CORRUPTION PREVENTION BASED ON THE PRINCIPAL-AGENT APPROACH AND GAME THEORY USING ICT: THE CASE STUDY OF KAZAKHSTAN

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Abstract. *Corruption is one of the most dangerous phenomena in many developing countries, including Kazakhstan. The negative effect of corruption can be felt directly or indirectly by all residents, largely due to the negative impact on the country's economy. The principal-agent model, where one party supplies a bribe and the other party accepts it, can be applied to almost all corruption offenses. At the same time, the interests of both parties are taken into account and can be calculated numerically when using this model. In the modern world, indicators within this model can be influenced by specific tools that reduce the risk of a corruption case, including cases when information and communication technology (ICT) is used. ICT, by the power of its capacity to control, trace, report, examine, and distribute enormous quantities of information, may encourage nations to identify and detain criminals, and prevent ultimate fraud.*

Santrauka

Korupcija yra vienas pavojingiausių reiškinių daugelyje besivystančių šalių, įskaitant Kazachstaną. Neigiamą korupcijos poveikį tiesiogiai ar netiesiogiai gali pajusti visi gyventojai, daugiausia dėl neigiamo poveikio šalies ekonomikai. Agentas-pagrindinis modelis gali būti taikomas beveik visiems korupciniams nusikaltimams, kai viena šalis duoda kyšį, o kita ima. Taikant šį modelį kartu atsižvelgiama į abiejų šalių interesus – juos galima apskaičiuoti, įvertinti skaičiais. Šiuolaikiniame pasaulyje modelio rodikliams įtakos gali turėti specialios priemonės, mažinančios korupcijos atvejo riziką, įskaitant atvejus, kai naudojamos informacinės ir ryšių technologijos (IRT). IRT, galėdamos kontroliuoti, atsekti, pranešti, nagrinėti ir platinti milžinišką informacijos kiekį, gali paskatinti valstybes atskirti nusikaltėlius nuo visuomenės ir užkirsti kelią sukčiavimui.

Introduction

The theory of the principal and the agent is an economic theory of participant interest, in which the agent and the principal pursue their goals in the management of firms and companies. The more employees the company has and the faster it grows, the more complex and difficult management matters become. Thus, the amount of information contained within the company grows and the transparency of business processes decreases. The principal-agent theory was proposed for use in the anti-corruption system by several authors (Rose-Ackerman 1978; Klitgaard 1988); however, their works rely on older technologies. Some ideas have to be changed in accordance with the era of digitalization.

Cleary and Stokes (2006) show in their research that low levels of citizens' confidence in their government are often dependent on and conducive to corruption; in this case, citizens tend to be clients who are willing to pay for protection. They were also able to prove that citizens with such qualities prevailed in corrupt bodies. In addition, Guerrero and del Castillo, using focus groups in Mexico City, were able to show that the risk of citizens being found and punished for bribery is reduced in bodies where corruption occurs (Guerrero and del Castillo 2003, 2).

Other sources describe corruption as a tool that undermines the political confidence of citizens. For example, Miller and Listhauga (1999) describe the correlation between a decrease in political trust and an increase in the level of corruption in a country, noting that it depends on weak institutional functioning. From the work of Pharr (2000), it can be seen that unethical employee behavior in any industry may be more indicative of low political trust than other results.

The concepts of all of these studies share a common view, although they do not refer to digital mechanisms. This article's purpose, then, is to highlight the case of ICT implementation in relation to corruption, and to investigate whether it is effective.

1. Literature review and hypothesis development

The theory of the principal and agent arose at the end of the 1970s through the integration of economics and institutional theory, which extended to the study of corruption. An example of this is provided by the work of Rose-Ackerman (1978). As a result of an efficient analysis of the impact of date on the effects of corruption on economic growth, it was concluded that all 39 theoretical studies included in the review either adhered to and clearly declared this approach to fraud, or their consideration was closely related to this approach (Ugur and Dasgupta 2011).

Governments see incidences of corruption as losses of budget where agents have the power and opportunity to abuse principals, and as a result seclude benefits at the cost of public matters.

To generate a more precise description of the application of the principal-agent theory in political policy, it should be mentioned that the roles might change according to different circumstances. In the case of political fraud, taxpayers may have acted as principals whereas lawmakers may play an agent role (Besley 2007). However, if we take the petty bribery case, then lawmakers may become more sensitive to crime while officials may play a negative role (Blackburn, Bose, and Haque 2010). This theory includes information imbalance, where the actions and intensity of one side can be shaded from another participant. Therefore, the agent has the power to serve their own interests. Corruption, therefore, appears as a sort of ethical jeopardy when the benefits of the parties do not match and the abusive party pursues their interests to damage the principal's affair.

The method of the principal and the agent is constructed on the hypothesis of a conscious option that the agent selects to engage in crime, particularly if the pure advantages exceed the pure values or the policy of containment, as Nobel Prize winning supply-side theorist Gary Becker (1968) observed. When determining involvement in fraud, a responsible agent examines the gains of corruption, such as the volume of a bribe, against costs that are essentially based on the chance of being arrested and imprisoned. Klitgaard (1988) noted that this cost-benefit estimation should likewise consider the moralistic sense of crime, which depends on one's own moral, social, and sacred measures and may equal nothing for an "immoral personality in a low subculture."

Therefore, Klitgaard (1988) proposed that a reasonable agent would commit bribery exclusively when corruption is considered attractive for them if the value of the bribe would be grand enough to meet all ethical and tangible values, and would also be efficient in a state of arrest and the adjustment of a fine. This number should be more distinguished than the individual's salary and ethical goods.

A primary result of this formula is, or at least should be, that in the meaning of institutional crime, motivations for controls to disclose and defeat fraud are low, so this dilemma may therefore be inexplicable if we address it at this level. Governmental inter-

ventions dependent on the principal-agent design remain, and relate to the field of the administration of private losses. These interventions include: efforts to raise the value of the bribe for agents, principally by increasing checking tools by principals; escalating penalties; and raising public intolerance. However, currently, state outcomes resulting in the principal-agent approach have radically formed global anti-corruption rules (Marquette and Peiffer 2015).

2. ICT as a corruption perception instrument

The primary function of using ICT in public sectors is the need to modernize the work of various services by increasing the efficiency and quality of the services delivered. The introduction of modern technology also increases the transparency of operations within the state, which in turn helps in the fight against corruption. There are many cases where the introduction of technology has improved anti-corruption mechanisms (Dupuy and Serrat 2014) and prevented corruption by significantly reducing incentives for it. All ICT tools and technologies that are used to fight corruption can be classified into two broad categories:

1. The automation of all types of transactions involving the government. The main idea here involves the usage of ICT tools in order to minimize the level of corruption with the participation of the state. These tools are supposed to automate processes and services, transfer traditional services online, encourage online reporting, and generate the ability to provide information, including complaints, online both from citizens and legal organizations. In other words, with the processes carried out online with the state, as well as with the analysis of the most vulnerable places and the automation of these places, the risk of corruption can be significantly reduced.

2. Analyzing the available historical information regarding transactions with government participation, and searching for suspicious information within them. The basic idea here is to use the data for analysis to identify the most at-risk areas and to analyze these areas in detail. Data science and machine learning tools can be used to find such suspicious transactions. In particular, when using machine learning algorithms, the search for suspicious transactions can be carried out by finding similar transactions in the past, i.e., forming a certain typology naturally, or using clustering methods, separating such transactions from the rest.

These ICT approaches and tools are mostly associated with improvements to clarity. The scope and goals of state ICT actions are remarkably wide and various. Moreover, they have been performed in various areas that have classically been exposed to fraud. Taxes and state obligations are fields in which e-Government is observed as a free and flourishing obstacle to fraud in most nations (Bertot et al. 2010).

3. The research model

Taking into consideration the basic principal-agent model and the fast-growing trends in technology, which were mentioned above, we can build a model of corruption as follows:

$$\text{Corruption (t)} = \text{Moral Cost} + \text{Probability of Detection} \times \text{Penalty}$$
$$\text{Corruption (t)} > \text{Salary} + \text{Moral Benefit}$$

At the same time, the monetary amount of a bribe should not exceed the sum of salary and the economic benefit of being ethical.

In this model, ICT, as a tool in the right direction, is used as a trigger to prevent corruption. This allows for incentives for corruption to be significantly reduced. For example, if we use this tool to increase the probability of detection (for example, by analyzing all historical data using data-driven solutions) or to tighten the penalty for corruption, then it will be very difficult to profit from corruption accordingly.

Therefore, the inclusion of the technological factor in the principal-agent model is advisable. In this case, we face the question of which indicators within the presented model can be affected by this factor. As we explained earlier, this study will not consider the moral benefits and costs associated with the accompanying body of information regarding the impact of technology on the ethical dimension; this issue requires a separate and detailed analysis.

4. The case study to approve the model

This case study concerns the Kazakhstani educational sector, where the upper management of a university were alleged to have stolen government money using a very simple scheme. The Kazakhstani government transferred over $23.7 million to the International University of Information Technologies (hereinafter the University) in the period of 2013–2018 (Alhabayev 2020) and, according to the accusation, the university administration artificially inflated the number of students who should receive a scholarship every year. As a result, 1.727 billion tenge, or slightly over $4 million, was stolen in total. The media reported that the stolen money was spent on apartments and expensive cars. Along with administrative staff, charges were brought against the University's former chief accountant under the article "Misappropriation or embezzlement of other people's entrusted property on a huge scale." According to the accused's plan, the head of the University's role was to sign deliberately false information about the scholarship fund's annual requirements, providing an overestimated number of students. This action was considered concealment of facts via the signing of fictitious agreements.

According to the results of the court, the defendants were found guilty of using their official position for the embezzlement of property on a vast scale by prior conspiracy (Mauletbay 2020).

The main document governing the procedure for granting scholarships in Kazakhstan is the Resolution of the Government of the Republic of Kazakhstan dated February

7, 2008, No. 116 "On Approval of the Rules for the Appointment, Payment and Size of State Scholarships to Students in Educational Institutions" (hereinafter the Resolution, the Rules). According to these Rules, in Kazakhstan, all students and interns who have received a state grant based on good grades (in this case, over 70%) receive a state scholarship for the first academic semester and beyond. The continuation of this grant for the next academic period depends on the learning outcomes at the end of the previous academic period. In other words, students specified in this Resolution receive a scholarship only if they have reached the required minimum following the results of the examination session, except in some instances for health reasons and other circumstances specified in the Resolution.

Consider those who do not receive scholarships: in general, these students do not reach the required threshold and, accordingly, the loss of scholarships is natural for them. Each higher education institution is to prepare an application to the authorized body at the end of the first academic period of study with a list of those students who should receive a scholarship. According to the Rules, all students who are admitted to the state grant receive a scholarship. Further, at the beginning of the second period, the list of students is reduced in size, considering the results of examination sessions. Universities prepare a budget application to the Ministry of Finance of the Republic of Kazakhstan. If we compose a business process for this action, we create the structure shown in Figure 1.

There are some opportunities for corruption within this process. First is the absence of normative legal documents regulating this process; at this stage, there are two laws and regulations that partially handle obtaining a scholarship. Second, a basis for verifying the submitted lists of students receiving scholarships is absent; in this case, we are talking about applying to the authorized body for finance, plans for which can include over 1,000 people. The process of employees of a state institution checking the data for each student is laborious, given the fact that more than 116 higher educational institutions are registered in Kazakhstan (Government Services and Information Online, n.d.). Third, the lack of cross-validation also creates an opportunity for corruption, as the General Prosecutor's Office of the Republic of Kazakhstan inspects the activities of universities only once every five years.
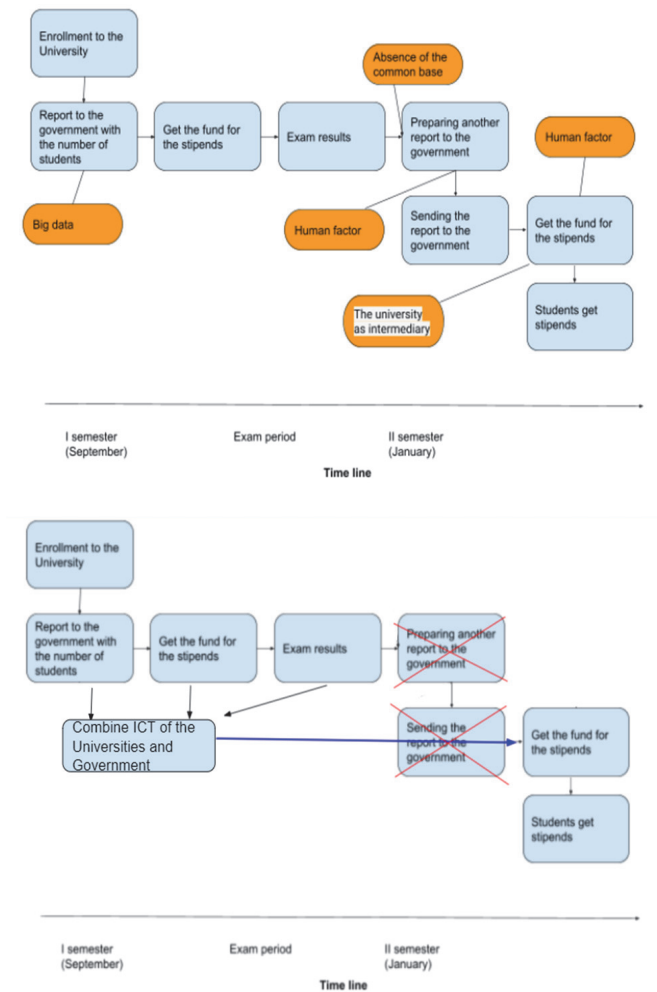
Figure 1. **The business process of the grant system in universities in Kazakhstan before (left) and after the implementation of ICT (right).**

Source: compiled by authors.

For this business process, the resources allocated for scholarships for students are sent through the educational institution. In this case, universities act as an intermediary between the state organization authorized for funding and the students, and there is a risk of corruption as the state is obliged to receive a large amount of information and cannot verify the information transmitted.

This case study indicates both the current model and the possibility of introducing new tools or technologies into regulating the scholarship fund in the education field. At the moment, there is only one digital tool that has been introduced in the Kazakhstani education system to ensure transparency and, as a result, improve the quality of education. This tool is called the National Educational Database (NED), and it cannot prevent the previously discussed risks of corruption.

The NED system is designed to form a static database that provides and submits information regarding educational institutions to the Ministry of Education and Science of Kazakhstan. The NED is used to collect and process information regarding the state of the industry, consider the dynamics of the development of the industry, automate and optimize the collection and processing of regulatory reporting, collect and store of data, and fulfil a number of other roles.

This system is part of a large project to analyze big data in the country's education system, and has several advantages:

- It ensures students' registration, since each organization is obliged to fill out a passport which contains information about the student.
- It eliminates the possibility of duplication when providing information. While working with databases, we cannot exclude the human factor. When filling out the necessary reports and providing information, there is a high probability that an employee will make a mistake and provide duplicate information that hangs in the system. In the case of the transfer of a student from one higher educational institution to another, information about them is also entered into the NED database – in this case, duplication of the same student in two organizations is possible. This problem is quickly analyzed and eliminated by the NED.

However, the expansion of the NED's capabilities is still relevant today.

5. Applying the model to a case study

This case study demonstrates that many factors work in favor of the commission of a corruption offense. That is, if we eliminate the moral component and all else remains equal, we can observe that the probability of being caught in this case tends to zero for the following reasons:

- Checking processes are carried out very rarely (checking from the General Prosecutor's Office of the Republic of Kazakhstan is carried out once every 5 years).
- There is a considerable volume of information submitted, in which it is difficult to keep track of corruption.
- The human factor is present; in this case, we assume that a vast amount of the information sent to government agencies may not be verified.
- There is no connection between the databases of educational institutions and the authorized body in education.
- There is an absence of cross-validation between databases.

We can look at this case study through the lens of game theory. The main players in this case are the agent – the head of the University – and the principal – in this case

the employees of the Ministry of Education and Science of the Republic of Kazakhstan. However, it should be taken into account that the principal in our case does not give or receive a bribe – they are not an interested party. What is their benefit? Due to the fact that employees of state institutions have to check the information provided by universities, the advantage here is not having to check a large amount of information, thereby preserving their perceived strength in their role and enabling them to continue receiving their salary.

It is profitable for an agent to commit corruption since their profit increases several times – in this case by $4 million if they are not caught, and by a little less if corruption is revealed, which in any case more than covers all costs.

Table 1 demonstrates the alignment of the game:

- If the agent decides to commit corruption and is caught, then their profit will be less than $4 million, but not 0, so they will still benefit. However, the principal checks the agent's work and spends a lot of time and effort on it. Even if the principal caught the corrupt official, it would not bring them additional bonuses or rewards that are sufficiently commensurate with the action of catching the agent. We can assume that the principal will spend a lot of time and effort checking the information provided by many agents who are not corrupt. The principal does not receive extra benefits for doing their job. Therefore, we will assume that it is of no benefit to conduct an inspection even if dishonest workers are revealed.
- If the agent does not commit a crime and the principal continuously checks the agent's information then, according to game theory, the principal is disadvantaged.
- If the agent does not commit a crime and the principal does not verify this, then neither party benefits, and both parties' costs are 0.
- Both players benefit when the agent commits a crime and the principal does not check.

Based on the game results, we can see that the Nash equilibrium occurs in the fourth variant of events. This case applies to many areas, and the result may be the same in many cases; thus, we can observe the probable cause of corruption crimes.

Table 1. **An analysis of the case study through the prism of game theory**

	The agent commits a crime	**The agent doesn't commit a crime**
The Principal verifies	(1, 0)	(0, −1)
The Principal doesn't verify	(1, 1)	(0, 1)

Source: compiled by authors.

Based on Table 1, we can observe that the agent is better off committing corruption than not doing so.

We will now consider another, alternative option, in which we introduce the ICT factor by connecting the databases of the agent and the principal, thereby increasing the likelihood of being caught. Checks are carried out automatically and, via the use of

artificial intelligence, human resources in this matter are minimized. We can also use the principal's additional reward for identifying corruption to enhance their incentive. However, even if we do not use rewards, the principal will still receive emotional or moral benefits for catching a criminal.

Table 2. **An analysis of an alternative to the case study through the prism of game theory**

	The Agent (commit crime)	**The Agent** (doesn't commit crime)
The Principal (checks)	(0, 1)	(1, 1)
The Principal (doesn't check)	(0, −1)	(1, −1)

Source: compiled by authors.

This innovation radically changes the situation when, as shown in Table 2, the benefits of the principal change. Taking into account encouragement, we can be sure of the principal's desire to identify corruption.

Here we see that both players win if the principal checks and the agent does not commit a crime. When additional barriers are introduced in the form of harsher punishments, then the agent's incentives to commit corruption disappear, since the costs, in this case, exceed the benefits of corruption.

6. Conclusion

Digitalization is an integral part of a rapidly developing world, without which society would function at a slower pace. Almost every organization – public, private, or otherwise – is associated with computerization and automation. New technologies are closely intertwined both with the work and social lives of citizens. Therefore, considering corruption, we cannot ignore this fact and are obliged to transform the established laws, rules, and models according to it.

Based on the results of the analysis of a case study, we can see that the correct implementation of ICT in anti-corruption measures benefits society by radically changing the incentives of the players according to the principal-agent model.

Therefore, this study shows the effects of ICT on the likelihood of being caught and the applicable penalties for committing corruption. The question of the economic benefits of introducing ICT into anti-corruption mechanisms is also important. According to this model, it can be seen that an increase in ICT in terms of probability of detection weakens the impact of corruption. This model can be considered in terms of a real case study, where the processes of how students receive allowances in Kazakhstani higher educational institutions was demonstrated.

7. Recommendations and suggestions

According to the analysis and the model provided, we can formulate several recommendations for Kazakhstan's anti-corruption policy. As we know, the principal-agent

model operates based on incentives and punishments. Therefore, it is necessary to tighten the punishment factors and increase the effectiveness of the incentive factors. Thus we can see that, legally, corruption crimes should be punished fully. The following measures would be useful in this regard:

- Increase punishment under the RK Criminal Code;
- Introduce incentives for assistance in catching corrupt officials;
- Increase the reward for assistance;
- Implement crosschecks (double checks) using new technologies;
- Conduct crosschecks, for which the NED must be linked to government databases;
- Improve the NED, and implement AI elements within it.

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Korupcijos prevencija, pagrįsta agento-pagrindinio vykdytojo metodu ir žaidimų teorija naudojant IRT: Kazachstano atvejo analizė

Anotacija

Šiame straipsnyje bandoma moderuoti agento-pagrindinio vykdytojo teoriją pagal Rose-Akkerman modelį, siekiama jį realizuoti šiuolaikinėmis sąlygomis. Siekiant pagrįsti modelio aktualumą, pasitelktas realus atvejis, susijęs su studentų pašalpomis Kazachstano universitetuose. Byloje parodomi tiek vykdytojo, tiek užsakovo interesai, papildomai atsižvelgiama į žaidimų teoriją siekiant išsiaiškinti, ar naudinga kiekvienai pusei duoti kyšį ir kokius veiksnius galima keisti, kad ši rizika būtų kuo mažesnė. Tyrimu atskleidžiama, kaip IRT (informacinių ryšių technologijų) priemonių taikymas veikia sukčiavimą ir kaip daugėja su šiuo nusikaltimu susijusių bausmių. Pateikiami pasiūlymai ir išvados yra diskusinio pobūdžio.

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