpose, a scatter diagram or a point cloud should be created from the data pairs from FDI and GDP of the three countries. If the point cloud resembles an inclined ellipse, the connection can be modelled using a linear function (Frost 2017, 3). Fig. 3 shows the scatterplots with the revision levels for FDI and GDP for China, India, and Europe. It can be seen that the relationship between FDI and GDP for China and India can still be easily represented with a straight-line regression, but this is not the case for Europe. This is consistent with the results of the Spearman correlation between FDI and GDP (see Table 2).

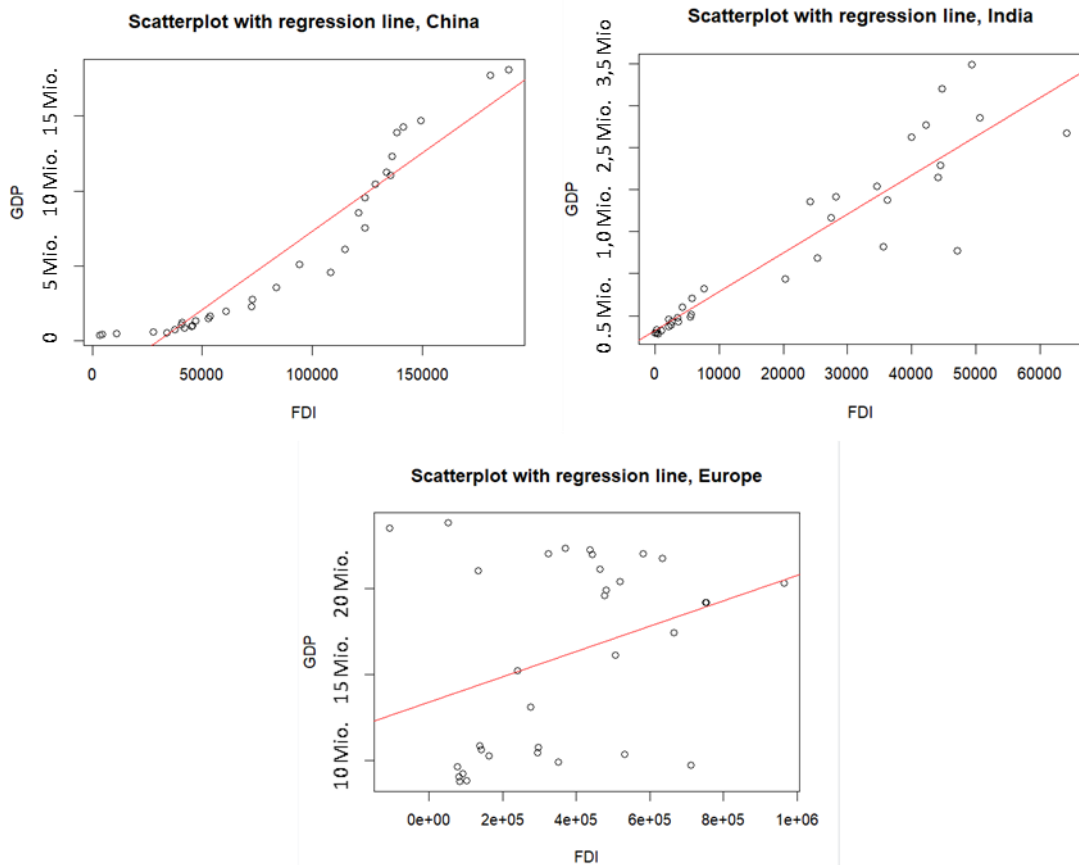


Fig. 3. Scatterplots of FDI and GDP with regression lines for China, India, and Europe.
Source: own figure

The general form of a linear regression equation is shown in equation (1):

$$Y = \beta_0 + \beta_1 \cdot X + \epsilon \quad (1)$$

with

X : The independent variable, in this case the FDI.

Y : The dependent variable, in this case the GDP.

β_0 : The Y-intercept that indicates the expected value of Y when $X = 0$

ϵ : The error term that represents the deviation between the actual and estimated values of Y .
 $\beta_0 + \beta_1 \cdot X$ represents the regression line (see Fig. 3)

For a better understanding, the ϵ in ϵ_{β_0} and ϵ_{β_1} will be broken down to represent the errors of β_0 and β_1 . See equation (2):

$$GDP = \beta_0 + \beta_0 \cdot FDI + \epsilon_{\beta_0} + \epsilon_{\beta_1} \quad (2)$$

RESULTS

Table 3 shows the determined values for the equation (2), calculated in R for China, India, and Europe. The t-value of β_0 and β_1 is the coefficient by the standard error: $t(\beta_0) = \beta_0/\epsilon_{\beta_0}$ and $t(\beta_1) = \beta_1/\epsilon_{\beta_1}$. High values of $t(\beta_0)$ and $t(\beta_1)$ were looked for. This may suggest that the standard error ϵ is small, compared to the determined coefficient β (Thime 2021). Regarding this, it is visible that the t-value for Europe is much smaller than the t-values for China and India. This indicates that the relationship between FDI and GDP can be modelled better as a linear regression for China and India than for Europe.

Table 3. Determined values for equation (2) for China, India, and Europe, additionally the t-values

	β_0	β_1	ϵ_{β_0}	ϵ_{β_1}	$t(\beta_0)$	$t(\beta_1)$
China	- 3.137 E+06	104.6 00	5.993E +05	6.0 67	- 5.2 34	17.2 41
India	3.237 E+05	46.23 0	1.020E +05	3.5 15	3.1 73	13.1 54
Europe	1.342 E+07	7.378	1.635E +06	3.7 06	8.2 05	1.99 1

Table 4 shows the determined p-values of the t-statistics. The p-value provides clues about the significance of the coefficient for the model. Typically, a p-value of less than 0.05 is considered significant. This suggests that the coefficient has additional utility to the model by helping to explain variation in the model's dependent variable (Thime 2021). It can be seen from Table 4 that the significance is given for both coefficients in the case of China and India, whereas the coefficient β_0 as in the case of India is less significant. In the case of Europe, the coefficient of β_0 is significant, while the coefficient of β_1 is not significant. This is another hint that the linear regression does not explain the connection between FDI and GDP for Europe. The multiple and adjusted R-squared shows the same. The multiple and adjusted R-squared gives the percentage of the variation of dependent variable (the GDP) which is explained by the variation of the independent variable (the

FDI) (Thime 2021). For Europe these values are only 0.113 and 0.085 and 11.3 % and 0.85%, respectively, while the values for China and India are above 84%.

Table 4. The determined p-values of the t-statistic, the multiple and adjusted R-squared

	$\Pr(> t(\beta_0))$	$\Pr(> t(\beta_1))$	Multiple R-squared	Adjusted R-squared
China	1.100E-05	2.000E-16	0.906	0.903
India	0.0034	3.180E-14	0.848	0.843
Europe	2.880E-09	0.0554	0.113	0.085

CONCLUSION

Results

A linear regression model was chosen to analyse the correlation between FDI and GDP using China, India, and Europe as examples, using GDP as the dependent variable and FDI as the independent variable. It is best to implement this model using China as an example, which showed the highest correlation of both factors with 0.9929813. For India, the correlation between FDI and GDP was slightly lower (0.9548797) while GDP and FDI seem to be relatively uncorrelated for Europe (correlation coefficient of 0.2576872).

This result is confirmed by the t-values of the linear regression equation. The t-value for Europe is much smaller than the t-values for China and India. This means that the standard errors of the coefficients are relatively high in comparison to the coefficients themselves in the case of Europe. It was also not possible to prove the significance of the coefficients in the case of Europe.

Limitations and further work

Countries produce their GDP estimates in their own currencies. In order to make these estimates internationally comparable, they must be converted into a common currency. This is often done using current exchange rates. However, this can lead to a misleading comparison as they do not reflect the actual quantities of final goods and services in GDP. A more accurate approach is to use purchasing power parities (PPPs). PPPs are currency converters that take into account the price differences between countries (OECD 2010, 16).

Furthermore, the restriction must be made that only the connection between two individual factors was calculated. Especially in the case of Europe, the GDP seems to depend heavily on several other factors, which requires further investigation. For example, Agrawal & Khan's (2011) model for GDP was examined with human capital, labour force, FDI and gross capital formation as independent variables (p. 76). By consideration of other factors, the GDP of Europe could be better described.

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ПЧИ И БВП: СРАВНИТЕЛЕН АНАЛИЗ ЗА КИТАЙ, ИНДИЯ И ЕВРОПА

Резюме: Преките чуждестранни инвестиции (ПЧИ) се считат за основен източник на технологии и ноу-хау в развиващите се страни (Agrawal & Khan 2011, 72). Тази статия има за цел да проучи връзката между ПЧИ и брутния вътрешен продукт (БВП) на Европа, Китай и Индия. За да се анализира връзката между ПЧИ и БВП, е избран линеен регресионен модел с Китай, Индия и Европа като примери, използвайки БВП като зависима променлива и ПЧИ като независима променлива. Най-добри резултати с този модел са постигнати за Китай, където е установена най-висока корелация на двата фактора при 0,9929813. За Индия корелацията между ПЧИ и БВП е малко по-ниска (0,9548797), докато за Европа БВП и ПЧИ изглеждат относително некорелирани (корелация от 0,2576872). Този резултат се потвърждава от *t*-стойностите на уравнението на линейната регресия. *T*-стойността за Европа е много по-малка от *t*-стойностите за Китай и Индия, което означава, че стандартните грешки на коефициентите са относително високи в сравнение със самите коефициенти в случая на Европа.

Ключови думи: ПЧИ, БВП, ЦСИ, линейна регресия

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ИНФОРМАТИКА И КОМПЮТЪРНИ НАУКИ **INFORMATICS AND COMPUTER SCIENCES**

LEGAL NATURE AND FEATURES OF THE TYPES OF ELECTRONIC SEALS

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Abstract: *This article examines the legal framework and practical applications of electronic seals as established by EU Regulation No. 910/2014, emphasizing their significance in ensuring the authenticity and integrity of electronic documents and transactions. By distinguishing electronic seals from electronic signatures and timestamps, the study delineates their unique features, including the classification into simple, advanced, and qualified types. The analysis further explores the role of electronic seals in enhancing cybersecurity within the digital environment. The findings highlight the pivotal function of electronic seals in digital transactions, underscoring their contribution to the reliability and security of electronic documents in the European digital single market.*

Keywords: *electronic seals, electronic signatures, cyber security, eIDAS, trust service*

1. NOTION OF ELECTRONIC SEALS

In the evolving digital landscape, the integrity and authenticity of electronic transactions have become paramount. The European Union, recognizing this need, established a comprehensive legal framework through EU Regulation No. 910/2014, also known as eIDAS, to govern electronic identification and trust services, including electronic seals. This article aims to dissect the legal nature of electronic seals, delineating their characteristics, classifications, and the role they play in securing digital documents and transactions. Unlike electronic signatures, electronic seals are specifically designed for use by legal entities, ensuring data integrity and origin authenticity with legal recognition across the EU. By examining the different types of electronic seals—simple, advanced, and qualified—the study sheds light on their practical applications and underscores their significance in enhancing cybersecurity measures. Through a detailed analysis of the regulation and its implications for the digital single market, this article contributes to a deeper understanding of electronic seals and their essential function in the digital age.

Regulation (EU) No. 910/2014, unlike Directive 1999/93/EC, introduces several new legal concepts related to electronic signatures. These concepts include electronic seals, electronic identification, electronic time stamp, website authentication, and electronic registered mail. These additions aim to enhance trust in cross-border electronic transactions in EU member states.

To better understand electronic seals, it is essential to consider them within the broader context of similar legal institutions outlined in Regulation (EU) No. 910/2014 and distinguish them based on their specific characteristics.

According to Article 3, item 25 of Regulation (EU) No. 910/2014, an electronic seal is defined as “data in electronic form, attached to or logically associated with other data in electronic form,

ensuring the origin and integrity of the latter” (Regulation (EU) No. 910/2014). The regulation does not explicitly define a “basic seal”, but it can be deduced from the general definition provided earlier.

Furthermore, Article 3, item 29 introduces the concept of a “certificate for an electronic seal”, which is an electronic attestation linking electronic seal validation data to a legal person and confirming their identity (Regulation (EU) No. 910/2014).

Another term defined in Article 3 of the regulation is the “advanced electronic seal”. An advanced electronic seal must meet specific requirements outlined in Article 36. According to Article 36 of the Regulation, the advanced electronic seal must meet the following conditions:

- (a) it is uniquely linked to the creator of the seal;
- (b) it is capable of identifying the creator of the seal;
- (c) it is created using electronic seal creation data that the creator of the seal can, with a high level of confidence under its control, use for electronic seal creation; and
- (d) it is linked to the data to which it relates in such a way that any subsequent change in the data is detectable (Regulation (EU) No. 910/2014).

Finally, the regulation defines a “qualified seal” in Article 3.27 as an advanced electronic seal created by a qualified electronic seal creation device, based on a qualified certificate for electronic seal.

The regulation defines two main functions specific to electronic seals. Art. 59 of the preamble of Regulation (EU) No. 910/2014 exclusively states that electronic seals should serve as proof that an electronic document was issued by a legal entity, guaranteeing the reliable origin and integrity of the document.

2. DIFFERENTIATION FROM SIMILAR REALMS

Electronic seals occupy a major place among other similar legal institutes from Regulation (EU) No. 910/2014. By their nature, electronic seals are closest to electronic signatures. In the Regulation, electronic seals provide the same legal possibilities as electronic signatures. For example, Regulation (EU) No. 910/2014 provides in Recital 58 that when a transaction requires a qualified electronic seal from a legal entity, the qualified electronic signature of the authorized representative of the legal entity should be accepted equally. Likewise, Art. 36, point 3 of the Regulation mandates that a qualified electronic seal based on a qualified certificate issued in one Member State is recognized as a qualified electronic seal in all other member states. Additionally, both trust services are admissible as evidence in legal proceedings.

In addition to the many similar legal requirements between the two institutes, electronic seals and electronic signatures share the same technology. In this regard, it should be noted, for example, that qualified electronic seals carry the technical characteristics of a qualified electronic signature (Schwalm 2015).

Despite the relatively widespread adoption of trust services in e-commerce, there is still a slight mistrust of e-seals over e-signatures due to the latter's wider distribution and longer history. An objective assessment requires comparing the two institutes and highlighting the advantages of electronic seals over electronic signatures.

“Electronic seals can be used to seal any type of digital data, not just standard documents. It can secure software codes or servers, satellite images, cadastral plans, in fact, any kind of data prone to misappropriation or modification” (LuxTrust). Yet as a practical application, electronic seals today are mainly used for so-called “code signing”. According to Recital 65 of Regulation (EU) No. 910/2014 “in addition to authenticating a document issued by a legal entity, electronic seals may be used to authenticate digital assets of a legal entity, such as software code or servers” (Regulation (EU) No. 910/2014). Code signing is the process of digitally signing executable files and scripts to verify the author of the software and ensure that the code has not been altered or corrupted after it

has been signed by using a cryptographic hash (Dumortier 2016).

As other additional examples of use in addition to those mentioned above can be such documents as tax and pension certificates or certificates and other certified documents that are issued and sent electronically (Dönnebrink 2021).

One of the most significant differences between electronic seals and electronic signatures is rooted in their functions. Electronic signatures are characterized by the functions of integrity, authenticity, confidentiality, and irrevocability (Dimitrov 2013), while electronic seals feature data integrity and authenticity features.

The first function of electronic seals is integrity or data integrity. Data integrity is maintaining and ensuring the accuracy and consistency of data throughout its lifecycle (Boritz 2005). It ensures the security of the data and guarantees its immutability over time after applying an electronic seal. By sealing documents with electronic seals through a content encryption process, the aim is to preserve the integrity of the data and ensure that it will not be altered at a later time. Furthermore, there is no certainty with electronic documents as to whether they have been altered (thus affecting their integrity) during their transmission path or while they are stored (Roßnagel 2013).

The second characteristic function explicitly stated in Regulation (EU) No. 910/2014 is authenticity. In fact, electronic seals were created in the current Regulation (EU) No. 910/2014 to replace the electronic signatures of legal entities used in the previous Directive 1999/93/EC. The purpose is to verify that a document really originates from a specific entity, thus ensuring its authenticity. For example, the fact of issuance (e.g., insurance certificate, permit) can be proven with an electronic seal. When it comes to electronic seals, this function ensures that the signed electronic document has not been tampered with after the electronic seal has been placed on it (Commission Staff Working Paper).

Ensuring the reliable authenticity of a particular document from a given legal entity is another distinctive function of e-sealing. This feature ensures that certain data originates from a specific legal entity or organization. After the electronic documents are stamped, the origin of the documents can be traced, i.e., from which legal entity they originate.

Another main distinguishing line between the electronic signature institute and the electronic seal institute is that the electronic signature refers to a natural person, and the electronic seal is used only for legal entities.

The protection in the use of this technology is based on the need to protect the information. The security of information is crucial to avoid its vulnerability, hence the importance of guaranteeing its availability (legal access to the information within the time limits established by its owner), its confidentiality (which excludes disposal of persons or unauthorized use), and its integrity (referring to its immutability) (De Miguel Asensi, PA 2002).

Electronic seals are very close to electronic signatures and share many common characteristics, but at the same time, have their own specifics, which makes them unique among other trust services.

Electronic seals also have similarities with electronic timestamps. Both institutes are data in electronic form that link other data in electronic form. However, with electronic timestamps, these are tied to a specific point in time and provide proof that the most recent data existed at that point in time, while with electronic seals, they are logically linked to data in electronic form to ensure its authenticity and integrity. Another similarity is that along with electronic signatures, electronic seals, and electronic timestamps are admissible as evidence in court proceedings. In addition, one of the requirements of a qualified electronic timestamp under Regulation (EU) No. 910/2014 is that it is signed with an advanced electronic signature or stamped with an advanced electronic seal of a qualified trust service provider or another equivalent method.

Electronic seals occupy their special place among other similar legal institutions of Regulation (EU) No. 910/2014, which distinguishes them from them, although they share common

characteristics with some of them. They have their specific role in commercial exchange, which is why their importance will grow more and more in the future.

3. TYPES OF ELECTRONIC SEALS

According to Regulation (EU) No. 910/2014, electronic seals are categorized into basic electronic seals, advanced electronic seals, and qualified electronic seals.

3.1. Basic electronic seals

Electronic seals, along with electronic signatures, are widely researched and used in two scientific fields – legal sciences and information technology (Menke 2009). The definition of a basic electronic seal is derived from the general legal definition of an electronic seal in Regulation (EU) No. 910/2014. It is described as “data in electronic form that is added to other data or logically linked to them to guarantee the origin and integrity of the latter.” Similar to electronic signatures, the holder of the electronic seal is required to use it for signing.

3.2. Advanced electronic seals

The definition of an advanced electronic seal, as stated earlier, aligns with the requirements defined in Article 36 of Regulation (EU) No. 910/2014. According to this article, an advanced electronic seal must meet the following conditions:

(a) Unique linkage to the creator of the seal. (b) Capability to identify the creator of the seal. (c) Creation using electronic seal creation data that is under the control of the creator. (d) Linkage to the associated data to ensure the detectability of any subsequent changes.

Unique connection to the creator of the seal is a fundamental requirement for an advanced electronic seal. The seal creator refers to the legal entity that creates the seal. It is crucial to ensure there is no confusion regarding the identity of the legal entity associated with the electronic seal. Authentication can be established through a PIN code or specific username and password. Another essential condition is the ability to identify the creator of the seal unequivocally. This identification provides legal certainty about the entity behind the advanced electronic seal. The third requirement is that the seal should be created using electronic seal creation data that is under the control of the seal creator. The regulation does not specify the technology for creating this data. Finally, the advanced electronic seal must be designed to detect any subsequent changes made to the associated data. Various encryption technologies, such as asymmetrical keys and certificates, are employed to ensure data integrity (Dimitrov 2014).

The advanced electronic seal and the advanced electronic signature share many similarities, but they are primarily used by different entities. The advanced electronic seal is used by the creator of the seal or the legal entity, while the advanced electronic signature is used by the holder of the signature, a natural person who creates the electronic signature. Both types provide a high level of control and traceability.

3.3. Qualified electronic seal

The qualified electronic seal is the highest level of judicial power and commonly used. In accordance with Article 3.27 of Regulation (EU) No. 910/2014, it is considered an advanced electronic seal and must meet two additional requirements:

1. Created by a device specifically designed for creating qualified electronic seals.
2. Based on a qualified electronic seal certificate.

According to Article 3.31, an “electronic seal creation device” refers to configured software or hardware used to create an electronic seal. Qualified electronic seals offer a higher level of protection against tampering or data falsification. The device does not necessarily need to be physically held

by the seal creator and can be controlled remotely by a qualified trust service provider using techniques like PIN codes.

Annex III of the Regulation defines the conditions that qualified electronic seal certificates should meet. These conditions include appropriate indications, an unambiguous representation of the qualified trust service provider, details about the creator of the seal, validation data, certificate validity period, identity code, and other relevant information.

CONCLUSION

eIDAS (Regulation (EU) No. 910/2014) establishes the principle of mutual cross-border recognition of electronic seals. Article 35.3 states that a qualified electronic seal, based on a qualified certificate issued in one-member state, should be recognized as a qualified electronic seal in all other member states. This provision ensures the seamless use of qualified electronic seals in cross-border transactions within the European Union, facilitating electronic trade.

Since the implementation of Regulation (EU) No. 910/2014, the use of electronic seals has increased, and their significance in cross-border electronic transactions within EU member states continues to expand. They play a vital role in ensuring cyber security and protecting data from external influences.

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ПРАВНА СЪЩНОСТ И ОСОБЕНОСТИ НА ВИДОВЕТЕ ЕЛЕКТРОННИ ПЕЧАТИ

Резюме: Тази статия разглежда правната рамка и практическите приложения на електронните печати, установени с Регламент на ЕС № 910/2014, като подчертава тяхното значение за гарантиране на автентичността и целостта на електронните документи и транзакции. Като разграничава електронните печати от електронните подписи и електронните времеви печати, изследването очертава техните уникални характеристики, включително класификацията на обикновени, усъвършенствани и квалифицирани печати. Анализът допълнително изследва ролята на електронните печати за подобряване на киберсигурността в цифровата среда. Констатациите подчертават основната функция на електронните печати в цифровите транзакции, като подчертават техния принос за надеждността и сигурността на електронните документи в европейския цифров единен пазар.

Ключови думи: електронни печати, електронни подписи, киберсигурност, eIDAS, удостоверителна услуга

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ИНФОРМАТИКА И КОМПЮТЪРНИ НАУКИ **INFORMATICS AND COMPUTER SCIENCES**

REGIME OF THE PRIVATE ELECTRONIC IDENTIFICATION SCHEMES IN BULGARIA

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Abstract: *This article investigates the regime of private Electronic Identification (eID) schemes in Bulgaria, set against the backdrop of EU regulations, particularly the eIDAS Regulation (EU) No 910/2014. It explores the legal framework, operational mechanisms, and coverage of private eID schemes, using Bulgaria as a case study within the EU's digital agenda. The analysis reveals Bulgaria's innovative approach to implementing private eID schemes that enhance digital security, user convenience, and comply with EU standards. By dissecting the legal regime governing these schemes, the article highlights the pivotal role of the Bulgarian Communications Regulation Commission in ensuring adherence to both national and EU regulations. The operational mechanisms illustrated through the Evrotrust system showcase advanced technologies in user registration, identity verification, and the integration of biometric analysis and video identification to mitigate identity fraud. Coverage across sectors demonstrates the schemes' adaptability and their impact on banking, e-government, healthcare, and beyond, enhancing the digital infrastructure and citizen engagement. This comprehensive examination aims to contribute to the understanding of private eID schemes' significance in the EU's digital transformation landscape, emphasizing the balance between innovation, legal compliance, and user accessibility.*

Keywords: *Electronic Identification, eIDAS Regulation, Bulgaria, Evrotrust, Legal Framework*

INTRODUCTION

In the rapidly evolving digital era, the significance of secure and reliable electronic identification (eID) systems has become paramount, particularly in the context of European Union (EU) member states. This article delves into the intricacies of private eID schemes in Bulgaria, a critical component in the broader landscape of electronic identification and authentication (Alonso et al., 2019). These private eID schemes, which operate under the overarching framework of EU regulations, offer unique insights into the fusion of technology, legal compliance, and user accessibility.

Bulgaria's approach to electronic identification presents a compelling case study within the EU's digital agenda. The country has adopted a pioneering stance in implementing private eID schemes that align with the eIDAS regulation – a cornerstone EU legislation that standardizes electronic identification and trust services for electronic transactions across EU member states. This article aims to dissect the legal framework governing these private eID schemes in Bulgaria, explore their operational mechanisms, and assess their coverage levels.

Through this exploration, the article seeks to illuminate the nuances of Bulgaria's eID schemes, underscoring their role in enhancing digital security and user convenience. By providing a

comprehensive analysis of these schemes, we aim to contribute to the broader understanding of eID systems' evolving landscape in the EU and the implications for digital governance and citizen engagement.

LEGAL REGIME OF PRIVATE EID SCHEMES IN BULGARIA

The legal regime governing private electronic identification (eID) schemes in Bulgaria is a complex interplay of national legislation and European Union (EU) regulations, particularly the eIDAS Regulation (EU) No 910/2014. This section delves into the nuances of this regime, exploring its foundations, operational oversight, and the intricate process of aligning national laws with EU standards.

At the heart of Bulgaria's legal framework for private eID schemes lies the eIDAS Regulation, an EU-wide directive established to standardize electronic identification and trust services for electronic transactions across the Union. This regulation is instrumental in creating a digital single market, fostering trust and security in electronic transactions.

Bulgaria, as an EU member state, has transposed the eIDAS Regulation into its national law, thereby committing to its principles and requirements. This transposition involved the enactment of specific laws and amendments to existing legislation, ensuring that national legal provisions align with the EU's overarching digital agenda. These national laws govern the operational aspects of private eID schemes, stipulating standards for security, interoperability, and user protection (Shehu, Pinto & Correia 2018).

The Bulgarian Communications Regulation Commission is the primary authority responsible for the oversight of private eID schemes. This body ensures that these schemes adhere to both national laws and EU regulations. Its role encompasses a wide range of responsibilities, from the initial assessment and approval of private eID schemes to ongoing monitoring and enforcement of compliance standards.

The Commission operates under a mandate to safeguard the public interest, focusing on the security and reliability of electronic identification services. It works in close collaboration with other national and EU authorities, exchanging information and best practices to enhance the overall efficacy of eID schemes.

A critical component of the legal regime is the notification and evaluation process for private eID schemes. This process is governed by a Methodology established by the Minister of e-Government, providing a structured approach to the assessment of these schemes.

The evaluation process begins with a detailed application by the eID service provider, outlining the technical specifications, security measures, and compliance mechanisms of the proposed scheme. This application is subjected to a rigorous review, examining aspects such as data protection protocols, authentication processes, and the scheme's ability to meet the high levels of assurance as required by the eIDAS Regulation.

Experts from various fields, including cybersecurity, digital governance, and legal compliance, are involved in this evaluation. Their analysis ensures that the eID scheme meets the stringent criteria set forth in both national and EU regulations (Park & Lee 2018).

As the digital landscape evolves, the legal regime governing private eID schemes in Bulgaria faces ongoing challenges. These include keeping pace with technological advancements, addressing emerging security threats, and ensuring interoperability with other EU member states' systems.

The Bulgarian government, in response, is committed to regular updates and revisions of its legal framework. This proactive approach aims to maintain the relevancy and effectiveness of private eID schemes, ensuring they continue to serve as a cornerstone in Bulgaria's digital infrastructure.

BULGARIAN NOTIFIED EID SCHEMES

In Bulgaria, the mechanism of action for private electronic identification (eID) schemes demonstrates a sophisticated blend of technology, security, and compliance, aligning with both national and European Union (EU) standards. This section explores the intricate processes and technologies employed in these schemes, using the Evrotrust system as a prime example.

The cornerstone of any eID scheme is the process of user registration and identity verification. In the case of Evrotrust, this process is designed to be both user-friendly and highly secure, utilizing cutting-edge technologies to verify user identities remotely. The initial step involves users submitting their personal identification documents through a secure online platform. This submission triggers a series of automated checks, where advanced algorithms analyze the documents for authenticity.

The Evrotrust system goes a step further by incorporating biometric analysis into its verification process. This involves using facial recognition technology to match the user's live image with the photograph on their identification document. This biometric verification ensures that the eID is uniquely and securely linked to the rightful owner, significantly reducing the risk of identity fraud (Páez et al. 2020).

Video identification is another innovative feature of the Evrotrust eID scheme. This process involves an automated live video interaction between the user and the system, during which trained personnel conduct additional verification checks. This interaction not only enhances the security of the identity verification process but also ensures compliance with Anti-Money Laundering (AML) and Know Your Customer (KYC) regulations.

The security protocols employed in this stage are multifaceted. They include real-time monitoring for signs of identity tampering or fraud, encryption of the video interaction, and secure storage of the recorded session for audit and compliance purposes.

Once the user's identity is verified, the Evrotrust system issues an eID in real-time. This eID enables users to access a range of digital services, sign documents electronically, and carry out secure online transactions. The eID is linked to a digital signature (Vasileva & Zahariev 2020), providing a legally binding method for users to sign documents and authenticate their identity in digital interactions (Dimitrov 2023).

The qualified electronic signature technology employed by Evrotrust adheres to the highest standards of security and is recognized across the EU, thanks to the compliance with the eIDAS regulation. This cross-border recognition is crucial for facilitating seamless digital transactions both within Bulgaria and throughout the EU.

A key aspect of the Evrotrust eID scheme is its integration capabilities. The system is designed to be interoperable with various digital platforms and services, ranging from government portals to private sector e-commerce sites. This integration is facilitated through well-documented APIs and secure authentication protocols, allowing for a smooth and secure user experience.

The Evrotrust scheme also supports multi-factor authentication processes, adding an additional layer of security for sensitive transactions. This feature is particularly important in sectors such as online banking (Dimitrov & Zahariev, 2022), e-government services, and healthcare, where data security and user privacy are paramount (Shrishak, Erkin & Schaar 2016).

The Evrotrust eID scheme is not static; it is continually evolving to adapt to new technological advancements and emerging security challenges. This adaptability ensures that the scheme remains effective and relevant in a rapidly changing digital landscape. Additionally, the Evrotrust team actively monitors trends in cybersecurity and eID technologies, ready to incorporate innovative solutions that enhance the system's security and user experience.

COVERAGE OF PRIVATE EID SCHEMES IN BULGARIA

The coverage levels of private electronic identification (eID) schemes in Bulgaria are a critical indicator of their effectiveness and reach. This section examines the extent to which these schemes have been integrated across various sectors, focusing on their adaptability, scalability, and the diversity of services they support.

Private eID schemes in Bulgaria, particularly the Evrotrust model, have achieved significant integration across multiple sectors. This wide-ranging application is crucial in a country striving to enhance its digital infrastructure. The Evrotrust eID scheme, for instance, is utilized in sectors as varied as banking, telecommunications, e-government services, healthcare, and real estate. This diverse applicability demonstrates the scheme's flexibility and its ability to meet specific sectoral needs.

In the banking sector, Evrotrust's eID scheme has streamlined online banking processes, enabling secure digital transactions and identity verification. Similarly, in healthcare, it has facilitated the secure access to and exchange of medical records, while in real estate, it has simplified the process of digital signing of property documents.

A significant area where private eID schemes have made an impact is in the provision of e-government services. The Bulgarian government has actively incorporated Evrotrust's eID technology to provide citizens with easier access to public services. This integration allows citizens to securely authenticate their identities online, access government portals, and complete administrative procedures digitally, significantly reducing the need for physical visits to government offices.

In the private sector, the Evrotrust eID scheme has revolutionized the way businesses and consumers interact. From online shopping to digital contract signing, the scheme has provided a secure and efficient way to authenticate identities and complete transactions. This has not only enhanced user convenience but also contributed to building trust in digital commerce.

The coverage level of the Evrotrust eID scheme is also notable in terms of its geographical and demographic reach. The scheme has been successful in making electronic identification accessible to a broad spectrum of the Bulgarian population, including remote and rural areas where digital services were previously limited. This inclusivity is vital for ensuring that the benefits of digital transformation are evenly distributed across the country.

An essential aspect of the Evrotrust eID scheme is its compliance with the eIDAS regulation, ensuring that it is recognized and accepted across the EU. This cross-border recognition is crucial for Bulgarians traveling or living abroad, as it enables them to access services and perform digital transactions within the EU seamlessly.

Looking ahead, the potential for further expansion and enhancement of private eID schemes in Bulgaria is vast. With the continuous evolution of digital technologies and the growing demand for secure digital services, these schemes are expected to extend their reach. Future developments could include integration with emerging technologies such as blockchain and AI, further enhancing security and efficiency.

CONCLUSION

The exploration of private electronic identification (eID) schemes in Bulgaria, particularly through the lens of the Evrotrust model, reveals a sophisticated landscape of digital identity management. These private eID schemes represent a significant stride towards enhancing digital security, efficiency, and user convenience within Bulgaria and in the broader context of the European Union (EU).

The legal and regulatory framework, as established by EU directives and Bulgarian national laws, provides a solid foundation for these eID schemes, ensuring compliance with the highest standards of security and interoperability. The operational mechanisms of these schemes, exemplified by the Evrotrust model, demonstrate innovative use of technology in facilitating secure and real-time electronic identification. The comprehensive coverage of these schemes across various sectors indicates their scalability and adaptability, making them instrumental in Bulgaria's ongoing digital transformation.

Furthermore, the success of these schemes in Bulgaria serves as an encouraging benchmark for other EU member states. It highlights the potential of private eID schemes in fostering a secure and seamless digital environment, essential for the growth of the digital economy and the enhancement of citizen-government interactions.

In conclusion, Bulgaria's implementation of private eID schemes, aligned with EU regulations, sets a precedent in digital identity management. It underscores the country's commitment to advancing its digital infrastructure and the pivotal role of private eID schemes in shaping the future of secure digital interactions.

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РЕЖИМ НА ЧАСТНИТЕ СХЕМИ ЗА ЕЛЕКТРОННА ИДЕНТИФИКАЦИЯ В БЪЛГАРИЯ

Резюме: Тази статия изследва режима на схемите за частна електронна идентификация (EID) в България, определени на фона на разпоредбите на ЕС, по-специално Регламент на EIDAS (ЕС) № 910/2014. Изследва се правната рамка, оперативните механизми и обхвата на частните схеми на ИД, използвайки България като пример в рамките на дигиталната програма на ЕС. Анализът разкрива иновативния подход на България към прилагането на частни схеми на EID, които подобряват цифровата сигурност, удобството на потребителите и съответстват на стандартите на ЕС. Чрез разглеждане на правния режим, регулиращ тези схеми, статията подчертава основната роля на Комисията за регулиране на съобщенията в България за осигуряване както на националните, така и на ЕС разпоредбите. Оперативните механизми, илюстрирани чрез системата EVROTRUST,

показват разширени технологии в регистрацията на потребителите, проверка на идентичността и интегриране на биометричния анализ и идентификацията на видео за смекчаване на измамите с идентичност. Покритието в секторите демонстрира адаптивността на схемите и тяхното въздействие върху банковото дело, електронното правителство, здравеопазването и извън него, подобрявайки цифровата инфраструктура и ангажираността на гражданите. Този цялостен анализ има за цел да допринесе за разбирането на значението на частните схеми на EID в пейзажа на дигиталната трансформация на ЕС, като подчертава баланса между иновациите, законодателството и достъпността на потребителите.

Ключови думи: електронна идентификация, Регламент EIDAS, България, Evrotrust, Правна рамка

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ИНФОРМАТИКА И КОМПЮТЪРНИ НАУКИ **INFORMATICS AND COMPUTER SCIENCES**

IMPLEMENTING INTEGRATED SYSTEM NETWORKS WITH 5G TECHNOLOGY IN THE GERMAN CAR INDUSTRY

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Abstract: *German car manufacturers' digitization initiatives encompass projects that aim to build integrated system networks supported by 5G technology. Here, the results of scientific research are presented in which IIoT ("Industrial Internet of Things") projects have been analyzed with regard to their suitability for 5G implementation, respectively the efficiency of the new technology within an integrated system network. The researched IIoT projects originate from a so-called press shop which is the part of the manufacturing plant in which automotive sheet metal components are formed in a metal press. On the basis of the insights drawn from the IIoT project analysis, it is shown that the implementation of a 5G-supported system network can transmit, bundle, and visualize huge data volumes, can moreover make the production process more efficient, and finally can improve collaboration and quality. A special focus is on the organization of information, which will improve significantly, since 5G allows real-time communication.*

Keywords: *digitization, automation, network building, management of information, 5G technology*

INTRODUCTION

For many decades, the German automotive industry has been a key industry branch contributing considerably to the country's wealth. For example:

- 4% of all jobs are associated with automotive manufacturing (Statistisches Bundesamt 2019);
- around 506 billion € in revenues were generated in the car industry in 2022 (Statista 2023);
- and around 70% of the value creation from German automotive suppliers occurs in the country itself (Bundesministerium für Wirtschaft und Klimaschutz 2023).

While these figures underline the importance of the industry branch for the BIP, the question whether this performance has always been achieved with the latest technological equipment is absolutely justified. At least at the beginning of the new millennium, the German car industry was still underdeveloped in regard to the degree of automation in their facilities. "Manual work still plays a major role in three quarters of the researched companies, and production is either based on it or strongly depends from it in a hybrid system. Less than a quarter of the researched productions are fully or highly automated" (Spath 2013).

Regarding the current status of digitization and automation in production, Volkswagen at Wolfsburg is a good example. "To date, Volkswagen's press shop is still a conventional production area. Large coils of sheet metal are shaped into vehicle parts, it is noisy, every stroke is noticeable" (Volkswagen AG 2022, 45). Nevertheless, digitization and network infrastructures more and more play a part. Andreas Ellermeier, head of Volkswagen's press tool construction department, says: "Processes such as trim and coining steel manufacturing now are increasingly being automated [...]"

Press tool construction which is the central pillar of classic vehicle production finds its way from a traditionally manual environment into the digital world [...] Now we are about to march towards digital and autonomous press tool production” (Volkswagen AG 2022, 44). So it is easy to see that “[...] the world of real hardware and that of virtual production is bridged by the digitized process chain” (Volkswagen AG 2022, 44).

These hybrid models are in use in other Volkswagen facilities as well. For instance, their “[...] Condition Monitoring Team [...] safeguards access to data and provides technical expertise. Together they are installing a network solution, in order to productively implement machine learning models. They prefer a hybrid system in which machine learning models nearly run in real time on shop floor level, generating forecasts. Additionally, we create connectivity with our digital production platform, in order to perform post-trainings for aged machine learning systems” (Volkswagen AG 2022, 45).

The Volkswagen examples prove that car makers have understood, since all of them have meanwhile taken measures to digitize or automate production. In this context, the author of this article was able to scientifically accompany a variety of IIoT projects (cf. *Table 1*), originating from the press shop of a renowned car manufacturer headquartered in Southern Germany. The goal of the research was to evaluate these projects in regard to their 5G upgrade potential and to the expected efficiency of 5G technology within an integrated system network.

RESEARCH METHODOLOGY

A press shop is that part of the plant where sheet metal is inserted into a press where the material is shaped into components that eventually form the cars’ bodies. The facility provides the ideal setting for this kind of research as it not only represents an “automotive mini-cosmos” in which all aspects of digitization can be studied in a nutshell, but is also one of those areas, where manufacturing is still characterized by principles of traditional craftsmanship so that the introduction of new technologies allowing data collecting and state-of-the-art digital data evaluation is considered to be revolutionary. Qualitative analysis was used to explain the circumstances of the case and to describe what is needed for developing an efficient integrated system network, while quantitative methods were used to evaluate statistics, perform calculations, and prepare scoring models on the basis of self-developed mathematical formulas. With the help of these scoring models, a total of nineteen IIoT projects were ranked according to their feasibility and to the expected efficiency of 5G technology within an integrated system network.

RESULTS

A VARIETY OF PROJECTS: The researched IIoT projects ranged from “Automatic maintenance order” to “Consistent online data use” or “Enterprise resource planning on digital terminal devices” to more technical applications such as “Inline crack detection”. The generation of data, that for instance are collected by newly installed sensors, their evaluation and visualization, and finally the impact of the transformed processes on the company’s information management were the main aspects of the research. The potential of implementing 5G technology in IIoT projects is huge, since the latest generation telecommunication standard is extremely fast and can transmit immense data volumes in real time. So when 5G potential was measured with the help of scoring models, it was no surprise that particularly “Big Data” and “Network” related projects made it to the top (cf. *Table 1*). In detail, these were the parameters that characterized 5G opportunities:

- the higher the frequency of data, the more the system will benefit from the implementation of 5G technology which in turn will significantly accelerate the information flow;
- the more data sources, the higher the data complexity and the greater the need to process the data with 5G that is low in failure rates and latency;

- the greater the need to evaluate the data in real time – for example, in order to be able to prevent or to quickly react to machine failure – the more the implementation of 5G in IIoT concepts will make sense.

THE IMPORTANCE OF NETWORK BUILDING: In the context of network building, the insight that “Big Data” and “Network” related projects are best suited for 5G upgrading and promise the optimum of 5G efficiency speaks for itself. So in order to fully benefit from the implementation of 5G technology and moreover to achieve the desired synergy effects, it is necessary to bundle the technological efforts in a comprehensive system network that eventually will guarantee a significant optimization of the information management. Because by harmonizing the individual information sources, by consolidating the extracted information and by providing information in a convenient, preferably visualized form, an integrated system network will allow managers, operators, or workers to react immediately after receipt of the respective information, which brings the organization of information to the next level and improves decision quality.

Table 1. Nineteen IIoT projects were scored according to their feasibility and to the expected efficiency of 5G technology within an integrated system network. (Own graphic)

Strategy	Project Name	Overall project feasibility	Expected 5G efficiency
360° network	ERP on digital terminal device	138	138
Big Data	Unidor monitoring	108	138
Big Data	Material parameters measurement	108	138
Big Data	Online quality data	138	123
Big Data	Drawing process management	108	108
Digital process chain	Remote Maintenance	92	108
Smart supply chain	RFID tags for block storage	77	108
360° network	Automatic maintenance order	92	108
360° network	Consistent online data use	138	108
Big Data	Digital control of milling machines	108	92
Big Data	Condition monitoring	108	92
Smart supply chain	Component traceability	92	92
Big Data	Steinbichler working packages	123	77
360° network	Paperless factory	62	77
Agile production systems	Light guide system	62	77
Big Data	Inspection by notch sensor	77	62
Agile production systems	Sarissa QualityAssist	62	62
Big Data	Inline crack detection	77	62
Agile production systems	3D printing in tool manufacturing	62	62

NETWORK BUILDING IN A PRESS SHOP: If equipped with sensors and upgraded with 5G, a sheet metal press is a very good and reliable source of valuable data. The respective management of information is exemplarily shown in *Figure 1* for one machine, but it is also easy to imagine how this unit can be expanded to an entire press line, all the more, since the implementation of 5G technology is scalable (cf. *Figure 2*). All the data generated at every process step are collected in a data pool located in “The Cloud” which is in a position to store huge data volumes so that external control of the press is possible. With the help of data mining, the structurally extremely diverse data are processed, evaluated and partly sent back to the production facility in order to take over controlling functions. It begins with the delivery of the coils when the material parameters and the supplier’s production data are recorded and counterchecked by the data mining system. During the insertion of the sheet metal, a camera examines the roughness of the material and the oil film thickness, while the mechanic material characteristics such as tensile strength are measured by the so-called bulge tester. All the gathered data go to the data pool where the information is compared with standard values so that the machine automatically adapts to the input variables. From time to time, the data mining system might issue a message such as “The oil film is below tolerance level in a certain area.” Now, a signal is sent to press control with the order that a certain area has to be re-lubricated before this section of the sheet metal can be transformed to an automotive component. From inline production, temperature values, information about power consumption or the current number of strokes can be passed on to the data pool. When so-called thin film sensors are attached to the cutting shears they can report if the tool is still sharp enough. This is an example of how condition monitoring combined with sensor technology and 5G provides operators with a perfect overview of the facility’s condition and the state of its tools, a benefit which helps to reduce or even avoid machine stoppage.

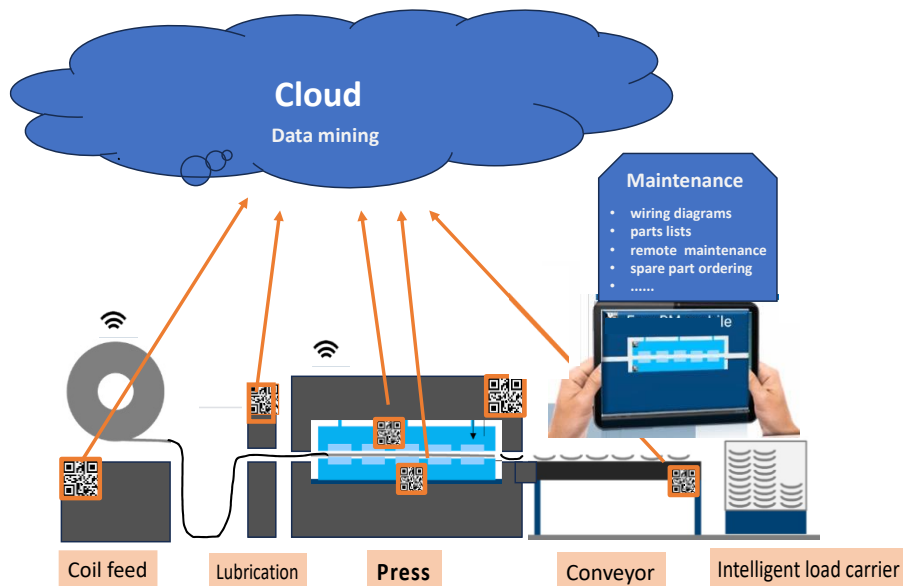


Fig. 1. Schematic illustration of a sensor-equipped sheet metal press delivering information to the data pool in “The Cloud”. With the help of 5G, information can not only be retrieved in real time, but can also be conveniently visualized on digital terminal devices. (Own graphic)

TOWARDS TOTAL CONNECTIVITY:

The importance of network building in the automotive industry was emphasized by Jürgen Prokop, CEO of Trumpf, a leading German manufacturer of machine tools offering “[...] machines for bending, punching, combined punch and laser processing, and also laser cutting and welding applications. Diverse automation solutions and a range of software for digitally connected production solutions round off the portfolio” (Wikipedia, n.d.). Prokop said: “For sheet metal manufacturers, connecting production processes and machines in a network will be the decisive competitive edge” (Mücke 2020).

German car manufacturer Mercedes-Benz seems to have acted on it, since they have turned many of the above-mentioned concepts into reality in their “Factory 56”, a digitized manufacturing unit which comes close to the idea of a smart factory. Particularly in regard to 5G implementation, they are proud of their achievements: “The use of state-of-the-art 5G network technology allows Mercedes-Benz Cars, among other things, to optimize existing production processes [...] with the help of new features. These include, for example, the data linking or product tracking on the assembly line. With a separate own network, all processes can be optimized and made more robust, and if necessary, adapted at short notice to prevailing market requirements. Furthermore, the mobile communications standard links production systems and machines together in an intelligent manner, thereby supporting the efficiency and precision of the production process” (Daimler Communications 2019).

However, under the motto “360-degree networking – from the supplier to the customer”, the automotive company makes clear that their vision of connectivity goes beyond the conventional IIoT concept: “[...] networking not only happens inside the factory. A significant feature of ‘Factory 56’ is the all-round networking across the entire value-added chain – from development and design to suppliers, production and customers. [...] For [...] production, 360-degree networking means quick and transparent communication across all units. Digital tools are used for development and production: for example, production processes are visualized and optimized by ‘Virtual Reality’ (VR) before a real production hall comes into existence [...] and] workstations and processes can be virtually tested and designed ergonomically” (Mercedes-Benz Group AG, 2023).

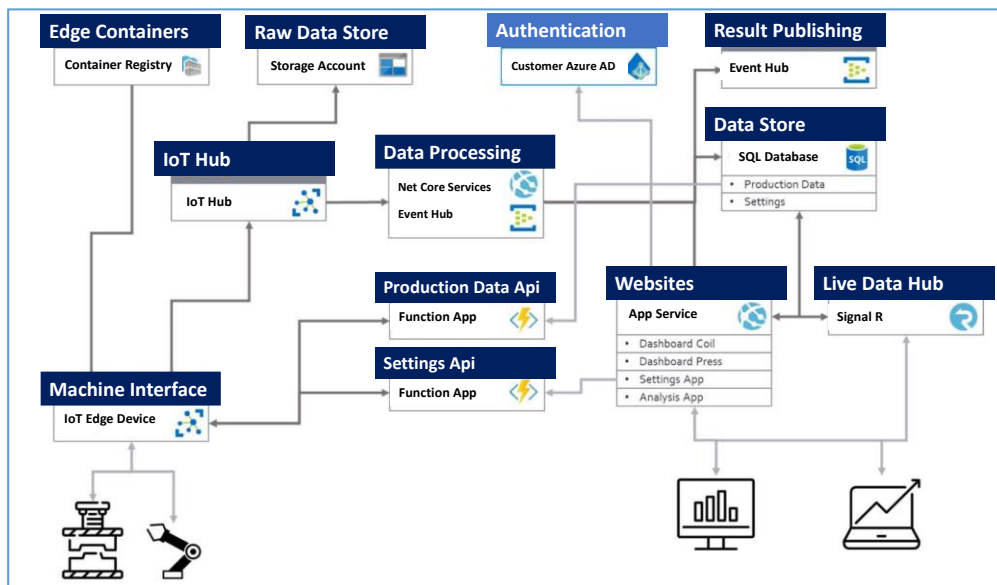


Fig. 2. Example of an integrated system network with extended functions, implemented in an automotive press shop. (Source: evopro systems engineering AG 2023)

SUCCESS MONITORING:

For the time after the implementation of an integrated system network, it is recommended that key performance indicators are defined. They serve as measurement parameters for the assessment of efficiency, productivity and capacity of the network. These criteria could be helpful:

- Throughput rate: the number of products that can be manufactured in the press shop per time;
- Downtime: the time during which the network is not available due to disturbances or technical problems;
- Production quality: the quality of manufactured products, as measured according to the defect rates or quality standards;
- Response time: the time needed to react to requests or orders that turn up in the network
- Network latency: the time lag that occurs when data are transmitted in the network;
- Data transmission speed: the velocity with which data can be transmitted in the network.

CONCLUSION

It became obvious that the implementation of an integrated system network supported by 5G technology is suited to facilitate a more efficient and less cost-intensive production. At the same time, information management will benefit, since the system allows instant data availability and real-time evaluation and communication. All of these achievements will entail better collaboration, optimized production processes, improved quality and more efficient utilization of resources. Eventually, the automotive company might thus become more competitive and innovative. When planned carefully, an integrated system network is easily scalable and allows many other applications and enhancements (cf. *Figure 2*) than those that were hitherto described.

In an integrated system network, the majority of data are generated by components of the facility itself (cf. *Figure 1*), i.e. they are recorded by sensors etc. that feed the information into the cloud-based data pool. However, it could be helpful if data from external sources were added such as statistics or survey results, in order to supplement the company-own information with relevant subjective outside assessments or third-party experience. Finally, the evaluation of the collected data shall result in the measurement of the achieved improvements and their impact on efficiency and productivity which – if the evaluation is positive, an outcome which is to be expected after all what has been said here – will be another proof of the integrated system network's benefits.

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ВНЕДРЯВАНЕ НА ИНТЕГРИРАНИ СИСТЕМНИ МРЕЖИ С 5G ТЕХНОЛОГИЯ В ГЕРМАНСКАТА АВТОМОБИЛНА ИНДУСТРИЯ

Резюме: Инициативите за цифровизация на германските производители на автомобили обхващат проекти, които имат за цел да изградят интегрирани системни мрежи, поддържани от технологията 5G. Тук са представени резултатите от научно изследване, в което са анализирани проектите за IIoT („Индустриален интернет на нещата“) по отношение на тяхната пригодност за внедряване на 5G, респективно ефективността на новата технология в рамките на интегрирана системна мрежа. Изследваните IIoT проекти произхождат от т.нар. пресов цех, който е част от производственото предприятие, в което се формират автомобилни листови метални компоненти в метална преса. Въз основа на прозренията, извлечени от анализа на IIoT проектите, е показано, че внедряването на поддържана от 5G системна мрежа може да предава, обединява и визуализира огромни обеми от данни, освен това може да направи производствения процес по-ефективен и накрая да подобри сътрудничеството и качеството. Специално внимание е отделено на организацията на информацията, която ще се подобри значително, тъй като 5G позволява комуникация в реално време.

Ключови думи: Дигитализация, автоматизация, изграждане на мрежи, управление на информацията, 5G технология

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ИНФОРМАТИКА И КОМПЮТЪРНИ НАУКИ **INFORMATICS AND COMPUTER SCIENCES**

THE IMPORTANCE OF PROJECT MANAGEMENT IN THE DIGITALIZATION OF THE PUBLIC SECTOR

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University of Library Studies and Information Technologies

Abstract: *This publication highlights the importance of project management in the digitalisation of the public sector in Germany. Due to the complexity of the many challenges associated with digitalisation and digital transformation, it is important to select the appropriate project management method. Due to the different frameworks and requirements in the projects, a precise selection of the project management method is required. It must be determined which project management method is suitable for the successful implementation of the projects. Particularly in complex projects with demanding requirements for public sector digitisation, framework conditions, stakeholders and milestones can change at short notice. It is therefore extremely important to be able to adapt to these complex conditions. Especially in public sector digitisation projects, there can be frequent phases of change. As a result, traditional project management methods are being replaced by modern approaches. This study examines the importance of project management in the implementation of digitalisation strategies, using helpful methods.*

Keywords: *Digitization, Digital transformation, Project management, Processes*

INTRODUCTION

The change brought about by megatrends such as digitalization and digital transformation can be felt in various areas of life. Since the coronavirus pandemic at the latest, it has become clear that the level of development in German administration and authorities is diminishing. In addition to a large number of technologies developed in the short term, such as the Corona-Warn-App or CovPass-App, some weaknesses have emerged. This means that structures in the German administrative landscape, such as health authorities, are too rigid. Added to this is the use of outdated information and communication technology such as fax machines.

In principle, administrative procedures and processes are still largely carried out in paper form. As a result, the federal government and its subordinate authorities will have used around 740 million DIN A-4 sheets and 13 million DIN A-3 sheets in 2022 (Deutscher Bundestag 2024). Taking into account the rollout of the electronic file (e-file) in the administrative landscape, the figures do not match the target set by the Online Access Act (OZG). The Online Access Act (OZG) stipulated that around 575 administrative services were to be digitized by the end of 2022. These targets were not achieved for various reasons. In addition to technical challenges such as interoperability or structural challenges within the administration, there are other hurdles to administrative digitization. In the coming years, a large number of projects for administrative digitization and digital transformation can be expected.

Due to the complexity of administrative digitization projects in Germany, project management is a suitable method for implementing complex issues. The aim is to efficiently and successfully implement strategies and complex issues in administrative digitization through the use of project management methods.

RESEARCH METHODOLOGY

This publication is based on a literature review, which was used as a research method. Existing data and sources from specialist books, journals, studies and online articles were used. The result of the investigation is an analysis of the current situation.

RESULTS

There is no concrete definition for the term “digitization”. In the narrow sense of the word, digitization refers to the conversion of analog values and data into digital formats.

This involves converting analog values and data into a discrete system with a minimal proportion of value states. To convert analog data into digital images, it is necessary to use technical systems that can represent digital rather than analog states using cheaper components. As a rule, the process of converting analog data into digital data involves images, documents, or films.

In this context, analog products are displayed or transferred digitally (Streicher 2020, 2). This process can also be applied to workflows that are carried out in paper form in analog form. In this step, formats such as documents are displayed digitally and made available electronically (Streicher 2020, 2). In addition to the conversion from analog to digital formats, digital transformation must also be considered in the course of digitalization. Although there are parallels between digital transformation and digitization, as it involves the consideration of content and digital transformation, among other things, there are other features to consider (Streicher 2020, 2).

Digital transformation looks at the current situation. This affects existing business models, applications, technology, structures, processes, and organizational forms. When looking at the current situation, an analysis is also carried out to determine whether existing structures, processes, or forms of organization meet current requirements or whether they are obsolete and can be replaced by new technologies. The digital transformation of the public sector should lead to the interaction between citizens and the administrative areas being designed in such a way that future procedures can be carried out electronically, consistently, and without media discontinuity (Streicher 2020, 2).

This requires a high level of organizational and technical resources from all stakeholders (Streicher 2020, 3). For this reason, it is important to implement comprehensive project management when implementing digitalization strategies in the public sector:

Project management

“Project management is a long-established discipline in organizations across all industries” (Schönert 2022).

The purpose of projects is to achieve specific and concretely defined goals. In order to achieve the project objective, a timetable and a framework of financial and human resources must first be specifically defined (Streicher 2020, 229).

In this context, it is important that these framework conditions are planned early and comprehensively, as otherwise there is a high risk that the specified project objective will not be achieved (Streicher, 2020, 229). According to the Federal Government's guidelines, the term “project management” refers to a one-off project with which the administration responds to special requirements by developing new or better services for citizens, new concepts for more effective task

performance, internal changes to increase efficiency and improve quality (Federal Ministry of the Interior 2013, 7). The Federal Government's practical guide defines the topic of “project management” with specific characteristics. According to this, it is necessary for projects to be carried out as projects if they are one-off and not a permanent or recurring task (Federal Ministry of the Interior 2013, 8).

A further characteristic is the factual and temporal limitation. An assignment, start and end date must be defined. Furthermore, there must be complexity and novelty, so that only partial recourse can be made to existing process patterns (Federal Ministry of the Interior 2013 8).

The fourth characteristic is cross-hierarchical responsibilities, which require intensive cooperation for the project (Federal Ministry of the Interior 2013 8). Project management includes the entirety of management tasks, management organization, management techniques and resources as the basis for the initiation, definition, planning, control and completion of projects. The primary objectives of project management are:

- Ensuring that the project is worthy in terms of definition and implementation;
- Effective organization of cooperation in complex projects;
- Increasing the focus on results and problem-solving skills;
- Increasing personal responsibility and employee identification (Federal Ministry of the Interior 2013, 9).

Examples of such projects at the federal level in Germany include the introduction of company accounts or the introduction of the central learning platform for e-government (eGov Campus) (Krause 2023, 271). In principle, public sector projects differ significantly from those in the private sector.

In the case of public sector projects, for example, budget principles and federal and state budget regulations form the basis for economic efficiency (Krause 2023, 271).

In practice, the framework conditions are created by determining and defining the requirements and objectives, budgets and timetable, personnel requirements and risks. This phase is very extensive, as it involves weeks of planning and communication with stakeholders, there is often no scope for subsequent changes and adjustments (Streicher 2020, 229). This leads to hurdles for projects for administrative digitization and digital transformation (Streicher 2020, 229). In order to plan and successfully implement a project, a suitable project management method is required:

Classic, agile and hybrid project management methods

“The foundation of any successful digital transformation is therefore the choice of a suitable project management method” (Streicher, 2020, 229).

Most organizations and institutions in the public sector have clear guidelines for handling projects. These guidelines can vary from rough descriptions to detailed collections of documents, project management regulations and comprehensive templates (Streicher 2020, 230).

These specifications and guidelines result from the time before technological change and only include classic project management methods (Streicher 2020, 230). Classic or traditional project management is based on a monolithic and holistic approach. The basic idea is that a defined end state is described at the start of a project (Ebel 2024). Traditional project management is based on a standardized process model that provides for a sequence of project phases with a linear progression. The classic project management method is particularly suitable for project plans with high legal and regulatory requirements or a high need for transparency and control (Ebel 2024). The requirements

arising from administrative digitalization and digital transformation are very specific, as they are continuous development processes.

It is also important to develop a certain amount of creativity, as administrative digitalization entails complex requirements. As a result, the requirements can change over the course of the project.

In the course of the digitalization and transformation of the public sector in Germany, it is of great importance to decide on a suitable project management method. Examples of classic project management methods include the waterfall model, V-model and PRINCE2 (Ebel 2024). Study results show that the V-model for the implementation of IT projects has been replaced by PRINCE2 as the classic project management method with a 32% share in use (AIOS, BearingPoint, Cassini, CGI, GBTEC, pwc 2019). The studies also show that agile and hybrid project management methods are becoming increasingly prevalent in digitalization projects in the public sector.

As a result, agile methods are used 26% of the time and hybrid methods 17% of the time (AIOS, BearingPoint, Cassini, CGI, GBTEC, pwc 2019).

This trend results from the fact that agile methods such as Scrum offer far greater flexibility than traditional project management methods (AIOS, BearingPoint, Cassini, CGI, GBTEC, pwc 2019). Agile project management methods are based on the Agile Manifesto of 2001, which serves as the basis for agile values, techniques, principles and methods are based (Ebel 2024).

The purpose of agile project management is to overcome the disadvantages of traditional project management. This is the case when requirements have to be formulated in concrete and comprehensible terms from the outset (Ebel 2024). Agile methods can be used flexibly in the event of short-term changes during the course of the project. Not all tasks and work steps are planned in full, but an iterative approach is taken with the most important stakeholders with the aim of using a version of the results.

The purpose of agile project management is to overcome the disadvantages of traditional project management. This is the case when requirements have to be formulated in concrete and comprehensible terms from the outset (Ebel 2024). Agile methods can be used flexibly in the event of short-term changes during the course of the project. Not all tasks and work steps are planned in full, but an iterative approach is taken with the most important stakeholders with the aim of using a version of the results. In this context, short planning and implementation phases and a reprioritization of the open task are advantageous (Ebel, 2024).

Modern project management methods are fundamentally based on the approach that all key stakeholders are involved (Krause 2023, 231). The central component of the approach is the optimization of customer benefit. This means that the technical and organizational areas of the stakeholders in the public sector must be fully taken into account. This is necessary for the integration of new processes so that they can run accordingly (Krause 2023, 231).

Agile project management reviews existing structures, processes and role allocations and replaces them with modern principles. The difference to the traditional method is that instead of comprehensive planning, an iteration is carried out (Krause 2023, 231). The term “iteration” refers to the subdivision of the stages of a project over time with the aim of defining a result.

This has the advantage that subsequent adjustments are possible, as these were not taken into account at the start of a project. In addition, agile project management methods are particularly suitable in a volatile environment (Ebel 2024). A key advantage of the agile approach is that the integration of stakeholders results in comprehensive networking, regardless of departmental affiliations and hierarchies (Streicher 2020, 232). Other features of the agile approach include the independent completion of work assignments through flexible role allocation (Streicher, 2020, 233). In the agile approach, work orders are completed without a project manager. The prerequisite for this is that project employees have an agile minimum. The successful application of the agile approach requires a comprehensive organizational culture with appropriate thinking, action,

flexibility and openness (Ebel 2024). When using the agile method, it is therefore important to note that the introduction of new techniques and processes also changes the working relationships of employees.

The agile method should therefore increase awareness through regular feedback loops (Streicher 2020, 233). Another feature of the agile approach is transparency about barriers and risks. In this context, it quickly becomes clear which factors can jeopardize the project (Streicher 2020, 233).

The use of an agile method eliminates the need for complex plans and key figures. The project is controlled and managed via regular feedback loops and the comparison of interim results (Streicher 2020, 233). However, this also has disadvantages, as the management level can no longer monitor the project on the basis of key figures, but must obtain the relevant interim results from other sources of information.

In addition to traditional and agile project management methods, there is also a hybrid approach. Hybrid management is a combination of classic and agile project management methods. This has the effect that the advantages of both methods can be combined and disadvantages can be compensated for more easily. In practice, the combination of both methods can be realized in such a way that the overall project framework is planned and managed in the classic way, but the sub-projects are carried out iteratively (Streicher 2020, 234).

Hybrid project management is created by combining the structural and procedural organization of the classic approach with the roles of the agile method. This approach to administrative digitization makes sense when it comes to larger projects and unknown requirements and risks.

The advantage here is that sub-projects and the associated subtasks can be carried out depending on their requirements (Streicher 2020, 235).

The hybrid approach can generally be used for agile conception and specification and classic implementation (Ebel 2024).

Furthermore, the hybrid method can also be combined with classic conception and management and agile implementation. Another option is to use individual agile elements in traditional project management (Ebel 2024). PRINCE2 Agile can be cited as an example of a hybrid project management method.

The choice of a suitable project management method depends on various factors.

Provided there is transparency and predictability regarding requirements, resources and timescales, the project result can be achieved using traditional methods.

Agile methods are more suitable for project plans with frequent changes to the requirements for the project result, a high degree of innovation and a complex project object (Ebel 2024).

The hybrid method is particularly suitable for larger projects with complex framework conditions, such as the digital transformation of the public sector in Germany (Streicher 2020, 235). This is also confirmed by figures from an evaluation of 10,000 projects, which were rated 20% higher in terms of success rate than traditional projects (Crapa 2024).

The success rate is particularly noticeable the larger the project is. The reasons for this success rate are that agile methods focus on user requirements, shorten the time to market and minimize risk through continuous feedback loops (Crapa 2024).

CONCLUSION

The public sector in Germany is being strongly influenced by change and the rapid increase in technological innovations. This trend is increasingly being driven by technological innovations such as artificial intelligence, chatbots, big data and the Internet of Things.

In the course of change, public authorities in Germany have come under the spotlight due to the digital transformation. In addition to formative influencing factors due to the coronavirus pandemic or legal regulations such as the Online Access Act, public authorities in Germany are under pressure

to digitize their services. Administrative services should be more efficient, flexible and accessible to citizens regardless of time and place. Administrative services must adapt to the needs of citizens.

In many areas of public authorities in Germany, services are still outdated and no longer up to date. Instead of making services available to citizens at any time and from any location, they are only available during certain opening hours. In addition, services can only be claimed if citizens appear in person at the authority. Another reason for administrative modernization is that there are still too many paper processes.

The introduction of electronic files (e-files) was an important step towards reducing bureaucracy. Nevertheless, the processes and administrative procedures in public administration institutions in Germany are largely outdated. In order to change this situation and improve the level of digitization. To achieve this level of digitization, a consistent digitization strategy is required.

In order to develop these digitalization strategies and implement the resulting projects in a results-oriented manner, many public authorities in Germany commission external consulting firms.

The reason for this is that external consulting companies have a high level of technical expertise in the development of strategies and implementation of corresponding digitalization projects. In practice, digitalization strategies are implemented via projects.

Due to the different challenges and framework conditions in the individual projects, it is very important that the right choice of project management method is made. Due to the variety of project management methods, it is important to analyze the framework conditions of the projects.

This is particularly necessary for projects involving digital transformation in the public sector. If a project is influenced by permanent and short-term changes and complex communication with all stakeholders is necessary, agile and hybrid methods are particularly suitable.

The advantage of these two methods is that they can be adapted quickly and flexibly to difficult and changing conditions. This view is also evident in many projects in the implementation of digitalization projects in the public sector in Germany. The trend is increasingly moving towards agile and hybrid project management methods, as these are much easier and more flexible to adapt to complex projects. In the future, traditional methods will be replaced by agile and hybrid methods.

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ЗНАЧИМОСТТА НА УПРАВЛЕНИЕТО НА ПРОЕКТИ В ЦИФРОВИЗАЦИЯТА В ПУБЛИЧНИЯ СЕКТОР

Резюме: В тази публикация се подчертава значението на управлението на проекти за цифровизацията на публичния сектор в Германия. Поради сложността на многобройните предизвикателства, свързани с цифровизацията и цифровата трансформация, е важно да се избере подходящ метод за управление на проекти. Поради различните рамки и изисквания в проектите е необходим прецизен избор на метод за управление на проекти. Трябва да се определи кой метод за управление на проекти е подходящ за успешното изпълнение на проектите. Особено при сложните проекти с високи изисквания за цифровизация на публичния сектор рамковите условия, заинтересованите страни и етапите могат да се променят в кратки срокове. Ето защо е изключително важна адаптацията към тези сложни условия. Особено в проектите за цифровизация на публичния сектор може да има чести фази на промяна. В резултат на това традиционните методи за управление на проекти се заменят със съвременни подходи. В настоящото изследване се разглежда значението на управлението на проекти при изпълнението на стратегии за цифровизация, като се използват полезни методи.

Ключови думи: цифровизация, цифрова трансформация, управление на проекти, процеси

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CAI REACHED BETWEEN THE EU AND CHINA IN 2020

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Abstract: *The study is about to compare the CAI between the EU and China in 2020 with its predecessor, the EU-China 1985 Bilateral BIT, and the Germany-China 2005 BIT in order to assess the effects of the CAI on FDIs and economic reciprocity. To fulfil this purpose, a comparative analysis of the three mentioned treaties is performed using the BMWK protection standards as comparison criteria. The new research aspect of this methodological proceeding is its assessment of the 2020 CAI on the basis of a comparison with prior treaties to evaluate the scope and meaning of the achieved agreement. The results of the comparative analysis elucidate that the 2020 CAI ameliorates marginally the framework for investments and market access between EU and China. Nonetheless, it is insufficient for facilitating FDIs of EU companies in China. China agreed to make relevant concessions in terms of environmental and labour standards, however, these do not compensate the persisting structural imbalance regarding market access between both parties.*

Keywords: *CAI, foreign investment, China, EU, bilateral treaty agreement*

1. INTRODUCTION

1.1. Background and Regulatory Framework for Direct Foreign Investments (FDIs)

To contextualise the findings of the comparative analysis performed later in this paper, it is paramount to first illuminate the background as well as the economic and legal framework of FDIs. From an economic perspective, it can be stated that FDIs are substantiated on three economic concepts:

- Michael E. Porter's competitive strategies;
- Ronald H. Coase's transaction costs theory;
- Kenneth Arrow's impossibility theorem.

Especially, Porter's (Porter 1985) research on the field of corporate governance is a relevant economic tenet for FDIs. According to Porter's theory, companies gain advantage over rivals when they master the competitive forces, he termed as the "Five Forces Model" (Mietzner 2009, 81). Identifying these five forces permits a given company to gather a detailed overview over relevant competitors and market players (Mietzner 2009, 81). The five forces determine industry attractiveness, as the rivalry among market players generates a competitive force, i.e., a competitive intensity. The efforts of individual actors aiming to improve their own competitive position (market share) occurs at the expense of its competitors (Bode 2009, 59 f).

Coase's transaction costs theory thematises the transfer of disposal rights over goods and services (Hornych 2012, 36). The transfer of disposal rights permits cooperating companies to benefit from specialisation advantages. In fact, cooperative ventures give rise to long-term

relationships that strengthen trust and thus reduce transaction costs (Hornych 2012, 37). Nevertheless, these cooperation agreements merely last until the market offers more favourable conditions (Hornych 2012, 37).

Arrow's impossibility theorem illuminates how decisions are adopted in markets environments (Arrow 1951; Kern/Nida-Rümelin 1994, 27). The impossibility theorem developed by Arrow is a social-choice paradox in the field of welfare economics and collective decision theory. It explicates the impossibility of yielding an ideal decision-making structure (Kern/Nida-Rümelin 1994, 27). It illuminates why collective decision-making processes do not lead to more beneficial decisions (Kern/Nida-Rümelin 1994, 27). If there are at least two individuals and at least three alternatives, no mechanism exists that can derive a collective decision from the individual decisions that satisfies all five parties involved Arrow, 1951).

Regarding the legal foundations of FDIs, three regulatory levels must be considered: the international, European, and national one (in this case, Germany). On international level, the manuals of the International Monetary Fund (hereinafter: IMF) and the Organization for Economic Cooperation and Development (hereinafter: OECD) prescribe the basic international framework of FDIs (Bundesbank 2022). One of the main functions of the IMF is to grant loans to countries that lack sufficient currency reserves (Bundesfinanzministerium 2022). The IMF publishes guidelines (Balance of Payments and International Investment Position Manual, hereinafter: BPM6) that must be observed by FDIs (IMF 2007). BPM6 regulates is the standard presentation of FDIs. The IMF stipulates that the concept of "assets and liabilities" is to be applied instead of the equity ratio (European Commission 2022, 5).

A gross presentation of FDI is specified, in which assets and liabilities should be explicated separately. Another source in this regard is the fourth edition of the reference definition of direct investment issued by the OECD (OECD Benchmark Definition of Foreign Direct Investment; hereinafter: BD4), which provides guidelines for elaborating statistics on FDIs (European Commission 2022, 1).

On European level, there are a series of requirements that constitute the legal framework for FDIs such as the EU Regulation 2019/452 of March 19, 2019. Regulation aims to establish a framework for the review of FDIs on European level to protect security and public order (Art. 1(1)) (Rusche 2020, 144). This Regulation equally requires member states to maintain, amend, or establish review mechanisms for FDIs (Art. 3(1)) and mandates that the rules and procedures of these review mechanisms are transparent and non-discriminatory (Art. 3(2)). The review mechanisms aim at determining whether an FDI is likely to jeopardise security or public policy (Art. 4(1)). Member states send annual reports to their national FDI commission (Art. 5(1)) and all FDIs subject to review must be reported (Art. 6 (1)). This European regulation was implemented mainly on the initiative of Germany in order to better regulate foreign takeovers and shareholdings of Chinese investors in Germany but also worldwide (Rusche 2020, 144).

The national legal framework for the examination of FDIs has been significantly tightened (Stompfe 2021), regulated by the Foreign Trade and Payments Ordinance (hereinafter: FTPO) and the Foreign Trade and Payments Act (hereinafter: FTPA). The FTPA regulates certain restrictions affecting the movement of goods, services, capital, payments, and other economic transactions with foreign countries (Section 1 FTPA). Restrictions can be adopted if an FDI threatens the protection of public security or foreign interests (Section 4(1) FTPA). The FDI review structure, provided by the FTPO and the FTPA, stipulates that the Federal Ministry of Economic Affairs has comprehensive review authority with respect to the acquisition of shares in German companies by foreign investors from non-EU countries (Stompfe 2021). The review process is triggered when 10 percent of a German company that belongs to a strategic sector (military, encryption, critical infrastructure) is acquired (Stompfe 2021).

1.2. Research Objectives

Objective of this paper is to perform a comparative analysis of the bilateral investment treaty (BIT) signed between Germany and China in 2005, the previous agreement between the EU and China of 1985, and the Comprehensive Agreement on Investment (hereinafter: CAI) signed between Europe and China in 2020. Research methodology will be described in more detail in the following section. Subsequently, the results of the analysis and comparisons of BITs will be described and assessed. Main findings will be synthesised in the conclusion sections as well as future research recommendations.

2. RESEARCH METHODOLOGY

To fulfil the formulated research objectives, a comparative analysis of a series of different BITs signed between different nations or organisations and at different moments in time, namely the Germany and China BIT in 2005, the previous CAI between the EU and China in 1985 and the CAI signed between Europe and China in 2020 is performed. This comparison is performed using the protection standards described by the German Federal Ministry for Economic Affairs and Climate Action (hereinafter: BMWK) as comparison criteria, namely the protection against expropriation, fair and cheap treatment, full protection and safety, Most-favoured-nation (MFN) treatment of residents, the breach of government commitments, and the transfer of capital and earnings. Once the comparative analysis of the content of the CAIs is performed, the effects of the CAI on FDIs are examined and the 2020 CAI is assessed from the perspective of economic reciprocity.

3. RESULTS

3.1. Content Overview of the 2020 CAI

The EU-China 2020 CAI is assessed as the most ambitious agreement China has ever agreed with a third country (WKO 2022). The agreement ensures China grants EU investors better market access that goes significantly beyond previous Chinese commitments in international trade agreements (WKO 2022). In broad terms, the CAI regulates three aspects:

- Market access;
- Conditions of competition;
- Sustainable development.

China has for the first time agreed to a commitment against forced labour, the ratification of the conventions of the International Labour Organization and the Paris Climate Agreement. The CAI also aimed at eliminating issues hindering competition, i.e., China's non-transparent approval procedures, preferential treatment of state-owned companies, discriminatory subsidies, and market access restrictions in certain sectors (WKO 2022).

Content of the CAI can be divided in six sections. **Section I** defines the objectives and formulates general definitions. Art. 1 defines the objective of the CAI as the “commitment to create a better climate to facilitate and develop trade and investment.” Art. 2 defines the key terms of the agreement, such as economic activities, enterprise, or measures. **Section II** thematises investment liberalisation. Art. 1. defines the scope of application, while Art. 2 stipulates the market access. Art. 3 regulates prohibitions on certain performance requirements, while Art. 4 and 5 prohibit unequal treatment. **Section III** contains the regulatory framework and provisions on licensing requirements, processes, or qualification provisions (Art. 1).

Section IV stipulates the provisions on investments and sustainable development and the obligation to comply with international standards (Art. 1). In addition to minimum labour standards, the commitment to corporate social responsibility is equally included (Art. 2). This section also ensures the sovereignty of both contracting parties regarding certain aspects of the agreement. **Section V** contains more detailed provisions on dispute resolution (Art. 3 and 5). The parties can

agree to a voluntary mediation at any time (Art. 4). If this is not expedient, an arbitration tribunal may be called upon (Art. 6). Decisions are based on the provisions of the CAI and the rules of public international law according to the Vienna Convention on the Law of Treaties (Art. 11). **Section VI** regulates in sub-section 1 the creation of an Investment Committee (Art. 1). It is prescribed that the committee meets once a year for reviewing various aspects of the CAI and the adequate compliance with all provisions (sub-section 1, Art. 3).

3.2. Comparison of the previous BITs and the EU-China Investment Agreement (2020)

The investment agreement between Europe and China will be compared with two prior BITs: The investment protection treaty between Germany and China, which came into force on November 11, 2005 (BMWK 2022) and the trade and economic cooperation agreement between the EU and China, which dates back to 1985 (WKO 2022). This BIT forms the basis of trade relations between the EU and the Asian nation. For performing the comparative analysis, the protection standards formulated by the BMWK (BMWK 2022) are used as comparison criteria:

Table 5. Comparison of various agreements

BITs:	Germany-China (2005)	EU-China (1985)	EU-China (2020)
Protection against expropriation	Article 4	no	Indirectly in Section V & Art. 16
Fair treatment	Article 3	Indirectly in Article 8	Indirectly in Section IV, sub-section 4 & Art. 6
Full protection and safety	Article 4	Indirectly in Article 12	Not wide-ranging in the sense of full protection and security (BMWK 2022a); not related to capital; indirectly in: Section III, Art. 2; Section IV, Art. 2; Section IV, Art. 2; Section VI, Art. 3.
MFN	Article 4	Article 3	Section II, Art. 5
National treatment	Article 2 & Article 5	Indirectly in Article 1	Section II, Art. 3bis; Section II, Art. 3ter; Section IV, sub-section 2, Art. 2, Section IV, sub-section 3, Art. 2, Section VI, Art. 4; Section VI, Art. 7; Section VI, Art. 9
Protection against the breach of government commitments	Indirectly in Art. 8 & 9 (Dispute resolution)	Indirectly in Article 15	Section V
Transfer of capital and income	Article 4 & 6	Indirectly in Article 12	Section II, Art. 3; Section II, Art. 6bis; Section VI, Art. 5; Section VI, Art. 6.

The comparative analysis of the three agreements elucidates that only the BIT between Germany and China contains all relevant provisions. The first agreement between China and the EU of 1985 contains hardly any regulations and, in the best case, merely hints at them. The agreement refers to trade between both parties but does not refer to investments. Only Article 12 alludes to the necessity of intensifying efforts regarding FDIs.

The regulations of the 2020 CAI between EU and China are more far-reaching. Nonetheless, many of them only indirectly relate to the BITs' protection areas. The MFN clause (with exceptions), national treatment, dispute settlement, and the transfer of capital and income are comprehensively regulated. In contrast, protection against expropriation, fair and equitable treatment and full protection, or full security are only vaguely regulated. This hesitant tone is especially recognisable compared to the BIT between Germany and China.

3.3. Effects of the CAI on Foreign Direct Investments

The influence of the CAI on reciprocal FDIs must be assessed considering that China is not a country open to foreign investments (Mildner/Schmucker 2021, 88). Hence, a relevant accomplishment of the 2020 CAI is gaining market access for FDIs, abolishing thus the existing restrictions and limits (Mildner/Schmucker 2021, 88). Concessions regarding investments are made for specific sectors, some of which are still subject to restrictions though. This is in line with China's policy of only making concessions for certain sectors (Mildner/Schmucker 2021, 88).

When evaluating the CAI against the background of the EU's expectation of opening up the Chinese market to investments through this agreement, the progress made can be assessed as rather marginal. The EU explained that this CAI would constitute a sort of disciplinary framework for Chinese state-owned enterprises (Hamilton 2022, 67). While this can be agreed with in principle, in practice this is not sufficient to facilitate European FDIs in China. Nevertheless, the CAI can be seen as a "new generation investment agreement" with regard to FDIs (Chen 2022, 11). It contains high minimum standards for the liberalisation of investments, creates a regulatory framework, and focuses on sustainable development (Chen 2022, 11). In this sense, the CAI provides marginal but measurable improvements for investments and market access (Chen 2022, 11). In addition, the CAI fills a previous gap in the investment relationship between the EU and China as it contains legally binding provisions (Wuttke 2022, 22).

3.4. Assessment of the CAI from the perspective of Economic Reciprocity

Initially, the CAI was fiercely criticised as it was considered too China-friendly (Mildner/Schmucker 2021, 87). However, this criticism must be seen in the context of the EU's objective of strengthening its own geopolitical position, for which China is a paramount market (Mildner/Schmucker 2021, 87). Accordingly, the assessment of the CAI must be made considering that China is a closed market economy and, consequently, following the credo "better than nothing" (Mildner/Schmucker 2021, 87). The CAI does not create an open investment climate nor does it gain new market access opportunities for European companies. However, it ensured a relevant objective, namely the establishment of fair competitive conditions (Mildner/Schmucker 2021, 88).

Essential points of foreign trade reciprocity are addressed and accomplished with the concessions on equal treatment of nationals and MFN treatment. However, there are no clauses protecting against expropriation without compensation or unfair treatment (Mildner/Schmucker 2021, 89). Since both of these exist on the EU market even without this CAI, but not on the Chinese market, an imbalance remains here. Important concessions made by China are the commitments to comply with environmental and labour standards (Mildner/Schmucker 2021, 89 f.; BDI 2021). Equally relevant is China's commitment to provide access to Chinese standard setting bodies for

European companies (BDI 2021). However, these concessions do not compensate the fundamental problem. This CAI does not resolve the structural imbalance when it comes to market access. The Chinese authorities still have numerous possibilities to intervene and block access, whereas the EU assures China an open market for an indefinite period of time (BDI 2021).

CONCLUSIONS

Summary of Findings

Put succinctly, the performed comparative analysis reveals that the BIT between Germany and China is the only agreement containing all relevant provisions. The EU-China CAI achieves marginal improvement for investments and market access compared to previous agreements but falls short for facilitating FDIs in China. It was accomplished, though, that China agreed to make relevant concessions such as complying with environmental and labour standards (Mildner/Schmucker 2021, 89 f.; BDI 2021). However, these concessions do not compensate the fundamental issue of the structural imbalance in market access.

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ПОСТИГАНЕ НА САІ МЕЖДУ ЕС И КИТАЙ ПРЕЗ 2020 Г.

Резюме: Проучването има за цел да сравни САІ (Цялостно споразумение за инвестиции) между ЕС и Китай през 2020 г. с неговия предшественик – двустранния ВІТ (Двустранен договор за инвестиции) между ЕС и Китай от 1985 г., и ВІТ между Германия и Китай от 2005 г., за да се оцени въздействието на САІ върху ПЧИ и икономическата реципрочност. За да се изпълни тази цел, е извършен сравнителен анализ на трите споменати договора, като са използвани стандартите за защита на ВМВК (Федералното министерство на икономиката и климатичните действия) като критерии за сравнение. Новият изследователски аспект на тази методологична процедура е нейната оценка на СИП от 2020 г. въз основа на сравнение с предходни договори, за да се оцени обхвата и значението на постигнатото споразумение. Резултатите от сравнителния анализ показват, че Споразумението за партньорство от 2020 г. подобрява незначително рамката за инвестиции и достъп до пазара между ЕС и Китай. Въпреки това той е недостатъчен за улесняване на ПЧИ на дружествата от ЕС в Китай. Китай се съгласи да направи съответните отстъпки по отношение на екологичните и трудовите стандарти, но те не компенсират продължаващия структурен дисбаланс по отношение на достъпа до пазара между двете страни.

Ключови думи: САІ, чуждестранни инвестиции, Китай, ЕС, двустранно договорно споразумение

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